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1. STUDYING SCIENCE TEACHER IDENTITY

An Introduction

This is a book on science teacher identity. As any book volume, it is the result of a collective effort, which represents the diverse perspectives, frameworks and tools that researchers have used to study science teacher identity. As such, the book introduces various theoretical approaches to framing science teacher identity and it reflects a series of methodological procedures as well as tools that researchers have employed in their works, situated within multiple kinds of contexts. The purpose of the book is not to suggest a single, individual theory or a methodological approach to studying science teacher identity. That would, in fact, contradict the multidimensional, fluid, and ever-changing nature of identity. Instead, through the individual chapters, this book aims to address various theoretical frameworks as well as methodological approaches to studying science teacher identity. At the same time, the book leaves open the application of other theories from multiple disciplines that would most adequately account for the study of science teacher identity and its development. The title *Studying Science Teacher Identity: Theoretical, Methodological and Empirical Explorations* was chosen as the most succinct encapsulation of the processes of studying science teacher identity, where "theoretical" refers to the various theories and frameworks that researchers have used to frame the construct of science teacher identity, "methodological" refers to the variety of methodologies and tools used to examine science teacher identity development, and "empirical" refers to the practical knowledge gained from the experience of studying science teacher identity. As hoping to show through this book, the construct of identity offers a powerful and multidimensional lens to study science teacher learning and development. I gratefully acknowledge the contribution of leading scholars in the field for sharing useful theoretical insights and for offering empirical findings situated within a variety of geographical and cultural contexts.

The book hopes to make a deeply critical contribution to notions around science identity and science teaching identity by providing answers to crucial questions, and by raising further questions, hence offering fresh perspectives, implications for teacher preparation, and directions for future research.

TEACHER DEVELOPMENT AS IDENTITY CONSTRUCTION

K-12 science teacher development has been conceptualized and studied by researchers around the world using a variety of frameworks and methods. Many researchers in science education have used frameworks associated with teacher knowledge (e.g., Avraamidou & Zembal-Saul, 2005, 2010; Zembal-Saul, 2009), teacher conceptions and beliefs (e.g., Abell & Smith, 1994; Bryan, 2003), teacher understandings about the nature of science and scientific inquiry (e.g., Akerson, Abd-El-Khalick, & Lederman, 2000; Crawford, 2007), pedagogical content knowledge and science teaching orientations (e.g., Avraamidou, 2013; Cochran, DeRuiter, & King, 1993; Friedrichsen & Dana, 2005; Friedrichsen, van Driel, & Abell, 2010) and knowledge about goals and the curriculum (e.g., Forbes & Davis, 2008). Regardless of the various frameworks used, the core intention of these studies has been to understand how teachers learn and develop. It is only in the past decade that researchers have adopted a multidimensional sociocultural lens to studying teacher development through the construct of teacher identity (Rodgers & Scott, 2008). Researchers have started to look at how teachers view themselves, how teachers are recognized by others, and how teachers' race, gender, personal histories and prior experiences with science shape who they are (Avraamidou, 2014; Luehmann & Markowitz, 2007; Moore, 2008; Rivera Maulucci, 2013; Saka, Southerland, Kittleson, & Hutner, 2013; Varelas, House, & Wenzel, 2005; Wallace, 2013).

Identity-based research has a long tradition in the field of education and it has begun to make its presence felt in science education as well (Lee, 2012). According to Bullough (1997) teacher identity "is of vital concern to teacher education; it is the basis of meaning making and decision making" (p. 21). Identity-based research is significant because it offers an ontological approach to learning, which examines "how learning changes who we are" (Wenger, 1998, p. 5). As Wenger (1998) argues, "because learning transforms who we are and what we can do, it is an experience of identity" (p. 215). Moreover, the construct of identity permits us to think about the interconnectedness of the individual and the world, and hence it addresses the role of the context and acknowledges the sociocultural nature of learning and development (Gee, 2000).

