Chapter 10
How Science Teacher Educators of Color Conceptualize and Operationalize Their Pedagogy in Science Methods Courses

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Introduction

This study explored how we, four science teacher educators of color, conceptualized and operationalized our pedagogy in elementary science methods courses. Conceptualization and operationalization in this study refers to the methodological tactics (Matias, 2013) we constructed in response to the particularities impacting our substantial selves and situational selves within the context of our teaching spaces. Particularities refers to the challenges, tensions, and problems impacting our substantial selves and situational selves within authentic settings during the process of educating our teacher candidates in the science methods course. In this study, we perceive methodological tactics as the modifications/transformations made to syllabi, course requirements, lesson plans, instructional strategies, skills and actions, and resulting classroom activities to circumvent and/or counter the challenges, tensions, and problems implicitly and/or explicitly created by teacher candidates. Substantial selves refers to the action of teaching (knowledge-in-practice) (Goodwin et al., 2014), learning about teaching (knowledge-for-practice), and researching about teaching (knowledge-of-practice) (Goodwin et al., 2014; Loughran, 2014) that essentializes us as science teacher educators while situational selves refers to ourselves as science teacher educators of color instructing teacher candidates on how to teach science within the authentic setting of a K-6 teacher education program. The research question that undergird this study was: "How do we as science teacher educators of color conceptualize and operationalize our pedagogy in elementary science methods courses?"

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A review of the literature on teacher educators reveals that there is a trend towards investigating the pedagogy of teacher education especially in light of teacher educators playing an important role in the preparation of high-quality teachers (Berry & Van Driel, 2013; Goodwin et al., 2014; Loughran, 2014). So far, studies within this research context have examined how teacher educators perceive teacher education within their institutions (Mevorach & Ezer, 2010; Murray, 2005; Murray & Male, 2005); how teacher educators perceive their preparation as teacher educators; how teacher educators' expertise, and their experiences as teacher educators informs their practice and their profession (Goodwin et al., 2014; Hinchman & Lalik, 2000; Johnston & Settlage, 2008; Loughran, 2014; Williams, 2014), how teacher educators' roles and identities impact the quality of teacher education (Genor & Schulte, 2002; Livingston, 2014); and how teacher educators' backgrounds in terms of demographics informs and impacts their practice (Atwater, Butler, Freeman, & Parsons, 2013; Cochran-Smith, 2003; Goodwin, 2004). Collectively, these studies are contributing to the limited knowledge base on what teacher educators know, "how they act and why" (Berry & Van Driel, 2013, p. 118).

In a similar fashion, scholars within the science teacher education research context are also investigating science teacher educators' expertise in instructing teacher candidates on how to teach science. For example, Berry and Van Driel (2013) investigated and articulated the specific expertise of 12 experienced science teacher educators, while Atwater et al. (2013) examined the constructed meanings of Black science teacher educators about their pedagogy for science teacher education that took into account their expertise with multicultural science education, equity, and social justice. Inclusive to this genre of studies is the recent call to investigate science teacher educators' expertise and experience in relation to Next Generation Science Standards (Lederman & Lederman, 2013).

Lacking within the aforementioned (limited) studies are the complex demands of the process of teacher education especially when teacher educators are faced with challenges impacting their substantial selves and situational selves within authentic settings. Above all, studies, frameworks, and perspectives fail to tap into the "rich mosaic of knowledge related to teacher educators themselves" (Martinez, 2008, p. 36) and ignore their lived experiences as teacher educators instructing teacher candidates. Moreover, most of the empirical studies and/or theorizing have proposed frameworks, and perspectives in relation to transitional spaces (teacher to teacher educator, doctoral student to teacher educator, teacher educator to teacher educator researcher) encountered by teacher educators. Additionally, these studies empirically investigated transitional spaces through surveys and follow-up interviews (Goodwin et al., 2014); interviews (Goodwin, 2004; Williams, 2014), retrospective interviews and essays (Vescio, Bondy, & Poekert, 2009), interviews and artifacts (Hinchman & Lalik, 2000), questionnaires (Mevorach & Ezer, 2010), metaphors (Mevorach & Ezer, 2010; Williams, 2014), and interviews, drawings and storylines (Berry & Van Driel, 2013). This is despite the calls for the use of self-study methodology to study practitioner research. For instance, Loughran (2014) claims that:

> There has been a growing momentum in practitioner research as methodologies such as self-study have created new ways for practice to be better understood, more highly refined, and increasingly more cogently codified. Self-study of teacher education practices (S-STEP) has proved attractive to many teacher educators because it places teaching and learning about teaching at the center of the research endeavor (p. 278).

In essence, the developing knowledge base for a pedagogy of teacher education and/or a pedagogy of science teacher education has made limited inroads into the pedagogic expertise developed in authentic settings: the knowledge "situated and constructed in response to particularities" (Cochran-Smith & Lytle, 1999, p. 262) within the "context of teachers' and teacher educators' teaching spaces" (Goodwin et al., 2014, p. 286).

Most importantly, the experiences of teacher educators of color has received minimal attention within this research context. Whatever limited studies there are seem to be concerned with teacher educators of color and their experiences with imparting and/or being experts in multicultural issues (Atwater et al., 2013; Goodwin, 2004; Vescio et al., 2009) or culturally responsive teaching (Goodwin, 2004) rather than how they conceptualize and operationalize their pedagogy for educating teacher candidates. Additionally, the research on teacher educators, so far, has neglected the "demographic imperative" (Cochran-Smith, 2004, p. 4) that demands a need for social justice and equity in education by being considerate to and inclusive for all actors involved in the education of teachers and students. Based on this standpoint, teacher educators of color and how they instruct teacher candidates need to be focused on and be studied especially in light of their teaching spaces being dominated by White female, middle class, and English speaking 18- to 22- year olds lacking "cultural frames of reference" for the *Other* (Cochran-Smith, 2004, p. 4).

