Science Education International
34(1), 42-51
https://doi.org/10.33828/sei.v34.i1.5

International Council of Association for Science Education

ORIGINAL ARTICLE

Transitioning Between Reform-Based Curricula: A Middle School Teacher's Construction of a Science Teaching Identity

Richard H. Kozoll[1]*, Peter S. Ower[2]

[1]Department of Teacher Education, DePaul University, Chicago, Illinois, United States; [2]Department of Science, Wilmette Junior High School District 39, Wilmette, Illinois, United States

***Corresponding Author:** rkozoll@depaul.edu

ABSTRACT

Research-based science curriculum has become a common means of supporting best practices in science teaching. In response to his middle school's transition from one such commercially available science curriculum to another, a seventh-grade science teacher elected to make certain changes to the newly adopted curriculum in its first year of use. These curricular adaptations took place despite a district directive to pilot the curriculum without making any such changes. The purpose of this phenomenological study was to understand this teacher's lived experience adapting the curriculum. The values that guided this teacher's curricular decisions situated his life world construction of a science teaching identity around an unremitting pedagogy that maintained his use of best practices. His identity construct further exposed certain self-understandings he held as a science teacher and understandings of his students as science learners. It was the intersection of these pedagogical values with those understandings of his students and himself that supported these curricular changes, providing the backdrop for his identity construct. Therefore, the construction of a science teaching identity, which relies on this intersection, offers deepened insight into teachers' implementation of reform-based curriculum.

KEY WORDS: Curriculum, identity, phenomenology, reform, science

INTRODUCTION

Commercially produced science curricula have become increasingly relied upon to actualize the vision behind reform documents and ensure best practices in science teaching. Consequently, how teachers respond to such reform documents (Nagle and Pecore, 2017; Ramnarain and Schuster, 2014) and implement their associated curricula (Bell and Sexton, 2018; Irez and Han, 2011; Jones and Eick, 2007a) has received international research attention. However, certain publishers are making a shift in their science curricula away from inquiry-based curricula. These new curricula combine inquiry learning with the use of phenomena to drive science instruction. In the United States, this change reflects the Next Generation Science Standard's (NGSS) emphasis on the use of phenomena, within the context of a storyline, wherein students use science and engineering practices to explore a central question or solve a fundamental problem (NGSS Lead States, 2013). Considering their state's adoption of the NGSS, a midwestern suburban school district elected to replace their inquiry-based science curricula with phenomena-centered science curricula.

Before implementing the newly adopted curricula, the middle school teachers (teachers of students aged eleven to thirteen) received professional development on the philosophy of the new curricular program, the curricular materials, and how to use it in their classrooms. After completing that training, the district's middle school structured a piloting phase where the teachers began the school year relying on three units from the phenomena-centered curricula. The intent behind starting with three units was to provide a more focused instructional context for beginning the school's curriculum mapping process. After completing the pilot phase, however, the school returned to using the inquiry-based science curriculum.

During this pilot phase the school's science teachers were asked to implement the phenomena-based science curriculum as it was written. Despite that directive, one of the school's seventh-grade science teachers, Grant (a pseudonym), made certain modifications when using the pilot phase's first three units. This raised two central questions. First, while negotiating a transition between reform-based curricula, how did Grant's adaptations reflect his pedagogical values? Second, how does this pedagogical stance construct a science teaching identity that enlightens instructional response to curriculum and the associated expectations of science education reform?

The purpose of this empirical study was to understand Grant's changes to the phenomena-based science curriculum amid the articulation of his lived experience using it. Those modifications illustrate a sustained reliance on—as opposed to changes in—his pedagogical stance, which support current science teaching best practices. However, the values Grant relied upon to enact curricular changes revealed understandings he held of his students as science learners as well as self-understandings of his position as a science educator in his classroom's life world. It was this intersection between

Science Education International
34(1), 42-51
https://doi.org/10.33828/sei.v34.i1.5

Grant's understandings of science teaching and those of his students and himself that holistically informed his curricular adaptations. Further, the backdrop of his curricular changes, through which this interconnection emerged, more broadly reflected his science teaching identity amid the goals, materials, and methods of science education reform. Therefore, Grant's accounts suggest a consideration of how such value-laden understandings might enhance professional development dedicated to the use of reform-based curriculum.

In addition to understanding Grant's curricular decisions, the intent behind focusing solely upon his experience was to establish the construction of a science teaching identity that considers prominent teacher voice through focused inclusion (Ritchie, 2009). The previous single-participant studies, which report on research about teacher identity, have offered deep insight into science teaching practices (Avraamidou, 2014a; Upadhyay, 2009). Grant's discourse did so as well, while contributing toward the broader need to connect science teacher identity research to reform initiatives (Avraamidou, 2014b).

LITERTURE REVIEW

The Lifeworld Construction of a Science Teaching Identity

A lifeworld viewpoint on a science teaching identity offers a theoretical perspective for identity construction and expression, as well as how such an identity informs teaching practices. This outlook on identity begins with the acknowledgement that in our knowledge constructions are presuppositions that inform our views on experiential possibility (Husserl, 1999). These might include opportunities a teacher sees within the context of teaching a newly adopted reform-based science curriculum. We draw our presumptions from the lifeworld in which we are embedded. In this case, it is created through an individual's experiences in their everyday teaching context, the activities, people, relationships, and materials therein, which constitute that world (Beauchamp and Thomas, 2009; Schwandt, 2015). The tacit insight and personal judgments science teachers draw from their lifeworld are used to construct their identity as representative of their views, orientations, understandings, and beliefs about science teaching and learning (Avraamidou, 2014c; Schwandt, 2015). In the lifeworld, with its everyday events, the negotiation of these experiences and their presuppositions are common (van Manen, 1997).