Researchers have viewed teacher identity in terms of: how teachers view themselves and are recognized by others (Gee, 2000); the stories that teachers create and tell about their teaching lives (Connelly & Clandinin, 1999); the communities in which teachers participate, learn and develop (Wenger, 1998); a gender perspective (Carlone & Johnson, 2007); and, through a positionality lens (Moore, 2008; Rivera-Maulucci, 2013). Despite the different ways in which identity has been conceptualized and studied, as described elsewhere (Avraamidou, 2014), looking across the studies on teacher identity and identity development, there seems to be a consensus about its nature and characteristics: (a) teacher identity is socially constructed and constituted; (b) teacher identity is dynamic and fluid and constantly being formed and reformed; and, (c) teacher identity is complex and multifaceted, consisting of various

sub-identities that are interrelated. In a review study published in *Studies in Science Education,* I summarize the findings of existing research on science teacher identity, which although by no means exhaustive, provide a comprehensive summary of existing knowledge and useful insights into the area of science teacher identity and identity development. These can be summarized in the following main assertions:

• Identity offers a powerful and multidimensional lens for studying teacher learning and development.
• The construct of teacher identity highlights the role of context in teacher learning and development.
• The construct of teacher identity has the potential to shed light on teachers' personal histories in relation to science.
• The construct of teacher identity allows us to examine the impact of social markers on teacher learning and development (p. 164).

The collective findings of the studies on science teacher identity support the assumption that teacher identity offers a powerful lens for studying science teacher learning and development. This argument contends that identity is a multidimensional and comprehensive construct that provides a useful analytical tool for examining science teacher learning and development. First, it pushes our boundaries and extends our definitions of science teacher learning and development as it proposes new ways of viewing the process of becoming a science teacher. Second, it emphasizes the role of context on science teacher learning and development and pays attention to the interactions that teachers have as members of various communities. Third, it allows us to examine the impact of various social markers, such as ethnicity, as well as the emotions and the personal histories of science teachers in relation to science.

WHAT TO EXPECT FROM THIS BOOK

The purpose of this edited volume is to examine how the construct of science teacher identity has been conceptualized and studied in science education. The overarching goal is to illuminate how research on science teacher identity has deepened and complicated our understandings of the role of identity in examining teacher learning and development. The collective chapters, both theoretical and empirical, present an array of conceptual frameworks (e.g., positional, narrative, gender, communities of practice) that have been used to frame science teacher identity and illuminate the various methodological approaches (e.g., biographical, narrative inquiry, discourse analysis, mixed-methods) that researchers have implemented in order to study science teacher identity in different geographical and cultural contexts. A few chapters highlight the various programs and approaches that researchers have used to support science teacher identity development, and as such they provide enlightening insights that serve as a significant contribution to teacher preparation programs. Given its sole emphasis on science teacher identity, the book provides a space for researchers exploring teacher identity to bring fresh perspectives that have yet to be reported in

published books on science identity, such as: the role of informal science approaches in teacher identity development; curricular identities; science apprenticeships; the use of blogging in supporting teacher identity development for leadership; science identity and the nature of science, and online mentoring for supporting teacher identity development. The following outline of contents is meant as a guide.

Chapter 2 with the title, *Practice-Linked Identity Development in University-Based Science Teacher Education: Get Real! Science as a Figured World*, argues that adopting an identity lens for science teacher learning is not only valuable, but also necessary to adequately understand and support teacher preparation. As April Luehmann describes, teachers' "becoming" work involves the authoring of selves in much more complex ways than simply knowing and being able to do things; it involves recognizing self and being recognized as a certain kind of professional who believes, values, acts and interacts in identifiably consistent ways. Identity as a lens for learning affords more sophisticated perspectives on the designed spaces of teacher learning, the resources available (or missing) in these spaces, the importance of recognition as a complement to participation, the personal nature and complexity of the learning process, and the complex collective work that happens as the discourse of reform-minded science teaching gets used and shaped by particular groups and over time. The context of the study described in this chapter is a 15-month masters' program called *Get Real! Science,* which is the focus of a ten-year social design experiment focused on understanding and nurturing the identity work involved in becoming reform-minded science teachers committed to social justice. This chapter outlines key design principles of this uniquely scaffolded approach that builds on teaching approximations in out-of-school times to explore the importance and complexities of using identity to understand science teacher learning in the current educational climate. The case study of one teacher learner's unique field experiences leading an after-school science club in this program demonstrates important professional identity development work that can only happen outside the constraints that result from the high-stakes accountability of school. This chapter sets the ground for using identity as a theoretical construct for studying teacher learning and development in science education. I have chosen to place this chapter early in the book in order to provide a substantive basis that informs readers about the theoretical foundations of identity-based research as well as exemplifying the value of using identity as a lens to study teacher learning and development.

