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Abstract

The adoption of Next Generation Science Standards (NGSS) and NGSS-like standards necessitates significantly different ways of thinking about K-12 science instruction as well as corresponding instructional approaches to successfully implement the standards. The general stance of the science education community appears to be that, ideally, all teachers will use a research-based constructivist pedagogical approach (i.e., three-dimensional instruction). However, to make this change to constructivist instructional practice and move beyond hypothetical teacher use requires a paradigm shift in how teachers choose to teach. That educators will embrace constructivist epistemology associated with the NGSS is taken as a foregone conclusion. Teachers play an invisible role in the foundational and supporting literature for NGSS and three-dimensional pedagogy, where the hypothetical teacher is addressed only in terms of what practices they need to adopt and what support to provide them. Expectations of teachers' pedagogical choices in science largely preclude consideration of the complexity and diversity of teachers' identities.

Teachers enact and negotiate their identities in the daily, ongoing classroom-level experiences, not just in their initial development of those identities. To better understand the impact of those identity negotiations on teachers' instructional choices requires greater breadth and depth of research on identity of science teachers as whole people. In this study I used a qualitative approach with an emphasis on participant narratives. Through interviews, written reflections, and classroom observations, I re-present the stories of how two middle-school science educators' identities influence their classroom instruction. Both teachers utilize three-dimensional instruction, but their identities manifest primarily in the ways in which they build classroom communities of practice and support the needs of students.

Chapter 1

The adoption of Next Generation Science Standards (NGSS) and NGSS-like standards necessitates significantly different ways of thinking about K-12 science instruction as well as corresponding instructional approaches to successfully implement the standards (Krajcik et al., 2014). Three-dimensional learning is a research-based constructivist reform approach, emphasizing the need for students to wrestle with concepts to develop understanding (Krajcik, 2015; National Research Council [NRC], 2012). The general stance of the science education community appears to be that, ideally, all teachers will use this pedagogical approach. However, to make this change to constructivist instructional practice and move beyond hypothetical teacher use requires a paradigm shift in how teachers choose to teach.

Research documents the ways in which science teacher identities impact their pedagogical decisions (Avraamidou, 2016; Zembylas, 2016) and their students' successful science practices (Madden & Weibe, 2013). What teachers believe about reality and knowledge and their intersectional lived experiences interact in complex ways in the construction of their identities (Zembylas, 2003). However, when teachers feel their personal stances and practice misalign with science reform assumptions, they can experience *pedagogical discontentment*, another effect which informs their ongoing pedagogical decisions (Castronova & Chernobilsky, 2020; Eick & Reed, 2002; Kahveci et al. 2017; Southerland et al., 2011).

Despite the research-based nature of instruction envisioned by the NGSS and associated literature, the expectation that teachers fall in line with the progress of reform further normalizes the very long-standing culture of compliance and accountability which three-dimensional instruction opposes (Au, 2007). Considering the ways three-dimensional teaching is being disseminated, and the deeply problematic curricular control via accountability culture (Au,

2007), one begins to wonder whether there is room for diversity of teacher identities in our collective enactment of such curriculum. As individuals, teachers must identify who they are in relation to the educational systems they inhabit and act within those systems in ways that maintain their sense of self in their role as a teacher. Consequently, the lack of consideration for teachers as individuals in the progress of science education is a significant oversight with consequences for both teacher well-being and education reform.

Definition of Terms

Identity

Whole-person identity. The whole-person identity is the intersection of a teacher's professional identity (e.g., science teacher), positional identity (e.g., race, gender), and their collective life experiences. Within this construct, none of the myriad identities of a teacher are prioritized or used a priori to frame the research.

Science teache(r/ing) identity. The science teacher or science teaching identity of a teacher is a professional identity shaped around the understanding of oneself as a teacher of science.

Positionality

Positionality refers to the sociocultural elements of a person's identity which situates them within and impacts their lived experience of the world (e.g., gender, race, orientation, class). "In the context of science education, positionality shapes how teachers think about the purpose, role, and significance of science to themselves and their students" (Teo, 2015, p. 382).

Reform-based/Research-based

These two concepts are interconnected and I will treat them as such within this prospectus. Modern science education reform is based upon learning research generally and

science learning research more specifically, and this academic work underpins the push for changes to how science is taught in K-12 schools (i.e., "reform"). Herein, reform-based is used in reference to science education broadly while research-based will refer specifically to classroom-level practices.

Three-dimensional (three-dimensional). Three-dimensional refers to the research-based approach to classroom instruction desired from teachers within the broader context of science education reform. three-dimensional is most often used in the context of the NGSS and NGSS-based standards, which include dimensions of (a) science content (Disciplinary Core Ideas), (b) practice (Science and Engineering Practices), and (c) broad interpretive lenses (Crosscutting Concepts). However, the integration of these dimensions can be done outside the context of specific standards. The *Framework* articulates this as,

> "students cannot fully understand scientific and engineering ideas without engaging in the practices of inquiry and the discourses by which such ideas are developed and refined. At the same time, they cannot learn or show competence in practices except in the context of specific content" (NRC 2012, p. 218).

While specific three-dimensional instructional practices vary, they generally include the use of an observable event or process ("phenomenon") which students work to fully explain with evidence during the learning experience, and an emphasis on student exploration of concepts before the explicit introduction of vocabulary and content.

How students engage with three-dimensional learning necessarily takes myriad forms from classroom to classroom, but characteristics of these learning experiences in a general sense, exist within the literature (NRC, 2012). The use of phenomena in three-dimensional learning serves to help students develop questions to explore as they engage with conceptual ideas and

provides a relatable context to which students apply their understanding (Furtak & Penuel, 2018). They support student sensemaking, wherein students focus on the underlying *why* and *how* rather than just the *what* in their development of conceptual explanations (Schwarz, et al., 2017). Part of sensemaking involves frequent opportunities for students to talk about science, using each other's ideas as further tools to construct their own understanding (Windschitl & Stroup, 2017). In alignment with this, effective three-dimensional instruction draws on student funds of knowledge (e.g., out-of-school experiences, cultural practices and beliefs, etc.), centering their voices, everyday experiences, and unique ways of sensemaking in the learning experience (Windschitl, et al., 2017; Fick & Arias, 2022). In a three-dimensional classroom one expects to see students engaged in cooperative learning, anchored around a phenomenon they find engaging, to develop evidence-based explanations and understanding of big conceptual ideas.

Background of the Problem

Revisiting the history of science education in the last several decades reveals repeated attempts at both official and unofficial science education reform (Blades, 1997; Rudolph, 2002; Southerland et al., 2007). In the late 1950s, early curricula developed by the National Science Foundation (NSF) built upon an interest in phenomena-centered instruction and revolved around explaining natural phenomena using a deep developmental knowledge of a few key scientific concepts. Initially, teachers tended to support these changes. However, resistance by textbook publishers and political opposition to federally mandated curricula led to a low adoption rate and failure of the NSF curriculum (Blades, 1997; Rudolph, 2002). With the shift to standards-based reforms of the 1980s and into the No Child Left Behind (NCLB) era, instructional focus turned toward basic facts and skills. Since NCLB, research shows resistance to reform by teachers,

often manifesting as resistance to changes in best practices and research-based pedagogy in science curricula (Rudolph, 2002). Calls for return to an experiential rather than the more recent textbook-lecture tradition in science education began long before NCLB. These calls echo the sentiments of the NSF and similar curriculum with student construction of knowledge at the center (Renner & Marek, 1990).

The latest reform transition efforts in science education follow in the wake of the publication of *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas* (referred to herein as the Framework; NRC, 2012). While not a governmentally mandated reform, the Framework served as the guiding document for development of the Next Generation Science Standards (NGSS; NGSS Lead States, 2013), which form the basis of current reform-based instruction. The Framework, and NGSS by extension, revives phenomena-centered instruction in much the same spirit as the previous NSF approach, and in opposition to the science instructional practices that reemerged from accountability culture (Southerland et al., 2007).

The steady adoption of the NGSS and NGSS-like standards necessitates significantly different ways of thinking about K-12 science instruction and new pedagogical approaches to implement such standards effectively (Krajcik et al., 2014). The pedagogy implied by the report intentionally integrates (a) science practices, (b) content, and (c) broad multidisciplinary lenses (e.g., scale, patterns), and has thus been dubbed three-dimensional. Three-dimensional learning is a research-based constructivist reform concept, emphasizing the need for students to wrestle with concepts to develop understanding (Krajcik, 2015; NRC, 2012). Rather than attempting to simply stop the bleeding of decreased quality science education, three-dimensional instruction as imagined by the Framework builds on the positive aspects of prior reform work of the National

Science Education Standards (NSES; NRC, 1996) to address science education in the context of increasingly complex technology and global socio-environmental entanglements. Ideally, by asking students to engage with science as a way of understanding the world through exploration and application to life outside the classroom, rather than as a static collection of facts and information, students will leave their K-12 education with conceptual understanding of content and the Nature of Science in practice.

Pedagogy During Major Historical Events and Social Upheaval

An additional layer of complexity in the discussion of science education reform is the sociocultural context in which it takes place. Science is not culturally neutral, and history shows that historically significant events have shaped science education and reform efforts. Considering the current sociocultural and political climate in the United States in the past several years (2012-present), it is necessary to look at the impact of context on the current efforts to implement the NGSS and three-dimensional science instruction in classrooms. From a historical perspective, events like the launch of Sputnik and the September 11, 2001 terrorist attacks both provide relevant parallels for the ways in which social context impacts reform in science education.

Sputnik. Retrospectively, the Sputnik Era is perhaps the closest in nature to our current sociopolitical climate: heightened racial tensions, generalized fear of Russia and Communism/Socialism, the increasing influence of religion on social discourse, and an influenza epidemic, among others (Wissehr & Concannon, 2011). Following the launch of Sputnik, America invested heavily into science education at a federal level (Blades, 1997; National Science Foundation, 2000) in an attempt to regain a global footing in scientific advances (Bybee, 2007). Reform in the wake of Sputnik largely emphasized the necessity of students learning

science as scientists do and prioritized the expertise and authority of professional scientists over classroom educators in the production of curricula (Blades, 1997).

The science education community has made strides in reform efforts; however, unlike the context of the late 1950s, there has yet to be a Sputnik-type catalyst event to spur public support of science education and renewed investment in strengthening the nation's scientific competitiveness. Climate change might have the potential to become a tipping point and represents an opportunity for our leaders to set a clear and explicit goal for scientific progress, but that is yet to be seen.

9/11. Following the terrorist attacks of September 2001, the U.S. took willing steps toward a state of surveillance and more militant control, in the name of Homeland Security. Where Sputnik inspired investment in science and science education, with direct influence and funding connected to national security (Blades, 1997), 9/11 weakened the educational infrastructure that supports scientific thinking and practice. Widespread attitudes about the military, patriotism, and government control, paired with educational accountability policies led to a suppression of teacher and student agency and undermined critical reasoning in and out of the classroom (Lipman, 2004).

Given the emphasis on student discourse, collaboration, and developing an understanding of the revisable nature of science present in three-dimensional instruction and the NGSS, 9/11's long-term impacts continue to undermine modern reform efforts. Unfortunately, teachers' (perceived) loss of freedom to discuss material outside of standardized content and structures constrain teachers' and students' opportunities for rigorous classroom discourse (Lipman, 2004, 2006; Melville & Bartley, 2013). Accountability practices under NCLB which normalize classroom-level surveillance create a culture of fear for students and teachers. The fear of

punishment, both for using unstandardized instructional practices and failing to achieve, further stifles learning experiences (Enyedy et al., 2006; Lipman, 2004, 2006).

Statement of the Problem

Three-dimensional pedagogy proposes a significant shift for all teachers, including those already working from a constructivist, student-centered tradition (Krajcik, 2015). To scaffold this transition, professional development and resources reduce three-dimensional teaching to an overly simplified version for ease of consumption and working through the disequilibrium it produces (Lowell, et al., 2020). Unfortunately, this also gives the erroneous impression that three-dimensional teaching is: (a) explicitly (rather than conveniently) standards-based; (b) another mandated reform expected of all teachers (for now); and (c) always a one-sized, packaged curriculum product (personal communication). In total, the Framework, NGSS, and three-dimensional pedagogy represent the views of a diversity of scientists, educators, and education experts, with the intention of serving a diversity of student experiences through a hypothetically flexible pedagogical approach.

Notably absent in this collection of curricular foundations is the diversity of teacher experiences. That educators will embrace constructivist epistemology associated with the NGSS (eventually) is taken as a foregone conclusion. Teachers play an invisible role in the foundational and supporting literature for NGSS and three-dimensional pedagogy, where the hypothetical teacher is addressed only in terms of what practices they need to adopt and what support to provide them (Allen & Penuel, 2015; Anderson, et al. 2018; Krajcik et al. 2014; NRC, 2012). Science education literature implicitly assumes all teachers will teach three-dimensionally given enough time and professional development (Andersson, et al., 2021; Bybee, 2014; NRC, 2012; Reiser et al., 2017), offering blanket best practices for successful implementation.

Expectations of teachers' pedagogical choices in science largely preclude consideration of the complexity and diversity of teachers' identities. Considering that educational research specifies a lack of compartmentalization among various intersections of complex teachers' identities, continuing to frame dialogue about science teachers as a monolithic interchangeable entity proves problematic (Akkerman & Meijer, 2011; Day, et. al, 2006; Zembylas, 2003). Teachers do not cease to be other types of people when they enter their classroom, but the literature treats them like they do. This oversight misses the vital contributions of teachers' feelings and who they are as complex individuals to the decisions they make in their classroom (Day et al., 2006; Zembylas 2003, 2011). Furthermore, assumptions of practice ignore teachers' personal epistemological beliefs, their lived intersectional experiences and positionality, and the sociopolitical structures in science which interact with all elements of teacher identity. This sort of structural repression of teachers' identities contributes to negative emotions and stances toward science (Zembylas, 2004).

In practice, many teachers' experiences with three-dimensional instruction fail to reflect the approach as intended—as a broad opportunity to flex their individual creativity in their classrooms. Instead, they feel unprepared to meet these new demands in science education (Haag & Megowan, 2015). After negative experiences over a long history of science reform (Haag & Megowan, 2015; Rudolph, 2002; Trygstad et al., 2013), translating our current understanding of student learning from research and academe to classroom level praxis has created yet another situation in which teachers express anxiety over their work. During my time as a middle school science teacher and department chair, and through my work now in teacher professional development, I continue to observe conversations in which teachers express distress over NGSS and NGSS-aligned standards.

This emotional and professional reaction to a new, difficult approach—one quickly becoming another buzzword-mandate—creates a situation in which teachers do not make a transition to a newer, highly effective pedagogy. While some show cautious optimism and choose to engage fully in making sense of three-dimensional pedagogy, many teachers remain firmly rooted in their traditional approaches. Science teachers experiencing pedagogical discontentment are more likely to reject new pedagogies rather than find a way to embrace the change. Without timely intervention in the classroom, at the curriculum enactment level, this disengagement by teachers with effective practice will almost certainly contribute further to the high levels of public science illiteracy (Trygstad et al., 2013).

This dialogue is not unique to my context or my colleagues. Teachers nationwide offer a host of reasons not to transition to three-dimensional pedagogy (e.g., insufficient resources and time, view it as another education fad). Whether or not reform-minded practice sticks with teachers seems inconsistent to the point of being unpredictable (Sloan, 2006). Given the repetition of failed efforts within reform history (Banilower et al. 2013; Johns, 1984; Trygstad et al., 2013), we seem to lack anything resembling a viable solution for the successful long-term adoption of three-dimensional instruction. Without knowing who teaches, the ability to move forward with science education reform will fail on the basis of unadopted practices.

To develop such an understanding educators requires us to move beyond an artificial divide between teachers as whole people and strictly as science teachers (Luehmann, 2007; Avraamidou, 2014). Instead, we must consider more holistically how teachers negotiate their positionality—who they are in regard to their intersectional social contexts (Moore, 2008)—and consider what individual teachers bring to their practice, beyond a narrow set of prior science-specific and academic experiences. Unfortunately, discussions of identity in science education

emphasize the formation and evolution of science teacher identities in a professional sense. Even when research takes a dialogical perspective, discussions of science teachers' identities focus on education-specific experiences and contexts almost exclusively (Luehmann, 2007; Avraamidou, 2014). Since reform happens in classrooms, approaches to three-dimensional instruction demand research that understands the teachers responsible and how they approach reform-based three-dimensional instruction (Avraamidou, 2014, 2016; Hopkins et al., 2015; Mansour, 2010; Roth, 2016; Sloan, 2006; Zembal-Saul, 2016).

Purpose of the Study

Teachers enact and negotiate their identities in the daily, ongoing classroom-level experiences, not just in their initial development of those identities. To better understand the impact of identity negotiations on teachers' instructional choices requires greater breadth and depth of research on identity of science teachers as whole people (Gee, 2000; Zembylas, 2018). Despite the substantial body of literature related to science education reform, science teacher response to reform, and science teacher identity in general, the field lacks an exploration of (a) how those elements interact with one another; and (b) how those elements may impact pedagogy in routine decisions made in K-12 science classrooms. For three-dimensional instruction to be a successful, approach to reform must be flexible enough to create space for all teachers to teach in ways which align with their beliefs and experiences without sacrificing the integrity of student learning. My research sits in this gap between what we know about teachers' implementation of three-dimensional teaching at scale (Anderson, et al., 2017; Avraamidou, 2014) and the ways in which the science education literature narrowly frames identity as explicitly "science teacher" rather than more holistically (Avraamidou, 2019; Zembal-Saul, 2016).

As we push for three-dimensional instruction and a shift to reform-based practice and reform-minded teachers, we continue to do so without the apparent consideration of what we are asking of teachers. Given the emphasis on equity for students in science within the Framework and NGSS, it seems productive to utilize positionality and intersectional diversity to investigate identity. Understanding teacher identity serves as a way to engage student identities to achieve genuine equity in science classrooms. As an equity concern, bringing specific elements of identity to bear provides lenses through which to question the structural power and cultural values in science that perpetuate inequity in science education (Allaire, 2013).

Reform becomes inseparable from identity in science classrooms, particularly regarding current assumptions of three-dimensional instruction. *Who* teaches impacts *how* and *what* they teach. If we as a community want science education reform to succeed, then teachers need explicit space in research and practice to choose effective instructional practices that honor their identities and impact students for the better. “An educator’s gender, nationality, language and interests among other tenets all permeate the classroom field and coexist alongside the professional role identity" (Grimes, 2013, p. 33). For teachers of diverse identities and experiences to enact change in their classrooms, they must have freedom to teach with practices that validate and represent them. In considering the voices of teachers, my interests lie in understanding how the experiences and identities of individuals impact the choices they make in their classrooms. Specifically, I want to explore the ways teachers’ identity experiences relate to how they choose to approach science instruction in the context of the distinct sociocultural tensions outside the classroom which impact their instructional decisions.

Research Questions

This narrative inquiry study will explore the ways in which secondary science teachers bring their whole-person identity into their classroom instructional practices by answering the following question: In what ways do secondary science teachers represent their personal identity while enacting research-based practices?

Significance of the Study

Navigating historic events within the classroom is not itself unique, but teachers have not had to contend with the particular combination of significant racial tensions, strongly polarized political unrest, and a global pandemic simultaneous with widespread anti-science sentiment. Furthermore, science is not a culturally neutral endeavor. This is apparent in the politicization of issues of global climate change, public debates on the nature of sex and gender, the very existence of a public belief that the Coronavirus pandemic is a hoax or conspiracy, and ongoing issues of diversity and representation within science. Public discourse reveals the persistence of the "us vs. them" mentality reinvigorated post-9/11 (Lipman, 2006), with science often politicized and caught in the crossfire. Given this intersection of science and the sociopolitical tensions currently at play, it stands to reason that this out-of-school context might exert a significant influence on what teachers prioritize, especially as it relates to their personal identities.

Standardization of science education in the interest of progress toward churning out productive citizens essentially removes teachers as active agents in their own careers (Pinar, 2012). If we value teachers and/or want science reform efforts to be successful and anti-oppressive, then failing to consider the complex identities of teachers in the discussion of instructional decisions suggests another reform failure. Without acknowledging teacher positionality and lived experiences, we miss an opportunity to make three-dimensional

instruction a tool for teacher agency, risking the silence of already marginalized teacher voices in the educational dialogue (Rivera Maulucci & Moore, 2015). By continuing to overlook teacher positionality as (a) a contributing factor to reform implementation and (b) as simply another element of "science teacher" identity, represents a challenge to broad adoption of three-dimensional teaching and learning.

Assumptions, Limitations, and Delimitations

The most fundamental assumption of my research is that there is a relationship between teachers' instructional practices and facets of their identity beyond a narrowly defined science teacher identity. I am also assuming as part of the narrative inquiry that participants are both honest and thorough in the stories they share, and that their stories are accurate recollections of past events and experiences. Likewise, such reflective work assumes a degree of self-awareness from teachers about their practice and ability to reflect upon their motivation.

One limitation of this research is the breadth of teacher experiences contributing to the data. Given the complexity of teacher identities, my work only captures a small selection of the varied experiences of science teachers. Likewise, by focusing on secondary science teachers, my work misses the unique experiences of elementary science teachers who often enact multiple content-specific professional identities. Teacher educators are also excluded from this study. Though research into the identities of science teacher educators exists, their roles at the university level are too far removed from the enactment of reform at the classroom level. Through my research I examined the experience of identity in practice in a classroom without considering identity development or the psychological underpinnings of identity. Furthermore, the goal of this study is not to examine or recommend specific applications of findings (e.g., professional development considerations, support for teacher identity development).

Conclusion

Current science education reform efforts seek to engage students in authentic scientific practice through meaningful exploration of natural phenomena in alignment with our current understandings of how students best learn. However, as reform progresses and more states adopt the NGSS and similar standards so too does the assumption that teachers are fully on board with the change. The unspoken expectation is that eventually everyone will use research-based instructional practices, three-dimensional instruction in particular, without consideration for the preferences of teachers themselves. Research documents the ways in which teacher identity impacts the instructional decisions made within their classrooms and the way these decisions drive the success or failure of education reform measures. In science education research, science teacher identity is narrowly defined and often neglects consideration of the complex identities of teachers beyond their science-specific experiences. For reform to succeed, it must be implemented by teachers in ways which honors their diverse experiences rather than as a one-size-fits-all approach. To make space for all teachers in the process of reform, we need a better understanding of the interplay between their whole-person identities and their practice.

Chapter 2

The current science education reform movement around the Next Generation Science Standards (NGSS) requires significantly different approaches to instruction than in previous reforms in K-12 science education to effectively utilize standards for instruction (Krajcik et al., 2014). The proposed instructional approach, dubbed three-dimensional instruction embodies the paradigm shift in expectations of how teachers should teach. Three-dimensional instruction is a research-based, constructivist reform concept, emphasizing the need for students to wrestle with concepts with multiple lenses simultaneously to develop conceptual understanding (Krajcik, 2015; NRC, 2012). Even for those already engaged in constructivist approaches, three-dimensional instruction presents as a lofty goal.