Gadamer (1994) labeled these perceptions "prejudices" and situated them within the horizon of our understanding. These prejudgments allow our experiences to orient us toward life in certain ways, and they make unfamiliar situations, such as teaching with a new curriculum, familiar (Gallagher, 1992). Despite their negative connotation, our prejudices help us to determine which encounters limit us, and which are enabling, rebuilding practices in an open and ever-changing manner (Bernstein, 1983). These form the perceptions that shape teachers' orientations toward science as they teach it and inform their teaching identities (Guzey and Ring-Whalen, 2018). A teacher's professional knowledge, the curriculum's subject matter, and the teaching environment can inform this identity (Proweller and Mitchener, 2004). However, it is also informed by personal teaching philosophies intended to support students' needs and interests (Hsu et al., 2017).

The values that guide teachers' practices and contribute toward their identities as science teachers link them to who they are in that vocational space (Taylor, 1992). In other words, a science teaching identity encompasses how teachers view themselves as educators, their students as learners, as well as how they perceive their lifeworld teaching science. Thus, the understandings teachers use to conceptualize teaching science can also reveal certain understandings of self and others that impact how science is approached and carried out in the classroom. A description of their lived experience teaching science illustrates what teachers value within the context of science education reform and amid their views of self, students, teaching, and learning.

Situating Teacher Identity within the Use of Reform-Based Curricula

Current reform literature advocates for the teaching and learning of science through methods that engage students in scientific practices and develop their understanding of science over time (Miller et al., 2018; National Research Council, 2012). Thus, teachers are being asked to unify their instructional methods in the name of a standards-based science education emphasizing the practices necessary for student involvement in scientific inquiry. Reform-based materials are one means of offering teachers the support needed to implement these teaching strategies (Powell and Anderson, 2002; Roehrig et al., 2007). Yet research has recognized that reform efforts and their associated curricula face resistance from teachers because their approaches can require drastic changes in teachers' beliefs and values (Anderson and Helms, 2001; Irez and Han, 2011). Thus, progress toward widespread, reform-based science instruction remains slow while teacher-centered practices that emphasize transmission of knowledge and rote memorization persist (Kazempour and Amirshokoohi, 2014).

Clearly, the adoption of reform-based science curricula does not necessarily translate into its envisioned use of connecting research on science learning to classroom practice. Barab and Luehman (2003) noted that any sustained use of such curricula, reflecting its intent to bridge theory and practice, necessitates that teachers adapt it for the classroom's local context and culture. Such considerations have been found to include class size, learning differences, applicability to students' lives, and student learning in science (Forbes, 2013). It is this contextualized decision-making process, and the values teachers hold that affect how science is taught and learned, and how students experience day-to-day science lessons, the broader science curriculum, and the curriculum's intended reforms (Enyedy and Goldberg, 2004; Roehrig and Kruse, 2005; Schneider et al., 2005).

Accordingly, reform efforts have acknowledged the pivotal role teachers play in achieving the goals of science education reform

Science Education International
34(1), 42-51
https://doi.org/10.33828/sei.v34.i1.5

(Cook et al., 2015). Thinking of students' science learning as a product of teachers' purposeful decisions concerning what and how to adapt curricula directs our attention to the pedagogical underpinnings that inform those choices (Debarger et al., 2017). These more expansive pedagogical values, as they enlighten instructional decisions, establish practice as a component of a science teaching identity (Enyedy et al., 2006). Thus, the adaptation and use of curriculum materials are a site for the ongoing lifeworld formulation, expression, and reformulation of a science teaching identity (Beijaard et al., 2004; Forbes and Davis, 2012; Wei and Chen, 2019). This manifestation embodies how individuals see their role as science teachers, their students as science learners, and how those understandings inform their efforts to implement reform-based practices (Avraamidou, 2016).

METHODOLOGY

Phenomenology of Science Education

This is a study situated in the phenomenology of science education. Østergaard et al. (2008) explained that such studies focus on the perceptions of students, teachers, or both to understand the processes and activities of teaching and learning science. Accordingly, Grant's descriptions of his teaching activities were explored to reveal the perceptions that shaped his use of the phenomena-based curriculum. Those accounts represented his lived experiences teaching science (Koopman, 2015). As such, they offered insight into those immediate experiences that gained significance in their illustration of Grant's pedagogically informed practices (Schutz and Luckman, 1973/1980). Phenomenology's relationship to Grant's identity construct sheds light on both his lived experiences adapting the curriculum and the pedagogical meaning behind those changes that contributed toward the construction of his science teaching identity (Volkmann and Zgagacz, 2004).

Data Collection

Grant's interviews were drawn from a larger phenomenological study on middle school teachers' lived experiences with their school's transition between research-based science curricula (Appendix for Interview Guides). After securing his voluntary participation and informed consent, Grant partook in five semi-structured, audio-recorded interviews the summer following his school year piloting the phenomena-based science curriculum. Each interview lasted around 2 h. Those individual interviews took place approximately a week and a half apart to support ongoing data analysis (Bogdan and Biklen, 2006).

Grant's interviews were planned with several phenomenological points in mind. Given the substantive nature of the research focus, interview questions encouraged him to offer detailed descriptions of his lived experiences with the curriculum. The intent was for Grant to describe these experiences teaching and working with the curriculum and to avoid more abstract explanations and generalizations (van Manen, 2014). Thus, whenever Grant generalized, he was encouraged to recount experiences that embodied those abstractions and demonstrate how their meaning emerged through experience (Holstein and Gubrium, 1995). These accounts were those Grant deemed pedagogically relevant to his perceptions of teaching and learning reform-based science (Wallace, 1994), thereby making their experiential significance clear on his own terms (Polanyi, 1985).

Analysis

Analysis of Grant's interviews was ongoing in that it constituted part of the data collection process, aiding in analysis after leaving the field (Bogdan and Biklen, 2006). In-the-field analysis included listening to the audio-recorded interviews and reading the transcripts to identify emergent themes. Any such themes were drawn from Grant's lived experience and thus grounded in the data, connected to the study's wider context, and as a result, had the potential to establish more formalized connections among the data (Williams, 2008). During in-the-field analysis, Grant's reoccurring theme of making adaptations to the phenomena-based curriculum during its pilot phase surfaced. This interpretation was discussed with Grant, allowing him space to react and interact with that idea (Lincoln and Guba, 1985). With the use of in-the-field analysis, data collection sessions were planned considering previous interviews.