Chapter 3, *Positional Identity as a Framework to Studying Science Teacher Identity*, considers how positional identity can capture a deeper understanding of identity when it involves teachers of color and science teacher identity. As Felicia Moore Mensah argues, positional identity (or positionality) is defined in terms of multiple social markers (i.e., race, ethnicity, economic status, gender, religion, and age), and is fundamental to understanding how particular social variables intersect with the development of a science teacher identity. Drawing from research on teacher identity, subject matter identity, and positional identity, the author tells the story of ten female elementary preservice teachers of color, in the context of a 16-week graduate level

elementary methods course. Data were collected through the participants' responses to pre and post questionnaires (e.g., do you see yourself as a science teacher?) at the first and last day of the course. The analysis of theses findings showed that the most common descriptions of how the participants saw themselves as teachers were: (a) having previous experiences, though not necessarily in teaching, such as playing teacher as a young child, or having previous career experience, such as journalism; (b) having student teaching experiences; (c) working with young people or adults; and (d) being seen by others as a teacher. These findings, as the author argues, point to the importance of looking closely at the incoming views preservice teachers of colors have about teacher and science teacher identity and how race-ethnicity intersects with other social markers in teacher education.

In chapter 4, *Identity and Discourse: Gee's Discourse Analysis as a Way of Approaching the Constitution of Primary Science Teacher Identities,* Anna Danielsson and Paul Warwick build on Gee's (2005) conception of discourse analysis, involving "actions, interactions, non-linguistic symbols systems, objects, tools, technologies, and distinctive ways of thinking, valuing, feeling, and believing" (p. 10), and share the findings of a study with eleven student teachers at an early point in their teaching certification program in the United Kingdom. The data for this study draw on interviews with the student teachers. At the point of the interview, the student teachers had received several lecture and seminar sessions in science, focusing strongly on inquiry-based learning and an active learning pedagogy; they had also visited several schools and had experienced a variety of approaches to primary science teaching and learning. The analysis of these data illustrated the following kinds of discourses from the participants' talk: (a) traditional science teaching discourse; (b) teaching science through inquiry discourse; (c) traditional primary teacher discourse; (d) teacher as a classroom authority discourse; (e) primary teacher as a role model discourse; and, (f) forming a teacher identity among conflicting and aligning discourses. As the authors conclude, these discourses can help us to better understand the processes through which student teachers construct their identities; they elucidate the interplay between their own educational biographies and institutionally sanctioned discourses; and, they illustrate the kinds of discourses made available through teacher education.

Chapter 5, *On the Nature of Professional Identity for Nature of Science: Characteristics of Teachers Who View Themselves as Teachers of Nature of Science, and Their Classroom Practice,* by Valarie Akerson, Ingrid Carter and Naime Elcan proposes a conceptualization of professional identity, specifically for the nature of science (NOS). In this chapter, the authors argue that one cannot develop an identity as a teacher of science without a conception of what actually constitutes science, and it builds upon Beijaard, Meijer, and Verloop's (2004) framework of professional identity, which includes the following essential features: (a) identity is an ongoing process of interpretation and re-interpretation of experiences; (b) identity implies both person and context; (c) identity consists of sub-identities; and, (d) agency is critical, and refers to the need of teachers to be active in the process of professional development (p. 122). In this chapter, the authors describe the characteristics of

