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Barriers to Authentic Science Inquiry in the Elementary Classroom

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Abstract: *This phenomenological study uncovered barriers early-career elementary teachers face when teaching inquiry-based science. During interviews, teachers shared a variety of challenges to the implementation of inquiry-based teaching. Inductive analysis revealed the shared barriers of time, curriculum, lack of administration support, pressure to focus on other disciplines, and lack of content knowledge.*

Key Words: Science Inquiry, Elementary School Science, Barriers to Science Inquiry

INTRODUCTION

Meeting the expectations of the *Next Generation Science Standards* (NGSS) for three-dimensional learning (NRC, 2014) requires a very intentional approach of authentic scientific inquiry. The experience of science teacher educators as well as evidence in the research literature (i.e. Bybee, 1993; Kulm, 2007; Pratt, 2002) show that historically teachers have faced a number of challenges when attempting to teach inquiry-based science regularly. We wondered if the barriers are the same now in the current NGSS era as in the past or if developments have occurred. Have the higher expectations of the NGSS led to more easily overcoming these barriers or is this still a difficult process? How do elementary teachers, newer to the profession, describe the challenges they face when teaching inquiry-based science lessons? We focused on teachers with less than three years of experience in order to inform our practice of preparing preservice teachers to implement science inquiry teaching. To explore the phenomenon, we employed one focus question to guide the study: What are the barriers early-career elementary educators face when attempting to teach inquiry-based science lessons?

REVIEW OF THE LITERATURE

It has long been recognized that students gain a deeper understanding of science concepts when they learn through engaging in authentic inquiry—the practices of science (Krajcik, Codere, Dahsah, Bayer, & Mun, 2014). More recently, it has become apparent that a stronger understanding of the practices of science are also enhanced when applied to content rich investigations (NRC,

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2007). The NGSS lead states (2013) capitalized on this mutually beneficial relationship when crafting the *Performance Expectations* of the NGSS with concept, content, and practice woven together. Engaging students in classroom experiences that meet these expectations will require teachers to move away from traditional fact based approaches. Instead they must provide students with opportunities to use the practices of science and the connecting concepts of science to explore the phenomena of science (Krajcik et al., 2014).

Providing these rich, inquiry-based experiences for students is not without difficulties. Barriers to authentic inquiry include lack of inquiry-based science curricula, weak teacher content knowledge, and lack of time (Appleton, 2007; Bainlower et al., 2013; Mansour, 2007). Curriculum materials meeting the expectations of the NGPSS must be built to integrate the three dimensions over a multiyear sequence so that progression of deep learning is not lost (NRC, 2012). Neither text series nor kits have historically met these needs (NRC, 2007). Teachers attempting authentic inquiry-based experiences must regularly supplement their curriculum with other resources (Bainlower et al., 2013). These challenges are compounded when teachers lack the personal content knowledge needed to succeed. Research has found that teachers often lack sufficient scientific content knowledge (Appleton, 2007) or the inquiry-based pedagogical content knowledge (Roehrig & Luft, 2004) to teach with confidence. Even when teachers feel competent, time constraints are a significant challenge. This, of course is not a new issue. Blasé (1986) found time constraints to be a predominate issue for teachers—compounding all other challenges. Nearly all the science teachers in Mansour's (2007) study reported time as being a challenge. Often, these constraints lead teachers to skip over powerful learning opportunities—even when they have previously recognized the importance of these experiences (Carrier, 2009).

RESEARCH METHODOLOGY

Employing a phenomenological methodology for this study was a good fit since it was the experience of a select group of individuals and of a particular phenomenon under study (Groenewald, 2004). The study explored the experiences and resulting barriers early-career elementary teachers face when attempting inquiry-based science lessons. Using homogeneous sampling (Patton, 2002) we identified eight early career teachers who, as preservice teachers, had demonstrated both interest and competence in science inquiry (See Table 1).

We conducted interviews, using a semi-structured protocol (Patton, 2002), to explore the challenges the teachers face in teaching inquiry-based science lessons and how empowered they feel to overcome these barriers. The interviews were recorded and transcribed when possible. When this was not possible, detailed notes were taken. These data were analyzed by inductively coding for descriptive themes (Miles, Huberman, & Saldana, 2014).

RESULTS

Five themes stood out as patterns in the experience of early-career teachers. Even though these educators had been accomplished and motivated as preservice teachers, they struggled to teach science lessons that were inquiry-based. None of them expressed satisfaction with science as it occurred in their classrooms. Also, there was almost complete agreement on the five barriers to science inquiry (See Table 2) (Insert Table 2 near here).

CURRICULUM

All eight teachers identified the curriculum they have in their school as one of the barriers. One teacher expressed doubt in the "homegrown" curriculum her district used because she felt the teachers who developed it lacked the needed pedagogical content knowledge. Others felt their district had focused more on the cost of curriculums instead of the quality.

> When we were doing the science PD, they told us straight up that we chose this curriculum because it was the cheapest. And so to know that we're doing this because it's cheap does not make you feel like you're doing the right thing for your students. (Heather, 2nd grade teacher)

To add to this, several felt their curriculums were not very inquiry-based because they are too structured and "cookbook" like. Students do not have much fun when things are so structured. "It's not engaging for me so I know it's not engaging for them" (Gina, 4th grade teacher).