Post-field analysis involved an open-ended examination of Grant's transcribed interviews (Rossman and Rallis, 2017). First, his dialogue was analyzed thematically (Riessman, 2012). With the identification of dialogue that reflected his curricular adaptations amid his overall experience piloting the curriculum, this recurring theme was further substantiated (Creswell and Poth, 2018). Focusing on this theme was meant to capture the details of his experiences teaching science and reveal the individuality of Grant's science teaching identity (Cole and Knowles, 1995). Following Coffey and Atkinson (1996), this theme was used to explore how Grant framed and made sense of sets of experiences while providing insight into his perceptions of those events.

Grant's broader theme of adapting the curriculum also constituted an analytic point of departure. This is where the data were reread and explored in more detail with attention paid to the descriptions of events and happenings central to his experiences. Thus, Grant's discussions surrounding his initial adaptations of the phenomena-based curriculum were categorized into groups that included "modeling", "assessment", and "student discourse" (Padilla-Diaz, 2015).

Finally, the dialog within each of these categories was coded (Brinkman and Kvale, 2015). These codes not only portrayed Grant's particular curricular adaptations; they also revealed their pedagogical underpinnings, as well as Grant's understandings of self as a science teacher and his students as science learners. Thus, these codes furthered an understanding of how Grant drew on and construed his experiences, unified aspects of his discussion, and more comprehensively established the perceptions central to his construction of a science teaching identity.

Science Education International
34(1), 42-51
https://doi.org/10.33828/sei.v34.i1.5

FINDINGS

Modeling

The first substantive adaptation that arose among Grant's lived experience piloting the phenomena-based curricula was his expanded use of modeling throughout the three initial units. When discussing his incorporation of modeling, Grant offered the following example, detailing the changes he deemed necessary:

> I think the phenomenon was why are some sort of storms more severe than others. I mean it's a good phenomenon, but I was just looking at the activities and the storyline that went with it, it was just really basic and slow. And I also didn't really think it was going to build any sort of conceptual understanding of how weather works and how storms work. My phenomenon was: why is it so hard to predict the weather? So, we went over the different variables that affect weather. We got into precipitation and storms, cloud formation, pressure systems, latitude, ocean currents. I just sequenced things where one activity led to the next so the kids could build that model of what they are thinking.

The use and development of models as a scientific practice allows students to describe, test, and predict more abstract phenomena and can include diagrams, physical replicas, mathematical representations, analogies, and computer simulations (NGSS Lead States, 2013).

Pedagogically, Grant's attention to modeling was on the progressive development of his students' conceptual understandings. This was opposed to a predominant focus on any type of reproduction itself:

> It's tough because when people hear the word "models," they think it has to be something physical. And it's not. It's what you're thinking. Models can be mathematical, they can be linguistic, they can be graphical, they could be diagrams, but they all are basically the same. They're just describing what you're thinking about something conceptually. And kids already have models about anything you're teaching, whether they're good, they're correct, misconceptions, preconceptions, or whatever. So, you roll them out through the unit, and it's all staged. It's like a story. And you lay out every activity strategically and during post lab discussions is where you really come to consensus. The kids are developing the model, they're coming to consensus, but a lot of times the models break down just like models do in real life. Modeling instruction is very effective because you're considering and developing student thinking and alleviating misconceptions in a way that traditional instruction doesn't.

As a tool for representing ideas and explanations, conceptual understanding is a common pedagogical reason for engaging students in modeling (Campbell et al., 2015; NGSS Lead States, 2013). Yet, Grant's pedagogical expression more broadly situated his lived experience adapting the weather unit for more substantial use of modeling. Conveying this instructional practice as a facet of his pedagogy constructed a science teaching identity reflecting consistency between Grant's professional actions and values (Enyedy et al., 2006; Ramezanzadeh et al., 2017).

Furthermore, this instructional and pedagogical balance elicited a certain understanding Grant possessed of himself within his lifeworld as a teacher:

> I consider myself a science teacher that teaches students how to do science like scientists. Science is a process. It's not done. It's always evolving, it's always changing, and our models are always changing. I can get that across to the kids and it doesn't matter what I'm teaching them.

Grant's understanding of his professional self as one who relies on modeling to teach science in a way that mirrors its process-oriented, changing nature offered more insight into the formulation of his science teaching identity. It moved his thinking beyond content and pedagogy, inviting reflection on how he maintained continuity between actions and values through his negotiated place in the classroom (Buchanan, 2015; Grimes, 2013). As this self-understanding informed his teaching, it had a reciprocal relationship with Grant's understanding of his students, which further elucidated his science teaching identity (Marano, 1998):

> And then when I first got here, I had to really ramp up my curriculum for our students because, I mean, my modeling instruction just wasn't challenging enough for them. I could probably throw them freshman, sophomore year stuff and the kids would be fine as well.

Assessment

A second adaptation Grant made to this curriculum addressed assessment. More specifically, Grant avoided using the multiple-choice questions the curriculum provided and offered this approach to assessment instead:

> We start with the invasion of the jellyfish in the glacier sea and we have this extreme boom in the jellyfish population. Based on what we've done the last two and a half weeks, what is causing jellyfish to bloom? Initially, most of the kids said in the discussion that it has everything to do with pollution. But they weren't taking into consideration that it was actually producing more zooplankton, which the jellyfish feed on. Also, we've been poaching the sea turtle population and basically disrupting a big food web. So, in the end what's causing the jellyfish to boom, and why in the glacier sea? Use evidence that we've collected in class and tie it all together in a cohesive paragraph. Just make your argument using evidence. And then, of course, I'm always hounding them to use some vocabulary, some of the words, that we learned along the way. That's how I totally did away with the multiple-choice questions.