elementary teachers who have developed professional identities as teachers of NOS in North America. To do this, they summarize the findings produced in their previous work from preservice and inservice teachers with whom they have previously worked, and develop themes across teachers who have: (a) developed accurate conceptions of NOS; and, (b) explicitly included NOS in their science teaching. These findings illustrate that common characteristics exist between preservice and inservice teachers of NOS, perhaps the most important one being that in order to have an identity as a teacher of NOS one must have accurate conceptions of NOS. The findings also point to specific characteristics of preservice and inservice teachers. As the authors summarize, inservice teachers must first develop an identity as a teacher of science, which can then lead to developing an identity as a teacher of NOS, which means that an identity as a teacher of NOS is possibly a sub-identity of a professional identity as a teacher of science. Moreover, inservice teachers may have competing identities, specifically their identities as teachers of other subject matters can either support or hinder the development of their identities as teachers of NOS. Another interesting finding, pointing to the significance of the context, is that inservice teachers' enactment of their identities as teachers of NOS is heavily influenced by the context in which they teach. For preservice teachers, some common characteristics among those who developed identities for NOS were that: (a) they had opportunities to conceptualize and enact strategies for teaching NOS; and, (b) they had support through either mentor teachers, methods instructors, or communities of practice. Similarly with the findings concerning inservice teachers' practices, this also points to the significant impact of the context on the enactment of identities for NOS. According to the authors, an additional component that is influential in terms of preservice teachers' development of identities as teachers of NOS is agency, which also features centrally in Gail Richmond's work (Chapter 11).

Maria Rivera Maulucci and Kassidy Fann in their chapter, *Teaching for Social Justice in Education: Helping a New Teacher Develop and Sustain a Social Justice Identity,* take upon the construct of social justice and examine the development of a new high school science teacher (Karen) as she navigates her preservice teacher education program and her student teaching. The chapter explores Karen's development as a teacher through three stages: (a) Science in the City in the fall of her Junior year; (b) Seminar in Multicultural Pedagogy and Urban School Practicum in Spring of her Junior year; and, (c) Student teaching during the Fall of her Senior year. In describing Karen's identity development, the authors examine how Karen takes on the role of a social justice teacher, rather than exploring her sense of belonging to a group of social-justice educators. Analysis of journal entries, reflection papers, lesson plans and classroom observations illustrate how Karen developed a social justice teacher identity because of the experiences she had at the teacher preparation, her practicum experience as well as her student teaching. In documenting Karen's journey, the authors provide evidence of growth in sociocultural awareness across five domains of knowledge: self, students, science, pedagogy, and school contexts. With respect to self, Karen learned that her worldview, including her beliefs about

school, science, and Physics, were not universal, but shaped by her particular life experiences. With respect to students, her opportunity to observe Martin, a student learning English, provided a powerful example of how differences in social location across race/ethnicity, social class, native language, gender, or sexual orientation are not neutral. Also, she saw how schools might fail to respond to a student's particular needs for support, and thus exacerbate differences. These findings point to important implications for science teacher education programs, and specifically for providing prospective teachers with opportunities to expand their sociocultural awareness across the five domains: self, students, science, pedagogy, and school contexts.

In chapter 7, *Curricular Role Identity: What Kind of Science Teacher Will I Be? Teachers' Curricular Role Identity for Elementary Science*, Cory Forbes and Mandy Biggers explore the construct of teacher identity in relation to curriculum materials. The authors propose the use of *curricular role identity*, which includes specific dimensions of teachers' professional identities concerned with the use of curriculum materials. The chapter offers a discussion on the conceptual grounds of curricular role identity, it highlights important findings from the authors' previous work with practicing elementary teachers, and it offers recommendations for future research. More specifically, the authors discuss and present example data from previous work to illustrate: (a) how elementary teachers negotiate spaces between themselves and their communities; (b) how teachers translate their curricular role identities into classroom practice; and, (c) how teachers' curricular role identities in science evolve over time. The outcomes of this work illustrate how curriculum materials can be designed with features that specifically target outcomes for teachers' learning and practice, which also contribute to elementary teachers' curricular role identities in science and highlight the need for partnership-driven, practice-based professional development opportunities for teachers.