Of the myriad factors which might contribute to curriculum choices, the perspective of teacher identity promises insight into instructional practices. The lived experiences of teachers, their beliefs about reality and knowledge, and their place in the world relative to social contexts interact in the forming and reforming of their identities (Avraamidou, 2019; Zembylas, 2003). The interacting realms of social structures, personal characteristics, and social discourse contribute further to the composition of those identities (Akkerman & Meijer, 2011; Beijaard et al., 2004; Gee, 2000). In the context of social structures in science education, research documents the ways in which teacher identities impact teacher pedagogical decisions (Avraamidou, 2016; Forbes & Davis, 2008, 2012; Vulliamy et al., 1997; Zembylas, 2016) and their students' successful science practices (Madden and Weibe, 2013). Moreover, other research demonstrates that teacher identity directly impacts reform success (Mansour, 2010; Moore et al., 2002; Sloan, 2006; van Veen et al., 2005). The centrality of teacher identity in choosing to use reform practices in their classrooms suggests a need to focus our attention on those individuals

(Alexakos, 2007). Indeed, this idea is foundational in the vision for implementation of three-dimensional instruction, as noted in *A Framework for K-12 Science Education* (NRC, 2012). This document upon which the NGSS were written notes that for standards and reform to take hold requires that they guide the infrastructure of education down to the classroom (NRC, 2012 p. 241).

Guiding infrastructure becomes problematic, however, when the stance becomes an expectation that teachers utilize a singular instructional approach, as it potentially devalues teachers without personal alignment to those methods (Edwards & Edwards, 2017; Palmer, 1997). The trouble in science education literature lies in the suggestion of A Way of Doing Science (i.e., three-dimensional instruction). Within the research, there appears an assumption that science teachers' identities operate in alignment with The Way of teaching science, which is taken as a foregone conclusion. This problematic assumption disregards the nuance of human experience that influences the differences seen among classrooms. In fact, explicit discussion within science education research, where it exists, acknowledges the impact of teachers' personal qualities, but does so in the generalities of what makes a good science teacher (Bybee, 2014). Limited research discusses this assumption of teacher compliance with science reform practices. Those who call attention to it do so in essentially the same manner of my personal concern. Sloan (2006) described the dialogue as,

> "a mostly mechanistic view of teachers' actions in relation to accountability-related curriculum policies. In each, teachers tend to be portrayed in unidimensional ways. That is to say, both the public discourse and the educational literature presents teachers as mostly passive agents whose teaching behaviors are leveraged (negatively or positively) in seemingly predetermined ways by accountability-related curriculum policies, such as

> rigidly scoped, sequenced, and benchmarked curricula that are vertically aligned, and high-stakes tests" (p.121).

Furthermore, Zembal-Saul (2016) pointed to the trouble of excluding identity in reform-based research and practice, noting that research around reform implementation "frequently include attention to incongruities between the vision and goals of reform and teachers' knowledge, beliefs, and practices" (p. 328). Even in cases that emphasize the necessity of curriculum designed and enacted relative to the diversity of a population, teachers are notably absent from the discussion, with some research going so far as to explicitly emphasize "*classrooms* rather than individual teachers or students as the unit of analysis" (Anderson et al., 2018, p. 1028). This builds upon Palmer's (1997) understanding that when fad/reform methods become prescriptive it leaves "people who teach differently feeling devalued, forcing them to measure up to norms not their own" (p. 16).

My research fills a gap in science education literature. Lucy Avraamidou (2019) in discussing her framework for understanding "science teacher" identity makes a decisive call for

> "future research examining teachers' narrative accounts of their science identities, given the potential value of gaining an understanding about the stories that teachers carry with them and how these stories are nested in larger narratives" (p. 25).

Based on the research available, I am inclined to agree with the gap she identified, as did Forbes and Biggers (2016), who articulated an insufficient research base on "the sense of self with which teachers position themselves within the work of teaching" (p. 131). However, I think a more fundamental question remains in the science teacher identity research. In practice, research framing positionality in the classroom exclusively in the context of science teacher identity presupposes this as the only identity at play in science classrooms. However, others have noted

that this stance fails to represent the complex lived experiences of teachers. Roth (2016) eloquently criticized the way in which identity is considered in science education research:

> "Moreover, saying that I have a science identity when in fact what I do in other areas affects, and is affected by what I do in science teaching...appears to be a considerable misnomer" (p. 296).

Grimes (2013) framed this complexity by pointing out that, "while I remain a science teacher in the classroom each day, I am still all of the other aspects of me and those other identities all coexist" (p. 351), as did Allaire (2013) in his study of Hawaiian science teachers, stating that, "[t]his is not to say that in particular situations participants stop being science teachers or stop being Hawaiian, instead they project which identity they wish to emphasize in a particular situation" (p. 36). Maintaining an assumption that an exclusive science teacher identity exists fails to consider the ways positionality simultaneously factors into the choices teachers make in their classrooms.

To present this in concrete terms, I offer two examples of the impact of my positionality in my curriculum and instruction decisions, independent of my "science teacher" identity, I am both a queer woman and a science teacher. I do not cease to be a queer woman when I step into the classroom any more than I cease being a science teacher when I step out of the classroom. I am at once queer and a teacher, regardless of whether I choose to integrate those facets of my identity as a "queer science teacher." In context of three-dimensional instruction specifically, while still in my 8th-grade class I had to weigh my curriculum and instructional decisions on my health (*Do I have the stamina to see this through to the end three weeks from now, effectively?*) and my capacity for conflict (*Is it worth the battle with these three parents and my cross-content team to frame the lesson in this context?*) on several occasions. Both impacted my classroom

decisions in the short and long term, but neither are part of my sense of self or my development as a science teacher.

Theoretical Framework

Identity is a multifaceted, integrated, ever-changing construct which we enact within different contexts of our lives. The divide between private and public, or personal and public is artificial (Akkerman & Meijer, 2011). Research on teacher identity acknowledges the dialogical nature of identity, specifically that professional identity depends, in part, on non-professional elements of teachers' lives and experiences (Akkerman & Meijer, 2011; Beijaard et al., 2004; Roth, 2016). Performance of identity happens in congruence with other individuals and in multiple other contexts (Butler, 2005), which creates difficulty in assessing precisely what constitutes an identity. How one engages within different social spheres varies depending on what aspects of "self" are salient for the context. Identity might be thought of like a wardrobe. Our clothing choices vary depending on where we intend to go and with whom we intend to interact; but changing our clothes does not make our body equally interchangeable, and the clothing continues to exist when we remove it from our bodies. Likewise, though we may present different aspects of ourselves—perform different roles—the rest of what comprises our identity continues to exist.

In practice, awareness of identity ("identity consciousness") on the part of an individual "requires something similar to the advice given when trying to look at a very dim star: don't look right at it, and you will catch a glimpse. Multiple glimpses, and you get a sense of the object" (Hoffman-Kipp, 2008, p. 154). Understanding identity in science education requires glimpses to get a sense of all the ways in which research literature conceives of it. Much of the science education literature emphasizes the development of a science teacher identity, specifically.

However, artificially distinguishing between a professional science identity and the personal dimensions of a science teacher's identity adds an unnecessary layer to the already complex challenge of identity research. To facilitate a better understanding of teacher identity, I utilize theories of positionality and identity as a form of freedom.

Positionality

Positionality at its most basic refers to the sociocultural elements of who someone is which impact their place in the world (e.g., gender, race, orientation, class), and serves as a useful perspective on identity to explore teacher curriculum choices (Johnson-Bailey & Cervo, 2000; Johnson-Bailey, 2003; Moore, 2016). The concept of a positionality (sometimes referred to as positional identity) comes out of positioning theory, which frames the experience of identity in terms of social relations within different contexts (Harre & van Langenhove, 1991; Holland et al., 1994; McVee, 2011).

The ways in which someone positions themselves, or is understood from a position, in relation to their sociocultural context is a means of constructing personal stories (Harre & van Langenhove, 1991; McVee 2011). In terms of narratives, positions help locate an individual in the discourse inherent in their stories (Knight, 2011), as positions are inherent to those stories (McVee, 2011). It is the space in which their experiences are performed, located in a given context (Harre & van Langenhove, 1991). In cases of self-positioning, wherein one expresses their identity, individuals exercise their agency, unique perspective, or personal biography to make their position public. This can be voluntary or forced, the latter in education by various demands, expectations, and role definitions imposed upon an individual (Harre & van Langenhove, 1991).

Furthermore, and specifically regarding educational research, examining position helps us describe the factors contributing to the forced positioning, the consequence of such positions (McVee, 2011), and the particularities of the curriculum decisions within teachers' experiences (Clandinin, 2006). In science education in particular, the study of identity from a discursive stance allows one to use narrative as the "carrier of knowledge and identity" (Lee, 2012, p. 38), a construction which also contributes to one's self-positioning within their own storied experience (McVee, 2011).

In terms of positionality specifically, several functional definitions exist, all of which shed some informative light on its use as a science education lens. Coldron and Smith (1999) framed positionality as relational, defining people in terms of "where and who they are by knowing their `proper' relation to others" (p. 713). Though her conversation centers on authorship and artistry embedded in culture, Maxine Greene (1972a) described this phenomenon as a space wherein cultural limitations intersect with and influence personal perspectives and feelings (p.167). In parallel, Seiler (2011) referred to identities enacted out of school—those which would fall within a formal definition of positionality—with the helpful shorthand of "who she is for herself" (p. 30). Who someone is for themselves does not exist outside of the context of relative sociopolitical structures. This generalized sense of positionality is one in which position is relative to the interconnections among fixed traits (i.e., skin color, physical identifiers), biographical experiences, and emotions that make up the lived experience of "self" (Palmer, 1997). Additionally, the context within which a teacher operates might define their positional identity without their own choosing (Rivera Malucci, 2013; Stapleton, 2015), sometimes described as "forced positioning" (Harre & van Langenhove, 1991).

Pinar (2012) pointed out some of these positional elements "are by definition de-individuating, always informed by stereotypes, and reproduced by ritual" (p. 207). This stance is not contrary to examining positionality in science instruction; in keeping with theme, understanding this sociocultural structure allows us to approach the curriculum from a social reconstructionist frame. The knowledge of most worth in this context are "ideas...and knowledge that encourage us to articulate what is at stake not only for us as teachers and students, but as persons struggling to understand what we experience" (p. 210).

"In the context of science education, positionality shapes how teachers think about the purpose, role, and significance of science to themselves and their students" (Teo, 2015, p.382). Positional identity influences how teachers mediate their sense of self and their professional image (teaching to a school's sociocultural expectations), and how they negotiate their positionality in their classroom (Ryder, 2015; Teo, 2015). Takacs (2003) summarized it neatly, noting that when we understand our positionality, we "come to know the world more fully by knowing how we know the world" (p. 29).

Positionality also shapes teacher epistemology through their unique experience of living in that the way one knows the world develops through their experience of it (Takacs, 2003, Schommer-Aikins, 2004; Avci, 2016). Teacher epistemology directly impacts teacher and student learning and instructional practices, including assessment (Schommer-Aikins, 2004; Green & Hood, 2013; Knight et al., 2014). Research indicates that teachers' epistemological beliefs about the nature of science relate to their instruction, including whether they help students develop an accurate understanding of how science works (Barnes et al., 2013); and constructivist ideologies correlate with deeper learning and more sophisticated beliefs about the nature of knowledge (Green & Hood, 2013). Since three-dimensional pedagogy draws from a

constructivist theoretical framework, whether or not teachers engage in three-dimensional teaching may depend strongly on whether they hold a similar epistemology.

Identity Perspectives

This research draws on Gee's (2000) four perspectives on identity—nature, institutional, discourse, and affinity identities—to frame the discussion of positionality in teacher experience. Nature identity refers to characteristics which can be attributed to our biological experiences and development (e.g., being a twin, the color of our skin). Institutional identities are those ascribed to us through the sociocultural institutions in which we operate. Discourse identities are the traits or characteristics of self which are given meaning by social discourse (e.g., charismatic). Finally, affinity identities are those that develop from the things for which we have an affinity or interest (e.g., music, birding, etc.). Positionality, in its various definitions, may operate in a teachers' experience in any of the four realms. In combination with Gee's (2000) approach, I also make use of Clandinin and Connelly's (2000) framework of three-dimensional narrative inquiry space. Under this framework, studies of identity are, (a) temporally situated in the context of one's personal narrative history, (b) formed in space where personal and social meet, and (c) situated in specific places which provide additional context for performance of identity.

Identity as Resistance to Invisibility. As positionality serves as a frame of reference within social contexts, it too can serve as a means to maintain the visibility of teacher identity. Identity formation requires both self-recognition and recognition by others (Butler, 2005; Luehmann, 2008). Butler (2005) devoted an entire book to the variety of theoretical stances regarding the "self" or personal identity. Through discourse with philosophical texts (Foucault, 1977, 1982) she outlined the necessity of another party for the very existence of oneself. Gee (2000) in discussion of teacher identity specifically, describing the recognition of self and others

as necessary for the formation of identity. There is no identity without giving “an account of oneself” to another (Butler, 2005, p.?).

Building upon the sense of recognition as a requirement for identity, Greene (1972b) related the recognition of self to visibility, noting that “in the struggle for visibility, to access to self-awareness is to regain one’s own biography, to discover one’s own true vantage point, one’s own biography, to recover possession of oneself” (p. 65). The ability to take back our self-identities counters the risk of conforming to a role—a forced position—that compartmentalizes us and “severs relationships” (Cooper & Olson, 1996, p. 84). The fracture of self from role (i.e., the loss of self in the name of teacher) makes it so that we lack the closeness demanded of meaningful relationships among people in context wherein the facets of our identities form (Cooper & Olson, 1996). By knowing self, by reclaiming our self-identity, we demand space for our own "capacity to surpass the given and look at things as if they could be otherwise” (Greene, 1988, p. 3).

Palmer (1997) stressed how central identity is to teaching. Without a strong sense of self, a teacher cannot fully embrace their content or their students. From the stories of students, Palmer (1997) painted a picture of a “good teacher” as someone who, regardless of their particular instructional practices, “teach from an integral and undivided self” (p. 16). Freedom is enacted through the identification of obstacles and the motion to overcome them. As teachers remain standardized in their instructional practices, many stop striving to surpass and see things as they could be otherwise (Au, 2013). Therefore, if our primary educational concern is ultimately rooted in student success, then teachers' sense of self must remain within the realm of their teaching experience.

Boundary Crossing. Bringing to bear one's whole person identity in instruction requires some degree of boundary crossing, wherein their personal self comes in contact with the professional space of a classroom. This is not to suggest a strong dichotomy between the two, in terms of identity, only to note that contextually the school is a distinct physical and social space into which one moves. Boundaries are a dialogical space (Akkerman & Bakker, 2011) where multiple perspectives engage with one another. In this way, the whole-person identity in the classroom represents a dialogue among the various facets of someone's identity, their professional practices, and the ways in which these intersect. To cross boundaries, then, is an act of becoming (Rule, 2011).

Teacher Identity, Pedagogy, and Reform. Research details the ways science teacher identities influence their instructional decisions (Avraamidou, 2016; Hankins & Yarborough, 2009; Zembylas, 2016). The stress of high-stakes testing control (Au, 2007) and the general disregard for teachers' experience, expertise, and intellect (Giroux, 1985) produce a context which puts their teacher identity at risk. Zembylas (2003) noted specifically that, "if teachers are denied recognition, this may cause them to internalize a demeaning image of themselves" (p. 223). This poor view of self and reduced self-efficacy may further impact the successful implementation of reform measures, regardless of teachers' willingness.

Prior research also suggests that teacher identity plays a role in the execution of reform efforts (Czerniak & Lumpe, 1996; Southerland et al., 2010; Zembylas & Bulmahn Barker, 2007). Failing to acknowledge teachers' lived experiences silences their contributions to the larger science education dialogue and reinforces marginalization of these identities (Rivera Maulucci & Moore, 2015). Continuing to leave teacher identity out of the overall discussion of science pedagogy represents a challenge to broad adoption of research-based teaching and learning.

To fully understand teachers' choices in practice requires a broader view of who teachers are and how they negotiate their identity experience (Gee, 2000; Zembylas, 2016). Acknowledging that, my consideration turns toward the complicated influences of sociocultural structures, how they act to constrain the ways in which someone is able to conceptualize or perform their identity (Greene, 1972a), and how teachers resist (or accept) the tendency of accountability culture to silence individuality. Resistance lives in awareness of oneself (Greene, 1972a) and the capacity it provides to use that closely held self to imagine possibilities (Greene, 1988), fully invest in their practices as a teacher, and to maintain the vital relationships necessary for authentic teaching and student learning (Cooper & Olson, 1996; Palmer, 1997). Teachers who feel their personal stances and practice misalign with science reform assumptions experience pedagogical discontentment, which further informs their ongoing pedagogical decisions (Kahveci et al., 2017; Southerland et al. 2011).

Review of Research

I sought to answer two questions with this literature review: (a) How is positionality described in science education literature, and (b) what is the impact of positionality on science teachers in the context of their work? Positionality per se is not widely discussed in the literature, so for the purpose of the review I considered any discussion of science teacher's identities regardless of whether or not the authors used the terminology explicitly.

Search Description

Sources were: a) retained from an earlier literature review I completed on science teacher identity; b) collected from the reference sections of several key sources; c) and acquired through Boolean searches on ERIC (EBSCO) database through the University of Oklahoma Library system, directly through several key education and science education journals previously

identified in Avraamdiou's (2014) review of science teacher identity (*Journal of Teacher Education*, *Journal of Research in Science Teaching*, *Science Education*, *Cultural Studies of Science Education*, *International Journal of Science Education*, J*ournal of Science Teacher Education*, *Journal of the Learning Sciences*, *Research in Science Education*, and *Science and Education*), and Google Scholar. For each database I used combinations of "identity" and "positionality" in titles and abstracts and included "science teacher" as an additional filter on ERIC and Google Scholar to keep results in-field.

Classification for Analysis

I classified sources by research method, data sources, grade level (elementary, grades K-5, if specified; secondary, grades 6-12), certification status (pre-service, in-service), and types of positionality. Studies addressing post-secondary science education, teacher educators, studies of elementary classrooms without a science-specific focus, and studies that examined identity but made no connection to an educator's perspectives or practice in their classrooms were excluded.

Findings

In total, 30 sources fit my search criteria and consider teachers from pre-service to in-service certification across both elementary and secondary grade levels (Table 1). Few studies explicitly referred to positionality or positional identity, but I have chosen to use the term positionality across all studies for consistency.

I identified ten different categories of positionality used in combinations across these studies: (a) race and ethnicity, (b) gender, (c) immigrant identity, (d) cultural values, (e) religion and spirituality, (f) affinities, (g) beliefs, (h) personality, (i) personal life, and (j) biographical experiences. The first five categories are clearly bounded and easily identifiable based on teacher self-reporting, while the latter five are composite or emergent categories. Affinities includes

hobbies, interests, and self-identification of science as deeply meaningful or at the core of one's identity. Beliefs is a broader category to include the stances and attitudes of participants for which there was only a single example in the category, which includes political views; moral stances; and beliefs about students, learning generally, or inclusion of Creationism in instruction. Personality refers to teacher self-identified personal characteristics (e.g., compassionate, self-sufficient). The personal life category addresses out-of-school experiences of teachers during the research period. In comparison, biographical experiences refer to teachers' stories of any events and experiences which occurred prior to the research period.

Table 1

Comparison of Grade Level and Certification Status Among Sources

Certification	Elementary	Secondary	Total
Pre-service	3	7	10
In-service	4	14	18
Pre- to in-service	1	2	3
Total	8[a]	23	30

[a]One teacher's grade level was unspecified, but the researcher biography noted their work with elementary pre-service educators, so classification is assumed

Within the identified research positionality primarily impacts science teacher identity, relationships with students, and perspectives and practice. Depending on the focus of a given study, these impacts overlap to some extent, but I attempt to address each discretely to give a clear picture of what patterns exist. The category of science teacher identity includes teachers' definitions, development, and experience in practice of their science teacher identity. I considered both descriptions of how teachers describe their intended interactions with students as

well as the actual ways in which they engaged with their students. The final category contains three components: teachers' instructional practices, teachers' views and theoretical stances on education (perceptions), and the interaction between perceptions and practice. While educational perspectives and practice are discussed independently in the literature, many sources identified a relationship between the two, wherein perspectives often influence practice in the literature. As such, I determined they should be discussed together.

Positionality and Science Teacher Identity. The complex relationship between positionality and science teacher identity appears in the literature primarily as a fluid negotiation of different identities within context, and to a lesser degree, the impact of interacting positionalities, and the conscious attempt to integrate positionality and science teacher identity.

Avraamidou (2019) developed a framework for science teacher identity formation during a study of the various contexts ("figured worlds") from which teachers constructed their autobiographies and science teaching philosophies. The preservice teachers drew upon their childhood, academic, scientific, professional, and positional experiences, which, along with their emotions, agency, sense of self, and various knowledge forms interacted to shape their science teacher identity. Different aspects of these experiences became more or less salient across time and context. Allaire (2013) found similar results in his study of the identities of native Hawaiian science teachers. He described teachers' "pluralistic identities" (p. 35) as a fluid relationship between their Hawaiian identity and their science teacher identity. This fluidity emerged as teachers identified which part of their identity is most salient and to what degree and enact those relevant aspects within context. As in Avraamidou's (2019) study, the shift among positionalities was not always a conscious choice.

Kozoll and Osborne (2006) explored the impact of one pre-service teacher's early science experiences on his science teacher identity. These experiences were inseparable from the teacher's positionality, as he told all of his stories through the lenses of family, Jamaican culture, and class. The complex relationship between his positionality and science experiences together shaped his science teacher identity. Childhood experiences also a shaped one beginning teacher's science teacher identity at the outset of his teaching, where tinkering and creating toys translate to his own views about what a physics teacher ought to be able to do (Wei et al., 2019). Furthermore, the interaction of these biographical experiences with his practical experience teaching science supported the ongoing evolution of his science teacher identity over time. Personal characteristics (e.g., adaptability), academic stances, and professional factors interacted to establish and develop the identities of teachers who teach out of their fields of training.

For teachers working out of field (i.e., teaching courses for which one has no "undergraduate and teaching qualifications," Hobbs, 2013, p. 278), science teacher identity in the out of field context differed from their regularly experienced science teacher identity in ways that varied across the teachers in the study (Hobbs, 2013). Though they shared significant positionality overlap (e.g., race), the in-service teachers in Moore's (2008) exploration of positional identity did not share much similarity with their science teacher identities. The biographical experiences of the teachers in conjunction with their experiences of race and gender uniquely shaped the science teacher identities of participants.

In their study of a first-year chemistry teacher, Volkmann and Anderson (1998) documented her struggle to integrate her personal and professional faces. In their work, the face one wears "communicates to others who we are" (p. 296), and the faces of the teacher in this study align with the personal life and biographical experiences categories of positionality I

identified. Ultimately the teacher reconciled her positionality and science teacher identity through the use of metaphors. For one middle school science teacher, the act of blogging allowed her to consciously integrate her personal life into her science teacher identity (Luehmann, 2008).