Grant's approach reflects reform efforts supporting assessments that avoid discrete facts and concentrate on broader, deeply explored concepts that can be used to explicate phenomena (NGSS Lead States, 2013; Tekkumru-Kisa et al., 2021).

Science Education International
34(1), 42-51
https://doi.org/10.33828/sei.v34.i1.5

Multiple-choice assessments are often found to contradict this ideal, failing to help students understand science while illuminating their conceptual progress (Linn and Chiu, 2011).

The pedagogical thinking behind Grant's avoidance of multiple-choice questions parallels Linn and Chiu's (2011) discussion concerning the educational value of multiple-choice assessments:

> I used to do multiple choice, years ago, but I've done away with it. It's all written responses now. And if it's math, do some math for me. Explain your reasoning and why you're correct. Yeah, multiple choice doesn't really tell me if they understand or not; it doesn't give me a window into what they're thinking. Did you get the right answer or not? That doesn't tell me anything about what they understand.

Looney et al. (2018) posited that teachers' beliefs about assessment and the perceptions of their role as assessors alone constitute a facet of their professional identities. Yet, if one notes the unified pedagogical motivation behind Grant's curricular adaptations involving modeling and assessment—that being how his students can best develop and express their understandings—another consistency arises. The pedagogical uniformity Grant created across differing aspects of his instruction substantiated the values apprising his construction of a science teaching identity (Ginsberg et al., 2021).

Grant's pedagogical perspective and resulting instructional practice elicited this depiction of how he resolved the curricular changes: "I look at it like this. You have your content and I'm still hitting the same core ideas. But I know how to restructure the curriculum, the assessments, so it's better and rigorous enough for our students." Here, Grant acknowledged himself as a teacher who is knowledgeable of and responsive to his students' needs. Moreover, the understanding Grant held of his students as learners was embedded in this resolution:

> Those questions are low cognitive demand anyway, and I need to make things high demand for my students because they're really smart. And if I come in with something weak and low cognitive demand like those multiple-choice questions, the kids will just eat it up and spit it back at me.

Student Discourse

Amid his lived experience piloting the phenomena-based units, the final change Grant discussed centered on the opportunities his students had to exchange their ideas discursively:

> Well, I left the teacher notes on how you're supposed to orchestrate the discussion. Basically, it wasn't really a class discussion. It was a lot of the teacher asking questions and student discourse became a huge problem. Oh, it was where the teacher initiates the questions, and the students respond. And then the teacher evaluates, "Yes, you're right," or "No, you're wrong." And I didn't want to do that because it killed the discourse. So, I just fixed it. I posed questions to elicit a good post lab discussion and I had them whiteboard their answers. White boarding for post lab discussions was great. The kids really bought into it, and I saw how much more my students were learning.

Reform documents have emphasized the language intensity of their various scientific practices. At present, students are asked to participate in classroom discourse as part of engaging in argumentation from evidence, constructing explanations, and communicating information (NGSS Lead States, 2013). Engaging in such discourse activities has also been found to advance students' understanding, as well as foster meaning in science (Larson and Jakobsson, 2020).

Much like his pedagogical discussion on modeling and assessment, Grant's justification for expanding classroom dialog centered on his students' conceptual understanding and their expression of those ideas:

> It's all sense making. We're building conceptual understanding and when we teach them science, we're teaching them in a deep conceptual level with the students, they're the ones doing the heavy lifting. They're the ones doing the leading. They're the ones talking to each other. Some teachers think they have to lecture in order for kids to learn and to understand. If I say it, there'll be understanding. It doesn't work like that. You got it? The kids are going to stop thinking; they're going to stop wondering. They're not going to think critically. They're just waiting for the right answer. And at that point they're not actually building conceptual understanding. The kids have to be the ones doing the talking, critiquing each other to really build any sort of understanding. Teachers talking doesn't do it. Lecturing does not work.

Grant established yet another congruency between his pedagogy and instruction, or values and actions, which informed his three adaptations to the curriculum. Thus, Grant's experience making these purposeful curricular adaptations further exemplified the import of this commitment to the construction of his identity as a science teacher (Clark and Groves, 2012).

This specific pedagogical and instructional example framed another understanding Grant had of his role within the lifeworld of his classroom (Bobis et al., 2020), whereby his pedagogical values can be instructionally realized:

> The kids have to be the ones doing the talking, critiquing each other to really build any sort of understanding. Teachers talking doesn't do it. Lecturing does not work. It's being a guide on the side. A facilitator. Honestly, it's like I'm a coach on the side and I know what to ask them, or I know what to do to get them in the right direction.

Grant's stance on his students' discourse, as well as the understanding he possessed of his position as a teacher who facilitates it, revealed a deeper understanding he had of his students when asked to converse in this manner:

> I'll be honest, you know, kids are kids and I think it's a social thing. At first a lot of students struggle with student-to-student discourse; they struggle with discussing with

Science Education International
34(1), 42-51
https://doi.org/10.33828/sei.v34.i1.5

their partners. But we have the best kids. I really think our kids, you're not going to get more hard working, more respectful students than at our school.

DISCUSSION AND CONCLUSION

When considering the literature on transitions within science education reform a prevalent theme is one of tension. Studies have revealed conflict between teachers' interests and their reliance on current best practices (Carlone et al., 2010), their beliefs concerning the use of those practices (Marshall et al., 2009), and their attitudes toward teaching reform-based science (Gado, 2005). This research has highlighted the tension between teachers' perceptions of teaching and learning science and their position on the new or modified emphases of science education reform documents and materials. Internationally, studies have noted the negotiations around—and deviations from—values and practices that are reflected in science teachers' professional identity constructions as they integrate shifts in science education reform into their classrooms (Guzey and Ring-Whalen, 2018; Huang and Asghar, 2018). Grant's piloting of his school's newly adopted science curriculum, with its reliance on phenomena and storylines to drive instruction, represented his involvement in such a change. However, within that context Grant's construction of a science teaching identity did not indicate any transformations to his pedagogy or related practices.