Significance

The significance of this study was twofold: First, the study aimed to highlight the insights of practicing science teacher educators of color, especially the methodological tactics used in relation to their preparation of a predominantly White female, middle class, and English speaking elementary school teacher candidates. This is significant because the current literature landscape on science teacher educators of color and their work of educating predominantly White female, middle class, and English speaking teaching force has been relegated to knowledge of their demographic backgrounds, and their capacities as multicultural and social justice role models. Second, the study aimed to provide a counterstory in response to the science teacher education literature, and teacher education literature about knowledge-based approaches to preparing a predominantly White female, middle class, and English speaking teaching workforce which is still being empirically studied from the standpoints of the mainstream White teacher educator.

This study is unique because it sought to contribute to the developing knowledge for a pedagogy of teacher education and specifically for a pedagogy of science teacher education from a standpoint of ourselves as teacher educators of color engaging in inquiry about how we conceptualize and operationalize our teaching space when educating teacher candidates. The resulting complex constructions of how teacher educators conceptualize and operationalize their teaching spaces can provide insights into the ongoing processes of changes in identities experienced by teacher educators in response to the personal, contextual, pedagogical, sociological, and social domains within the process of teacher education (Goodwin & Kosnik, 2013). Moreover, teacher educators of color inquiring into their own processes of teacher education can provide insights into how they construct teaching and learning actions in teacher education programs (Atwater et al., 2013).

Next, the discussion shifts to the review of the limited literature from both the teacher education literature and the science teacher education literature that currently attempt to construct plausible explanations about teacher educators and the process of educating teacher candidates.

Review of Literature

Although studies from both general teacher education, and science teacher education are limited, the similarity between the two research contexts lies within the aim of developing frameworks for a pedagogy of teacher education, or in the case of science teacher education, a pedagogy of science teacher education. Goodwin et al. (2014), borrowing from Cochran-Smith and Lytle's (1999) review of the research on the relationships of knowledge and practice, provide a tripartite approach to a pedagogy of teacher education: the knowledge-in-practice (action of teaching), knowledge-for-practice (learning about teaching), and knowledge-of-practice (researching about teaching) (Table 10.1). Basically, this tripartite framework for a pedagogy of teacher education focuses on providing explanations for the

Table 10.1 Tripartite knowledge structure for pedagogy of teacher education

Knowledge-for-practice	Knowledge-in-practice	Knowledge-of-practice
Externally generated	Internally generated	Composite of externally and internally generated knowledge
Formal knowledge acquired during	Situated knowledge acquired from	Knowledge acquired through
Doctoral program	On the job experience and reflection	Participation in K-12 teacher education empirical research
Formal study to teach K-12 science methods	On the job experimentation and practice	
	Observations of peers/colleagues/mentors who teach K-12 science methods	
	Emulating peers/colleagues/mentors who teach K-6 science methods	

Table 10.2 Tripartite knowledge structure for pedagogy of science teacher education

Knowledge-for-practice	Knowledge-in-practice	Knowledge-of-practice
Externally generated	Internally generated	Composite of externally and internally generated knowledge
Formal knowledge acquired to	Situated knowledge acquired from	Knowledge acquired through
Promote the development of teacher candidates as future science teachers	Reflection and analysis of one's own science teaching/ science teacher education practice	The study and dissemination of empirical research that contributes to the field of science teacher education
Model current and accepted science teaching strategies	Designing and engaging in experiences that promote meaningful and appropriate learning for all participants in the learning to teach science process	
Develop an understanding of the nature of science and its relevance to science teaching/learning		

professional identities, roles, and understandings that teacher educators need to acknowledge, exhibit, and practice within transitional spaces (Margolin, 2011) they encounter. Transitional spaces include doctoral programs, college/university-based teacher education programs, and teacher education research contexts.

Berry and Van Driel (2013), adapting Loughran's (2006) framework for a pedagogy of teacher education, provide a version of a pedagogy of science teacher education. The constructs that make up this a pedagogy of science teacher education are presented in Table 10.2 and have been assimilated into the tripartite approach to a pedagogy of teacher education to create a tripartite approach to a pedagogy of science teacher education.

Counter to the aforementioned pedagogies of teacher education and science teacher education, some scholars have proposed other pedagogies for the process of teacher educating. Goodwin et al. (2014) describe the pedagogy of survival tactics that is opposite to the accepted knowledge-in-practice in the tripartite approach to a pedagogy of teacher education as put forth by Cochran-Smith and Lytle (1999) and their own adaptation of the tripartite approach. Goodwin et al. (2014) contend that the pedagogy of survival tactics is the knowledge-for-practice that are basically the teacher educators' "understandings acquired through experience and on the job whether through own experimentation and practice or by observing and emulating peers/colleagues/mentors to teach K-6 science methods" (p. 296). Additionally, they claim that the pedagogy of survival tactics has similarities to the methodological strategies of K-12 novice teachers as both are constructed without theoretical underpinnings and are born out of the necessity to keep one's job intact and/or sustain one's daily perfunctory approach to instruction.

Matias (2013) provides the label "pedagogy of trauma", derived from her own experiences as a teacher educator of color that is basically a pedagogy to overcome and endure the racial microaggressions inflicted on her by both the teacher educa-

tion institution and by her White teacher candidates. She characterizes this pedagogy of trauma as "a survival mechanism" (p. 54) which functions as a methodological tactic, a version of knowledge-in-practice that counters the persistent cognitive resistant reactions and self-affirmed colorblindness (racial microaggressions) of White teacher candidates. Most importantly, she claims that these survival tactics transform microaggressions into an awareness for the propagation of racial equity.