Chapter 8 tells the story of Nina, a preservice elementary teacher in Cyprus, and how she came to construct her science identity through time and space. As the title suggests, *Telling Stories: Intersections of Life Histories and Science Teaching Identities*, in this chapter I propose a conceptualization of teacher identity through the lens of personal histories. Connelly and Clandinin (1999) refer to teachers' professional identity in terms of "stories to live by" (p. 4) and suggest the notion of narrative inquiry, which is premised on the idea that, as human beings, we come to understand and give meaning to our lives through stories. An exploration of these stories is at the heart of the account of this chapter, which aims to explore how a purposefully selected beginning elementary teacher has been developing her science teaching identity throughout her life as a learner of science and as a future teacher of science. Data sources for this case study include biographical assignments, a personal philosophy for science teaching, lesson plans, video-recorded micro-teaching experiences, as well as in-depth interviews with Nina. As illuminated through her own words, the development of her identity in science teaching was influenced by various experiences, events and interactions throughout her life, with critical events taking place at elementary school and university. Detailed and personal information

about how Nina perceived certain experiences related to science, either as a learner of science during the younger years of her life or as a future teacher of science at university, enables us to better understand how her identity as a science teacher was being formed. Such information brings to light the impact certain experiences a teacher may have during her early years of life on her science identity, and it illuminates the ways in which teacher preparation could cause shifts to the process of her identity development.

Justine Kane and Maria Varelas, in chapter nine with title *Elementary School Teachers Constructing Teacher-of-Science Identities: Two Communities of Practice Coming Together* aim at addressing the challenge of elementary school teachers not seeing themselves as "science people", explore the ways in which six teachers who participated in a year-long professional development course (*Integrated Science Literacy Enactments)* constructed teacher-of-science identities as they were also constructing their students' science identities. Analysis of qualitative data consisting of audio recorded teacher meetings during the project, and conversations with individual teachers and university-based members at the end of year showed that as teachers came together to discuss their own and their students' experiences of engaging with science in their classrooms, the teachers' own sense of themselves as "science people" began to shift. As the teachers who taught in urban public schools, were supported to dialogically engage their students with science ideas, they were propelled by their students' interest in, enthusiasm for, and ways of making meaning in science. Furthermore, as the students, most of whom were African American and Latino/a, began to see themselves as people who could do science, the teachers similarly began to see themselves as people who could do science. In other words, children's science identities were shaped by, but also shaped, their teachers' science identities in positive ways that fostered further engagements with science in the classroom. The implications of these findings, as the authors argue, point to the fact that supporting teachers within communities of practice in which teachers listen to each others' narratives about their own and their students' experiences with science have qualities that foster positive science identities for elementary school teachers.

In the chapter that follows, *Science Teachers' Identities as Teacher Leaders: The Role of Professional Development,* Deborah Hanuscin, Somnath Sinha and Mike Hall explore the construct of teacher identity through a leadership lens. As they argue, science teachers' identities as leaders are influenced by teachers' competence, the knowledge and skills they possess as both teachers and leaders; their leadership practices, or how they enact their roles as leaders; as well as the perceptions they have of themselves as 'leaders' and which others have of them. The authors offer an argument about how professional developers can draw on identity theory to inform the design of programs to support science teachers in becoming teacher-leaders. In doing so, they highlight relevant literature at the intersections of leadership, identity, and professional development and they propose a set of design considerations for professional development. In addition, they share examples from their own work implementing a professional development program (i.e., *Leadership in Freshman*

Physics, an NSF Math and Science Partnership in the US) for science teacher-leaders, including narrative vignettes by a teacher-leader participant (3rd author) regarding his personal transformation and identity through his involvement in the program. Mike's story is shared as an example of a teacher participant who was successful in realizing the affordances of the professional development for developing as a teacher-leader. His story is discussed under the design principles of the program: (a) an explicit focus on teacher leadership; (b) constructing a common vision of teacher leadership; (c) flexible support that takes into account teachers' readiness to lead; (d) providing teachers with opportunities to lead; (e) receiving feedback and recognition; (f) reflecting on teachers' growth as leaders; and, (g) maintaining support for teacher leadership development.