Grant's lived experiences piloting the phenomena-based science curriculum revealed adaptations centered on an expanded use of modeling, alterations to assessment, and increasing student discourse. All three of these adaptations reflected a steadfast pedagogy concerning how his students could fully develop and express their scientific understandings. Despite research that has uncovered inconsistencies between professional actions and values (Mansour, 2009), Grant built his science teaching identity around both, reliably informing each of his curricular revisions. Moreover, Grant's science teaching identity, constructed around this consistency, situated his modifications in science teaching best practices.

Classroom practice, as a reflection of teacher identity, has been previously examined (Golzar, 2020). However, Grant's revisions to the curriculum were accompanied by various self-understandings as a science teacher. Those, in addition to Grant's understanding of his students as learners, offered deepened insight into the formation of his science teaching identity. And while making these curricular adaptations, Grant's understanding of himself as one who teaches science in a way that reflects its contemporary nature emerged, resulting in increased use of modeling. The understanding of self that Grant articulated when forgoing the use of multiple-choice questions was one of a teacher who knows and instructionally responds to his students' needs. Finally, his self-understanding as a science teacher who guides his students arose when Grant described increasing his students' discursive opportunities. Such self-understandings not only illuminated an aspect of his multifaceted place within the lifeworld of the classroom; they—along with his joint understanding of his students as capable, intelligent, and hardworking learners—further informed his lived experience adapting the curriculum. Thus, Grant's understanding of self and other sustained that interconnection of practical experiences and pedagogical values central to the lifeworld construction of his science teaching identity (van Manen, 1997).

As previously indicated, in conjunction with his school's adoption of a phenomena-based curriculum, Grant participated in professional development. Participating in such professional development allowed Grant to become acquainted with the curriculum's broader instructional philosophy and features. In addition, Grant and his fellow middle school teachers partook in exemplar unit activities so they could better plan and prepare for using the curriculum in their classrooms. Thus, the emphasis of this in-service would coincide with certain findings regarding effective science teaching professional development. These findings include using the curriculum to employ activities that model lesson design and engaging teachers in those lessons to facilitate the curriculum's implementation in the classroom (Jones and Eick, 2007a).

Despite this professional development and the directive to use the newly adopted phenomena-based science curriculum as written, Grant constructed a science teaching identity within the setting of his curricular changes. Jones and Eick (2007b) posited that if teachers are truly to be a part of science education reform, their individual context and interests need consideration. The construction of Grant's science teaching identity extends this discussion beyond simply contemplating how teachers are being asked to implement reform-based science. Grant illustrated the need to consider teachers' professional values regarding the methods intended to support the larger ideals of reform-based curricula. Yet, Grant's science teaching identity in twined these values with his understandings of self as a science teacher and his students as learners of science. This more comprehensively revealed the individual context and interests of his classroom's lifeworld. While, in Grant's case, this understanding maintained alignment between his teaching and best practices, in other cases, those same interests and values have been shown to compromise their consistent use (Kozoll, 2020). Thus, attention to these ideals as well as those related to science education reform may enhance professional development by better recognizing a teacher's positional identity as instrumental to classroom practice (Moore, 2008).

Ethical Statement

This study was conducted and its data collected with the approval of the affiliated institution of higher education's Institutional Review Board. This ensured the study conformed to United States federal regulations and abided by the statement of principles contained in the Ethical Principles and Guidelines for the Protection of Human Subjects (The Belmont Report). Institutional Review Board approval confirmed the

Science Education International
34(1), 42-51
https://doi.org/10.33828/sei.v34.i1.5

methodological and ethical quality of this research (Research Protocol #RK081919EDU).

REFERENCES

Anderson, R.D., & Helms, J.V. (2001). The ideal of standards and the reality of schools: Needed research. *Journal of Research in Science Teaching,* 38(1), 3-16.

Avraamidou, L. (2014a). Tracing a beginning elementary teacher's development of identity for teaching science. *Journal of Teacher Education,* 65(3), 223-240.

Avraamidou, L. (2014b). Studying science teacher identity: Current insights and future research directions. *Studies in Science Education,* 50(2), 145-179.

Avraamidou, L. (2014c). Developing a reform-minded science teaching identity: The role of informal science environments. *Journal of Science Teacher Education,* 25(7), 823-843.

Avraamidou, L. (Ed.). (2016). *Studying Science Teacher Identity: Theoretical, Methodological, and Empirical Explorations*. Netherlands: Sense Publishers.

Barab, S.A., & Luehmann, A.L. (2003). Building sustainable science curriculum: Acknowledging and accommodating local adaptation. *Science Education,* 87(4), 454-467.

Beauchamp, C., & Thomas, L. (2009). Understanding teacher identity: An overview of issues in the literature and implications for teacher education. *Cambridge Journal of Education,* 39(2), 175-189.

Beijaard, D., Meijer, P.C., & Verloop, N. (2004). Reconsidering research on teachers' professional identity. *Teaching and Teacher Education,* 20(2), 107-128.

Bell, S.E., & Sexton, S.S. (2018). Science education professional development for primary/elementary teachers: A tale of two systems. *Science Education International,* 29(2), 117-123.

Bernstein, J.R. (1983). *Beyond Objectivism and Relativism: Science, Hermeneutics, and Praxis*. Pennsylvania: University of Pennsylvania Press.0

Bobis, J., Khosronejad, M., Way, J., & Anderson, J. (2020). "Sage on the stage" or "meddler in the middle": Shifting mathematics teachers' identities to support student engagement. *Journal of Mathematics Teacher Education,* 23(6), 615-632.