Methodology

The decision to explore how we conceptualized and operationalized our pedagogy in elementary science methods courses in relation to the challenges, tensions, and problems impacting our substantial selves and situational selves during the process of educating our teacher candidates cohered with the growing popularity for the methodology of self-study (Dinkelman, Margolis, & Sikkenga, 2006; Kaufman, 2009; LaBoskey, 2004; Loughran, 2014; Pithouse, Mitchell, & Weber, 2009) and its focus on "teaching and learning about teaching at the center of the research endeavor" (Loughran, 2014, p. 278). Apart from this coherence, self-study as a suitable methodological framework for this study was underpinned by the constructs from the literature on self-study. Feldman (2003) and Kaufman (2009) claim that the methodology of self-study is suitable for one's inquiry into their own practice because it provides clear and detailed data collection procedures, flexibility in representation of data, variety of data representations, and the need for catalytic authenticity when undertaking self-study of practitioner knowledge.

Moreover, the pragmatic nature of our decisions and the context-specific nature of the research question were key determinants in choosing the methodology of self-study. A number of scholars claim that methodology of self-study (1) provokes and challenges one's current norms of practice, (2) emphasizes the quality of inquiring into one's practice as being disconcerting rather than confirming, (3) supports the intentionality and systematic inquiry into one's practice using personal, formal and substantive theories of knowing, and (4) situates one's inquiry into their own practice within a verified epistemological way of knowing (Dinkelman et al., 2006; Kaufman, 2009; LaBoskey, 2004; Loughran, 2014; Pithouse et al., 2009). Apart from the aforementioned claims, scholars also claim that methodology of self-study de-emphasizes (1) the need for generalizability to confirm and conform, and (2) the accepted norms of methodological rigor (validity, reliability and objectivity).

Our Substantial Selves and Situational Selves

Three of us, Karthigeyan, Kia and Sumreen taught the K-6 science methods course using a standardized syllabus with similar course elements like textbooks, assignments, course readings, and activities while Eun Young taught science methods as a

component of an early childhood (K-3) methods course. The conceptual structure of both types of science methods courses was underpinned by an inquiry-oriented focus to science learning. In view of the teacher education program's accreditation efforts all syllabi and assessments within the K-6 teacher education program were standardized. Eun Young, Kia, and Sumreen were graduate teaching assistants as well as doctoral candidates while I, Karthigeyan, held the appointment of assistant professor of science teacher education, and was the lead instructor for the K-6 elementary science methods courses. In this institution graduate teaching assistants/on-campus doctoral graduate students teach one to two undergraduate courses per semester.

We taught our respective science methods course in the same semester and were assigned to teach the science methods course because of our experiences (1) with field supervision of elementary teacher candidates, (2) as teachers in K-12 school settings, and (3) as mentors to teacher candidates. Most importantly, our preparation as K-12 science teachers in university-based teacher education programs was a key determinant for being a participant in this self-study. Williams (2014) contends that the aforementioned criteria are important because field supervision experiences, mentoring experiences, and K-12 teaching experiences are the common contexts that most teacher educators have experiences in and thus, provides some generalizability across teacher education programs. Above all, our knowledge and experiences of supervision of teacher candidates in the field, as teachers in K-12 school settings, and as mentors to teacher candidates cohered with tripartite knowledge structure of knowledge-for-practice (K-12 science teacher preparation), knowledge-in-practice (teaching in K-12 school settings and field supervision) and knowledge-of-practice (K-12 science teacher preparation and mentoring). Table 10.3 provides background information about us, our knowledge-for-practice, knowledge-in practice, and knowledge-of-practice, and the transitional spaces we were situated in during the study.

During the semester when this study was conducted, the 96 teacher candidates enrolled in the K-6 elementary science methods sections, taught by the four of us, were predominantly White female candidates (84 %) while the rest of the female candidates were Hispanic (8 %); Asian (4 %) and African American (2 %). Two percent of the teacher candidate population was male. Teacher candidates were in their final semester of coursework prior to student teaching practicum, all candidates had to have a minimum grade point average of 2.75 for all the teacher education courses and all candidates had to have completed 12 semester credit hours of science (four courses), selected from the biological sciences, chemistry, physics, geology, environmental science or astronomy.

Data Collection, Sources and Analysis

The study composed of two data collection phases. Phase 1 comprised the collection of two sets of metaphors: (1) a metaphorical statement that captured our practice of teaching the elementary science methods course, and (2) "*Elementary science*

Table 10.3 Our profiles

Name/current status	Years as teacher/ teacher educator	Tripartite knowledge structures	Transitional spaces
Karthigeyan Subramaniam Asian-American Male Assistant Professor	8/10	Knowledge-for-practice: I have a masters in science teacher education. My doctoral dissertation was on science teaching. I have taken multiple professional development courses throughout by years as science teacher and as a science teacher educator	Teacher educator to teacher educator researcher
		Knowledge-in-practice: I have eight years of teaching experience in K-12 science content in both private and public schools. This is my tenth year in higher education and I have taught general teacher education courses but my main teaching load is science methods course	
		Knowledge-of-practice: I have conducted a number of empirical studies related to science teacher education and presented at a number of conferences on science teacher education	
Kia Rideaux African American Female Doctoral Candidate (ABD)	10/2	Knowledge-for-practice: I don't recall any of my coursework during my doctoral program focusing on teaching science methods	Teacher to teacher educator
		Knowledge-in-practice: Professional development during my classroom teaching experience with organizations such as Project Wild, Aquatic Wild, and Fort Worth's Children Museum provided. Professional Experience as a curriculum writer for a local district	Doctoral student to teacher educator
		Knowledge-of-practice: Observation of preservice teachers during visit to Informal Science Center on campus for science methods course. Participation in peer's study on informal science teaching methods	