Positionality and Student Relationships. Regarding teacher relationships with their students, positionality becomes apparent in direct connections. The results of these studies draw a clear link between positionality and the specific ways teachers engage their students. In two cases, female teachers' own experiences with gender, particularly as it intersects with science and science education, shaped their relationships with female students in theory and in practice. For a pre-service teacher this emerged as a conscious choice to being a female role model for her students (Avraamidou, 2014), and for an in-service teacher it manifested as the conscious and unconscious ways in which she engaged girls and boys in her class (Zapata & Gallard, 2007). Two separate studies of Caribbean teachers reported on how positionality impacts relationships with students. In the first, Caribbean teachers who engaged in "personally engaged pedagogy" (bringing the whole-person identity of a teacher to bear in practice) built meaningful relationships with students through practices that honored the experiences and identities of both the teacher and students (Seiler, 2011). In her autoethnography, Grimes (2013) discussed the ways in which she as an Afro-Caribbean teacher differentially built relationships and changed the nuance of her interactions with students based on their experiences with other Afro-Caribbean women (primarily as nannies). Marco-Bujosa's (2023) work with a Jamaican secondary science teacher illustrated a tension between her conception of education inequity from her cultural background and the context of an urban classroom in the United States. Her approach to tackling inequity was through greater emphasis on content and de-emphasizing relationship-building, which made her less receptive to the specific needs of her students early in

her first years in the classroom. Combinations of self-identified positionalities (e.g., race, gender, immigrant identity) also shaped how pre-service teachers imagined their identities would impact their future relationships with students (Moore, 2012). They saw their identities as resources to support students as they learned to see themselves in science.

Though less proximal than the aforementioned studies, childhood experiences also contributed directly to teacher-student relationships Positive childhood experiences engaging in exploration with her father shaped one teacher's desire to provide students with similar experiences (Alexakos, 2007). In her interactions with young students the teacher consciously cultivated a learning environment that supported opportunities to experience science in enriching ways. Conversely, negative experience with her own teachers in middle school informed the boundaries she drew around appropriate student-teacher relationships with older students. She also made respect for students a priority in her classroom to prevent them from the discouraging messages she received in school science.

Positionality, Perspectives, and Practice.

Perspectives. The relationships between teachers and their biographical experiences, their observable positionality (e.g., gender), and beliefs informed the kind of educational stances and views about what a teacher ought to be that teachers brought to their classrooms. Spirituality, morality, and ethics underpin part of this group of studies. In these cases, a teacher's personal moral beliefs or ethical views of the world become part of their views of science education. Personal spiritual and moral beliefs shaped teaching philosophy (Alexakos, 2007) and epistemology (Helms 1998). Alexakos (2007) identified the "teacher as a moral agent whose purpose and agenda transcends the classroom and the content taught" (p. 894) as part of a broader commentary on the teacher as an organic link for students to science. Helms (1998)

examined teacher epistemology through their understanding of the nature of science. Perhaps unsurprisingly, teachers' religious and spiritual convictions strongly aligned with their nature of science understanding. Just as his childhood experiences, culture, and class shaped his science teacher identity, the positionality of the Jamaican student from Kozoll and Osborne's (2006) work shaped his view of science as a way of understanding and an "ethic of caring" through exploration of the natural world (p. 178). From his perspective, the act of observing an environment carries an inherent care for that space.

Positionalities associated with race, gender, and immigrant identity also strongly shaped teacher perspectives. These views overlap with student relationships and, to a lesser extent, practice but not in enough specificity or detail for me to consider them fitting better in one of those two categories. In Moore's (2008) of positionality, one teacher in particular discussed how her childhood experiences as "a little Black girl" (p. 693) compelled her to share her knowledge and experiences with her students. Through science, she hoped that sharing in this way would encourage more African American students to pursue science. Components of one pre-service teacher's core identity of being an immigrant and an English language learner (ELL) herself as a student directly impacted her views of education in complicated ways (Rivera Malucci, 2008). Her experience in her pre-internship placement school made apparent ways school structures and practices affirmed or reduced power of students with identities similar to hers and further shaped her views on the role of language in science classrooms. While most studies addressing racial positionality do so from a non-dominant lens, Gomez et al. (2017) studied the changing views of a pre-service teacher as she grew increasingly aware of her whiteness. As her understanding of race in school and in the broader sociopolitical context became more complex, she stopped

viewing science as a neutral endeavor and her expressed approach to science instruction became more inclusive.

Practice. Studies that explicitly explored the relationship between identity and practice demonstrate a consistent relationship between teachers' positionality and classroom practice. Teachers' prior racial, ethnic, and cultural experiences tend to translate into practices that explicitly affirm students of similar positionality, and strong affinity positionality shapes teachers' practice in ways that draw upon those interests.

Edwards and Edwards (2017) shared the story of a teacher whose bicultural upbringing and school experiences shaped his own classroom practice. His experiences as a student in classrooms that valued his Maori identity and traditions led him to purposefully selected instructional strategies that created a supportive classroom environment through the use of oral assessments. This approach explicitly valued Maori student traditions and served to promote the expression of all students' ideas. In a vignette of one Caribbean African American teacher, Seiler (2011) described the transformation of the teacher's pre-service classroom instruction when she began incorporating her positionality into her practice. The introduction of call and response storytelling (cultural practice), and familiar gestures (religious experience) elicited enthusiastic participation and conceptual understanding from students after a rocky start using stiffer, more traditional science instructional practices. In Zapata and Gallard's (2007) study of one teacher's gendered interactions with students, the teacher's commitment to supporting girls in the science classroom was regularly undermined by her own instructional practices. Though she intended to affirm and improve science self-efficacy of her female students, she tended to engage in the kinds of entrenched practices (e.g., praising boys more than girls for their ideas) that contribute

to girls' low self-efficacy. In this case, positionality did influence practice, but not always in the well-intentioned ways the teacher intended.

For teachers working out of field, the strength of their out of field feelings, combined with affinities and their personalities, influenced the ways in which they navigated curriculum use, instructional practices, and what aspects of teaching they prioritized (e.g., focus on providing content, attempts to teach with grade-appropriate strategies; Hobbs, 2013). As with the impact of biographical experiences on teacher identity, the complex interplay of positionality and context made each teacher's instructional practice and experience unique. Two studies addressed research-based practice and its relationship with positionality. At a school for deaf children a language teacher was moved into a science specialist position, a role for which she lacked experience and expressed a low sense of self-efficacy (Marco-Bujosa et al., 2020). Due to her discomfort with her new placement, the teacher continued to centralize language in her instruction. However, this ongoing identification as a teacher of language first, in combination with strong reform-based curriculum, resulted in strong science discourse practices in her classroom. Madden and Wiebe (2013) provided an interesting account of the use of science notebooks with elementary students. Though all three teachers in the study used science notebooks, they attributed the differences in overall student experience and degree of successful use of notebooks to variation among the teachers' science affinity.

Perspective on Practice. The research that in some way addresses the relationship between perspectives and practice varies substantially in what that relationship entailed. Broadly, teachers' race/ethnicity, culture, biographical experiences, science affinity, and beliefs about learning all shaped teachers' views of science education and subsequently influenced their practice accordingly.

In work by Brand and Glasson (2004), teachers described their early experiences with race, ethnicity, and/or class and explored how that shaped their views on multicultural education and subsequent instructional practices. For the two teachers who held neutral and negative views of multicultural education each taught with a more traditional teacher transmission approach, seeing science as a neutral endeavor that simply required students to understand content. The third teacher expressed a personal commitment to multicultural education, vis-à-vis making dominant sociopolitical structures visible to students. His specific approaches to instruction varied depending on the racial/ethnic makeup of each of his classes wherein he emphasized revealing oppressive structures to his African American students in addition to conceptual learning and skipped over those social structure discussions with his white students. (Brand & Glasson, 2004). Another teacher's negative experiences with an oppressive sociocultural system shaped his instructional choices, so too did a teacher who lived through apartheid in South Africa (Jita, 2004). This teacher connected with his own experience to bring an activist stance to his classroom to undermine what he saw as authoritarian educative practices in his building.

Cultural experiences also shaped the relationship between perspectives and practice for teachers in Taiwan and mainland China. Confucian traditions and cultural values in Taiwan produced conflict for teachers between their beliefs about education and their practices in regard to science education reform. Deeply rooted cultural values and, to a lesser degree, a lack of understanding of reform made efforts to shift pedagogies difficult in essentially every level of interaction (parents, admins, students, etc.; Huang & Asghar, 2018). Moreover, Wei et al. (2019) described the way one teacher's attempt to put his perspectives on science education into practice found himself constrained by sociocultural expectations of school education. The interaction of personal childhood experiences and orientation toward science inquiry contributed to this

teacher's science teacher identity. Though he attempted to use practical and inquiry instruction, social constraints and expectations within his school and community context limited his instructional vision from being realized. Even as his science teacher identity shifted due to context, he remained committed to his beliefs about instruction and ultimately resolved the tension engaging in his preferred instructional practices through extracurricular settings.

Teachers' prior experiences with science throughout their lives, both in and out of academic contexts, directly influence their teaching philosophies and practices. Avraamidou (2016) described the ways in which the biographical experiences and science affinities of several pre-service teachers directly shaped their views of science education which were reflected in their lesson plans. For example, one teacher who saw a necessary connection between people and nature took students outside to explore as part of a microteaching activity. Eick and Reed (2002) described the way teachers' prior experience as learners shaped their own teaching philosophies (or lack thereof) and how this related to their use of inquiry instructional practices. The teacher who struggled to learn and experienced failure as a student believed science needed to have practical relevance and application and engaged students in concrete, collaborative learning experiences. On the other hand, for the teacher with no clear teaching philosophy other than making science fun, science instruction followed traditional lecture and textbook practices with an occasional confirmatory lab. Enyedy et al. (2006) discussed how the interaction of teachers' beliefs about learning and their personal goals for students and a classroom community interact with their pedagogical content knowledge (PCK) to influence their use of inquiry in the classroom.

As was the case within the Practice theme, studies reporting the relationship between perspective and practice also described disconnects between the two. This disconnect is resolved

in complex ways ranging from negotiation of the perception and practice relationship to falling back on positionality at the expense of both perception and practice.

Two teachers in these circumstances experienced moments when their positionality-shaped perspectives produced different instructional practices than expected within the context of a pre-made curriculum (GLOBE). To resolve this incongruence, they negotiated different aspects of their positionality and professional identities in a way that helped them rationalize the disconnect between perception and practice (Enyedy et al., 2006). However, the teacher with a more rigid approach to science instruction (traditional, scientific method) was still less likely to engage in authentic inquiry experiences despite the ways her approaches misaligned with her perspective of science as a collaborative, exploratory practice. Pankratius (1995) also told the story of one pre-service teacher who entered her placement school with the personal belief that creationism should be taught in a biology classroom. However, through her constructivist course work and observations in classrooms, she ultimately determined that teaching creationism in science was not appropriate. She reframed her approach from a logical perspective and chose to disregard her personal feelings on the matter. Pankratius did not discuss what underpinned this teacher's belief, only that it existed and appeared to still exist to some degree despite the changes she made to her practice.

Disconnect between positionality and social justice-aligned practices came up twice in my review, in pre-service and in-service. The pre-service teacher entered her education program with a strong social justice orientation stemming from her background as a self-identified poor black woman. However, she expressed ambivalence about and some resistance toward actual instructional practice necessary for a social justice-aligned classroom (Rivera Malucci, 2013). Becoming aware of the disconnect, this teacher eventually did shift her instructional practices to

align with her perception. Similarly, Teo (2015) shared the stories of two in-service teachers with strong beliefs about their positionality in relation to STEM; however, these beliefs did not shape either teacher's perception as they saw their positionality as necessary to their classroom practice. The lack of this positionality consequently left one teacher to reconstruct the very power hierarchies in her classroom that she criticized in STEM writ large (Teo, 2015). Another study examined how a beginning chemistry teacher navigated the discrepancy between perspective and practice (Saka et al., 2012). Positionality in this study falls loosely under the affinity category, but I chose to retain it because it explicitly considers research-based practice as I have defined it. This teacher entered his classroom with a strong "reform-minded" perspective (p. 1226). Unfortunately, conflicts with veteran teachers in his building who disagreed with his approach coupled with the stress of being a new teacher led him to fall back on his positionality and abandon his reform-minded approach. According to the teacher, "my personality is more important than how good of a teacher I am" (p. 1233).

Discussion

Teachers with a strong sense of their positionality describe their science teaching when discussing their non-school lives, and their non-school lives while describing their science teaching (Alexakos, 2007; Grimes, 2013; Helms, 1998). In effect, these teachers live a singular identity without a clear separation of their personal life from their professional. Positionality must be made available to the teacher to be of any value beyond a concept. Teacher awareness of how their positionality interacts with their teaching experience can lead to changes in instruction (Brand & Glasson, 2004; Gomez et al., 2007; Rivera Malucci, 2013; Seiler, 2011). Connecting with one's positionality explicitly helped teachers match their identities as people with their teaching identities (Rivera Malucci, 2008; Seiler, 2011), develop meaningful relationships with

students (Allaire, 2013; Grimes, 2013), and led teachers to orient their instruction toward liberatory, equitable practices (Edwards & Edwards, 2017; Jita, 2004; Rivera Malucci, 2013). Teachers struggling to negotiate their identities made greater progress toward an integrated or bridging identity when considering how their positionality interacted with their context (Avraamidou, 2014; Moore, 2012; Volkmann & Anderson, 1998). Metacognition around this integration dialogue also helps science teachers more clearly define their science teacher identity around reform practices (Luehmann, 2008); and connect with students on a personal level through their shared positionality (ethnicity; Allaire, 2013). In contrast, disconnected (or unexamined) positionality created conflict between belief and the nature of science they are meant to teach (Helms, 1998), their intentions for supporting students (Zapata & Gallard, 2007), reconstruction of power hierarchies (Teo, 2015), and retreat to identities which further separate teachers from their teaching (Saka et al., 2012).

Given the fluidity of identity, to fully understand teachers' choices still requires us to more thoroughly describe who teachers are as people (Gee, 2000; Zembylas, 2016). Perhaps unsurprisingly, positionality itself is insufficient to explain science teacher identity and the interplay of context must be taken into consideration. Literature currently concerns itself with how teachers' positionality affects their relationship to science teaching, and to a lesser degree how it shapes their choices in instruction. Since reform happens in classrooms (Moore et al., 2002; van Veen et al., 2005), approaches to three-dimensional instruction demand research that understands the teachers (Avraamidou, 2014, 2016; Sloan, 2006; Roth, 2016; Zembal-Saul, 2016) and how they approach research-based practice. However, Cooper and Olson (1996) contended more than twenty years ago that,

> it is important to be both aware and critical of just exactly what it is that we are asking our children and teachers to become. Failure to do so may result in the continuous perpetuation of a 'prescribed' and passive role, one that ultimately affects us all (87).

As we push for research-based three-dimensional practice and reform-minded teachers, we must take into consideration what we are asking teachers to become.

Chapter 3

Within physical, external reality, our experience of reality depends on who experiences it and what each individual brings to the experience. Creswell and Clark (2017) described this development of knowledge and understanding as being "shaped by social interaction with others and from their own personal histories" (p. 36). Put another way, within this constructivist stance "meaning is not discovered, but constructed" (Crotty 1998, p. 9). Inquiry into individuals' meaning requires an understanding of experiences, whether first-hand or vicarious. We filter our experiences through a variety of lenses at any given point, choosing what stimuli to respond to and what to set aside as irrelevant. These choices shape our narratives of self, both what we internalize in the stories we tell ourselves, and in the way we narrate ourselves to others. To fully understand the extent of some truth requires the qualitative nuances of experience that measurements of external and objective reality cannot convey.

Each person exists as a unique collection of dialogues and experiences which become more or less salient depending on their immediate context. Consequently, our knowledge of reality is shaped by our experience with it. Two science teachers may share the same working reality, the same physical space in the form of a building, including the external structures imposed upon them. However, neither teacher experiences their work in the same way despite otherwise identical physical circumstances (Enyedy et al., 2006). Rather, each engages with their job in a way that represents the way in which all their previous experiences arrived at a given contextual point. Furthermore, their interactions in social contexts must shape their views—perhaps in similar ways between these two educators—but they each reach their own personal understanding of the experience independent of how the other personally experiences it. As a consequence, I take the stance that our lives are storied, constructed narratively as we personally

ascribe meaning that connects our history with our present circumstances (Clandinin, 2013). As such, our immediate experiences of reality exist inseparably from our pasts and our futures, all being connected in a continuous string of story. My aims and review of the literature as viewed through this lens have led me to a qualitative approach with a primary emphasis on narrative for my research.

Research Question

1. In what ways do secondary science teachers represent their personal identity while enacting research-based practices?

Research Design

Specific to this research inquiry, to make sense of the experiences of teachers' identities and their classroom practices requires a small story, the day-to-day experiences of the non-generalizable sort (Vasquez, 2011). Narrative inquiry uses stories situated in people's lived experiences to describe the reality of who they experience themselves to be (Rivera Malucci, 2008). In thinking about science education through a lens of teacher identity, narratives are not objective reality, and they cannot be averaged. While it is perfectly reasonable to assess the breadth of impact (e.g. does impact exist and how much is there?) as one might with quantitative research, in the context of visibility what matters more is the specificity of impact. As such, a purely qualitative approach is most sensible in this case.

This qualitative research study borrowed heavily from a narrative inquiry approach (Clandinin, 2013; Tracy, 2013) to construct the stories of how teachers' identities and practice operate within their classrooms. Clandinin (2013) described narrative inquiry as both a theoretical stance and a methodology. An understanding of stories as the means through which people experience their truths necessitates ontological and epistemological commitments *and*

implies the manner in which inquiry proceeds. “Narrative inquiry is a way of understanding experience” through the stories we use to tell our lived experience (Clandinin & Connelly, 2000, p. 20). Using narrative as the framework and data brings research results much closer to the reality experienced by the teachers who author their own identities and experiences. By examining the autobiographical stories of teachers, I gain the perspective of that individually-constructed experience (subjective truth) and an insider view of the broader context (objective reality). It lends insight into potentially oppressive elements teachers face in their practice of research-based science instruction. Furthermore, the fact that identity is grounded in the “internalized life histories” belonging to both ourselves and others (e.g., policymakers, parents, etc.) “invite[s] autobiographical investigation” (Pinar, 2012, p. 39).

In addition to teachers’ stories of self, I also utilized classroom observations and a science teaching reflection to gain a concrete sense of what their instruction looked like in practice.

Setting

Research was conducted during the 2022-2023 and 2023-2024 school years in two middle schools in central Oklahoma. By chance, both schools had similar size and student demographics (Table 2). One site was at the public middle school of a micropolitan city (population <50,000 people) in a STEM classroom. The second is a public middle school in one of the largest cities in the state. Conversations and interviews with the teachers took place in their classrooms and over Zoom.

Participants

In my review of the literature, sample sizes for narrative studies of science teacher identity included no more than four teachers and tended to include only one or two unless

participants were chosen from part of a larger study. Based on this benchmark, a lack of explicit guidance for sample size selection from seminal work on narrative inquiry (Clandinin & Connelly, 2000), and practical considerations, I selected two teachers to participate in this research. This sample size came as a balance between gaining multiple teachers' stories and the timeliness of my research questions. While more teachers would provide a broader scope of experiences, I was limited by the time investment necessary to engage meaningfully with participants around their personal stories and in their classrooms.

Table 2

School Demographics

School	Students (#)	White	Black	Hispanic	Native	Asian	Two or More
Anywhere Middle School	711	46	6.2	13.9	11.3	<1	22.2
Central Middle School	713	51.3	4.9	20.9	4.6	1.1	17.1

Teachers were selected utilizing a purposeful theoretical sampling approach. Given the deeply personal nature of narrative inquiry, I felt it important to select teachers with whom I had a prior relationship. These existing relationships set up a level of rapport and trust from the beginning, which is an important consideration when asking teachers to share their stories. Since my interest was understanding identity *and* research-based instructional practice, knowing my participants in advance also provided me with an initial sense of the degree to which they use three-dimensional instruction, allowing me to find the stories that address my research question.

Colette. My first participant was selected based on our long-standing prior relationship. I have known Colette since her first year of teaching, at which point she and I were colleagues at an urban middle school. Since then, I have worked with her in a professional capacity through

workshops and programs I facilitated during every step of her teaching career. Additionally, we have been friends over the course of this time, just shy of a decade.

Mariah. My second participant was selected based on our prior relationship through the context of the university. I knew how she was trained as an educator through our program, and we have collaborated together on research with our advisor.

Data Collection

Data were collected from teacher- and researcher-generated sources: interviews, written teacher reflections, classroom observations, and researcher reflections. Three formal interviews were conducted, before class observations, at a midpoint, and after the final class observation. Interviews were a combination of narrative interviews, biographic (life-story) interviews, and semi-structured/unstructured conversations (Appendix A). Narrative interviews elements were conducted as "open-ended, relatively unstructured interviews that encourage participants to tell stories rather than just answer questions" (Tracy, 2013, p. 141). Whereas narrative interviews emphasized the telling of stories around events and experiences, biographic or life-history interviews emphasize the participant discussing their "life as a whole, their memories, and what they want others to know," and provide a more comprehensive picture of the continuous nature of a teacher's identity (Clandinin & Connelly, 2000, p. 141). The combination of these two interview approaches allowed me to situate teacher instructional practices in the context of their lives and specific meaningful events. Additionally, the use of semi-structured interviews about practice and unstructured conversations as they arose, particularly during and after classroom observations, provided real-time context and reflection as teachers' stories unfolded in their classroom practice. During each formal interview, teachers were asked to engage in a Five Whos

exercise in which they answered the question “who are you?” five times and could not repeat answers from previous interviews.

Teachers completed one initial science teaching model reflection exercise which asked them to provide an illustration and written reflections on who they were as science teachers, including their history with science and their personal vision for science education (Appendix B). Additionally, they completed sporadic written reflections which provided context and rationale for instructional practices on the day-to-day scale, by answering the question, “In what ways did you feel your identity was or was not represented in your classroom throughout the week?” As part of this work, teachers were asked to explicitly consider how they bring themselves into their classroom during a given teaching moment under consideration. While the intention was for these to be weekly reflections, teachers completed these instead as time allowed. In addition, one participant provided several unsolicited self-reflections as she thought of things she wanted to share.

The goal of classroom observations was two-fold: to gain an etic perspective of teacher narrative in practice and to establish what research-based practices were present in teachers’ instruction. An observation protocol was created by modifying an existing NGSS Lesson Screener (NGSS Lead States, 2016; Appendix C) which includes a checklist for a variety of NGSS-aligned characteristics. From these I selected criteria which were specific to teacher actions and facilitation behaviors and rephrased them as necessary to remove any student-specific components. In conjunction with field notes during observations, I also maintained my own personal reflective notes during the process of data collection and analysis. As a participant in narrative exchange, I intend the additional view of what occurs in the classroom and my

ongoing reflections to serve both as a form of triangulation and as data upon which to reflect during teacher conversations.

Data Analysis

Narrative is meant in the literal sense of the term, specifically the notion of a plotted story (Clandinin & Connelly, 2000; Polkinghorne, 2006). The use of narrative in this manner fits within the three-dimensional narrative inquiry space (Clandinin & Connelly, 2000) by rooting a personal-social experience in the continuity of the time and context of space (Polkinghorne, 2006). Data were analyzed in two ways: paradigmatic analysis of narrative data and narrative analysis, per Polkinghorne's (2006) definitions. In the former, the narrative served as the data source from which I identified the positional elements of the teachers' identity. In this process, the text was coded to identify positionalities without imposing a priori boundaries on what categories those must fall under. Teacher positionality was taken primarily from their Five Whos responses, with other elements that surfaced through coded themes. Analytic codes were iteratively identified for meaningful chunks of the text (e.g., whole sentences, thoughts). Discrete stories were identified within the text, and the initial codes were compared across stories to find higher level themes and broader narratives.