Bogdan, R.C., & Biklen, S.K. (2006). *Qualitative Research for Education: An Introduction to Theory and Methods.* 5th ed. Boston: Allyn and Bacon.

Brinkman, S., & Kvale, S. (2015). *Interviews: Learning the Craft of Qualitative Research Interviewing.* 3rd ed. California, United States: Sage.

Buchanan, R. (2015). Teacher identity and agency in an era of accountability. *Teachers and Teaching,* 21(6), 700-719.

Campbell, T., Oh, P.S., Maughn, M., Kiriazis, N., & Zuwallack. R. (2015). A review of modeling pedagogies: Pedagogical functions, discursive acts, and technology in modeling instruction. *Eurasia Journal of Mathematics, Science, and Technology Education,* 11(1), 159-176.

Carlone, H.B., Haun-Frank, J., & Kimmel, S.C. (2010). Tempered radicals: Elementary teachers' narratives of teaching science within and against prevailing meanings of schooling. *Cultural Studies of Science Education*, 5(4), 941-965.

Clark, J.C., & Groves, S. (2012). Teaching primary science: Emotions, identity and the use of practical activities. *The Australian Educational Researcher*, 39(4), 463-475.

Coffey, A., & Atkinson, P. (1996). *Making Sense of Qualitative Data: Complementary Research Strategies*. California, United States: Sage.

Cole, A.L. & Knowles, J.C. (1995). Extending boundaries: Narratives on exchange. In: Josselson, R., & Lieblich, A. (Eds.), *Interpreting Experience: The Narrative Study of Lives.* Vol. 03. California, United States: Sage. pp. 205-251.

Cook, N.D., Walker, W.S., Weaver, G.C., & Sorge, B.H. (2015). The Indiana science initiative: Lessons from a classroom observation study. *School Science and Mathematics*, 115(7), 318-329.

Creswell, J.W., & Poth, C.N. (2018). *Qualitative Inquiry and Research Design: Choosing among Five Traditions*. 4th ed. California, United States: Sage.

Debarger, A.H., Penuel, W.R., Moorthy, S., Beauvineau, Y., Kennedy, C.A., & Boscardin, C.K. (2017). Investigating purposeful science curriculum adaptation as a strategy to improve teaching and learning. *Science Education*, 101(1), 66-98.

Enyedy, N., & Goldberg, J. (2004). Inquiry in interaction: How local adaptations of curricula shape classroom communities. *Journal of Research in Science Teaching,* 41(9), 905-935.

Enyedy, N., Goldberg, J., & Welsh, K.W. (2006). Complex dilemmas of identity and practice. *Science Education,* 90(1), 68-93.

Forbes, C.T. (2013). Curriculum-dependent and curriculum-independent factors in pre-service elementary teachers' adaptation of science curriculum material for inquiry-based science. *Journal of Science Teacher Education,* 24(1), 179-197.

Forbes, C.T., & Davis, E.A. (2012). Operationalizing identity in action: A comparative study of direct versus probabilistic measures of curricular role identity for inquiry-based science teaching. *International Journal of Science and Mathematics Education,* 10(2), 267-292.

Gadamer, H.G. (1994). *Truth and Method.* 2nd ed. Weinsheimer, J., & Marshall, D. Trans. New York: Continuum. (Original work published 1960).

Gado, I. (2005). Determinants of K-2 school teachers' orientation towards inquiry-based science activities: A mixed method study. *International Journal of Science and Mathematics Education*, 3(4), 511-539.

Gallagher, S. (1992). *Hermeneutics and Education*. New York, United States: State University of New York Press.

Ginsberg, A., Gasman, M., & Samayoa, A.C. (2021). "When things get messy": New models for clinically rich and culturally responsive teacher education. *Teachers College Record,* 123(4), 1-26.

Golzar, J. (2020). Teacher identity formation through classroom practices in the post-method era: A systematic review. *Cogent Education,* 7(1), 1853304.

Grimes, N.K. (2013). The nanny in the schoolhouse: The role of femme-Caribbean identity in attaining success in urban science classrooms. *Cultural Studies of Science Education,* 8(2), 333-353.

Guzey, S.S., & Ring-Whalen, E.A. (2018). Negotiating science and engineering: An exploratory case study of a reform-minded science teacher. *International Journal of Science Education,* 40(7), 723-741.

Holstein, J.A., & Gubrium, J.F. (1995). *The Active Interview*. California, United States: Sage.

Hsu, P.L., Reis, G., & Monarrez, A. (2017). Identity discourse in pre-service teachers' science learning autobiographies and science teaching philosophies. *Canadian Journal of Science, Mathematics and Technology Education,* 17(3), 179-198.

Huang, Y.S., & Asghar, A. (2018). Science education reform in Confucian learning cultures: Teachers' perspectives on policy and practice in Taiwan. *Cultural Studies of Science Education,* 13(1), 101-131.

Husserl, B. (1999). *The Idea of Phenomenology*. In: Hardy, L. Trans. Berlin, Germany: Springer-Verlag. (Original work published 1907).

Irez, S., & Han, C. (2011). Educational reforms as paradigm shifts: Utilizing Kuhnian lenses for a better understanding of the meaning of, and resistance to, educational change. *International Journal of Environmental and Science Education,* 6(3), 251-266.

Jones, M.T., & Eick, C.J. (2007a). Implementing inquiry kit curriculum: Obstacles, adaptations, and practical knowledge development in two middle school science teachers. *Science Teacher Education,* 91(3), 492-513.

Jones, M.T., & Eick, C.J. (2007b). Providing bottom-up support to middle school science teachers' reform efforts in using inquiry-based kits. *Journal of Science Teacher Education,* 18(6), 913-934.

Kazempour, M., & Amirshokoohi, A. (2014). Transitioning to inquiry-based teaching: Exploring science teachers' professional development experiences. *International Journal of Environmental and Science Education,* 9(3), 285-309.

Koopman, O. (2015). Phenomenology as a potential methodology for subjective knowing in science education research. *Indo-Pacific Journal of Phenomenology,* 15(1), 1-10.