(continued)

Table 10.3 (continued)

Name/current status	Years as teacher/ teacher educator	Tripartite knowledge structures	Transitional spaces
Eun Young Lee Asian Female Doctoral Candidate (ABD)	3/2	Knowledge-for-practice: I have a master's in Curriculum and Instruction. During my course work, I took a course about how to teach math and science for young children	Teacher to teacher educator
		Knowledge-in-practice: I have taught early childhood courses for undergraduate students pursuing an education major in EC-6. These experiences have provided me an opportunity to not only learn how much preservice teachers know about science content and pedagogical knowledge but also practice my knowledge and experience to my students	Doctoral student to teacher educator
		Knowledge-of-practice: I have written many papers with various topics related to science education for young children and preservice teachers. While working on my doctorate, I have done many independent studies with professors in science education and have assisted a professor in his science methods course for a semester	
Sumreen Asim Asian-American Female Doctoral Candidate (ABD)	5/3	Knowledge-for-practice: I have a master's in Elementary Education, as well as a master's degree in Science and Environmental Education. During my coursework as a doctoral student my focus surrounded the Project Wild curriculum. The coursework has allowed me to better understand the layout, theories and goals that were taken into consideration when creating this particular curriculum. Knowledge-in-practice: I have taught as classroom teacher and a specialist in a K-6 settings. I was fortunate to have a science lab and taught science using *Science Curriculum Improvement Study* (SCIS) curriculum, an activity-based program, for students in a K-6 settings. I also have the experience of teaching as a facilitator for colleges. Knowledge-of-practice: My research interests have evolved from both my course work, my dissertation study, my professional experience as a K-12 science teacher, and as a science methods course instructor for K-12 preservice teachers	Teacher to teacher educator
			Doctoral student to teacher educator

teacher educator as …" metaphor. Phase 2 was comprised of a focus group interview where I (Karthigeyan) was a focus group participant together with Sumreen, Eun Young, and Kia and also took on the additional role as moderator. Table 10.4 shows the timeline for the phases of data collection (and analysis of data). Collectively, the choice of metaphors and a focus group interview as methods of data collection facilitated "a stepping back, a reading of our situated selves as if it were a text to be critically interrogated and interpreted within the broader social, political, and historical contexts that shape our thoughts and actions and constitute our world" (Pithouse et al., 2009, P. 45). This cohered with the pragmatic nature of our decisions, the context-specific nature of the research question, and choice of a methodology of self-study. Additionally, the choice of metaphors and the focus group interview as primary qualitative methods of data collection provided varied accounts of our inquiry and satisfied what LaBoskey's (2004) contends are integral aspects pertinent to the process of utilizing a self-study methodology.

Phase 1-Writing Metaphors

In the field of explicit metaphorical statements research, metaphors have been used to investigate (1) the images of how practitioners view themselves and their learners in the classroom (2) the images that practitioners have of themselves in fulfilling their roles; and (3) the images of personal practical knowledge (Inbar, 1991, 1996). The underlying themes in the utilization of metaphors in these areas of research were based on the assumptions that "images lead to metaphors"; "metaphors provide a careful means for clustering images"; and "images are metaphorically embedded" (Bullough, 1991, p. 200). In this respect, the use of metaphors as data sources helped us, the practitioners, to shed light onto our own images and thereby capturing and encapsulating our practice, and the knowledge that structured and enabled our instruction (Mevorach & Ezer, 2010; Williams, 2014).

Data collection for this part of the study consisted of three steps. First, each of us individually wrote down a personally constructed metaphor in the form of an explicit metaphorical statement. Second, each of us individually wrote narratives that expressed the meanings encapsulated within our individual metaphorical statement. The final step of this data collection stage involved the derivation of "*Elementary science teacher educator as …*" metaphor. In this step each of us read and re-read our own personal narrative and then wrote down another personally constructed metaphor, the "*Elementary science teacher educator as …*" metaphor. This step gave us an opportunity to individually reflect on our own practices, and look at the language we had assigned to our practice. This was also a way for us to individually refocus our construction of metaphorical sentences and related narratives, and contextualize our teaching actions into another metaphor, thereby structuring our practices and making explicit personal practical knowledge. Moreover, this process enabled us to get a further set of coherent and consistent metaphors that alleviated the major concern of single metaphors not being enough to describe the complexities of our practice.

Table 10.4 Timeline of study: conceptual structure of the course and phases of study

Week	Conceptual structure of the course	Phases of study
1.	Course introduction	Phase 1:
		Writing a metaphorical statement that captured our practice of teaching the elementary science methods course
2.	Discovering science through inquiry	Individual analysis of metaphorical statement
3.	Planning for inquiry: 5E learning cycle	Writing a narrative encapsulating the meanings of the metaphorical statement that captured our practice of teaching the elementary science methods course
4.	STEM and science instruction	Individual analysis of narrative: Reading and re-reading of narrative followed by the derivation of "*Elementary science teacher educator as …*" metaphor from narrative
5.	Inquiry and assessment	
6.	Inquiry experiences for all children	
7.	Inquiry learning opportunities	
8.	Inquiry learning opportunities: informal science instruction	
9.	Mid-term exams	
10.	Field trip	
11.	Microteaching: lesson presentation	
12.	Microteaching: lesson presentation	
13.	Microteaching: lesson presentation	
14.	Microteaching: lesson presentation	
15.	Microteaching reflection and debriefing	
16.	Final exam	Phase 2:
		Focus group
		Collective analysis of metaphorical statements, narratives, and "*Elementary science teacher educator as …*" metaphor
		Individual and collective analysis of focus group transcripts: verification and consolidation of themes

Phase 2-Focus Group Interview

Phase 2 comprised of a focus group that was grounded by the following questions:

1. Please share your *Elementary science teacher educator as …* metaphor and describe it.

2. Please share your metaphorical statement that captures your experiences of teaching the elementary science methods course and describe it.
3. Share your experiences in teaching the elementary science methods course.
4. What would you change, and not change in your teaching in your future/continuing role as a science teacher educator.