The narrative analysis involved constructing the story of how teachers experience their positional identities and instructional practices, according to their experiences. Meaningful stories were arranged chronologically for Colette's narrative, because a clear timeline in her identity and instructional experience became apparent throughout the data analysis process. From this arrangement I developed a working narrative that situated her positionality within the historical and spatiotemporal context of the overall story. For Mariah, a chronological arrangement did not produce a coherent narrative. Instead, her narrative was arranged

thematically and sequenced in a way that illustrated the connections among stories. Following the synthesis of storied data, the working narratives were composed into a story which painted a full picture of each teacher's identity experience as it related to their instructional practice.

In re-presenting the teachers' stories, I prioritized their words over my own. Whenever possible, I used their stories as they told them rather than my own interpretation of events. In the following narrative chapters, teacher quotes are formatted in italics to make their voices explicit. These quotes come directly from texts and were modified only for transcript clean up (e.g., removing repeated words, speech fillers) and the occasional replacement of an ambiguous pronoun with its context for clarity (e.g., "it" became "the lesson"). My insertions into the narrative were included to construct the architecture of the story, to summarize or provide context, and to reflect my own observations within their classrooms.

Credibility and Trustworthiness. Creswell (2007) suggested implementing at least two measures of quality control, or credibility enhancement in qualitative research. I used three. As this research was based on deeply personal stories of self and practice, member checking with my participants was paramount. Ongoing results were shared with teachers as positionality was identified, in discussion of classroom observations and narrative, during the construction of the working narrative, and during the final storying process. By checking with the teachers, I ensured that my re-presentation of their stories captured their experiences in a way that was both authentic and resonant. In addition, I triangulated my results from data collected in reflective writing, interviews, and field notes. Finally, employing a narrative analysis approach demands the thick description necessary for establishing qualitative credibility (Cresswell & Clark, 2017; Tracy, 2013). Comparing interviews and written responses added to the trustworthiness of results by deepening my understanding of teacher experiences (Creswell & Clark, 2017).

Ethical Considerations. Engaging in the construction and analysis of narratives with teacher participants involves a high degree of personal interactions. Great care was taken to keep the teachers' identities anonymous through pseudonyms, non-identifying descriptions of their context, and data security for the storage of their narratives. Misrepresentation of stories or treatments of data which becomes disempowering for teachers was also of major concern. Transparency on my part with participants and in analysis, self-reflexivity on my own position relative to my teacher participants, and ongoing member checking helped to guard against these ethical problems. That I have existing relationships with these teachers also served as a layer of trustworthiness, as I had additional context with which to guide my interactions with them.

Conclusion

My research proposed to understand how the whole-person identities of secondary science teachers influenced the research-based instructional decisions they make in their classrooms. By engaging in a narrative inquiry with two teachers with whom I have a preexisting relationship, I re-presented the stories of how their lived experience and histories inform who they are as people and how they bring their identities to bear in their classroom. To accomplish this, I collected interviews (narrative, life-story, semi-structured/unstructured), written reflections (teachers' and my own), and field notes from classroom observations as data to analyze as the basis for two final storied narratives.

Chapter 4

Colette: Kicking and Screaming

Becoming a Science Teacher

"Tell me the story of how you became a science teacher."

"Well, it was very roundabout, and it was sort of kicking and screaming," Colette laughed. She was in good spirits, the day after Christmas, sitting in front of her camera in her living room as we caught up. "And I remember in high school I was like, 'Oh, I am never going to be a teacher ever, ever. Not happening. I don't even like people!'" Even though I knew this part of her story, I still felt a kinship to it. We both came to education through similar paths, a point we bonded over when we first met in 2014. Her background was in biological sciences, and her path to K-12 education looked to me, as an outsider, an inevitable conclusion.

"So how did you end up here? Take me back to the beginning."

I started my bachelors in oceanography. And well, "yes, of course I will be a TA [teaching assistant] for the World Oceans class. But no, I'm still not going to be a teacher, thank you." There were two professors from the Education Department at the University, and they came to observe this World Oceans class, because I think it was one that their students could take. We were doing this exercise where there was a tote that had a seafloor profile, and the students had to do a transect across it to take bathymetric readings. So they were dropping a little weight and measuring the string that was underwater, and they were supposed to then plot these on a graph so they would see what the sea bed looked like.

There was one group that did five random points. I was talking with them. And they were like, "Okay, so how do we do this?"

And I said, "Well. What you have done is like a topographic map, right? So like, you have these points, and you could—"

"Is that what we needed?"

"No."

"Can we use that?"

"No. You're gonna have to go back, and you're gonna have to take five points in a straight line so that you can make this."

And I remember the science professor said, "please tell me you're going to be a science teacher."

She was very disappointed when I told her, "Oh, no, no, never! That's no, no, no, no, no!"

That's my favorite memory, and I really wish I could find these people. But after that experience, I was like, "Oh, I'll be a college professor." So I went on. I got my masters, and I was a TA again, and I loved that. That was a lot of fun. So, you know, I was gonna be a college professor, so I got my PhD. I was in the zoology department at the State University, and kind of not being happy as a science researcher, but seeing it as the means to an end, cause I wanted to be a college professor. And then that just got to the point where that wasn't working out.

And even then*, I would do things with the local school district, and the curriculum director would ask, "When am I gonna get you in a classroom?"*

"That's cute. No. No. Because I'm the crazy aunt of science. I come in. I rile them up, and then I leave, buddy!"

"I decided that, you know, I was not leaving the State University without a PhD, come hell or high water." Colette's whole demeanor changed, grinning. "I had been doing all of this

informal science and teaching, and so knew people in the science education department. I went and talked with them, and they just, like, welcomed me with open arms."

"I want to come back to how you got into science education, but let's detour for a minute. Tell me more about informal science." As it happened, Colette grew up immersed in informal science education.

My family definitely encouraged curiosity, investigation, and new experiences. I played outside a lot, especially around my apartment complex. There was an open "lot" between my building and the next. A sort of greenspace or park in the middle of our ring of buildings, with a pine tree that served as a kind of cave. Even just the juniper bushes along our little porch held a lot to explore. As a kid, I had every collection imaginable. Rock collections, bug collections, fossil collections; even a skeleton I found, that was probably the remains of a previous tenant's parakeet.

When my dad took college courses, he would bring me on his field trips for geology and photography. Hiking, camping, and ranger talks in National and State parks all over the country were extremely common weekend and vacation activities for my family. Also, I would say my mom was an informal educator in that, like, she's the Sunday school teacher. She taught Junior church. She was my Girl Scout leader. She was, you know. When my brother was in Boy, well, Cub Scouts, she was a Den Mother. She did a lot of teaching.

"When I sit back and think about it," she said, "honestly, I have been teaching since high school in some ways. Especially informal science education. I think I mentioned to you the Gold Award and Silver Award." Her Silver and Gold Awards were earned in freshman and senior year, respectively, through the Girl Scout's Career Exploration. Both of these were awards for impressive science education projects.

I did like a science education night as a freshman—or "traveling science shows" is what I called it—where I would do these science shows at younger scout meetings. And then in my senior year of high school we were in Japan and I programmed a summer camp and was the camp leader. "Shell-ebrate an Ocean of Adventure." We did, oh my gosh, five days! Crafts, science lessons, projects, and songs. Your Gold Award has to be community based, like, it can't just be Girl Scouts, so they opened the camp up to girls in the community.

"Let's circle back then to how those experiences connect to where you are now."

I love science, and I love asking questions, and I love being curious. "Oh, why is that happening? Why is this? Why is that? You know, how did the tarantula get into my room? Let's figure this out." As I progressed through a science career, I found that I enjoyed sharing the love of science with other people.

I think initially, when things ended in biology, it was devastating. And I was angry. There were people within the department that I was angry at, because I felt like they didn't really communicate things soon enough. But I also understood, too, that I wasn't happy, and, well, I was at a research university. They weren't interested in creating educators; they were interested in creating researchers, and I was not fulfilling that for them necessarily. So here was the devastation and the anger, but then there was the determination. And for me, a really integral part of that was a faith piece. There was just always this feeling of like, "Well, it's gonna be okay, because whatever is gonna happen is gonna happen. God sees it. God has control of it." And so I think, in a sense, that then freed me to move forward and to say, "Alright, well, I'm gonna go to the people who are my people, who are the educators and who are interested in education." Then, there's a pretty good rebound there, quickly enough that I could keep momentum and move into this new role.

"With the anger gone, how were you feeling at that point?"

Being as finishing the PhD was less traumatic, it's harder to remember. But in some sense, that part was a little bit of mental rest. I had just written a dissertation, and the last thing I wanted to do is to try to be really looking for a position at different universities. But I wanted to have a job, right? I really thought that, at that point, that given my relationships, I was gonna be able to find something without a lot of intense work, in terms of interviews, and applications, and cover letters, and resumes and, "What's your next research gonna be?" By that time it was like, "If you're gonna work in a science education department, you need K through 12 experience." And I said, "Okay," and I got alternatively certified. And then there was the excitement, right, going into the classroom. I think I spent $1,000 that summer getting stuff for the classroom. It was very exciting. It was an exciting time.

I love it. And I don't always feel that the policies of the state are encouraging to teachers, or supportive, thereof, and so that part of that, then, is, like, my political protest. Now it's like, "Oh, go ahead! The only way you're gonna drag me out of this classroom is kicking and screaming!" Kinda, you know, full circle. But yeah, I love it.

Year One

Colette began her foray into formal K-12 education in the fall of 2014 when Urban Middle School offered her a position as an 8th grade science teacher. The department was impressed by both her lengthy CV, the diversity of her experience, and her enthusiasm for science education. That first year of teaching was exceptionally rough, but Colette loved it despite the significant challenges. Amidst the struggles faced by first-year teachers, Colette also dealt with less trivial frustrations, and her response to the conflict was not always constructive.

“People, I swear, don't believe me! I was in a screaming match with a 13 year old. I'm like no, I knocked over a desk.” She explains, “they had to write me up. They had to, because I screamed things that you have to write up teachers for, you know?”

Despite this, Colette persevered through a second year, thanks in no small part to the support system within Urban Middle School’s science department. The 8th grade team was tight-knit, and Colette identified having that team as invaluable to her as a new teacher. Unfortunately, the culture of Urban Middle School deteriorated over the course of her second year after the turnover of three of the four school principals. This served as the impetus for Colette to change schools, moving from the large public district into an urban Charter High School nearby.

This experience, too, was rocky.

While Colette enjoyed the shift to teaching Biology and Forensics in this new environment, her relationship with the head principal never quite connected. The Superintendent hired Colette, without the input of the head principal at the high school, and it laid an unstable professional foundation. From the outset, animosity grew there, despite Colette’s efforts to integrate into the school culture. Even at the classroom level, the instructional approach her principal expected misaligned with the reality of Colette’s teaching, leading to further conflict.

So my principal was a Spanish teacher, right? She would tell me all the time, “Okay, yesterday we went over yo hablo and today we're gonna go over tu hablas. We're focusing on this very specific thing. I'm going to tell you how to do it. You're going to do it the way that I did it, and then you're gonna memorize this.” When that principal would come and evaluate and observe, that was often very difficult.

Colette, after actively seeking out science-specific professional development during summers and academic years, adopted a three-dimensional pedagogical approach in her classroom.

Nothing she did measured up to her principal's expectations, and after three years there, Colette's contract was not renewed. Colette's departure traumatized her professionally. Her principal refused to use her title in the termination paperwork, instead calling her "Mrs." and using only Colette's husband's name rather than her fully hyphenated last name. In the end, the conflict went up to the Superintendent who ultimately settled the paperwork matter: two copies; the incorrect one signed by Colette's admin, and the properly addressed paperwork stapled to it and signed by him.

Anywhere Middle School

Following this, Colette landed in Anywhere Middle School teaching 6th through 8th grade STEM. Hired by one of her former principals at Urban Middle School, Colette has outlasted his tenure at the school and has remained in this position for the past four years. In those first years, Colette found stability and fulfillment. Unlike the negativity under his leadership at Urban Middle School, Colette found herself in a positive culture and climate of Anywhere. Here, she was valued as an educator, encouraged to think big and put in a position with resources and structural support.

In this environment, Colette set out to create the classroom she wanted, one that supported all students. When the room was not redone like she was told would happen, she decided to find the source of funding for that. It took time, but Colette slowly created the modular classroom with alternative seating. She replaced traditional tables with trapezoid-shaped stations and individual adjustable desks with tilting desktops; swapped out some of the

stationary plastic classroom chairs with a variety of desk chairs and some classroom chairs on wheels.

At Anywhere, Colette was asked to teach the Project Lead the Way pre-packaged curriculum, which did not wholly thrill her. "*Let's say I use Project Lead the Way as a framework to sort of set the topic, If you will. I'm thinking about how to engage kids. Like, how can I make this better? How can I make this more worthwhile to them? How can I get them on board?*" The degree to which her classes stuck to the curriculum varied, with most of her decisions based on whether the students would care about the activities and how much guidance they required. Rather than simply show the videos provided with the curriculum, Colette took the things from the videos and the students did them in real life.

"That's nice," she said, laughing. *"We'll see you later. I'm going to strap parachutes to my children, and have them run down the street."*

In the Flight and Space unit with her seventh graders, Colette realized her students did not need to memorize the parts of the airplane; thought that even if she brought out a big foam airplane that she got at the hobby store as an object lesson to point out the parts, to talk about things like yaw and roll, that the students would not care. More importantly, she did not think memorizing that collection of facts met their needs. Instead, they flew drones. In that context, discussing pitch, yaw, and roll with the students meant something. Those concepts had tangible impacts. After early successes with these variations on the curriculum, Colette restructured some of the unit activities to better suit the needs and interests of her students. Within this context, Colette began developing an instructional philosophy that reshaped learning in her classroom.

"What do you mean, 'yes, and'?" her colleague asked when she mentioned it.

"It's an improv thing," she explained. "In improv, whatever happen, you, 'yes, and.' Like, you go with it."

"So it's, like, unplanned?"

"I'm not explaining this right. It's not about wanton permission; it's about being open." She continued, "it isn't just permissiveness with wild abandon, it is purposeful and given parameters."

That was the context in which I began my research with Colette. Between our friendship and the fact that we had already been working together in both professional development and science education research capacity every year since we left Urban Middle School, this was a seamless process.

January 2023

I began visiting her classroom in January of 2023, not long after the start of the spring semester. Like the classroom seating Colette incorporated into her class, flexibility permeated her approach to her teaching as well.

"*I always try and give the kids as much flexibility in, like, how they want to turn things in, whether it's written or audio, or video. I try and give them a lot of choices.*"

This carried through to her instruction as well, necessitated in part by Colette's unusual class structure. As an elective course, she started each semester over with new students. Her 6th, 7th, and 8th grade classes are all separate, and while she treated each one differently, they all started out a bit more teacher led, especially toward the beginning of the semester. In the beginning they tend to be focused on one task at a time: how to measure with rulers and tape measures, how to use software so they can make a three-dimensional print. The flexibility came into the picture as the class moved past that initial introductory period. The sixth grade tended to

stay a little bit more that way, in the sense that they had a specific project. They had a lot of leeway in that, though, so what they produced could look very different. With the seventh grade, in the beginning they did some kinesthetic, hands-on, whole-body activities to learn about motion and Newton's Laws, specifically. As the semester progressed they moved into more open-ended activities.

"*This year I had some groups of kids, just some strong personalities who are just really excited*," Colette said. "*Which is good. I'm glad for them to be excited. But, they came in and they were like, 'whatever you have planned, that's nice. We're doing whatever we want.*'" Rather than push back on that, she leaned into it with her 8th graders. Compared to the other two grades, she let the 8th grade be very open-ended from the start.

Entering Colette's classroom, I saw the flexibility and leeway she gives students to flourish in the learning environment. The result was a sort of loosely controlled chaos. Due to the size of the class and the variety of activity happening at any one time, Colette used a wireless headset to ensure students hear her above the noise. An alarm clock on her desk went off at pre-programmed times to ensure she stays on track in terms of time. All things considered, I thought the structures she put in place worked well to manage everything.

That day in her seventh-grade class, students tested balloon rockets as part of their space and flight unit, focused on flight forces. Before beginning, they drew models of their rocket apparatuses and labeled forces, after which they went off to test their designs. It was an open-ended investigation without strict guidelines. Throughout their work time Colette encouraged them to try different parameters, offering more specific suggestions to groups who seemed stuck or tried to rush through without collecting sufficient data. Work time sounded joyful with students laughing and animatedly discussing their tests. The purpose of the learning experience

was apparent to me, with the integration of Newton's Laws baked into the conceptual experience of assessing force on their balloon rockets. Whether this resulted more from Colette's instruction or the Project Lead the Way unit was less clear.

A prepackaged curriculum can only accomplish so much, with the real work of teaching resting on the teacher's shoulders. Colette's instructional practice came through strongly throughout the lesson. Her transparency with students stood out to me in particular. At every step along the way, Colette explained herself to students, made her thinking visible.

"I made the incorrect assumption that all of you were looking at this image and understood what's happening," she said, stopping the class when they expressed collective confusion. Many students failed to keep up with her instructions for completing the model and her attentiveness to this stopped her from getting too far ahead. She circled back to the point where students appeared to get lost and modeled the procedures so students could follow along.

In addition to this being a solid teaching practice, it also revealed an interesting dichotomy in Colette's instruction: she was simultaneously attentive to what students are doing while still missing things. No teacher sees everything, regardless of how much "with it-ness" they show, but the flurry of activity in Colette's class made the task more difficult. She moved seamlessly between groups, easily identifying who needed assistance and exactly how to help. While she helped one group she caught other behaviors in need of redirection on the other side of the room, but also missed others happening right beside her. Perhaps this is a consequence of her willingness to allow kids to be kids. She actively ignored the students making squeaking noises with their balloons, for example, making eye contact with me and shrugging when it happened.

Regardless of the reason, when she caught students acting inappropriately she used it as an opportunity to be transparent and hold them accountable for their actions. Colette regularly

told students to make more responsible choices and offered them alternative choices rather than simply telling them to stop their negative behaviors. When those actions impacted other students, she also reinforced the need for compassion and decency toward one another. Her sixth grade class seemed inclined to disrespect one another, despite her success at creating a culture of kindness in her other classes. *I'm a STEM teacher, and I'm in my classroom trying to teach kids about things like consent.*

"Here," she said, handing a pair of headphones to a student on the computer. "I see that you're struggling to stay on task, so why don't you go ahead and use these." The student in the chair next to them had been complaining that the noises from the computer bothered them, and rather than stopping, the student on the computer ramped up the behavior instead. *"When someone says what you are doing is making their head hurt, that is the time to stop what you're doing. That is a reasonable request."*

Care for others lies at the heart of Colette as a person. When asked about herself, what makes Colette *Colette*, her immediate descriptions centered on her relationships with others. Spouse, daughter, friend, partner. Comforter, encourager. At all times Colette thinks of the needs of others, and in made this apparent in the ways she engaged with and modeled it for her students.

I think that it is important to me that the people that I interact with, particularly the ones that I interact with a lot, that they know that they are loved. And that we all struggle with things, and that they have a future, whether they're a kid or an adult. In recent years I feel like there's a theme too, sort of about kindness, in that we interact with people, and we don't know what's going on. What's happened in their lives. What's happening in their day. Whatever it is, chances are there are things that they are worried about, things that are going on that are hard for them,

and like we don't need to make their day worse. It's important that people feel loved, that they know that they're loved, and just to convey, and to convince, and to encourage or even inspire them to love others.

Passion Projects. In addition to regular instruction using her modified Project Lead the Way curriculum, Colette is supposed to be integrating Technology Student Association competitions into her class. Once again, she used this as a springboard to have her students engage in "passion projects" throughout the semester. *I kinda have the luxury of being able to bring my hobbies and interests into my classroom, and I like to try and encourage them to find hobbies and interests. It's hard. They don't wanna do that all the time. I tend to be crafty. I would say that's a large part of my hobbies or interests, crafty. Whether it's woodworking or three-dimensional printing, it comes in. Learning and creating, like, there's joy in that for me. I want them to be able to experience whatever that is for them, to have that joy. To work hard at something. To find things that are worth working hard for, and I guess making sure that people know that they can do things, you know? There's a way for you to figure out how to do this, how to take care of this problem, or to find this person who can help you.*

My goal is to encourage the sparks of curiosity in my students and empower them to act on that spark... to go research, investigate, explore. It's a chance to guide students in inquiry that is relevant to them and challenges them to communicate and plan ahead. It encourages research. My hope is that it builds confidence within students and provides them with a scaffold to use the tools available to them to help with investigations in the future.

When Colette spoke about the kinds of projects her students were working on, she lit up. Her excitement and joy, palpable. Some projects stood out among the others, showcasing Colette as her authentic self alongside the students in her classroom.

"Okay, what is it that you want to pursue?" she asked a pair of girls.

"We want to do this photography thing."

"Okay. Okay, we can do that."

She looked at me wearing an approximation of the wide-eyed uncertainty she must have given the girls, nodding and smiling. *"I never took a photography course. I don't know. I have no idea!"* Colette wrote a Donors Choose Grant for a Canon Rebel camera, after researching for the best student camera for them. She then got them a course specifically on how to use this particular cameraI on Udemy, and returned to the girls with the resources.

"Okay," she said. "*Here's what you're gonna do for your passion project. Step one is you're gonna take this online course, and you're gonna complete these lessons. And whatever exercises they have, you do with the camera.*"

One of the girls takes some really beautiful photos. I love these photos! I'll have to show you some. She submitted some of them to Technology Student Association. So the portfolio she submitted was about patterns in architecture, and the last photo she chose was a bunch of rocks from her driveway in the grass. Basically, if you think of architecture as, as you know, modification to the environment, and it in particular, bringing materials together that weren't necessarily a natural occurrence—I think that's architecture. The judges probably didn't, but I don't really care. I think the child is brilliant.

Colette said what she loved about integrating passion projects was the opportunity to problem solve with the kids. Projects like the photography exploration allowed her to bring her love of learning and seeking out new information to the students.

Among the pursuits Colette discussed, she was especially enthusiastic about a video game project. In her personal life, Colette enjoys games. While she herself did not comment on

this point of connection between her interests and the student's, it stood out to me that she told a significantly more detailed story about this project than others. This particular student's passion project requires a combination of three different interconnected games, because he wants to learn about race cars and crashes. As she explained it, there is a game called BeamNG, and it is a racing simulation that uses soft body physics—that is, a car crumples and bodies move approximately as they would in the real world.

"It is frickin' awesome!"

In the second game you can build a car and change all manner of features on it, at which point you can put the car into BeamNG, which allows you to test it in the soft body physics simulation. BeamNG will also collect speed data for you, and you can see how changes to your car affect parameters within the game. There's another game called iRacing, which was relevant because the student wanted to test his cars on custom tracks. Colette explained it to me with increasing excitement.