Kozoll, R.H. (2020). Content vs. process: The life-world construction of a science teaching identity. *Electronic Journal for Research in Science and Mathematics Education,* 24(1), 5-25.

Larson, P.N., & Jakobsson, A. (2020). Meaning-making in science from the

Science Education International
34(1), 42-51
https://doi.org/10.33828/sei.v34.i1.5

perspective of students' hybrid language use. *International Journal of Science and Mathematics Education*, 18(5), 811-830.

Lincoln, Y.S., & Guba, E.G. (1985). *Naturalistic Inquiry*. California, United States: Sage.

Linn, M.C., & Chiu, J. (2011). Combining learning and assessment to improve science education. *Research and Practice in Assessment,* 6(1), 5-14.

Looney, A., Cumming, J., van Der Kleij, F., & Harris, K. (2018). Reconceptualising the role of teachers as assessors: Teacher assessment identity. *Assessment in Education: Principles, Policy, and Practice,* 25(5), 442-467.

Mansour, N. (2009). Science teachers' beliefs and practices: Issues, implications, and research agenda. *International Journal of Environmental and Science Education,* 4(1), 25-48.

Marano, N.L. (1998). The teaching learning dialectic: Two cases of teachers in graduate school. *Teaching and Teacher Education,* 14(4), 429-443.

Marshall, J.C., Horton, R., Igo, B.L., & Switzer, D.M. (2009). K-12 science and mathematics teachers' beliefs about and use of inquiry in the classroom. *International Journal of Science and Mathematics Education*, 7(3), 575-596.

Miller, E., Manz, E., & Russ, R. (2018). Addressing the epistemic elephant in the room: Epistemic agency and the next generation science standards. *Journal of Research in Science Teaching,* 55(7), 1053-1075.

Moore, F.M. (2008). Positional identity and science teacher professional development. *Journal of Research in Science Teaching*, 45(6), 684-710.

Nagle, C.E., & Pecore, J.L. (2019). A veteran science teacher's transition to NGSS. *Electronic Journal of Science Education,* 23(2), 1-15.

National Research Council. (2012). *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*. Washington, D.C., United States: The National Academies Press.

NGSS Lead States. (2013). *Next Generation Science Standards: For States, By States*. Washington, D.C., United States: The National Academies Press.

Østergaard, E., Dahlin, B., & Hugo, A. (2008). Doing phenomenology in science education: A research review. *Studies in Science Education,* 44(2), 93-121.

Padilla-Diaz, M. (2015). Phenomenology in educational qualitative research: Philosophy as science or philosophical science? *International Journal of Educational Excellence,* 1(2), 101-110.

Polanyi, L. (1985). *Telling the American Story: A Structural and Cultural Analysis of Conversational Storytelling*. New York: Ablex.

Powell, J.C., & Anderson, R.D. (2002). Changing teachers' practice: Curriculum materials and science education reform in the USA. *Studies in Science Education,* 37(1), 107-136.

Proweller, A., & Mitchener, C.P. (2004). Building teacher identity with urban youth: Voices of beginning middle school science teachers in an alternative certification program. *Journal of Research in Science Teaching*, 4(10), 1044-1062.

Ramezanzadeh, A., Zareian, G., Adel, S.M.R., & Ramezanzadeh, R. (2017). Authenticity in teaching: A constant process of becoming. *Higher Education: The International Journal of Higher Education Research*, 73(2), 299-315.

Ramnarain, U., & Schuster, D. (2014). The pedagogical orientations of South African physical science teachers towards inquiry of direct instructional approaches. *Research on Science Education,* 44(4), 627-650.

Riessman, C.K. (2012). Analysis of personal narratives. In: Gubrium, J.F., Holstein, J., Marvasti, A., & McKinney, K.D. (Eds.), *The Sage Handbook of Interview Research: The Complexity of the Craft.* 2nd ed. California, United States: Sage. pp. 367-380.

Ritchie, S.M. (2009). Looking for daisy: Constructing teacher identities. *Cultural Studies of Science Education*, 4(3), 595-599.

Roehrig, G.H., & Kruse, R.A. (2005). The role of teacher's beliefs and knowledge in the adoption of reform-based curriculum. *School Science and Mathematics,* 105(8), 412-422.

Roehrig, G.H., Kruse, R.A., & Kern, A. (2007). Teacher and school characteristics and their influence on curriculum implementation. *Journal or Research in Science Teaching,* 44(7), 883-907.

Rossman, G.B., & Rallis S.F. (2017). *An Introduction to Qualitative Research: Learning in the Field.* 4th ed. California, United States: Sage.

Schneider, R.M., Krajcik, J., & Blumenfeld, P. (2005). Enacting reform-based science materials: The range of teacher enactments in reform classrooms. *Journal of Research in Science Teaching,* 42(3), 283-312.

Schutz, A., & Luckman, T. (1980). *The Structures of the Life-World.* Vol. 1. In: Zaner, R., & Engelhardt, J.T. Trans. Illinois, United States: Northwestern University Press. (Original work published 1973).

Schwandt, T.A. (2015). *The Sage Dictionary of Qualitative Inquiry.* 4th ed. California, United States: Sage.

Taylor, C. (1992). The dialogical self. In: Hiley, D.R., Bohman, J.F., & Shusterman, R. (Eds.), *The Interpretive Turn: Philosophy, Science Culture*. New York, United States: Cornell University Press. pp. 304-314.

Tekkumru-Kisa, M., Preston, C., Kisa, Z., Oz, E., & Morgan, J. (2021). Assessing instructional quality in science in the era of ambitious reforms: A pilot study. *Journal of Research in Science Teaching,* 58(2), 170-194.

Upadhyay, B. (2009). Negotiating identity and science teaching in a high-stakes testing environment: An elementary teacher's perceptions. *Cultural Studies of Science Education,* 4(3), 569-586.