In *Making Sense of the Interplay of Identity, Context, and Agency in the Development of Beginning Secondary Science Teachers in High-Poverty Schools,* Gail Richmond explores the interplay between professional identity and contextual factors and how those contribute to a sense of agency. In this chapter, using interviews, journals, course and field assignments and related artifacts, the author reports the efforts to elucidate how science teacher candidates preparing to work in high-poverty schools in the United States, make sense of their multiple contexts, and how this sense-making shapes their professional identity and agency as science educators committed to working in challenging settings. In this chapter, the author shares three of what she calls "re-constructed" narratives, which are composed of first-, second-, and third-person narratives that are constructed from a variety of data sources collected during the final two years of the teacher preparation program of three participants. The purpose of these re-constructed narratives, as the author states, is to illustrate, and, problematize the relationship between agency and identity, and point to ways in which various kinds of contexts can serve to help move an individual's identity as a teacher forward or can serve as obstacles to growth. The findings of this work show that: (a) the consonance between the professional identity one sculpts and the agency one has for making intentional moves likely to have positive outcomes are critical to creating the conditions for success, in the immediate present and in the future; and, (b) contextual factors matter, not only for a sense of agency to develop initially, but also to be maintained.

Shifting contexts, Phyllis Katz, in the next chapter, explores twelve women's identity development in the context of an afterschool science enrichment program. As the title suggests, *Identity Development of Mothers as Afterschool Science Teachers*, the participants in the study reported in the chapter, were women who engaged in an afterschool science program for their children. As such, the teachers who were called 'Adult Leaders' considered their primary identities to be 'mothers'. The purpose of this chapter, as the author describes, is to explore the contribution of the context to the identity changes the participants described and were observed as undergoing. A secondary purpose of the chapter is to examine the interaction between the participants' afterschool science teacher identity development and its influence on their parenting identity. In doing so, the author provides samples of the evidence

of a diverse group of twelve women and their journeys in becoming members of the afterschool science enrichment program teaching community, an NSF funded program of national scope in the United States. In addition to interviews, observation notes, and journal entries, these women were asked to draw images of scientists. The drawings provided additional insights into the changing, mental models these women held as they came to see themselves as competent science participants and teachers in the setting. The outcomes of this work illustrate how the women in this study developed an interest in afterschool science teaching because they wanted to aid their own children's science education both directly in teaching and through their own learning. As the author discusses, the entire process of building a staff of afterschool science teachers was one of intentionally developing a community, and afterschool science teacher identities within it (e.g., induction, orientation, training, ongoing support by phone or email). Lastly, the findings of this work show how these women developed alternative (i.e., non-stereotypical) images of scientists as their afterschool science enrichment program experience continued.

In *Practices and Emerging Identities of Beginning Science Teachers in Online and Offline Communities of Practice: A Longitudinal Mixed Methods Study,* EunJin Bang and Julie Luft present findings from a two-year study, which explores changes in inquiry-based instructional strategies and changes in the teaching practices and identities of beginning secondary science teachers who participated in an online science-specific mentoring program, as part of a large five-year induction study conducted in the Southern and Midwestern regions of America. In this chapter, the authors take an in-depth look at beginning secondary science teachers' changes as they participated in online mentoring communities as core members, and, concurrently, in offline communities as peripheral members. The questions of interest in the study are: (a) what is the overall pattern of inquiry-based instructional practices of beginning secondary science teachers who participated in the program? (b) how do beginning secondary science teachers change their teaching practices over two years? (c) what are the characteristics of the emerging identities of beginning secondary science teachers? Fourteen beginning secondary science teachers were selected for this mixed-method study, and three of them served as focal cases (Isabel, Norma and Deborah). Data included a demographic survey, mentor online applications, semi-structured monthly and yearly interviews, classroom observations, and two years of online written discourse in the form of asynchronous threaded posts. Analysis of these data showed that three different groups formed within the overall group which participated in the program: Group 1 increased their use of inquiry-based instructional strategies; Group 2 made no changes in their use of inquiry-based instructional strategies; and, finally, Group 3 decreased their use of inquiry-based instructional strategies. The three cases, as the authors argue, illustrate the interplay between teaching practices that consist of inquiry-based and non inquiry-based instructional strategies, and how corresponding identities emerge within each quarter – especially in light of "negotiability" as defined by Wenger (2000). Moreover, the findings of this study indicate that the cultures of

the schools that Isabel, Norma, and Deborah taught at influenced considerably both their teaching practices and their emerging identities. As the authors conclude, the findings show that participating in the program provided Isabel, Norma, and Deborah with additional skills and powers of negotiation through which all three had opportunities of constructing identities that were somewhat different from the ones constructed within their institutional settings.