"So they went out with the frickin' car and they drove racetracks. These people are using LiDar*!"* She did not shout, but it was a near thing. Her enthusiasm was contagious, and I am already predisposed to be impressed by the use of satellite technology for mapping a video game. *"And the child in my class was explaining to me that during the pandemic, the Nascar drivers got bored. And because they couldn't drive in races, they, like, all signed up on iRacing, and they would have these events where they would drive for 24 hours on the tracks. But because they use LiDar, if there is a pothole slightly to the left of the inside track on the Daytona track, right? It's in the game!"*

Not only was her student "wildly excited" about the way the simulation behaved so realistically, Colette saw the games as a broader opportunity for learning. In this specific

instance, only one student learned about soft body physics and satellite imaging, but Colette talked about the potential application of it.

"He's excited, cause it's cars, and it's a video game," she said with air quotes. *"But I'm like, this is a model! It's a simulation! It's using remote sensing! Like, holy cow!"*

Beyond just this set of games, Colette found a collection of games with educational application she wanted to introduce to her students: city planning simulations, and a space exploration game that uses a mix of real data and procedural generation, among others.

"You could use that to talk about, like, modeling. Right?" In the moment, she seemed a bit exasperated, because despite her best efforts to scale up the video game use to her whole class, roadblocks along the way prevented her from seeing it to fruition. *Using video games to learn, or thinking about technologies that they've used to create a video game, they are things that I learned in other realms.* The nature of online gaming and the tools available to educators to help control over what games and features kids can access at school can be difficult to explain to people without relevant experience. Colette brought her expertise to the table, presenting the idea to her administrator. *She kind of nixed it. I mean, it's not like she's against it. I think, really, it's because she doesn't understand.*

At the same time she was working with the photography girls and the boy was working with BeamNG, someone wanted to learn digital art. A different group of students wanted to create a terrarium. A student was going to fix a Keurig for their history teacher. Another group wanted to build a table. These projects contributed to the variety of activity going on in her class at any given time, but Colette seems to thrive in this environment.

When I asked Colette when she felt most like herself in the classroom, she said to me, *"I think I, a lot of the time, feel like me. The benefit of teaching STEM is I think I get to kinda be*

wild and crazy with my kiddos. Getting to help them to use tools to learn something new kind of on their own. And to help kids pursue their interests and to learn." She paused to think for a while. *"Those moments when things are probably at their most chaotic, I guess."* This idea of chaos followed us through the research, a loose thread at which we both took turns picking.

Chaos. Chaos was baked into the very structure of her class at the scheduling level. *I have 3 different classes throughout the day that use different materials. We use the middle school model, so we have blue team, white teams, and we have split bell. What that means is that the White Team bell rings and they have three minutes to get to their class. When the Blue Team bell rings, then all of the White Team students should be in their classes, and then Blue Team has three minutes, and then they're all in their classes. Until they come to our Life Links [elective] classes, and then we have both Blue Team and White Team students. And so, what that then means is that I have, let's say my first hour class: my White Team eighth graders leave my room; the Blue Team eighth graders are still in my room; the White Team seventh graders who are coming next are now outside my door.*

And then when you add on top of that just stuff happening. Oh, hey! Here's packages that came in for you. Oh, hey! Here, they need you to sign blah, blah, blah. Oh, you know, I have a student who just suddenly showed up from another grade level who wants to know what they missed. There is no moment that I have five minutes to go to the bathroom and grab copies. There's no five minutes that I have to, like, reset for the next class. And I'm okay with that cause, I'm, you know, 'm the little whirlwind. I have that chaotic nature, but it then compounds.

Colette lives with, among others, ADHD and OCD which manifest in her classroom in ways she did not consciously notice, even though she brought them up herself. I mentioned it to her, though, after ADHD came up more than once amidst her calling herself chaotic.

"How much do you feel like your own mental health, ADHD, etcetera factors into the things you do in your class, either purposefully or just the way that your class plays out?"

Mental health, or like ADHD helps in terms of, like, "Okay, I can cope with this because I'm accustomed to this sort of chaos." But at the same time it can then become overwhelming. I have this image in my head, of like, "Oh, I need to keep this room clean. I need to keep these students under control. I need to make sure that…" Well, the biggest area is the orderliness in the room, and I think that there's a myriad of factors that go into that. I don't have a lot of storage space, but I have a lot of equipment. I always start out the year organized, and with the best of intentions to stay organized.

The description understated the positive feedback loop of chaos in the room. The diversity of equipment Colette's classroom holds overwhelms the physical space available. Desktop computers sat beside robotics kits on top of tables which house boxes of Legos and K'Nex under them. Miniature model homes stacked atop any available space, too large to fit in small organizational cubbies and too numerous to contain in a single centralized place. An empty aquarium waiting for its next project lived on top of a rolling tool chest. The surface of her desk was buried beneath handouts, equipment to be repaired, things students deposited on the surface for unknown reasons, and the basic equipment a teacher needs to function.

I genuinely believed that Colette would have struggled to maintain the room even without ADHD making it more of a challenge.

It's a lot to keep track of, and I can't always. And so that's the part that ADHD doesn't help. If something doesn't get cleaned up, things can spiral out of order quickly. That's the aspect that there's a lot happening every time or at any moment. It can be very overwhelming, I guess.

Then I tend to feel like, how are other people doing this? Like, am I that inept? Am I that broken that I can't manage this? She paused for so long I considered prompting her to speak again. *"Is it me, or is it that there's all these things that are going on? You know, like those are the kinds of questions that I tend to then ask myself. What's the balance there? Is there something that I need to change what I'm doing? And then how do I change that? Because then* that's *overwhelming. Or is this just the way it is? Should I not worry about it at all? I don't know.*

I was really happy that when my principal came in to observe recently, she got to see. I had, thank God, one of those lessons that I could show like, "Oh, yes, I know how to do I, We, You! And here's me doing I: here I've got my document cam, and we're making measurements, and we're, you know, building our little hover car." The fact that my principal got to see the chaos of all the things happening, and got to see me handle that, it was good. I appreciated that. And of course she was supportive, as always, and I had a really great evaluation.

Then, of course, the room wasn't very clean, and she was like, "You're gonna have to do something about this."

"Uh huh." As she recounted the interaction, the stress she felt in the moment with her administrator presented itself between us. She gave me an anxious smile, deer in the headlights wide eyes.

"So, there's the central issue that the room needs to look nice, because the STEM room should be a showcase."

"Yes. Yes it should." Neither of us knew precisely for whom the room should be a showcase, but that was hardly the point when the room fails to measure up to that stated expectation.

"So evaluations are still kind of a nightmare for you?"

"Even with a much more supportive principal, I go through a little bit of the same thing sometimes, because she was a math teacher. And so it's like, "Okay, you're gonna teach them the skill. You're gonna show them. They're gonna practice it. They're gonna I do, we do, you do."

"Yikes."

"Yeah. So that's hard. That's hard for me when I'm sort of forced into that, "Okay, well, I better show this lesson where I have this. Where classroom management looks like everybody's in their seats, and they're all quiet, and they're all… That's hard. And I think that gives me the most anxiety. Trying to take that information on, "this is what classroom management should look like, and this is what my classroom looks like, and is there somewhere that's in the middle?" That's the hardest for me. I've learned a lot more recently that I have a lot of, like, leftover fear and anxiety. There's that anxiety that's within me just because of experience with past principals that has been like, "Oh, I'm I'm out to get you."

"Does it help any knowing that this principal supports you?"

I'll tell you, my principal now is fantastic. She's the sweetest woman ever, and everything she does is with the goal of helping. Genuinely. Her facial expression doesn't look like that, necessarily. So she'll say something, and I'm, like, terrified. "Oh, she looks mad. She must be mad." And you know, she's not. So I think, definitely, when I know an observation is coming up, I've gotten a lot better. But sometimes there's a lot of me saying, like, "Okay. Here's what's real: these, these people, your administration, they are here to be supportive. The expression on their face is just that. It's not an indication of your impending doom."

So in that regard, those are the times of the most reflection, because I start to feel that anxiety sometimes. Not always, but sometimes. That's when I really have to think, "Okay, that, this is what happened then*. This is* now*." I've learned that I'm not the only one, also. I still have*

teacher friends from Charter School who go through the same thing, and so that's helpful to know that they're struggling too. When they're under a new principal, they're having the same kinds of feelings.

May 2023

We ended January on a high note, but by May a shift happened. In the interim since I last visited, Colette dealt with more stress than perhaps any time prior at Anywhere. Her husband, Issac, was diagnosed with cancer. The city was hit with multiple tornados while Colette was out of town on an overnight trip for a TSA competition with a group of students. The conversations about the state of her classroom were increasing in both frequency and perceived stakes. Colette's optimism seemed dimmer to me than in the early spring. Her once enthusiastic stories took on a tone of resignation.

"It's wearying, is what it is."

She told me more stories of conflict and frustration than those of celebration. It reminded me in many ways of the way she spoke of her time leaving the biology department during her PhD, a return to her dogged determination to get through it. Then, it was to find her people; now, though…

Oh, we're, we're gonna process this. Like, get a shovel. What else are you gonna do? Shit happens, and you gotta deal with it. You've got to roll with it. And if you lay down on the floor and die, what are the kids gonna do?

The state of the room remained an ongoing point of contention between Colette and her administrators, and the progressive fallout from this issue bled over into her classroom instruction. Whereas before the room only posed a challenge in terms of a mismatch between administrative expectations and reality, the interventions offered to correct the situation left

Colette alienated across several axes. She called me while I was Japan, outside of any of our planned conversations or meetings, because the stress reached a point she felt compelled to share it immediately. We came back to it later to talk in-depth.

The whole thing is strange and distressing. My evaluator and head principal has been communicating with me regarding the room and the cleanliness thereof, and basically had to write a letter of expectation.

She was very careful to say, "You know, this doesn't go on your record," but I was really stressed out.

I basically had this conversation with her at that point where I said, "Here's where I'm frustrated. This is not intentional, and I've been trying to do things differently, but it's not happening. There's some sort of deficiency that I'm not seeing, detecting, overcoming. Whatever it is I'm doing is not working and I need help with that. I don't know what else to do."

She said, "Okay, yes! We're very happy to help you," and that never completely materialized. Things sort of returned to normal, maybe a little tiny, teeny, weeny bit, and my room was clean enough. But I got my annual observation, and again it was brought up that the room was still a mess. Yeah. Lord, like, I see where she's at, and I understand. Because, of course, I've got these little pockets of projects, and supplies, so the room was tight. Anyway. I'm at a complete and utter loss. At this point I've accepted that I'm gonna be fired for not being able to keep the room straightened up.

I did my best to reassure her that, like she said, her administrators expressed their support and I doubt they would fire her for it. She said she appreciated the sentiment, though, understandably, I doubt it made her feel any better. The addition of an instructional coach to Colette's classroom represented the real change in the situation from the beginning of the

semester to that point. Administration paired her with Colette with the assumption that the room problem stemmed from issues of her classroom management.

I basically said, "Alright, Jess. I'm gonna just tell you everything that is happening in my mind at any given moment: okay, we have a competition coming up on xyz day, and I need to put in the order for the eSports, jerseys, and so-and-so needs the email, and there's a survey that needs to be filled out, and then I need to check the kids' grades, and I need to talk to this teacher, and I need to—alright, and that's for eSports. Then, you know, I need to grade because I haven't graded in like 3 weeks." It was just this list of all of these things. "And now I have to figure out how to clean this room and keep it clean." This room needs to be accessible to all types of people and students. It needs to be safe right?

Then we sort of got into this, "The countertops need to be clear."

"Please come help me figure out what the problem is."

I was really kind of with students like, "Don't touch that. Don't get up! Don't move over there. Don't!" It clearly pained her to recount the conversation, given how far that was from "yes, and."

There was one day, at lunchtime, I saw that somebody had literally cut the cord on a television, because sometimes kids are just destructive—which I don't understand. Then that afternoon, I went to call a parent and my landline phone was weird, and I figured out that a child had poured glue on the buttons. I didn't know and couldn't figure out who, and so I went to my vice principal..

"I don't even know."

"Well, you're gonna have them copy an essay."

So the next day I set my desk in rows. I assigned seats. Throughout the day, my students know what to do with desk in rows. She looked sad telling me this, the reminder of how the system trains students to conform. *I told them all, "Listen, I'm sorry. I know that it was one or two people, but because I don't know, we're we have to copy this essay."*

My last hour of the day, there was a young man, and he is sitting there doodling on his paper. The instructional coach comes in, and she is just on him. Just hounding him.

"You need to be writing this like. Okay, write the first word. Write the second word."

Heather, I have never seen that child so ugly. Well, what I didn't realize, because I hadn't had a problem with him the entire quarter—and I do read through their IEP's, but I just didn't—he's in the behavioral class. To watch this kid just… I guess somebody might call it defiance. Like, he was staying in his seat, but I went up to him at one point, 'cause it was killing me, and I got down next to him.

I said, "Listen, we've got 10 minutes left. Hang in there for 10 minutes."

"Oh, I don't even care." He wasn't hearing anything I was saying; he wasn't processing anything I was saying. And it just hurt. It hurt so bad. I sat there, and I thought about everything. I mean, we just had this suicide training, and it really focuses in on Adverse Childhood Experiences scores. I'm sitting here watching this, and I'm like, why the hell do we do these trainings? We talk about differentiation, giving students what they need. But then we say one thing, do another, is kinda how I felt..

That was the moment that I felt like, "This is not who I am. This is not how I do things." And on top of that there's 150 kids that are being punished for what one or two kids have done, and I don't like doing that. But then, you know, your supervisor basically tells you, "Well, this is what you should do, and this is how you do it." I don't know if I got into the state of like, "I gotta

be me," but I can't keep doing this. I can't keep doing whatever this is. I got to a point where I looked at someone, and I said, "I feel like I'm being erased from my classroom."

True to her "gotta be me" attitude, the instruction in Colette's room remained much the same as before. Despite the strife of forcing students into compliance and rows, her classroom environment still felt the same to me. On this visit, all three grade levels worked on the same project, constructing model spider webs as a means of testing the strength of different engineered structures. Discussion of their models included explicit exploration of the importance of scale in their tests, relative to real-life webs, and comparisons of different survival strategies implied by different web forms. On-task students seemed to enjoy it, and throughout all three classes, students' evaluations and talk of "fair tests" spoke to Colette's vision for how students engage in curiosity and research. Students behaved rowdier on the whole, but the 8th graders spent the end of the previous week state testing and Colette mentioned the 7th graders were having an off day.

In retrospect, I wondered if some of the behavior difference there—less willingness to respond to redirection, disregard for the state of the room, carelessness with the equipment and materials—might indicate lost ground in her relationships with students. Earlier in our discussion about essays as punishment, Colette had said, *"You know, one of the things that people say a lot is, 'Oh, we value you. You do amazing things. You give these kids wonderful opportunities. And you have relationships with kids that no one else in the building has."* I wondered, later, if she felt that lost ground too.

Spring 2023 Autopsy

A week after my visit, once the semester wound down further and Colette had a moment to breathe, we met again over Zoom to talk about the year. Unlike our previous conversations, this one drifted towards the philosophical.

I feel fragile. Just the feeling that impact of, like all the things. And some of the things are really, really big, but then sometimes it's the little things, too. I looked at Issac last night, and I asked, "When did I become such a miserable cuss?"

"I'm not gonna answer that question, but it's been a long time."

It was good to have a little levity. I think the miserable cuss, maybe it's the other side of fragile. You know? Like, the recognition that, well, heck, this is a lot on a person. I think sometimes the way it comes out is, " I'm gonna go fight a tornado." Or even, "You know what? I'm doing what I can, but if you guys have to fire me cause there's stuff on the floor. Okay. Fine."

"You do seem to be running yourself ragged."

"I'm gonna have to start listening to true crime, cause I'm in this funk." Another time a comment like this might have been funny, but I could feel the weight of the sentiment then. *"And some days, I wonder what my job actually is, or what job I'm doing. Lately I have been asking myself, am I teaching STEM? Or am I teaching social skills? You know, like, what lesson is it that I'm supposed to be giving them? We talk about how the system is failing the kids. How am* I *failing the kids? Because I'm part of that system. So what is my purpose?"* Neither of us had an answer for the questions, but she kept wrestling with them, circling back to her instructional choices.

This semester, this quarter, I said, "Alright. The purpose of bell work is that you come in, you put your happy butt in a seat, you get the things you need, you start thinking about this class, and you do your bell work." It's maybe like a third of their weekly grade, no more than. I made the decision to close those assignments at 4:00 every day. Because they're bell ringers.

"Doc, I couldn't turn that assignment in."

"Well, why didn't you do it in class?"

"Well, cause I figured I do it at home."

"Well, that's not the point." This child sat in my class, and she played around on her cell phone, or she wandered the hallways. And now there's eight days left in the semester, and for whatever reason she's realized that she has a D, and that she does not want a D. And now she has to do something about it.

What educational theory are we gonna go with here? What is it that I should be teaching these children? Should I be teaching them that, "Well, beloved, you should have kept that in mind this entire semester. It's a little late now, and I'm sorry, but this is the result of the choices that you've made." Or, because it's middle school and we assign you points but the points don't matter, do I take away volleyball from you because you don't do bell work? The invention that she described and looked up and did her research on was volleyball. And so I was thinking, like, the real world is gonna hit these children on the ass. You know, we talk about how schools are passing kids along, and they don't know how to read, or how to do math without taking their shoes off. Well, I'm part of that system, so what part of the problem am I? What do I need to do about it?

Texas just was trying to pass the law where you would have to be 21 to purchase an AR style weapon. And I thought to myself, how many of these 18 year olds basically have gotten out of high school and they are unprepared for the real world? Now there's consequences, and shit is happening, and they feel like they have no hope. How am I helping to create the next 18 year old who leaves high school and is angry because they suddenly realized that we haven't prepared them for the real world?

"I think asking those questions is important, but I also, as your friend, want to remind you that you can't take on all the ills of the world." As long as I have known her, she has always been

quick to accept responsibility for things that are not her responsibility alone. Colette's heart is so big and I struggled to articulate what I felt for her in the moment. Productive reflection is good to a point, but it seemed to be part of a bigger spiral into which the end of the year pushed her. "Not that you should stop considering it, but I don't want to see you slip into being the only person internalizing that responsibility where it's not necessarily yours to internalize. You know what I mean?"

"Right, and that's true. I agree with you."

We steered the conversation out of the deep waters and talked about the possibilities for next year: setting norms for classroom values rather than as rules; maybe explicitly integrating her ADHD and OCD coping mechanisms into her instruction, or teaching the skills directly to the students. The call ended more hopeful than much of our recent conversation.

Fall 2024

Unfortunately, the fall semester of 2024 brought little good news. If anything, Colette's quality of professional life deteriorated further from where the previous year left off. Once again, the room. An increasing feeling of isolation within her building. The issue of the room was no longer about the room, at least not for Colette. Instead, the room felt to her like an indictment of her as a teacher and a person. It represented a failing on the part of her and her administrators, and it eroded away the trust she had in them.

I feel like I'm screaming into the void. We have this ongoing problem, and I logically understand, and I agree. I think what it is, is like, "You're coming in. You're telling me that this thing needs to change, and I understand, and I agree. I'm not telling you to fuck off. I don't know how to make it happen."

"Okay, but you know, we've given you this help. We've offered to help; and you've had conversations with these people; and you've done these things; but it's still not better. So you need to fix that."

"Do I not get points for effort?"

"Well, it's not fixed though. We told you, you need to do a thing, and you're not doing it."

"I'm seeing that there is not an understanding of what is happening. I can see you don't get it. You don't get it. So what? I can't trust you. I can't tell you that everything's falling apart. I can't sit down with you."

I got the comment that I'm handling things with my husband well. I'm compartmentalizing that. Like, my world is on fire. I have people who are supposed to be helping me who aren't, and because I don't want to be a rat, I don't see where I can have that conversation and be understood. I've gotten to a point I feel paranoid. And maybe it's me. Maybe I'm not communicating this well, but I think the best example is this: I can explain to you how a transmission works. I understand the steps that one goes through to use a stick shift to manually shift a vehicle. I understand about RPMs, and having to disengage to use the clutch to disengage the gears so that you can move to another gear. I understand how that works. I know that you've got to do this before that. My parents could not teach me how to drive stick. It is not about knowledge. It's not about that.

The problem is not that I'm stupid. The problem is that I don't have the muscle memory for this skill. I don't have the skill. I don't recognize where in this moment I would have done something else instead of putting that pen on the table and walking to the other side of the room. Whatever that is. If you would just. If you would just. I understand completely what you're

saying, and if it was that simple, we would not have this conversation. Something is broken, so you are misdiagnosing the problem, and the prescription that you are trying to provide is exacerbating the problem.

Thinking about it, we make accommodations for students, but I feel like we don't when you're in the workforce. Where is my 504? Where is my IEP? Because this issue comes from my ADHD, which I did not have the benefit of knowing until I was in my mid to upper 30s. This is not intentional. I am not trying to defy authority. I'm aware that this is a problem. I'm trying. I've cleaned, I've organized, I put stuff into containers, yadda, yadda. I'm trying to fix the problem, but I am failing.

You can either keep going or you can lay down and die. Well I'm ready to lay down and die.

There was a kind of cognitive, or maybe emotional dissonance in the stories she told me in the fall. On one hand, she kept stressing how supportive her administrators were, and all the kind things they kept saying to her. Her colleagues had just awarded her the school's Innovator Award for the quarter. At the same time, her administrators also called her in for a meeting to discuss a laundry list of problems and perceived failings on her part. As Colette ran through the list, many of these issues occurred when she was physically absent from school, were policy changes which no one communicated to her in advance, or were either wholly or shared responsibilities of a partner teacher—hence the "because I don't want to be a rat."

The stress being what it was, the opportunity to plan for value norms and teach skills to the students never materialized. If nothing else, though, the frustration and hurt seemed to galvanize Colette. I could see it reflected in a shift of her classroom instruction, though she may herself have missed it.

What part of this do I have control over, and what is the primary goal? What is the purpose of my classroom? What is it I want my kids to learn today? What do I want them to get out of my class?

Don't touch that desktop.

Don't move that.

Hey, welcome to STEM where you need to be creative. You need to collaborate. You know we're going to do some really exciting things! A lot of hands-on.

Don't touch the desktop.

Straighten that back out.

Okay, this is first hour and so we're talking about automation and robotics and gears, and…

Don't touch the desktop.

If the goal is that they are paying attention to what I am telling them to pay attention to; if they are writing down what I'm writing down; if they have, essentially, a worksheet in their hands, and we are going over that, anything on the periphery is a temptation. Now, if your goal is to have an ordered classroom, they're going through the motions. I don't know that they're actually learning things, right? Because it's just information. They're just writing stuff down, and it's not important because it's not a core class. They're not going to be tested on it. We don't have tests. So if that's your goal, then the structure of my classroom and allowing kids that leeway to play? Then I fucking suck as a teacher. My classroom management is miserable, and that's why I have the problems that I do.

All of that said, I did notice a change in how she managed her classroom, but for the better. In the fall she doubled down on being transparent with students, positively reinforcing

students by identifying specific ways they succeeded or behaved appropriately in a given context. Redirections contained more actionable feedback. The clear procedures for entry and exit from class, while not executed perfectly, seemed to support learning more than it detracted from student freedom. The new group of students notwithstanding, students showed more consistent, sustained engagement with the work. The 6th and 7th grade classes were kinder to one another. Colette's signature chaos was still there, just more controlled.