The focus group was chosen as another approach for data collection because focus groups generate high-quality data in a social context thus enabling the collection of data that highlights the collective concerns within an open and supportive environment (Cochran-Smith, 2003). According to Krueger and Casey (2008), focus groups generate large amounts of data in less time than other methods and give rise synergistically to insights that may not occur in individual interviews resulting in greater depth and details. They also claim that focus group interviews also enable participants to recognize "hidden parts" of themselves and reconstruct opinions from other's stories unfolding in discourse. The adoption of this qualitative method enabled us to substantiate each other's interpretations within the study's context: the culturally patterned signs and symbols extant within the science teacher education context in which we were situated. One focus group interview lasting about two hours was conducted at the end of the semester. As metaphors were the predominant data in this study and collected throughout the study, we did not want to have a focus group prior to the end of the semester since a focus group, with its shared agenda focus, might contaminate and/or provide checks and balances on our developing and evolving metaphors. Clearly, our intent on using the focus group was to recognize hidden parts of ourselves and reconstruct opinions from each other's metaphors and narratives, collected and shared at the end of the science methods course.

Data Analysis

The data were analyzed using inductive analysis and thematic analysis. Both these approaches to analysis were used because of the limited previous studies dealing with this phenomenon. Inductive analysis utilized Thomas's (2006) general inductive approach for analyzing qualitative data while the thematic analysis was guided by Braun and Clarke's (2006) thematic analysis approach. Thematic analysis was used to interpret discernible patterns within the narratives and the focus group interview transcript. The purpose of the inductive analysis was twofold. First, we sought to see similarities and differences in our interpretations of the instructional practices. Second, we sought to identify the challenges, tensions, and problems impacting our substantial selves and situational selves within the methods sections. We first familiarized ourselves with the data corpus by reading and re-reading each data set (metaphors, narratives, and focus group transcript) and identified meaningful data extracts, and created and assigned a code for each data extract (the text segment). Text segments containing similar assigned codes were grouped together and assigned codes were developed into distinct categories. The distinct categories were

then cross-referenced to identify relationships, and causal sequences between categories. Following this, a thematic analysis approach to data was carried out. In constructing preliminary themes we grouped together categories across data sets to seek coherent and meaningful patterns that were relevant to the study's research question. For example, data extracts categorized by the notion of "*acquiring a role*" across data sets were further analyzed for coherence with our verbal descriptions within narratives and the focus group interview transcript. In doing so, the preliminary theme of "*acquiring a role*" was constructed. The preliminary theme of "*acquiring a role*" was then reworked into all coded and categorized data extracts across data sets to seek patterns that confirmed, disconfirmed, expanded upon and/or clarified the preliminary theme of "*acquiring a role*". As a result of reworking the preliminary theme of "*acquiring a role*" across data sets, we were able to refine and thus further define this theme. Analyzing data with the preliminary theme of "*acquiring a role*" enabled the identification of different roles: leader, choreographer, and captain. As a final step in the thematic analysis process we weaved together the constructed themes resulting from the identification of consistent and predominant patterns across the data sets for relevancy with the study's research question.

Trustworthiness

Figure 10.1 indicates how the claims made in this study were substantiated in three ways: firstly, each of us, as a researcher, individually reflected on the phenomenon through the construction of our personal metaphors and narratives, and individually analyzed the metaphors and narratives to construct individual meanings of how we perceived the phenomenon; secondly, as a group we collectively analyzed the metaphors and narratives within a focus group setting to construct shared meanings of how we perceived the phenomenon; and thirdly, as a group we analyzed the resulting focus group transcript to further seek consensus on the shared meanings that underpinned our perceptions of the phenomenon. By looking at the phenomenon from three vantage-points we were able to corroborate, confirm and/or disconfirm the underlying shared meanings of how we perceived the phenomenon. It is obvious that triangulation metaphor is suitable in describing this process for seeking trustworthiness.

Additionally, analysis strategies were collectively orchestrated by the four of us and were underpinned by systematic steps to seek agreement and/or disagreement to validate the themes (Kurasaki, 2000). We sought to collectively replicate each other's work of assigning codes/patterns to data and assess insights arising from agreements and disagreements during the process of assigning codes/patterns to data through verification and validity (de Wet, 2010). The focus group interview and resulting focus group transcript served as the sites of this collective analysis process to seek inter-coder agreement/disagreement on evolving themes in this study. Lastly, to enhance the rigor of analysis, raw data from transcripts (Jordan & Duncan, 2009) are provided in the findings section to enable the reader to generalize the findings to his or her contexts.