Adopting an auto-biographical, socio-historical approach in *Becoming and Belonging: From Identity to Experience as Developmental Category in Science Teaching and Teacher Education,* Wolff-Michael Roth makes an argument for conceptualizing who teachers are in terms of the Deweyan category *experience* or the equivalent Vygotskian category of *perezivanie*. His argument is based on a critique of the construct of identity, which either treats the person as independent of all contexts or constitutes the person as the totality of all the situated micro-identities they have. In this chapter, through a biographical account of his own becoming and unbecoming a science teacher, the author illustrates how the category experience provides us with opportunities to theorize *becoming in* and *belonging to* science teaching. Situated in different geographies, the author's biographical account through five critical points of his life, are articulated in different sub-sections in this chapter: (a) teaching as a career possibility in Germany; (b) teaching physics as a career in Canada; (c) new possibilities and realities: beginning a PhD program, getting a tenure track position at Indiana University, ending up working as a physics teacher at a private school; (d) teaching physics and heading a science department; and, (e) teaching statistics, doing research, and finding new opportunities at Simon Fraser University. Through discussing these life events, the author exemplifies how a set of categories, namely, subjectification, personality, and experience, which are embedded in a socio-historical approach, allow us to: (a) realize how change occurs because the individual and environment mutually affect each other; (b) understand science teaching in the context of the overall life of a person; and, (c) capture material-practical, intellectual and affective dimensions.

Embarking upon science teacher identity demands that researchers carefully consider the implications that studying teacher learning and development through the lens of identity holds for science teacher education research and practice. In the last chapter, *Implications of Framing Teacher Development as Identity Construction for Science Teacher Education Research and Practice,* Carla Zembal-Saul offers a discussion of these implications. In her commentary chapter, she discusses the unique contribution of each of the chapters to science teacher identity research as she argues for the need for coherent conceptual frameworks in teacher preparation in light of recommendations for reform in science education.

CONCLUDING COMMENTS

The aim of this introduction has been to sketch out the broad field of science teacher identity, and to provide an overview of the contents of the volume. I am, of course,

fully aware that this book does not exhaust research in this area and that it most likely overlooks important work carried out in specific parts of the world, possibly even excluding researchers who do not produce manuscripts in English. It does, however, lead to significant depths in terms of its purposes, as it is the first book solely dedicated to an exploration of the construct of science teacher identity. In writing this introduction, I have ventured to cover the same themes, although not in detail, as the collected papers in this volume: identity as a lens to teacher preparation, discourse and identity, nature of science and identity, leadership and identity, positional identity, curricular role identity, after-school programs and science identity, online mentoring programs and science identity, life history and identity, the interplay of context, agency and identity, and experience over identity.

Collectively, the chapters of this book offer a set of theoretical conceptualizations of science teacher identity and provide empirical evidence of programs and approaches that support its development. Hence, the authors of these chapters provide a set of theoretical, methodological and empirical insights, which offer specific contributions to theory, research, teacher preparation and practice. Beneath these specific contributions, which the construct of science teacher identity is capable of making, lies one more fundamental. Science teacher identity, more than any other construct used to explore science teacher learning and development, can give meaning to the notion of a *process* in becoming a science teacher. In thinking about the processes of constructing a science identity, we must strive for the analytic over the descriptive for, as with life, in identity what is on the surface typically reflects a tiny fragment of what lies below. Identity is not an identity on its own; its meaning derives from a systematic, continuous, social, contextually and culturally situated whole *self*. I envision that this book volume will provide some guidance to the readers to uncover those systems and contexts, to make sense of the parts that comprise the whole, and to conceptualize the processes of *becoming* a science teacher in new and compelling ways. I hope that this book volume will provide the basis for conversations aligned with identity and identity development in science education and move the field forward in directions that examine important research areas left unexplored, as well as respond to questions that remain unanswered. Finally, and above all, I hope that readers will gain some sense of our fascination with science teacher identity.

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