If you think about providing students with access to experiences, manipulatives if you will. Just thinking about play, in general. Thinking about a differentiated classroom. Thinking about meeting needs of all learners. I'm thinking about shaking students out of that, "there is a right answer, and I have to play this game, where I behave a certain way. And I interact a certain way. And I give certain answers." If you think about all of those things, then locking up all the stuff, making sure that everything is clean and spotless and beautiful at all times— I think that they are missing out on a huge learning experience. We were learning at some point, in some class, about Montessori schools and how the kids had a question. And reading happened, math happened, science happened, because they were answering this question. They were doing activities; they were doing a project; they were creating things.

What's hard about that is that there's a degree of internal motivation, I think. That's one thing I've been trying to figure out, how do I teach a student that they are not helpless? And that if they get stuck on something that the answer is not, "well, I couldn't do it because you didn't come help me. And I asked you one time, and then didn't do anything after that." I don't know how to. I don't know how to help provide that motivation.

I believe that Colette consistently sells herself short as a matter of habit, and the strained relationship with her administrative team did her no favors. Which is to say that the attempts she

made to motivate her students were working. Slowly, perhaps, but students showed progress. In the spring, Colette's classes reflected elements of the standards in science and engineering, which was expected given the curriculum she used. While that remained true in the fall, her instruction shifted into emphasizing student experiences and the relevance of the content of a given unit. In addition to small group collaboration, Colette facilitated more whole class discussion. Solicited more student reflections on how the material related to their lives. Asked deeper probing questions to encourage the students to meaningfully connect with their learning.

She continued the practice of closing bell work assignments at the end of the day, still with the expectation that students would complete it in class. *Because I had kids who were like, "I'll do it later. Because right now I want to hang out with my friends and do whatever I want to do. Because I don't see value in this. I don't see purpose in this." And so I really, really try to make things real. Even with a universal joint, you know. I drew their attention to this: there is a little allen screw. You put the shaft into the universal joint, and then you tighten that screw to close the gap.*

I said, "Here, you may not do anything with universal joints. Right? You don't have to memorize stuff about universal joints. But here's something I want you to see, this way of attaching things. The doorknob on my screen door keeps coming off, and when that happens, it's because this screw has gotten loose. It has this *kind of screw. Your toilet paper hanger, your towel bar. They all do." I try to instill in them that interest.*

Sometimes it works.

Looking Ahead

It would be nice to wrap up this story with an optimistic anecdote to bring us full circle to where we began, full of excitement and possibility. Instead, the ending goes like this:

Right now I get up in the morning at about 5:00, 5:30. I leave the house by about 6:00, 6:15. I get here by about 7:00. I leave here usually around 7:00. I get home around 8:00. I go home right now and I color and I do crossword puzzles, which is fun, but that's not a really good sign. Because I get home and I turn off. And so now I get home and my husband—who we're pumping poison into—wants to spend time with me. He's trying to talk to me about political things and I can't take that in. I'm snapping his head off. My house is a shambles. It's too much, and I'm not getting enough rest.

Right now I need something that I can go in and I can do. You know how you were saying earlier, about how you wanted to organize all my little bins? That's what I need. To be able to know that today I'm going to come in. I'm going to run this report. I'm gonna send this email. I'm going to talk to these people. I'm gonna go home at five o'clock. And I'm going to be done." There's nothing I'm going to take home with me. Now I can go home, and I can be with my husband, and I can do creative things. I can take care of my house. I don't have to be emotionally available to 120 people. I don't have to know each of those people as individuals, and remember their needs and traumas, and differentiate while keeping information about why I'm differentiating private. That's where I'm at. I want to get up. I want to clock in. I want to go to my cubicle. I went to run my reports. I want to be able to use my creativity for things I enjoy.

And that hurt me to say, because I love these kids. I love teaching. But right now I'm so tired, and I'm so worried I can't be the creative that I love. It's not it's not fun. It's stressful and I don't want to go through this cycle over and over again. I used to say I'm not gonna let them push me out, so there's part of me that's like, "well, if you leave you've let them *push you out." Well, no, actually. I don't like this, whatever this is. I don't like how everything is shaking out.*

Colette *is* leaving. I have already received reference requests for her for other jobs. She is burnt out. Weary. The combination of the stress in her personal life, the frustration with her administrators, the growing perception of a disconnect between what is said in education versus what is done in practice, together became too much. I keep wondering if the time we spent digging into how much of herself was reflected in her own classroom contributed to everything coming to a head. It feels too self-important but I still cannot shake the feeling.

The silver lining, if there is one to be found, is that Colette seems content to stay in the realm of science education. She will not be organizing little bins or running reports in a cubicle, but neither will she be standing in a classroom surrounded by children learning to love science.

Chapter 5

Mariah: Protecting Her Peace

Mariah teaches 7th grade science at Central Middle School, an urban middle school in Oklahoma. She describes herself as a wife and mother, a partner and friend. A collaborator. A compassionate advocate and caregiver. As a life-long learner, she is working on her PhD in science education, a journey which influences her teaching and this in turn influences her research. She is, perhaps above all else, a helper. It brings Mariah joy and fulfillment for people to see her as a peer, resource, and safe space to come to with their needs. To tell Mariah's story as an educator requires less of a temporal recreation and more a holistic look at the way her identity, her leadership, and her instructional practices are inextricably entwined. Rather than starting at the beginning, the story begins in the midst.

A Developing Leader

Because I'm seventh grade team leader, I'm the one that does lunch detentions. I had a repeated student, and every time I had this conversation with the student, they were telling me that they didn't do any of the things that the teacher was talking about. It was obvious to me, through the things I was receiving from the teacher, from the student, that that relationship is, like, non-existent at this point. And it is in a bad place.

In my conversation with the student, they asked, "Can we go talk to her?"

"You know what? Yeah, let's, let's go do that."

Honestly, I didn't know what I was walking into.

We came up with a game plan, the teacher, myself and the student to write questions down—like those repeated questions that kept coming to mind—on a post it note, and then either halfway through the hour or nearing the end of the hour, that teacher would send the student to

me. That way, I can try to answer the questions. It's at least a break for both of them, and some space to re-collect, to get up and move a little bit, and then come rejoin class and be productive and focused, etcetera. I'm across the school. So it gives him time to walk and get some of those wiggles out, and then come back and meet expectations.

"I think he needs more opportunities to get those wiggles out in a way that will still meet your expectations, yes, but also acknowledge what he needs."

We also looked at a seating change, so that the student didn't have to travel as far to collect their book, because in that distance to walk over to the book, we were messing with other people and things along the way.

I think it helped out though, because at the end of the day, I got an email from that teacher saying that the student was a model student that day, and did all the things. So it was really great to get to sit there, and then at the end of the day to receive that email, and at least know that the teacher had a better day with that student. The goal now is, of course, to make that a repeated thing, but at least this is a good start. I need to also develop a relationship with the student now, and then utilize that *relationship to help foster a better relationship between those two. So that's kind of where I'm at with this teacher, providing those extra supports to retain and to make them happy. I mean, we want them here educating in a way that makes them passionate educators.*

Mediation is not technically part of Mariah's leadership role in her building, something in which she takes great pride, but students and teachers feel comfortable seeking her out for this help. The trust in her within the school is a testament to Mariah's strengths and leadership. Both have been formally recognized since she started three years ago, beginning with the district's Rookie Teacher of the Year award.

I think that opened up doors for me to be in spaces to build. It was networking opportunities, and the opportunities to put my face and name in front of people that have a voice in the district. My second and third year, I was seventh grade team leader, and now, in my third year, I'm New Teacher Liaison. And so that has really put me in a position to work really closely with our new educators in our building. I have loved it, quite frankly. Just having that title, I think, encourages them to come to me. I always made sure to communicate that they could come to me, but now like being under that banner, they're like, "Oh, this is my point person for this." So this year, more than ever, I've had so many more opportunities to help out educators.

She actively supports her peers even outside of the explicit conversations they have together, reinforcing positive behaviors in students in the halls and inside her own classroom. I find the intentionality of her choice to do so refreshing. Rarely do teachers so purposefully cultivate a culture of mutual support in the way Mariah does, in my experience.

"Today, we have a lot of people out," she tells me. *One of our teacher's moms passed away unexpectedly, so she's not here today, and of course, all the students know. So I've started every single class today with reminders about how we treat our substitutes. That's going to be a repeated conversation for sure, because we know, students' behaviors drop with subs. But we've had some really good conversations about how we are supporting this teacher by doing what we're supposed to be doing in class. Even though I am not in that teacher's class, even if those students aren't getting those reminders in other classrooms, hopefully by having it in mine it at least drops that little seed that they might think on it later.*

She tells me, too, about a conversation she had with a new teacher about some troubles with student behavior in her class, specifically talking too much and using codewords to signal to one another. The students in question are athletes, and in addition to practical suggestions about

changing the seating chart, Mariah talked about approaching these students like a coach. Despite the conversation with the teacher ending there, Mariah carried it with her to the following day to engage with the students herself.

I also grabbed one of them at the beginning of school, and I was like, "What are we doing? Why is this a thing? Because I know you, and I know, this isn't usually a thing. So why is it?"

"Oh, it's funny. We're just joking." Typical middle school answers.

"Yeah, that's funny. Sure. But we're kind of crossing the boundary now where we're being disrespectful about it. And it's not cool to be disrespectful." I'm hoping by having said that, to that one student, it might cause a little trickle effect across the rest of them.

Transparent Vulnerability

I appreciate that this conversation constructively redirected behavior rather than undermining her peer by putting the onus on the student to reflect on their own actions. Taking this in as a whole, the willingness of students to ask for her support and listen to her when she pulls them aside demonstrates an extension of the environment Mariah cultivates in her classroom. Her classroom is a place of laughter and learning, features of her teaching she always speaks of together. Part of this environment comes from Mariah's intentional modeling of transparency and vulnerability for her students. This comes up frequently in our conversation, but the act of modeling these values for students while not at her best is particularly illustrative.

"I know yesterday was kind of a rough day for you."

Yeah, yesterday was a rough day, for sure. I don't know what it is about my third and my seventh hour, they both do it. The swarm of students, just like literally from one end of my desk all the way to almost behind me. And it's for all *the reasons, just bombarding me with questions.*

"I don't get this. I don't understand this. How do I do this? Help me do this." And it was the most overwhelmed I have felt, literally I think ever, as a teacher. I was snappy with some students who didn't deserve that, but I was in such a place of dysregulation and stress. I literally looked at one student who was just trying to say something about not being here tomorrow, and I said, "I love you, and I'm sorry, but I need to be left alone right now." And you know, that's stuff that you don't really hear your teacher say very often.

"How did you deal with that today, now that you've gotten to, I don't know, reset?"

I opened up my third hour by saying, "That was rough. I love you. I love talking to you. But whenever you come in, I need you to follow our procedures, because our procedures allow for class to get started the way that I need it to so that I can be the best teacher for you." And I thought we had a really good conversation in third hour. It went really, really well.

"So it's not just emotional transparency."

"Oh no, definitely not just that. *One of the things that I feel like I do, that I do not typically see in a classroom, is I explain my decision making to students pretty explicitly. That is one way that I try to make students aware of, like, teachers make these decisions for a reason.*"

They built chemical models the day before that required color coordinating atoms. The intention was to help them see the same elements on both sides of a chemical reaction, but the students grew confused the further they progressed. *I realized that that was adding a layer of directions that was actually causing more confusion than being helpful. There was something about just that added piece of direction that was causing their working memory to go kerplunk.*

So today when we started class, I said, "I reflected on this and I felt like it could have gone better yesterday. And after my reflection, I asked myself, 'How can I make this better for you?' I realized that color coordination is a helpful thing, but it's not a necessary step. You

know, if that helps you, because it allows you to see the colors on each side, go for it. If it's just making you more confused, you don't have to do it. Just label it the way we've been labeling it."

Student Vulnerability

This process of modeling her thinking and being vulnerable in admitting she makes mistakes creates an environment where students also open up. *I think it goes back to the classroom community, and to model to them like, "This is how you can be even if you are in a certain headspace" or "How do you ask for support if that's what you need at that time?" Even though they probably don't realize, of course, that that's what's happening, but the hope is that that's a nugget that they remember. I mean, if I'm willing to be vulnerable and transparent, then they feel like this is a safe place for them to be vulnerable and transparent.*

It helps them feel like wherever they are at, whatever their 100% is for that day is valued and welcomed here in class. It helps with them being willing to put their ideas out there and know that they're not going to be judged harshly and critiqued in a manner that makes them feel stupid, or belittled, or anything like that. By focusing on that and creating a space where that's supported and welcomed, that in turn increases engagement. By engagement, I mean likelihood that they would participate with whatever it is that day. Share out, talk with a neighbor, be focused. Just smaller things like that.

It is apparent to me, as an outside observer, that her students *are* encouraged by this and readily willing to share. While it does not surprise me that this environment supports student learning, I am surprised by the precise ways it unfolds. In the most recent unit I observed, students were presented with a medical mystery phenomena which they must solve: middle schooler McKenna and her undiagnosed symptoms. Within this context, both individual students

and the class, collectively, built upon personal experiences to develop shared understanding straight from the start.

There's been a ton of opportunities where students are willing to incorporate their experiences. Anytime they do, I try to pause and really make sure we give it the time and space, because I want them to see that I love that. I want them to do that more. And I think by showing students that I'm willing to listen to them and allow time and space for that, I hope that it encourages others to do the same. Especially in a unit like this, where we're having to talk about some pretty sensitive subjects. Like, I have a student with Duchenne Muscular Dystrophy. They are in a wheelchair, but because of the muscular dystrophy that's taking place and progressing, they can still get up and walk some smaller distances and stuff like that. They're really willing to educate people around them. So I hope much like my transparency, their transparency might invite others to share what they've experienced.

After I had that conversation about sensitivity and willingness to share, when we started the lesson they actually stood up and said, "Would it be okay if my mom came and taught a class about my condition?"

"That's so cool! Yeah, yes."

And then in eighth hour, I have a student with a lot of allergies, and it's kind of just become like this punch line joke in our class, and we all laugh together about it.

"The student is in on the joke?"

"Yeah. We're laughing *with*, not *at*."

So the students were saying, "We have all these foods, we're gonna kill them!" But as they were saying these things, they started to suggest really right on the money ideas for investigations. "Are we going to look in our digestive systems? Are we going to use a camera?"

They were just bouncing off of each other nonstop, and it was super overwhelming for me. But through all of that, we are jumping ahead so many levels. Actually, because of their experience, the suggestion that they gave out, that McKenna has is a gluten intolerance, is right on the money. And this is exactly what I need them thinking, but not like this. So I'm gonna use that today in class to start trying to get them to think in a more structured way about ideas for investigations. This is why funds of knowledge and all that stuff matters! My teacher heart, of course, just got super happy.

Motherhood

That students feel safe to share their lives like this in class is a testament to the way Mariah values her students as individuals. When I ask her about what drives this, she talks about the changes in her perception since becoming a mother.

I mean, I just see the kids in a totally different light. Like, each of these kids are somebody's baby, and I think it's just made me so much more compassionate. That's not to say that I wasn't beforehand, I think it's just different. I think I appreciate their individuality even more than before. Which again, is surprising, because I thought I did that a lot beforehand! But your perspective changes so much whenever you're a parent. And I think as I have gone through that identity transformation, it has happened with how I see my students as well. So just acknowledging that they each have their own background, how do I meet them where they're at that day. Their 100%, one day might not look the same as the next day, and that's okay. Sometimes, they need a space to just lay their head down, and that's okay. I mean, that's always been my approach, but I just feel it a lot differently now as a mom.

There was a situation at the very beginning of the school year, where we did a Camp Turning Point for the incoming sixth graders. We're on the football field. We had cheer, band,

music, all the things were happening. I honestly don't know how we missed it, but there was a student there who lives with Down syndrome, and poor baby was so overwhelmed. We started to group up and he sits on the floor, and just has his head down, covering his ears, and my heart burst. I started crying. I immediately went, and found one of our SPED educators. I got him by the hand and I walked him over to one of them as I'm signaling for them to come over. I just thought, in that moment, so much about my own son, too, and what I would want somebody to do for him, if that was him. I think that Mama Bear analogy just kind of came out, and that's still true every single day in my classroom. It's just different. I don't know.

Some of the students tell me, "she's my mom," when they stop by to say hello between classes.

"My brother is also a teacher here and they call him their uncle," Mariah laughs. "If they see me as that caring and supportive, I don't see a reason not to let them keep calling me mom."

Intentionality

I find it interesting how many ways this sense of value manifests in her class, down to the practical planning details. I visited her classroom at a few different stages during one particular unit, and after, she told me about all the prep work she and her partner teacher put into the lessons to make it effective for their students. All good teachers modify their curricula to meet their students' needs, but with Mariah it feels like another piece of how she values her students. The way she considers their reaction to material, not just its content, reflects a particular kind of care.

Anytime I'm deliberately planning something out, my thoughts just go to, like, what do I want the students to be able to accomplish? "I Can" statements. At the end of the day, what is the main goal that I need them to walk away with today in class, and how do I get them there?" I

think I'm pretty in tune with my students and what they think is boring and what they think is not, so I start to think, "how can I make this fun and engaging?" How are we going to have good conversations but also laugh together and have space and time for that? I think that naturally then lends itself to finding multiple ways to allow them to demonstrate their knowledge and to engage with the material.

Open SciEd, our curriculum, it's great for a lot of reasons, but it has its flaws. One of the primary things is that it is a behemoth to pick through. It is overwhelming, and it's really repetitive too. Which, double-edged sword. We know that repetition helps, and we know that repetition helps whenever it's also done in different kinds of ways. But how much repetition is also too much repetition for the amount of time that you have? Being able to make those kinds of decisions just depends on your students. Granted, this could just be kind of where the students are at because of reading and literacy skills that they're struggling with, partially due to COVID and all of that, but the instructions that they give students on those worksheets are also expansive. It's a lot. So the students see it and their brains just, like, shut off completely.

So I've been really interested about how to utilize this curriculum more effectively and how to choose what you use, what you don't use. What do you adapt? What do you keep as it is? Because all the lessons after that last one you observed were a lot of like, let's test it, and let's redesign it. Let's build it again. This was a good enough stopping point, and we felt like students understood it. They also kind of naturally got to this place where they were ready to build their designs. For those other lessons there were also three or four different rubrics, all for different things. I was just envisioning giving every single one of these really wordy rubrics to my students, and like, they were gonna put my head on a stake. They would not have done that. So we kind of took all three rubrics and compiled them into one and used that.

I really see the intentionality that went into the unit, not just the scaffolds and planning, but the ways the class engaged and Mariah interacted with the students. Even the walls support it, with simple rubrics for students to indicate their understanding, conversation stems for sharing their ideas, and class consensus models posted up around the room. She weaves transparency into every step of the learning process. For the last two days prior to my visit, students have been doing school-wide suicide prevention training so science has lived on the backburner. The students come into class in a flurry of chaos and sound, only some of them settling into their bellwork.

"We've had a few wonky days and I can see it has thrown us off our regular routine," she tells them once the bellwork timer goes off. "So we're going to reset. Let's try it again." Bellwork time ends, regardless of who actually completed it, and Mariah moves on to re-establish classroom procedures. "*I'm giving you constructive feedback, because being able to follow instructions sets you up for success. You're working with groups, and it's easy for us to get off task or to start talking about something else, and then we're not getting something else done. You have less check-ins with me, and so you naturally tend to lose track of time."*

Success today looks like annotating a reading about food safety and jigsawing different parts of the passage with partners. The unit focuses on an engineering problem of creating a device that heats up food without electricity, specifically utilizing chemical reactions. Before starting the reading, the class takes time to review the results of their chemical reaction lab from the week prior, and Mariah asks students to make connections between their results and what they know about endo- and exothermic reactions. Building upon that discussion, the reading provides additional information which students need in order to assess whether their designs will *safely* cook their food.

She gently reminds them, "*If we're not listening, when I ask you to start working you won't know what you're doing,"* before modeling how to effectively explain their reasoning when they highlight a portion of the passage.

It tells me blank. This is important because blank. I learned blank.

As Mariah makes her rounds through the room, she stops to ask a student, "What do you think is important in this section?" Another, she asks, "Why do we care about that?"

"If our chemical reaction isn't hot enough, the food won't be cooked safely." Most students she interacts with, like this one, require minimal prompting to reach conclusions that demonstrate their understanding of how the content in the reading will impact the success of their devices or what kind of revisions they need to make.

Meeting Students Where They're At

After class we talk about her approach to instruction in a practical sense. *I feel like the way that I work, I just kind of gauge where students are at based on my conversations and interactions. While they work, I get to walk around the room and meet individual students with where they're at. As I'm floating around the room, I get a vibe for it and adjust my instruction as I'm going.* At one point in the middle of first hour, she stopped the whole class to have a brain break after noticing their collective squirrely behavior. *Something that's really hard for me is actually collecting the data and being like, "here it is, this is why I'm doing what I'm doing." That takes up some of my time that I really don't have, and so I'm more accustomed to just kind of making those decisions on the fly. It's all in my head, like, I just know. That's where my wheels, I guess, really spend a lot of time turning. Like, how do I give myself the time and space to be able to work most directly with those kiddos that are the most likely ones to kind of drop off?*

And honestly, the part that is most difficult for me is teaching emergent multilingual learners. They, at this point, have been conditioned to act a certain way in class, and they usually get by with being under the radar. So how do you pull them out of that? I don't know the answer to that. I don't know if we ever will have a concrete answer for that, but it bothers the crud out of me. I have my two friends that you saw. One of them is an emergent multilingual learner, but he's been here for a hot minute now. Speaks pretty good English. But for the life of me… I explain everything in all the different ways. I pull out all the stops. Every single time he will look at me in the face and say, "Huh? Huh?" I could have just said it! Literally, verbatim, said what I need him to write. And he'll go like this: pencil to paper, and then look at me and say, "Huh?" And I can't tell if it's because they don't know how to. Is there a learning disability that we need to address? Or is it that at this point, they have realized that, because of all the other things that the teacher needs to be doing, that that is the task avoidance. That's how they get the teacher to leave them alone, or the teacher will write it for them, or whatever it may be.

I watched an example of this with a student who came in and put their head down to sleep the moment they got into class. Mariah mentioned along the way that sometimes she understands that students just need to sleep, but this particular case was, apparently, a task avoidance moment. She repeatedly, gently, came by to wake them up and re-engage them with the work. All that came of it was the student batting her hand away and refusing to participate. No other student I observed behaved this way, even in the most "high flying" classes, as Mariah calls them. As frustrating as Mariah finds this conundrum, other students do show competence—or intrinsic motivation, perhaps—and growth in her classes. The combination of her instructional choices and *her* as a person, together, provide significant support for these students to be successful, when they make an effort to try.

The other friend just joined us a month ago now. Newcomer. Doesn't speak any English. Nothing. But does *speak Spanish, so it has been a wonderful opportunity for myself. I grabbed him early on and explained to him, "even if you do not understand what they are saying to you, your brain is still processing the English that you're seeing. And so it's really important that you're always watching the teacher and seeing, what hand gestures are they doing? What are they pointing at? Even if you're just looking at it, your brain is processing that." So he has been working wonderfully. He has been doing phenomenal. It's really affirming to me that it has something to do with that conditioning piece.*

"Are there structures or activities in particular where those students seem more successful? Or better able to demonstrate, like, maybe they can't give a full explanation because they don't speak English, but they are able to demonstrate in some way that they're picking up what's being presented to them?"