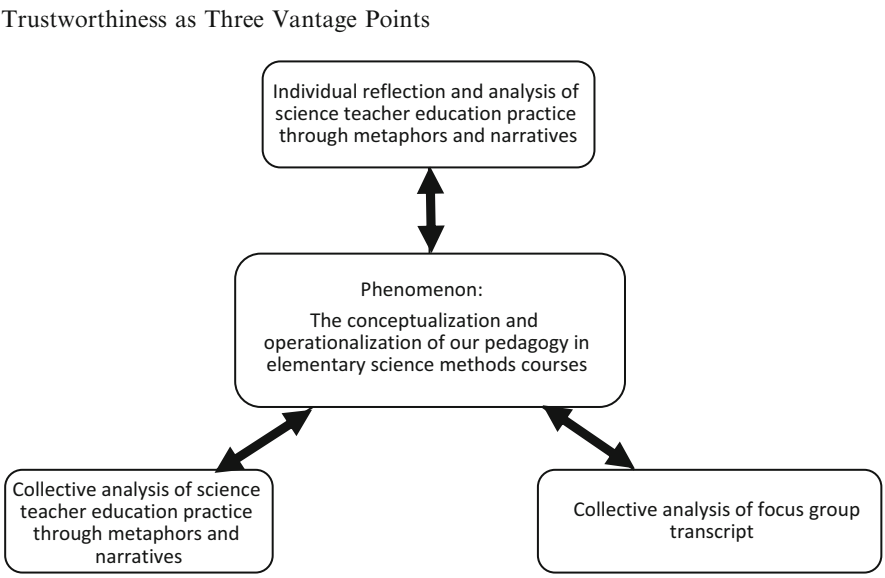

Fig. 10.1 Trustworthiness as three vantage points

Findings

Analysis of data revealed that we conceptualized our pedagogy in two ways: (1) we conceptualized our pedagogy within a role, and (2) and we conceptualized our pedagogy as needing safety nets to remove barriers that impinged on our professional roles. Each of these conceptualizations were in reaction to our experiences of dealing with teacher candidates' predetermined notions about us. These predetermined notions were (1) teacher candidates seeing us, the science teacher educators of color, as different from themselves and from mainstream White science teacher educators; (2) teacher candidates perceiving our attempts to include/integrate personal experiences, multicultural strategies, social justice issues and diversity issues as a "minority problem"; (3) teacher candidates not acknowledging us as science teacher educators who were modeling the practice of science teachers; and (4) teacher candidates perceiving the process of science teaching as fixed products or "recipes" to be delivered to K-12 students.

Conceptualization as a Leader

Analysis of data revealed that three of us, Karthigeyan, Kia, and Eun Young conceptualized our pedagogy within a role. Metaphors in Table 10.5 illustrate these roles as "a choreographer" (Kia), "a captain" (Karthigeyan), and "a solitary leader" (Eun Young).

Table 10.5 Our metaphors

Authors	Metaphorical statement	"*Elementary science teacher educator as …*" metaphor
Karthigeyan	Teaching elementary science methods courses is a force to reckon with, the mostly winter wonderland terrain is filled with avalanches waiting to be triggered; one's safety is always the first thing to consider	The elementary science teacher educator as the captain of an already capsizing ship with powers to righting the ship, most of the time
Kia Rideaux	To teach the science methods courses is to teach in a sterile operating room, a methodical and privileged space with zero room for error. All eyes are on the surgeon/expert	The elementary science educator is choreographer attempting to lead the troupe, yet assisting each future educator to perfect their own individual craft. While the teacher educator of color might see teaching the methods course an opportunity to infuse different genres of dance or to invent a new style, all the audience (the preservice teacher) seems to want is Swan Lake
Eun Young Lee	Teaching elementary science methods courses is doing a density experiment to see layered liquids with oil and different less dense liquids with different colors in a narrow cylinder. The oil goes first and all the different liquids go next one by one forming layers with different densities and colors. They never mix, but when you dump the oil and liquid into the sink they a totally new color, something that is not tangible and difficult to fathom	The elementary science teacher educator is a solitary leader crossing a desert with people who watch for their opportunities to raise rebellions. The leader is looking for an oasis but it is always a mirage. The leader is always on the look-out as there are always perilous burglars approaching and cajoling the people to usurp leader
Sumreen	Teaching elementary science methods courses is a way to clear the unpaved path that is unfamiliar and unknown to help discover the amazing wonders of species new and familiar, and terrain that can be smooth as a frozen lake, choppy as the waves of the ocean on a stormy night, as well as ornamented as a tree with icicles	The elementary science teacher educator is the icing of a decorative cake that hints to the layers and the flavors that are inside waiting to be discovered through the use of the person's five senses along with the choice of the plethora of tools at hand given a place and time

Collectively, these three roles were underpinned by the notion of a *leader* who was in constant battle with his/her *subordinates* (the predominant White preservice teacher candidates): "… captain of an already capsizing ship with powers to righting the ship, most of the time", "… attempting to lead the troupe, … all the audience (the preservice teacher) seems to want is Swan Lake", and "… leader is always on the look-out as there are always perilous burglars approaching and cajoling the people to usurp leader." These roles to us were in response to teacher candidates, espe-

cially, White preservice teacher candidates' seeing us, science teacher educators of color, as different from themselves and from mainstream White science teacher educators. Eun Young's comment, "they see themselves as them and me as different" characterized this barrier that centered on color and ethnicity as determinants of our worth as science teacher educators. Support for this conceptualization was also evident within our metaphorical statements that contained glimpses of challenges in carrying out the task of teaching teacher candidates: "All eyes are on the surgeon/expert", "a force to reckon with", and "They never mix …."

Taking on the role of leader was more of "trying to prove" ourselves as being science teacher educators or perceived as being a constant tussle to always prove ourselves as science teacher educators. Within this context we were encountering our substantial selves and situational selves as somewhat of a penalty, and thus, we resorted to taking on leadership roles like choreographer, captain, and solitary leader. The analysis of narrative data and focus group data indicated that we wanted to move away from the conceptualization of a leader who was constantly scrutinized as being "a force to reckon with". For example, the following focus group excerpt indicates that the we were proposing a need for both teacher candidates, science teacher educators of color, and other teacher educators to focus on understanding the practice of teacher education as a holistic endeavor for supporting the success of each teacher candidate and this endeavor be equally shared by all teacher educators, no matter their ethnicity and/or color.