Van Manen, M. (1997). *Researching Lived Experience: Human Science for an Action Sensitive Pedagogy.* 2nd ed. England, UK: Routledge.

Van Manen, M. (2014). *Phenomenology of Practice: Meaning-Giving Methods in Phenomenological Research and Writing.* Oxford, United Kingdom: Taylor and Francis.

Volkmann, M.J., & Zgagacz, M. (2004). Learning to teach physics through inquiry: The lived experience of a graduate teaching assistant. *Journal of Research in Science Teaching,* 41(6), 584-602.

Wallace, J.B. (1994). Life stories. In: Gubrium, J.F., & Sankar, A. (Eds.), *Qualitative Methods in Aging Research.* California, United States: Sage. pp. 137-153.

Wei, B., & Chen, N. (2019). Agency at work: Two beginning science teachers' stories in a context of curriculum reform in China. *International Journal of Science Education,* 41(10), 1287-1302.

Williams, J.P. (2008). Emergent themes. In: Given, L.M. (Ed.), *The Sage Encyclopedia of Qualitative Research Methods*. California, United States: Sage. pp. 248-249.

Science Education International
34(1), 42-51
https://doi.org/10.33828/sei.v34.i1.5

APPENDIX FOR INTERVIEW GUIDES

Interview 1: Teaching background

Primary Question	Probes
1. How did you decide to go into science teaching	• What inspired you? • What were your experiences with science? • What were your feelings about science?
2. What is your teaching background?	• How long have you been teaching? • Where have you taught? • What subjects have you taught? • What do you currently teach? • What professional development have you taken?
3. What is your science teaching philosophy?	• How do you implement your philosophy? • What challenges do you face with following your teaching philosophy?
4. How do you identify yourself as a science educator?	• Describe your understanding of science as a discipline? • What does it mean to be a science teacher? • What is important in teaching science?
5. If you had unlimited time and resources, how would you teach science?	• What resources would you want? • Why would you teach it that way?
6. Why do we have students learn science?	• What is the purpose of students learning science? • What are the most important things for students to learn?
7. What do students struggle with the most in science?	• How do you respond to these struggles?

Interview 2: Teaching with inquiry-based curriculum

Primary Question	Probes
1. What is the pedagogical framework for the inquiry-based curriculum?	• How was it implemented in your classroom? • How did this change over time?
2. What has a typical science unit/lesson looked like in your classroom?	• What are your roles as the teacher? • What are the roles of your students?
3. Please describe what you taught?	• What were the goals of the curriculum? • What topics were taught? • What resources did you rely on? • How were content and activity balanced? • What was the role of activities or labs? • How did student develop content knowledge? • How were students assessed with this curriculum?
4. What are the strengths and weaknesses of the inquiry-based curriculum?	
5. Describe any changes you made to the inquiry-based curriculum.	• What did you add, remove, or change and why?
6. How is your teaching philosophy represented in the inquiry-based curriculum?	• How does the curriculum align with or contradict your values as a science teacher? • What examples can you provide of how the curriculum aligns with or contradicts your values as a science teacher?
7. Please describe Next Generation Science Standards.	• How do you feel about these standards? • How do these standards align with your values about how and why students should be taught science? • How does the curriculum align with these standards? • How is the curriculum successful or deficient in meeting these standards? • How have you incorporated the standards into the curriculum?

Science Education International
34(1), 42-51
https://doi.org/10.33828/sei.v34.i1.5

Interview 3: Phenomena-Based Curriculum Professional Development

Primary Question	Probes
1. Why was the inquiry-based curriculum replaced?	• What were the deciding factors in switching the curriculum?
2. How was the new curriculum selected?	• Were you part of the selection process? • How were your opinions incorporated into the selection process?
3. What concerns did you have as the new curriculum was selected?	• To whom did you express these concerns? • How were your concerns addressed?
4. How were you prepared for the new curriculum?	• What was your experience like? • Describe some things from the in-service that stood out.
5. What differences do you see between the inquiry- and phenomena-based curriculum?	
6. How did the in-service inform your thinking on the role the students, the teacher, and the content play in the curriculum?	• How were the expectations of the students portrayed? • How was the teacher's position in the classroom portrayed? • How was the students' position in the classroom portrayed?

Interview 4: Piloting phenomena-based curriculum

Primary Question	Probes
1. What is the guiding pedagogical framework for the phenomena-based curriculum?	• How would you describe the teaching/learning style? • How does this compare to the inquiry-based curriculum?
2. What did you teach using the phenomena-based curriculum?	• Describe the kits you used? • What were the major goals? • What were the specific topics?
3. What do lessons look like?	
4. What role did you, the students, and the content play when you piloted the curriculum?	• What were your classroom expectations for students? • How were you positioned in the classroom? • How did students receive lesson content?
5. What were the strengths and weaknesses of the curriculum?	
6. How did you feel teaching lessons from the curriculum?	• Describe some of the lessons you taught. • What would you change about those lessons?
7. How comfortable were you teaching the phenomena-based curriculum?	
8. How does the curriculum align with your values on science education?	• How does it align with your values concerning how students should learn science? • How does it align with your values concerning why students should learn science?
9. Please describe the Next Generation Science Standards.	• How does the curriculum align with these standards? • How is the curriculum successful or deficient in meeting these standards?

Interview 5: Post-piloting reflections

Primary Question	Probes
1. Having experienced the phenomena-based curriculum, would you change anything?	• What would you change about your teaching style? • What would you change about how the new curriculum is taught?
2. How did you transition back to teaching the inquiry-based curriculum?	• What did it demand of you and your students? • What did you change about the inquiry-based curriculum?
3. Did your experience with the phenomena-based curriculum inspire any questions or concerns about the inquiry-based curriculum?	
4. What concerns do you have moving forward with the phenomena-based curriculum?	
5. What, if anything, would you like to add for us to understand your experience with the inquiry-based curriculum?	