I always consider the differentiation piece, but I just kind of naturally build all of that into how I teach the mass. Because what benefits those that need the differentiation really benefits all. I'll give them the opportunity to model and stuff like that, which we know is supposed to support that kind of thing. It's another frustrating piece, I'll be honest, because there's some of them that just won't do it. You could sit right there with them, and do all the things to try to explain what they need to do, and to understand, and they won't. So it makes it hard to even evaluate what is it that they are understanding? Now with my newcomer student that's been a little different because I've been able to express to them, "you can write in Spanish. If you want to attempt copying in English, I support that. Do whatever you're most comfortable with." They've been doing both. So I think the modeling piece helps a lot, both in giving them the structure to do it, but also modeling in the sense of following along with me. Both of those, I

think, are really important. Modeling for everybody to just follow along, I think is imperative, especially at this level. I think it makes a huge difference for them, because they just don't have basic note taking strategies, stuff like that. They just don't. So I think that helps a lot.

Controlled Chaos

I visit again just days before they cook actual food in their devices. Everyone, including Mariah and her partner teacher, are excited for s'mores. Today, groups of students are at a variety of stages: testing and completing last minute redesigns on their prototypes, creating their final posters, and getting peer feedback on the effectiveness of their setup procedures. They take time before unleashing constructive chaos to revisit important ideas. On the board are examples of "good models" where students previously identified the necessity of keys, labels, and arrows illustrating processes.

"Be sure to think about the small processes," she reminds them. "How is energy moving in and out of your system?" Through the discussion, students demonstrate an understanding of the relationship between exothermic reactions and the flow of energy in the context of their systems. Mariah reassures them that even at this stage in the process, revisions are acceptable. *"Models are always changing."*

She puts out so many fires in her 7th hour alone that it stresses *me* out as an observer. I forget how chaotic inquiry activities get. In the course of 20 minutes she:

Suppresses middle school-typical mayhem. *"Rubber bands in my hand in the next five seconds or we're moving disciplinary steps."*

Proactively redirects the class. *"Be respectful of the materials we provide you with."*

Calls a parent about a separate disciplinary problem. *"Thank you for your support. Please know I'm not mad at him, it's just this repeated behavior."*

Patiently explains the purpose of peer feedback. Twice. *"You are working under the biases of being the creator and innovator who made it. We want to see how effective your information is from the perspective of a person without the bias of already knowing your idea."*

Redirects students in one group while in the middle of helping a different group troubleshoot. *"By doing that you are creating more chaos and it's making your neighbor squirrelly. Get back to your seats."*

"It's bonkers in here!" she loudly exclaims at one point. There is no ire there, just something a little like disbelief. "*Just because we have a relatively unstructured day today, it's not an excuse for us to be disrespecting the materials and our room. I have friends in here who can't concentrate on their task. If you are done, that is good for you, but it is not an excuse to add to the mania."*

Later when she has a moment to breathe, I ask her how she manages it all so gracefully.

It can be really stressful! Having to also have lower structure in my classroom for a string of days can cause a lot of chaos pretty fast, as you saw. I was really transparent with students throughout that process. There are some days where we outline goals, and just things like that to help move them forward, that I think are things I also just do in my day-to-day life.

Collaboration and Agency

Despite the controlled chaos of the day, it impressed me how well the groups worked together. Yes, many were bouncing off the walls, but the group work itself went so smoothly. Everyone in the groups seemed to contribute to the process; no one bickered; work got done, even if it required some redirection on Mariah's part. It speaks to how much she values collaboration that her class so effectively supports it. By this point, students have practiced

working together in the context of her expectations for an entire quarter, but this unit seems to be special, like something clicking into place.

I think because the project emphasized the importance of collaborating, the importance of making sure everybody's thoughts—that equity piece—of making sure that everybody's thoughts are being contributed to their models. Which were things that I scaffolded, and talked the students through, again, having to make them mindful of that. But we also celebrated everybody's thoughts whenever we took all the things that we did and made a class consensus model out of it. I got to make deliberate decisions to make sure that that was being supported. And then just to get to see the growth of the students off of that.

On my visit in early January, students are collaborating once again. Seated in clusters on the floor around the room, colorful sheets of butcher paper with the approximate outline of a 7th grade-sized person litter the space. Together they illustrate models of McKenna's medical symptoms. The room fills with laughter amidst the sound of model negotiations.

"*This was one of those times where I like them to be with their friends because they feel safer to give their ideas that way*," Mariah tells me as she finishes her first lap around the room to visit the groups.

In the group closest to the desk where I sit, one student draws on the head of the model while their group mates work on the digestive system and labeling the relevant symptoms. Eventually, someone notices the lack of active contribution.

"What are you doing?"

"They're air pods!" The student gestures toward the headphones now visible in the ears. "They're listening to music."

"Ohhh. Alright."

The student looks so proud of themself, especially when they receive no push back on the addition. Their academic contribution happened before, when the team discussed how to draw their model, so this moment is strictly one of creativity rather than off-task behavior. A little tiny spark of joy in the midst of the team working, negotiating what went in the model in terms of actual content: “how do we best illustrate that?” and “what question should we write down?”

“It was very fun to watch.”

Oh, yeah. And all the hairstyles that I see. The eyelashes are always there. There's one of them that they did fingernail art on. Another one did “plastic surgery”, verbatim quote, and gave them longer fingers.

I love having that opportunity to just be like, "Yeah, do it.”

“Really? I could do this?”

“Yeah. Go for it.”

Or this group over there in the corner, she gestured to the pod of kids, *said, “So and so is not letting me put diarrhea on there.”*

I was like, “You could put diarrhea on there.”

“We can*?”*

“If you don't want to, like, make it gross, you could use the poop emoji.”

“Okay, we'll allow the poop emoji.”

“Okay,” she laughs.

“I could see so many teachers just being like, ‘Nope, we're not talking about that. Potty humor doesn't belong here.’ But that's like it's a thing kids want to talk about,” I say.

Oh, they do. All the time. Literally one of them took too long in the bathroom and the first thing she said to me was “I took a fat dump”. I was like, okay, go to class, please.

People ask me all the time about the relationship building, and that's like my punchline at this point. At this age, they want to be mini adults. Anytime that I have a student asked me, like, "can I do blah, blah, blah?" I almost always will find a way to say yes, because it's the time that they become the most passionate about whatever it is they're doing. They want the power to make decisions because, A, their egos are huge right now. B, they now have some sort of basic understanding of the things that happen and revolve around them, and so they think that they've seen enough to make decisions. So whenever you're trying to take that away, that's where they think they're at. I remember feeling that way. I remember getting so stinking frustrated with my parents whenever they would talk to me like I didn't know. And I hear it all the time from them. "They think I don't know. They think that I'm a kid." They don't like to be talked to like kids anymore. They like feeling like you respect them as an adult. So I think anytime that you can let them have that voice and decision, whenever they live so much of their lives without that, technically, I think they cherish that and they'll do anything for that more often than not.

It's why I think sometimes I see the behaviors that I do in my classroom because they grow to know that like this is a safe space for them to exercise that, and to be themselves. And I impower that, but then there's also some times where I have to rein it back and be like, "Whoa. Whoa, bucko. We're not gonna do that either." So it's all a delicate balance, needless to say.

Boundaries

While Mariah herself does not explicitly identify boundaries and expectations, per se, as talking points, I see a clear thread of how the strength of both help sustain the safe environment of her classroom. It stretches across stories, both in and out of her classroom. Our conversation weaves in and out of time and place as we chat.

Last year was a little hard for me. I think with my pregnancy, I was just trying to protect my peace a lot, and so it made it kind of hard to create those relationships the way that I like, and give as much as I like of myself to my class and my students.

This phrase, protecting my peace, sticks with me. It describes so clearly what Mariah does in all of her interactions. Protecting her peace. Protecting the peace of her classroom. Protecting the peace of her peers. Also clear to me, that disrupting that peace impacts her relationships, which are central to her teaching.

I dropped a curse word in front of a student yesterday, she tells me, *because I was just so fed up with that hour being so mean to each other.* We are talking again about the day students swarming her desk made her snap. She covers PE sometimes, and baseball that day was another mess on her plate. *I mean, all hour I spent saying, like, "be kind to each other. Go to the dugout. Sit down. Don't hit each other with the bats."" That class just gets so invested, to put it nicely, and they just become mean to each other.*

There was not a moment to stop and take a deep breath, and I felt that all day. I mean it! Quite literally I got home and it was just like a weight had been taken off my shoulders, because all day I've been so pent up with stress. And I don't like being in that space, because I'm not helpful to anybody. But most importantly, it's as the saying goes: you can't fill somebody's cup if yours is empty; and mine was empty yesterday. The healthy thing would have been to lock my door and be left alone for two hours after that third hour class, but because of my responsibilities, that wasn't an option. I never found an opportunity to even take a minute to have that pause. It just led to… I mean, my instruction across three out of my four core classes could have been way better. Way, way better.

I want to always be somebody that the teachers and students feel safe to approach and ask questions. Yesterday I was so dysregulated that I don't know if I was that person, and I don't like that.

In the moment it didn't occur to me to point out the way her boundaries and expectations seem to keep her sane on the rougher days. It comes up in all of the stories she tells, little ways that the expectations she sets keep her classroom reflective of the kindness and inclusivity she values.

"Your students don't seem the type to get mean. Not many of them, at least." She shakes her head.

I think it really comes down to what their exposure has been growing up and how that causes them to respond. I would say the ones that immediately become mean, it's the ones that I know don't have any kind of emotional development support from home. Any time that they make any kind of progress as far as processing that kind of stuff, it's because of school, and counselors, and teachers. But that's also part of our training as teachers to be able to recognize that kind of thing. It's why relationships are important, because some of those kids, like, you come at them sideways and they will pop off. I mean, a lot of the time, students that don't get certain supports at home. The teachers, usually, are the ones providing that support instead. Whether it be through structure or an emotional support.

There are several students, especially in my third hour, where I am the emotional support for them. I got a taste of that in an IEP I was in yesterday for one of them. Their guardian wanted very strict limitations, which I think are important and necessary for that student, but the way that they wanted me to execute that doesn't really fit with how I conduct myself. I did push myself a little bit more today with that student, being more firm and, like, "you need to get

started with this," etcetera. So that was a little bit out of my comfort zone, I would say. But definitely is an example of one student who I have to provide extra emotional support, boundaries, stuff like that to get some sort of product from them.

"What was that like? Having to do something that's different than how you conduct yourself, in terms of helping a student be successful or trying to, I don't want to say accommodate a parent's desire, but what the their family expects of them as well."

I'll be honest that in this case, I was willing to do that because I have been feeling kind of manipulated and taken advantage of by the student. So it was part of the reason why whenever that guardian was giving that feedback, I was like, "Okay, I'm willing to sacrifice a little bit of this relationship at this point to see if this works." Because I had been hitting a point where I was feeling really depleted by that situation. And that sounds really cruddy to say, but it's also cruddy to feel taken advantage of and like that student thinks that my class is a class they can just goof off in. Because then I feel like you're not taking me seriously as a professional, and that's something that I'm really big on for teachers. I'm a strong advocate that teachers are professionals and so whenever I have a student not treating me as such… Yes, in my head, I'm like, "they might be acting like this because this is their safe place, and might be one of the few points in their whole day where they feel like this is a safe place to be themselves," but there's a limitation to that. I still need them to produce work so that I can assess and do my job, and help them grow as individuals and scholars. If they aren't doing anything, I can't do that part. And so then we start to cross some of those boundaries.

Kindness and Inclusivity

We let that story trail off into silence without much else to say about it, letting it sit there between us for a moment before I circled back around. "I think your class is the kind of space

that makes it hard for students to be mean. Or maybe it's more accurate to say a place that encourages them to be nice."

Those baseline things like it being fun, us laughing together, us enjoying each other's company, not being rude or disrespectful to one another. Those kinds of things create a wonderful synergy in our classroom of it being welcoming, and that everybody's accepted here, which are really important moral values for me. So I think whenever those are being exemplified through my teaching and my decision making, then that's also exemplifying who I am as a person, and what I want to create for my students in my classroom.

A pair of students interrupts us to bring Mariah their extra desserts. She beams at them, and even after they've left maintains that delight. I am thinking about how sweet they are and remembering all the little moments when cultivating kindness in my own classroom was difficult. I ask her, "Do you ever have those times where students are doing something relatively minor that you *have to* stop and make a big deal out of anyway? For the sake of classroom culture?"

"Like, I've heard my bilingual students, between each other, say stuff about their dialects if they are from different spaces. And I nip that in the bud."

"What do you mean?"

My entire life anytime I shared that I was Argentinian, be it in the United States or if I've gone abroad, if I shared that I was Argentinian, the reaction is like, "how the heck did you land here?" So I get that a lot from students as well. I think it interests not just our Hispanic population students, but I think all students are like, "Okay, how did this Argentinian end up in friggin Oklahoma?"

It's been my whole life, literally. And I love it, I really do, but it was really confusing as a kid. Talk about an identity crisis! Whenever I was in that student population, I got rejected a lot—because I wasn't Mexican, because I wasn't whatever—because they would talk to me in their Spanish dialect, and I could barely understand it because it's so very different from mine. I could pick up on the gist, but the tone, the jargon, the speed at which it is used is so different. It was so confusing for me. And that happens sometimes now with students, I'm just more confident in it.

It was something that I really struggled with growing up, so I try to catch it as much as I can as a teacher who's had that experience. I think that's also why I emphasize so much to them that having multiple languages is a superpower, and it's awesome. I try to advocate that you should want that superpower. You shouldn't be belittling or making fun of them for it. I also don't play that game of, like, other students mimicking accents. That's been a whole dilemma with our refugee students from Afghanistan, so I'm definitely trying to be more and more intentional about saying, "No, no, no. No, we're not going to be doing that."

With such a limited amount of time spent in her classroom, I missed opportunities to see these moments in action. Catching little snapshot moments of her connecting her life to her students—discussing whether she was a cat or dog person with a student, how that's changed now that she's a mother; comparing dialects with a student for differences in how they say "making a mess" in Spanish—without being present to audience the unfolding of those relationships. "Are there other parts of your life that you're able to bond with students over?"

Honestly, being Argentinian and being a soccer player are really personal, like who I am, but they're also so stinking important in forming relationships with some of our toughest kiddos. There is a whole group of them that will give teachers a run for your money if they do not

like you. Just naturally, because I apply the strategies that I do with all of my students, but also because I am who I am—and part of that being Hispanic, and soccer player, and all those things, and a bilingual person—they respect me a heck of a lot more than most people in this building. They naturally come to me if they need things. That relationship piece and me being able to advocate for them across the school is important, helping them to feel seen, connected.

All of those things come down to me being Argentinian, but also the soccer piece has been huge for that population of students, especially. Really, a lot of other students too, because in our community here soccer is a huge thing. So in PE whenever I get to play soccer with them, it's just so much fun, and they get to see me get competitive. Like, nothing is sweeter than just absolutely schooling a student at soccer, because they think that they are the hottest soccer player in the town. And then they get beat by a teacher, and a girl teacher on top of that, and it's like, the best. The competitive side of me just cannot resist that. You know, humility is good too, but, honestly, we laugh. I get to apply a little bit of that coaching side. It's, you know, it's a stress reliever for me. And it's just, it's fun. Anytime you can have fun with your students, it builds that relationship and they learn to respect you more because of it. So those things just really are huge pillars for some of the relationships that I have across the building.

Becoming a Science Teacher

Coaching comes up a few times in our discussions, and I see it connect to another thread that passes through all of Mariah's stories: mentorship. It is visible in the ways she serves her school community as a leader and in the way she models for her students, but also a reflection of the support she received throughout her journey to becoming a science teacher. Sitting in her classroom on a Zoom call with me, she tells me about her parents and how she became a science teacher.

I think everybody's road to education is unique, and very much tied to prior experiences. Whenever I think of educators, there's usually that background that they had educators as their parents, or as very close models. Initially, I thought that I was not under that banner, but as I think more on it, I think I very much did have that model through my mom and my dad, just in maybe some non-traditional context in comparison. My mom is an early childhood educator, essentially, without, like, the official title of being that, and my dad is a chemist. We did science experiments at home, and I grew up going to his lab with him and around that kind of thing. He loves to tell the story of me being a baby, and he would take me to his classes, and he would bounce me while he was teaching the undergrads. So I mean, like, it's always been around me. I think there's some important modeling that happened as a kid early on with my dad being involved with the university. Then, even after he left and started working for Phillips 66, he's always been a mentor for students. Even though I didn't always directly observe that, I indirectly, very much did.

My experience from the veterinary field, even though you know it's in a non-traditional setting, I was educating clients all the time about their pets' well-being, things to do for their pets, etcetera. Actually, it was in between whenever I was deciding which route to take with veterinary science or education that I had this epiphany one day while I was working, that the part that I'm really enjoying about being in this clinic is whenever I get to talk to the patients. Whenever I get to educate them, on their pets, and be a support for them. And so I thought, you know, what better way to do that than in the classroom.

"That's a pretty substantial change, going from vet science to education."

Yeah, but I knew I was coming up in a place in life where I wanted to get married. I wanted to have kids. I got burnt out on sitting and waiting for these things to happen because I

was so tied up with school stuff. I didn't feel like my veterinary science program supported what I wanted out of that, either, and I just didn't want to be buried in debt for 20 years. I know the saying goes, you know, teachers have debt too, and we don't get paid. But I was in a place to be able to start pursuing education without it putting me in the same kind of position I would be in if I would have pursued veterinary science.

Being somebody who didn't come from a traditional education background, and came from just sciences, I think I was in this really great position to be able to be molded. I had no idea what I was doing! That's why I decided to go with my advisor for my graduate work, because she was phenomenal. I always tell people, it took one meeting with her to realize that this is what I wanted to do. I wanted to be her whenever I grew up. She's awesome. And I loved that the university had the opportunity for me to do an internship….

And then I did not do an internship. Instead, I had various conversations with my principal and my advisor about how I did not want to take the job because I was scared. I didn't feel prepared. I didn't feel capable. I very much still live with impostor syndrome. I think we all learn how to navigate that, but having just one conversation with my advisor, I felt like I was capable, and that I could do these really cool things. And then the validation that I got from the last three years from people who know way more than I do—who I look up to, and admire, and aspire to be—has definitely been reaffirming that I'm in the right place and doing the right thing. I found that last year and then going into this year, that I want to be in a place where I can help create passionate and happy educators as much as possible, while also promoting student learning. It's a big reason why I decided to do the PhD, too.

Looking Ahead

That piece about creating happy educators signals a change on the horizon. Despite the love Mariah has for her students, her path will likely lead her out of the classroom. Just as the life she wanted to live helped transition her out of veterinary medicine, her next expected step in education reflects the life she wants to live.

"Do you see yourself staying in the classroom long-term?"

I'm very driven by like, we have one life to live. And I know what I want from that life. I know how I define living a beautiful life. And I don't think I can accomplish those career and life ambitions, staying in the classroom, unfortunately. If I could, I would love to. But unfortunately, our society isn't set up for that.

"So what does living a beautiful life look like?"

Chapter 6

In an effort to further the implementation of research-based, constructivist science instruction, the science education community has taken the apparent stance that all educators will use three-dimensional instruction given sufficient time and professional development. However, in doing so, research into science education effectively erases the unique experiences of educators in their own classrooms. Reform measures succeed or fail at the level of the classroom through the choices of individual educators. For widespread adoption of research-based science instruction, we must consider the individuals expected to implement these practices. Who teachers are as complex people impacts how they choose to teach, and to understand those choices requires that we understand the people making them.

Understanding the relationship between identity and instruction requires a level of nuance best captured by small stories and teachers' narratives of self. The use of narrative centers teachers' voices as they tell the stories of who they are and how they approach science instruction. Paradigmatic and narrative analysis allowed me to identify evidence of positionality found throughout the stories told by the participants. By further triangulating these narratives with observation of classroom practice, I re-present these individual stories as a holistic picture of the whole-person identities and their contribution to the instructional decisions participants made within their classrooms.

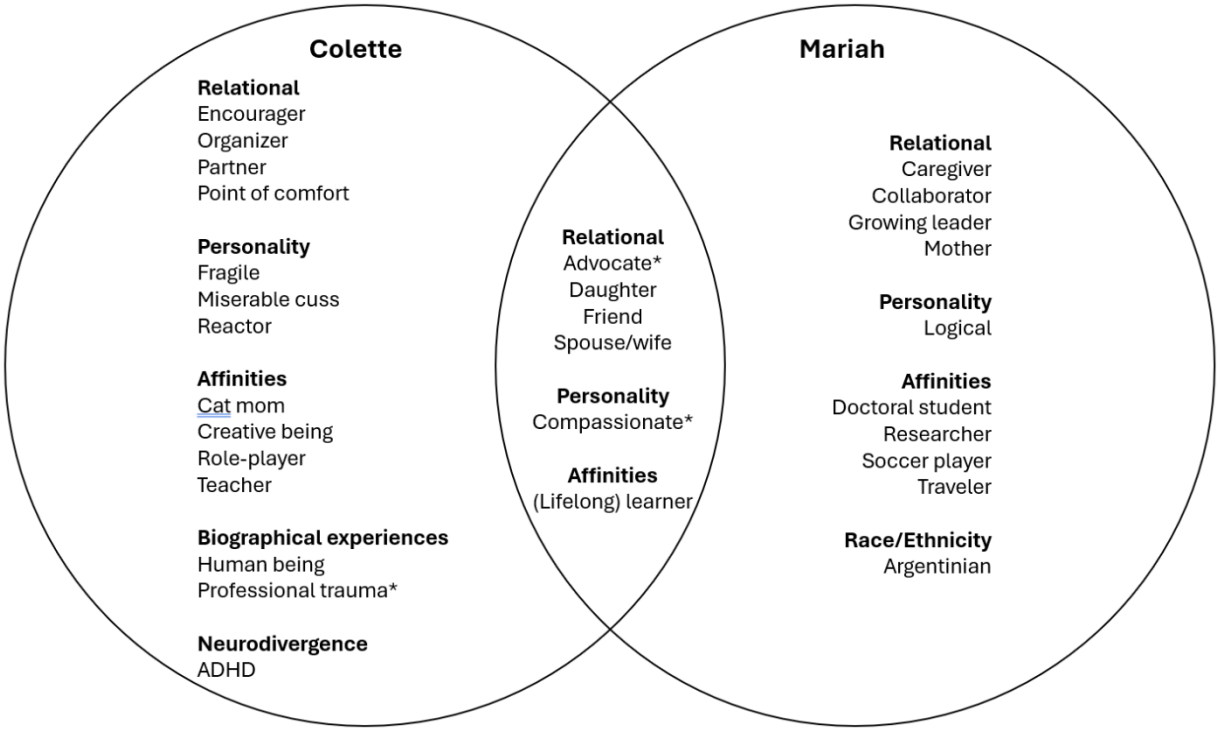
Interpretation of Results

This study sought to answer the question, *In what ways do secondary science teachers represent their personal identity while enacting research-based practices?* Colette and Mariah's stories reveal explicitly a relationship between reform-based instructional choices and their whole-person identities. I discuss each of their individual positionalities and those they share

below (see Figure 1).