Sumreen:	When we step into the science methods class I am already barricaded by a painted picture of me as different from the other teacher educators.
Kia:	Yes. They already see us as different not as a science teacher educator or even as a science teacher.
Eun Young:	They see us as different not as an educator.
Karthigeyan:	It is different with their other teacher educator methods professors who they seem to identify with because of similarities in ethnicity and color.
Kia:	Yes. They see us a certain way, different from the rest of the teacher educators.
Sumreen:	Yes.
Eun Young:	Okay, true.
Karthigeyan:	There needs to be common cultural frame. I mean a frame that sees us and all teacher educators as using our experience, expertise, and knowledge for the success of the teacher candidates and not a cultural frame centered on ethnicity and color.
Kia:	True, the cultural frame now is based on appearance
Sumreen:	It is more about the powerless and the powerful.
Eun Young:	There needs to be change, teacher candidates need to understand themselves as professionals who are going to teach a diverse population and us as professionals who bring about this change.

Karthigeyan: Change, needs to come from all involved in teacher education, it is not only us, teacher educators of color. The frames from which other teacher educators work from and from which we work from needs to be shared. By doing so we might be able to understand the causes for the constant need to prove oneself and move away from our narrow perception of a leader. Our expertise should not be at stake because of our ethnicity or color.

As evident from Table 10.5 and the analysis of data, Sumreen's metaphors were different from the rest of us. In fact her metaphors and narrative helped us as a group to define and refine our collective analysis of data. In doing so, we were able to see, with clarity, how our roles were distinct from that of Sumreen's and how our roles were dominant. Eventually, as we proceeded with the collective analysis in the focus group and in the analysis of focus group transcript we did see that Sumreen was in consensus with the rest of us on the theme of conceptualization as a leader: "When we step into the science methods class I am already barricaded by a painted picture of me as different from the other teacher educators" and "It is more about the powerless and the powerful" (Focus group transcript).

Conceptualization of Pedagogy as Safety Nets

A common pattern that was inherent in all data was our conceptualization of our pedagogy as needing safety nets to remove barriers that impinged on our professional roles. We as science teacher educators felt that teacher candidates' predetermined notions of us were detrimental to our work as science teacher educators. Anything we did to change these predetermined notions were seen as going against the norm. Kia remarked that that teacher candidates "wanted a recipe" for teaching science and any integration/inclusion of personal experiences, multicultural strategies, social justice issues and diversity issues or modeling of science teaching practice that were different were met with unfavorable responses. The following quote captures the essence of this resistance: "Does she know what she is talking about", and "… they want a science teacher with recipes to teach not a science teacher educator" (Kia, Focus Group Interview). Karthigeyan's narrative also sums up this resistance:

> Teacher candidates are always looking for you to fumble over something, this could be science content, the syllabus, the questions on the quiz, etc. I am already shortchanged in these teaching situations, my color, and my accent are penalties that act against me in every science methods class I teach. They see me as someone who is different and thus inferior and less able to teach science content. Every lesson I teach, I have to have safety nets to protect myself from being singled out because of my penalties. Safety nets include the watering down of the science content in lessons I model, not using too many multicultural examples, not giving graded assignments in class, etc. I do all this to avoid the confrontations that are waiting to explode. Their lack of science content and/or their weakness in science content must not be judged as I am already assumed to be less able to teach science content even though most of my teaching career was teaching high school biology, chemistry, and physics.

The quote above also reveals how we operationalized our instruction in the science methods courses. We emphasized the need for safety nets ("a methodical and privileged space with zero room for error", "one's safety is always the first thing to consider", and "always on the look-out") to protect ourselves from repercussions from teacher candidates. Finally, the analysis of narrative data and focus group data indicated that we wanted to move away from the conceptualizations that were making our pedagogy subjugated by the constant need to stand guard against possible resistance. For example, the following focus group excerpt indicates that there is a need for both teacher candidates and science teacher educators of color to engage in dialogue and this should be centered on the changing demographics of student populations in today's science classrooms.

Karthigeyan: I see that we need to get our teacher candidates to imagine themselves as someone who is different from the students they will be teaching.

Eun Young: They need to hear our voices in their heads and they need to acquire the role of someone who is different, like if they imagine they are me, a minority teacher educator, teaching them.

Sumreen: Yes. True. Diversity is not only in the textbook, it is all around us, in classrooms, universities …

Kia Agreed. We need to move on. A change towards a better understanding of us as science teacher educators of color.

Karthigeyan: Vocational socialization with the teaching profession needs to include walking in each other's shoes and feeling one's frustrations and joys and not only be about learning the skills for the effective teaching of science content.

Discussion

Tripartite Knowledge Structure for the Pedagogy of Science Teacher Education

The findings of this study provided only a limited perspective into the lived experiences of ourselves as science teacher educators of color in relation to how we act and why within the context of science teacher education. This study highlighted how our knowledge as science teacher educators of color was situated and constructed in response to particularities (Cochran-Smith & Lytle, 1999) of ethnicity, and resistances (Goodwin et al., 2014; Matias, 2013) within the context of our teaching spaces (Goodwin et al., 2014); and, within personal, pedagogical, and social domains of educating predominantly White teacher candidates (Goodwin & Kosnik, 2013). However, our conceptualizations and operationalization of our pedagogy as a role, and as needing safety nets did provide a lens into the complex demands of science teacher education. Conceptualizations were in response to the

complex demands of dealing with teacher candidates' predetermined notions about us. Indeed for us, these predetermined notions seemed to form the problems and tensions and were of concern even though we had been exposed to the tripartite knowledge structure for the pedagogy of teacher education (Cochran-Smith & Lytle, 1999; Goodwin et al., 2014) and for the pedagogy of science teacher education (Berry & Van Driel, 2013).