Figure 1

Positionality Types Identified in the Data



Note. All positionalities were identified explicitly by the participants in their Five Whos reflections, except those marked with an asterisk, which I identified from the coded data.

Colette's Positionality

Based on the types of positionality I identified in the literature review, Colette's unique whole-person identity included four types (relational, personality, affinities, biographical experiences) and a fifth type I categorized as neurodivergence. In relational terms, Colette saw herself as an organizer who coordinates many moving parts and people; as a partner who supports her colleagues and friends, personally and professionally; an encourager and a point of comfort for her peers and her students. She values the cultivation of supportive relationships.

Her personality centered on how she felt though the experience of teaching during the research period, seeing herself as fragile from dealing with so much stress and expectation, and consequently feeling like a miserable cuss. In this context she saw herself as a reactor, responding to things in less productive ways than she might otherwise, were it not for the stress of the conflict with her administration over the physical condition of her classroom. Amidst that conflict, which I labeled as a biographical experience of professional trauma, she identified herself as a human being, reinforcing her own identity and self-worth to herself.

In terms of affinities, beyond being a teacher, Colette strongly identified with her sense of being a creative being, in the descriptive sense of possessing creativity and literally in the sense of creating products (e.g., crafting). With some encouragement to think of herself as an individual beyond her relationships with other people, Colette also identified as a cat-mom and a role-player. Finally, she identified her neurodivergence, ADHD and to a lesser extent her OCD, in direct relation to her teaching experience.

Mariah's Positionality

Mariah discussed her positionality within four of the types identified in the literature review: relational, personality, affinities, and race/ethnicity. She centered her relationships in a place somewhere between personal and professional. In her building and district, Mariah saw herself as a growing leader, continually developing skills as she gained more experience in formal roles. As a collaborator, Mariah saw herself as working with both peers and students, as well as modeling and encouraging others to become more collaborative themselves. Mariah's recent motherhood and perceived role as a caregiver transcended her home to apply to how she related to students in and out of her classroom. The interplay of these personal-professional

identities reflected Mariah's desire to be a welcoming person and safe place people can turn to in need.

The affinities and personality portions of her identity overlapped in some areas. Mariah viewed herself as a logical person (personality) which interacted with her affinities as a doctoral student and science education researcher. The interplay of these positionalities manifested in her thoughtful approach to problem solving and a deep self-reflectiveness in regard to both her personal life and instruction. Likewise, her affinities also interacted with her race/ethnicity positionality. Mariah had affinities as a soccer player and traveler, features of self through which she connected with students. Being Argentinian was a path to connection with her students as well, as both a native Spanish speaker and an emerging multilingual learner in her childhood. Additionally, Mariah played soccer for the Argentinian national team, which contributed to her ability to travel, and introduced an additional point of connection with her students through her experience of having met Lionel Messi.

Shared Positionality

In addition to their unique positionalities, Colette's and Mariah's identities overlapped in a number of ways. Relationally, both identified themselves as spouses, daughters, and friends. These connections to family and friends were most salient in their stories of becoming science teachers and their lives outside of the classroom. Their advocacy (relational) and compassion (personality) overlapped in the ways in which they both engaged with students within and outside their classrooms. For Mariah this surfaced specifically in how she supported her emergent multilingual learners, while Colette primarily embodied this in out-of-class support for special education and neurodivergent students who needed someone in their corner. It should be noted that Colette did not explicitly identify herself as either an advocate or compassionate, but

both qualities were sufficiently apparent in her stories to include them in a description of her positionality. Additionally, both Colette and Mariah identified themselves as lifelong learners. They brought this part of themselves to bear in the vision they had for their students to develop that same desire to continue learning outside of the classroom.

Influence of Positionality on Instruction

Both Colette and Mariah described complex personal identities through their stories and the Five Who's exercise. Some of the positionalities they embodied proved more relevant than others in directly influencing their instructional practice, though all contributed in some way to their experience as science educators overall.

Colette. Colette's ADHD and identification as an organizer contributed to her ability to manage the chaos of a classroom where students engaged in both curriculum-based learning and individualized passion projects. Having lived as "an agent of chaos" herself, the coping mechanisms she had developed over her life helped her feel equipped to manage the stress of so many things going on at once, which allowed her to persist and continue the passion project approach each semester. In practice, this did also contribute to a degree of apparent permissiveness, as one is limited in what one can observe at any given moment.

Additionally, the passion projects allowed her to bring herself as a lifelong learner and creative being to bear while inspiring students to find their own passions. Bringing her creativity and personal hobbies (e.g., video games) to the classroom also allowed her to connect to her students individually through their interests while simultaneously cultivating the curiosity she hoped to see them exhibit.

It would be reductive to focus explicitly on the conflict in Colette's professional life through the course of this study, but neither can I overlook it. Colette's identity, the combination of her self-identified neurodiversity and the experience of professional trauma from a previous teaching assignment, contributed to a conflict within the context of her building and the expectations of her administrators. This conflict shaped her instructional choices over the course of two school years. While Colette attempted to assimilate herself into the explicit and implicit expectations set for her, her attempts at changing her practice led to a sense of alienation from herself and her classroom. Ultimately, she consciously leaned into her identity, choosing to "be me" rather than sacrificing her sense of self to fit the vision of her administrators.

From the beginning, Colette identified herself as a teacher. As she wrestled with conflict, this aspect of herself increasingly interacted with her sense of being a "human being" in the self-reflection she engaged in around her role as an educator. The growing sense that students should find meaning in the work and leave her classroom equipped with vital skills created a sort of advocacy that underpinned her instructional choices. This manifested as a shift in how she taught from the beginning of my research to the end—the span of two semesters across academic years. While the coverage of content remained stable over time, by the end of the study she spent more energy on making lessons relevant and authentic to student interests, built more explicitly on prior knowledge, and shifted from small group work almost exclusively to more whole class discourse.

Mariah. Mariah's motherhood and identity as a caregiver played a prominent role in her classroom, shaping the ways she viewed her students and engaged with them. The change in her perspective after having her son meant that she reframed her interactions with students through the lens of ways she would want people to treat him. As a result, her classroom became a space

where students were treated as individual people with different needs. She attended to these on a case-by-case basis, knowing when to push a student, when she needed to step away to facilitate a more constructive learning moment later, and how to frame her transparency in ways that spoke to students' ways of knowing (e.g., coaching).

Furthermore, knowing her students so well shaped how she modified her curriculum in ways that appealed to them personally. Through her understanding of what students would and would not enjoy, she tailored her instruction to spark curiosity and wonder in them in the hopes that it would contribute to an internal motivation to become lifelong learners themselves. An additional aspect of knowing her students came into play directly through being Argentinian. The ability to speak Spanish and her experience as an emergent multilingual student herself allowed her to connect to the students in unique ways. Instructionally, her experience manifested in helping these students acquire effective language and learning skills in the context of science.

Mariah's experience as a doctoral student and researcher also play a role in how her classroom operates. Through her experiences exploring research, and data specifically, Mariah worked to develop data-driven decisions in her classroom. After learning more about the collection and use of data through her academic studies, Mariah began shifting her approach to more explicitly consider what her student data says and how to apply that to her instructional choices. Her application of it, though fledgling, shaped how she grouped students up to offer remediation and enrichment during class.

In addition to the purposeful grouping, Mariah also emphasized productive collaboration between her students in class activities. Whether students self-selected groups or she purposefully assigned them herself, her classroom ran such that groups engaged in constructive

academic dialogue and teamwork. Transparency with students in the context of group work involved explaining what behaviors in groups support success, and modeling effective ways both to communicate and to complete a given activity. Her identity as a logical person fueled her transparency, which was apparent in the methodical way she employed think aloud explanations and broke down information.

Reform-based Pedagogy. The goal of this research was to determine how teacher identity influenced their instructional decisions, specifically in the context of three-dimensional (i.e., reform-based) instruction. Both teachers employed three-dimensional instruction in their classrooms, to different degrees. Mariah's curriculum was more explicitly three-dimensional than Colette's, and she integrated a more diverse set of the dimensions through her instruction. That was largely due to the difference in expectation between being a grade-level core content class with predetermined standards and a STEM elective course with flexibility in what to teach. Colette's integration placed less emphasis on Disciplinary Core Ideas in favor of centering Science and Engineering Practices and a smaller subset of Crosscutting Concepts which lend themselves more readily to engineering.

Interestingly, neither Colette nor Mariah seemed particularly preoccupied with whether their instruction was three-dimensional. Despite having been trained in the use of three-dimensional instruction, outside of what was baked into their curriculum, neither of them explicitly discussed it without specific prompting. The exception to this was the use of relevant phenomena and engineering problems, where they both consciously considered the interests and experiences of their students in their use of these features. Instead, they actively cultivated in their classrooms an environment which supported the intended learning outcomes of three-dimensional instruction. Though neither explicitly used the Ambitious Science Teaching

approach (Windschitl, et al., 2018), it serves as a useful point of reference in explicating what an environment that supports three-dimensional instruction looks like. Colette and Mariah both leaned heavily on several key elements: (1) anchoring learning experiences in phenomena; (2) students use a variety of practices to develop explanations and models; (3) student funds of knowledge were treated as resources for whole class learning; and (4) student thinking is made visible to the classroom community (Windschitl, et al., 2018).

Students engaged in collaborative discourse; they provided evidence-based arguments; they explained phenomena and solved engineering problems, took risks and showed initiative. Both teachers also heavily emphasized students using modeling in their classes. Both regularly asked students to draw and revise models over time, often returning to them as a point of reference throughout a given unit. By and large, students' construction of explanations was tied to this, with models being used as the basis for or the elaboration of students expressing their understanding of big ideas. During this explanatory process, students' specialized knowledge and individual experience were valued as part of the discourse. Furthermore, in Mariah's stories, relying on student funds of knowledge allowed her students with medical conditions to bring their lived experience into the discussion of their class medical mystery; Colette, by the end, regularly asked students to explicitly identify parallels between the in-class learning and their out of school experiences. In seeking out this input from students, both created a public sense of value around student ideas. As a result, when students discussed content, in small groups and as a class, they showed boldness in sharing their ideas and building off one another's ideas.

Through these processes both teachers cultivated strong communities of practice within their classrooms. Communities of practice operate on the basis of joint enterprise (accountability to their shared understanding of their community), mutuality (establishing shared norms and and

interactions), and shared repertoires (e.g., language, tools, etc.; Wenger, 1998, 2000), all features which were visible in their classrooms. According to Peele-Eady & Birr Moje (2020), "(t)he purpose for coming together is what makes a community" (p. 234). Differences among members of a community expose learners to diverse ways of thinking and experiences to learn from one another, and through these individuals create connections among different communities. In both classrooms, the centering of student voices and the enactment of their whole-person identities celebrate these differences and in doing so strengthen their communities.

Boundary Crossing. Both Colette's and Mariah's whole person identities shaped their classroom communities of practice, wherein they served as boundary brokers between their identity and the classroom community of practice. They facilitated boundary encounters as they brought their whole person identity to their classroom communities of practice, interactions which produced their lived experience in the classroom (Wenger, 1998). These boundaries "can also be areas of unusual learning, places where perspectives meet and new possibilities arise" (Wenger, 2000, p. 233). For Colette, the combination of her personal passions, hobbies, and intellectual values (e.g., lifelong learning) contributed to her vision for her students, which in turn shaped the way she structured her teaching. By bringing to bear the expertise and competencies developed in her personal life, she created a generative tension in her classroom where students' own experience (e.g., personal interests and skills) and their competence—as individuals and as a community—were at a distance from one another sufficient to produce learning (Wenger, 2000). For Mariah, the boundaries of her identity, her classroom community of practice, and her school community of practice consistently produced generative tension. Boundary crossing experiences within her classroom allowed her to bring her compassion and advocacy to her instruction, especially in how she engaged her emergent multilingual learners.

Through modeling and vulnerable transparency, she translated her experience as herself a multilingual learner to help those students build necessary academic skills. Seeing herself as a collaborator and connector allowed her to teach students how to become productive collaborators themselves. The logical part of her that framed her transparency with students also served as a model for them to see the rationale in her actions and to construct their own logical ways of approaching information as they learned.

Limitations

A small sample size inherently limits the extent to which I could draw conclusions from the data. Narratives and small story approaches are not intended to be generalizable, but even still, a sample size of two gave me only a narrow view of the complexity of identity and instruction. Both my participants were women teaching in urban districts with similar demographics, were trained through the same university education department (though at different time periods) and had existing district/class curricula at their disposal. Additionally, both received formal training through their program (Mariah) and extensive professional development (Colette) in three-dimensional instruction. This allowed me to conclude that a relationship exists between identity and instruction, but I presume with confidence that this relationship holds true across other contexts.

The framing of the study and the relationship I have with both Colette and Mariah may have influenced how they thought about their identities. In Colette's case, the parts of her identity she articulated, especially the personality components, reflected her immediate experience at the time we sat down to talk. Despite describing herself as a *miserable cuss*, a *reactor*, and *fragile*, these are not ways Colette generally speaks of herself, nor how I have

perceived her as an outside observer over the years. I intended the intermittent identity reflections to help surface additional positionality experienced over the course of time, but these returned much the same data as our interviews. Whether this reflects a strong core of positionality as it relates to instruction, or simply a narrow focus on what is most readily apparent about oneself remains to be seen.

In reflecting on the data, I realized that I entered this research with the assumption that because both Colette and Mariah use three-dimensional practices that they necessarily did so consciously. Consequently, the depth of their reflection on the topic was significantly shallower than in other arenas, and it is possible that additional relationships exist between their identities three-dimensional instruction, per se, but never surfaced.

Implications and Recommendations for Future Research

Given the preliminary nature of this line of inquiry into whole-person identity and instruction, the implications of this research remain tentative. At this juncture, the most fruitful application of results is in helping teachers purposefully reflect upon how they bring themselves to their classrooms. Colette and Mariah's stories reveal deep connections between who they are and how they teach, particularly in regard to how they structure their classrooms. Through the course of the work, interrogating their own identities allowed Colette to clarify her sense of purpose as an educator, and subsequently shift her practice to better reflect both herself and her vision for her students. For Mariah, reflecting on how her identity manifested in her classroom instruction (e.g., transparency) helped her consider other ways she could scaffold her practices to make explicit for the students the skills they had learned passively prior to the research. Pre-service teachers might best be served in this regard by forward thinking about ways they might

bring themselves more fully into their classrooms through their instructional practice, whether that be through affinities, relationships, or other positionalities.

Developing a robust understanding of how identity influences reform-based instructional practices requires a larger body of data. While this study demonstrates a clear connection between identity and instruction, the voices of more teachers from diverse contexts must contribute to the discussion. Educators who create their own curriculum and those who do not engage in reform-based/three-dimensional pedagogy are of particular interest comparatively. It is possible that teachers who develop curriculum for themselves may focus more explicitly on three-dimensional approaches, which would provide a more nuanced understanding than what a sample size of two provides. Additionally, understanding the relationship between identity and practice in teachers not engaged in reform-based practices may shed light on why teachers do or do not choose to implement reform-based instruction.

Colette and I discussed the possibility of intentionally integrating her whole-person identity into her classroom, bringing to bear her own personal coping skills as tools for the students and integrating her vision for their success explicitly into the culture of the classroom. However, the negative experiences she had during the Fall 2023 semester deprioritized the idea before she could explore it. Future research would further benefit from assessing the effects of purposeful inclusion of whole-person identity in the classroom. Since boundaries "can also be areas of unusual learning, places where perspectives meet and new possibilities arise (Wenger 2000, p. 8), this act of intentional boundary crossing has the potential to transform the learning environment of the classroom community of practice in interesting and unpredictable ways.

Teacher neurodiversity and trauma unrelated to classroom teaching both serve as additional avenues of inquiry. As Colette described in her stories, neurodivergence (i.e., her ADHD) directly impacted her instruction and her relationships within her building. While pathways exist in the academic and professional world for disability accommodations, how one accesses those as a classroom teacher is significantly less clear. Considering the ways in which neurodivergence might shape classroom instructional choices, better understanding of the impacts of teacher neurodivergence in the classroom and the support they do or do not receive is of direct relevance and interest to the broader discussion of whole-person identity. Likewise, both teachers discussed trauma which occurred outside their classrooms but nonetheless impacted their lived experiences as educators: a difficult pregnancy in Mariah's case, and anxiety-inducing professional trauma in Colette's. However, the literature addressing teacher trauma appears all but nonexistent outside of (1) trauma-informed training, and/or (2) secondary PTSD, compassion fatigue, and burnout due to teaching children with trauma. An in-depth exploration of this literature proved beyond the scope of this dissertation—in no small part due to the lack of discrete keywords to tease out contextual nuance—but is a potentially fruitful research topic.

Appendix A

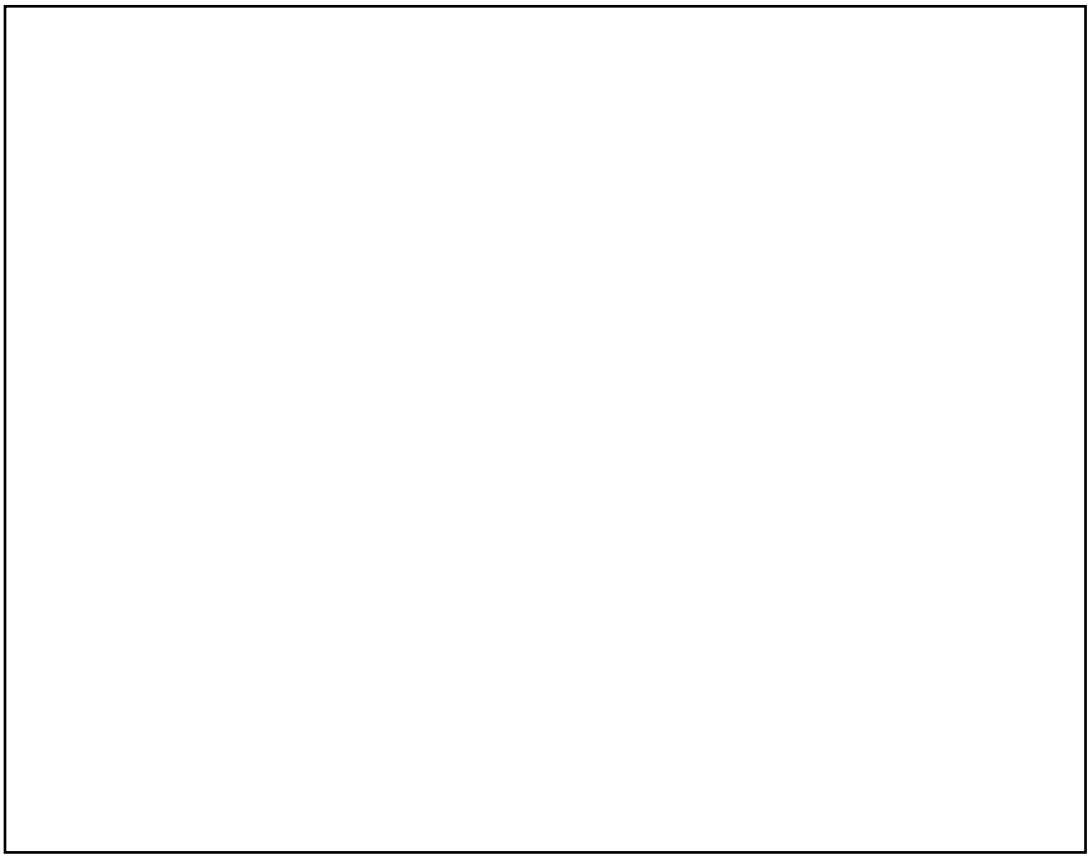
Interview Protocol

1. Who are you? (Repeat five times.)
    - Probing questions to solicit additional stories or details about self-identification. Examples:
        - What experience(s) led you to see yourself in this way?
        - Can you tell me more about…?
2. Tell me the story of how you decided to become a science teacher.
    - Probing questions will solicit information about:
        - Education (science content and education pre-service)
        - Emotions/feelings about the decision
        - Context (e.g., time, place, salient life events, etc.)
3. Tell me a story about a time you felt the *most* like yourself while teaching.
4. Tell me a story about a time you felt the *least* like yourself while teaching.

Additional questions to be informed by initial written reflection.

Appendix B

Science Teacher Model Reflection



In the middle of the page, draw and/or describe yourself as a science teacher at work. Feel free to use colors, labels, etc. Around your description/picture, describe significant personal experiences you have had related to science, positive or negative (e.g., scientists; science teachers; informal science experiences, such as museums, zoos, camps, hobbies; school science, etc.).

Related to the description you wrote and/or picture you drew, answer the following questions:

1a) Write FIVE words that describe **yourself**.				
1b) Describe what **you** are doing in the picture.				
2a) Write FIVE words that describe **your teaching style**.				
2b) Explain **why** you choose to teach the way you do.				

Appendix C

Classroom Observation Protocol

Three-Dimensional Characteristics Lesson Checklist			Notes	Observation Notes
Explaining Phenomena or Designing Solutions		Facilitated lesson provides direct (preferably firsthand, or through media representations) experience with a phenomenon or problem that is relevant and developmentally appropriate.		
		Facilitated lesson results in the development of science ideas anchored in explaining phenomena or designing solutions to problems.		
Three-Dimensions		Facilitated lesson design supports acquisition, improvement, or use of specific grade-appropriate elements of SEPs and CCCs to help explain phenomena or solve problems during the lesson.		
		Facilitated lesson requires explicit use the SEP and CCC elements to make sense of the phenomenon or to solve a problem.		
		Engineering lessons result in the acquisition and use of elements of DCIs from physical, life, or Earth and space sciences together with elements of DCIs from engineering design (ETS) to solve design problems.		
Integrating the Three Dimensions		The lesson is designed to build student proficiency in at least one grade appropriate element from each of the three dimensions.		
		The three dimensions intentionally work together, resulting in students explanations of a phenomenon or designed solutions to a problem.		
		All three dimensions are necessary for sense-making and problem-solving.		
		Teacher deliberately solicits student artifacts that show direct, observable evidence of learning, building toward all three dimensions of the NGSS at a grade-appropriate level.		

		Facilitated lesson uses tasks that ask students to explain phenomena or design solutions to problems, and that reveal the level of student proficiency in all three dimensions.		
Relevance and Authenticity		Facilitated lesson actively motivates student sense-making or problem-solving.		
		Facilitated lesson uses student questions, prior experiences, and diverse backgrounds related to the phenomenon or problem to drive sense-making or problem-solving		
Student Ideas		Teacher facilitates classroom discourse to solicit explicit expression and clarification of student reasoning.		
		Facilitated lesson provides students opportunities to share ideas and feedback with each other directly.		
		Facilitated lesson results in the production of student artifacts which include elaborations (which may be written, oral, pictorial, and kinesthetic) of reasoning behind their answers, and show how students' thinking has changed over time.		
Building on Prior Knowledge		Facilitated lesson content builds on students' prior learning in all three dimensions.		
		Facilitated lesson explicitly works together with students' foundational knowledge and practice from prior grade levels		

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