Looking at both the conceptualizations and operationalization of our pedagogy of science teacher education it seems that the conceptualizations and operationalization share similarities with Matias's (2013) methodological tactics and Goodwin et al.'s (2014) survival tactics. First, both were constructed in response to teacher candidates' predetermined notions about science teacher educators of color. Second, both were constructed to avoid resistances in the process of teaching science teacher candidates and were not substantiated by accepted theories. Our choice to transform the inherent predetermined notions and resistances through dialogue in the focus group interview suggested that we were keen on changes and that our methodological tactics were not static but being challenged. Most importantly, the pragmatic nature of our decisions to transform certain elements of our practice resonated from within our knowledge-in practice.

Finally, the notion of transitional spaces (Margolin, 2011) as an element that impacts the development of pedagogy of science teacher education was not obvious (Berry & Van Driel, 2013; Cochran-Smith & Lytle, 1999; Goodwin et al., 2014; Loughran, 2006; 2014) in this study. Even though, Sumreen's transitional space differed from the rest of us, collectively the conceptualizations and operationalization of all our pedagogy were more in reaction to the particularities Cochran-Smith & Lytle, 1999) of ethnicity, and resistances (Goodwin et al., 2014; Matias, 2013) within our teaching spaces (Goodwin et al., 2014).

In sum, our tripartite knowledge structure for the pedagogy of science teacher education was influenced by our teacher candidates' predetermined notions about science teacher educators of color. Basically, our conceptualizations and operationalization of our pedagogy of science teacher education showed some signs that were indicative of the pedagogy of survival tactics (Goodwin et al., 2014) and the pedagogy of trauma (Matias, 2013). Additionally, conceptualizations and operationalization of our pedagogy of science teacher education was more in-tuned with the knowledge-in-practice component of the tripartite knowledge structure for the pedagogy of science teacher education: the situated knowledge acquired from reflection and analysis of one's own science teaching/science teacher education practice. In contrast, the methodological tactic of needing safety nets while instructing teacher candidates how to teach science was lacking in theoretical soundness.

Self-Study Methodology

According to the teacher education literature, self-study methodology is a useful tool for teacher educators in inquiring into their own processes of educating teacher candidates (Dinkelman et al., 2006; Feldman, 2003; Kaufman, 2009; LaBoskey,

2004; Loughran, 2014; Pithouse et al., 2009) and in this study the self-study methodology provided a lens to examine our pedagogy of science teacher education. Specifically, the use of self-study methodology together with qualitative methods like metaphors and the focus group interview helped us to reflect onto our pedagogy of science teacher education within our own teaching spaces. The use of metaphors was unique in that it helped us to relate our pedagogy of science teacher education into images about our practice, images about our roles; and the images of our personal practical knowledge. Moreover, unlike interviews that produce data in response to interviewer agenda and questions, the use of metaphors helped to bring forth the challenges inherent in our practice of educating science teacher candidates from our substantial selves and situational selves. The use of the focus group interview did provide an avenue for us to share our collective concerns within an open and supportive environment (Cochran-Smith, 2003) and additionally, enabled us to substantiate each other's interpretations within the study's context: the culturally patterned signs and symbols extant within the science teacher education context in which we were situated. Furthermore, it was obvious to us as researchers studying our own practice that we were engaging in knowledge-of-practice, a component of the tripartite knowledge structure for the pedagogy of teacher/science teacher education. In doing so, our study substantiates the role of self-study as a purposeful methodology that maps the outcomes of teacher educators' inquiry into their own instructional practice.

Conclusion, Implications, and Challenges

This study showed how the four of us, science teacher educators of color, conceptualized and operationalized our pedagogy and especially how we overcame and endured our teacher candidates' predetermined notions about us and our practice of science teacher education. Even though our self-study of our practitioner knowledge, through metaphors, narratives and a focus group interview, revealed that we had aspirations to help transform our pedagogy of science teacher education for the success of our teacher candidates, these transformations were situated within tensions of role, identities and methodological tactics for survival. More research is needed to study how science teacher educators of color conceptualize and operationalize in response to the particularities within the context of their teaching space so that counterstories and/or counternarratives are produced to substantiate/refute the tripartite knowledge structure for the pedagogy of science teacher education. Most importantly, this needed research must be situated within the challenges, tensions, and problems impacting science teacher educators' substantial selves and situational selves. An additional implication is that components of the tripartite knowledge structure for the pedagogy of science teacher education, knowledge-for-practice, knowledge-of-practice, and especially knowledge-in-practice need to be approached in conjunction with the research on preparing a predominantly White, middle class, female teaching workforce, and from the standpoints of the

mainstream White teacher educator. As this study has shown, these two factors form the basis of the teacher candidates' predetermined notions and which in turn impact science teacher educators of colors' instructional practice.

Based on our self-study of how we conceptualized and operationalized our instruction in science methods courses we acknowledge the following challenges that impact our pedagogy of science teacher education. First, we argue that tripartite approach to a pedagogy of science teacher education is predominantly focused on how to educate teacher candidates and lacks the substantial knowledge-base for science teacher educators to look inwards into their substantial selves and their situational selves. Above all, the specific challenge we faced was the lack of discourse structures that we could use to unveil the unique ways of how we as science teacher educators of color conceptualized and operationalized our instruction in science methods courses to a predominantly White teacher education faculty.

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