Table 1

Eight Early-Career Participating Teachers

Pseudonym	Years of Experience	Grade Level	Amount of Science & Inquiry
Laura	1	1st	60 – 90 minutes per week Always attempting inquiry
Heather	1	2nd	Regularly when we have the kit Inquiry doesn't happen often
Gina	1	4th	2 to 4 lessons per unit are inquiry
Sara	1	4th	40 minutes, 4 days per week for 6 weeks on and off
Joanne	1	4th	40 minutes on Fridays No time for inquiry
Barb	3	4th	STEM challenges on Fridays
Tanya	2	5th	3 or 4 investigations per trimester 2 or 3 times a week
Alice	2	5th	30 minutes each day

TIME

As reported in the research literature, the teachers participating in the study identified time as a barrier to science inquiry. They shared a frustration with the amount of time during the day allotted to teach science as well as the preparation time required for many of the aspects of science inquiry. "If you want to teach science, you have to fight for it!" (Alice, 5th grade teacher).

Table 2

Five Barriers to Science Inquiry

Pseudonym	Time	Curriculum	Support from Administration	Pressure to focus on other Disciplines	Content Knowledge
Laura	Yes	Yes	Yes	Yes	
Heather	Yes	Yes	Yes	Yes	Yes
Gina	Yes	Yes		Yes	Yes
Sara	Yes	Yes	Yes	Yes	Yes
Joanne	Yes	Yes	Yes	Yes	Yes
Barb	Yes	Yes	Yes	Yes	Yes
Tanya	Yes	Yes		Yes	Yes
Alice	Yes	Yes	Yes	Yes	Yes

PRESSURE TO FOCUS ON OTHER DISCIPLINES

Much of the conversation about the barrier of time related to the larger issue of the pressure to focus on other disciplines deemed more important. "Also, our ELA curriculum is just huge! There is just so much that you are expected to get through. So much material–definitely there is some pressure there" (Laura, 1st grade teacher). This pressure is associated with high stakes testing. "When I started last year it was like, 'Get your 90 minutes of ELA in.' 90 minutes! I don't even have my kids for 90 minutes, I mean, not straight! I just feel we are very ELA and math focused" (Heather, 2nd grade teacher). This pressure has left some of the teachers, who desire to address the challenge of time with an integrated approach, struggling to find a way. "It is hard to implement themed/combined units because we are given very specific ELA lessons. There is no supplementing them; everything is step by step. So, no flexibility. The reality is not what I thought it would be" (Barb, 4th grade teacher).

SUPPORT FROM ADMINISTRATION

With the pressure to focus elsewhere, it follows that many of the teachers felt that they lacked needed support from their school or district administration. None described administrators as hostile or even negative towards science inquiry; several even teach in STEM schools where science is viewed positively. However, actions speak louder than words. "If the district really wants us to do inquiry-based science, then they need to provide opportunities to explore more with that and, you know, have PD. And to make it a clear priority along with the other standards" (Laura, 1st grade teacher).

CONTENT KNOWLEDGE

Almost all of the teachers reported that their own content knowledge is a barrier to implementing inquiry-based science. For some, part of the issue was poor advising from when they were their undergraduate programs. "In school I only took – we had to take two science classes. I took the two easiest science classes I could take. I only really took geology. [Science content is] definitely a little bit of a challenge" (Gina, 4th grade teacher). For others the difficulty goes deeper. "It's really hard for me. My brain doesn't really understand. I struggle as a student of

science; I always have, and so being able to teach that is a really big deal" (Heather, 2nd grade teacher). Without a deep personal understanding of the science content, these teachers often struggle to plan for and implement inquiry-based science teaching.

> If I understood the concepts better and understood how [the NGSS] is put together better – I mean I remember taking the class and it making sense. I mean I could answer the questions and I remember liking it. But, doing it with kids is different, and doing it in a way that makes sense to them and in a way they will remember is different. (Tanya, 5th grade teacher)

A deficit in content knowledge definitely impacts the ability to plan for inquiry-based science lessons (Appleton, 2007); however, this challenge is compounded by a weak pedagogical content knowledge (Roehrig & Luft, 2004). Although only a few of the participating teachers actually mentioned this as a barrier, answers in other places of the interviews indicate that it might be a larger issue than they believe. When asked to describe how the 3 Dimensions of the NGSS appeared in her science lessons, 2nd grade teacher Heather said, "I don't think I know them well enough. I felt very confident in college when, you know, you see them all the time. And then [as a teacher], when you have curriculum, it's like, 'here's your standards!' Alright, check, done!"

Further concern for pedagogical content knowledge appeared in the shallow answers the teachers shared when describing what they identify as the key features of inquiry: students asking questions; students presenting, explaining, and describing; being student-directed; problem solving; and having students share ideas with everyone.

IMPORTANCE TO THE FIELD

This study begins an exploration into the context of early-career teachers in order to gain a picture of the barriers they identify as critical to impeding their implementation of inquiry. We hold confidence in the validity of the five barriers identified due to consistency across the eight teachers interviewed. It will be important to gather additional information on these identified barriers in order to provide preservice teachers in our preparation programs with strategies and skills to mitigate the effect of the barriers when they attempt to implement inquiry-based science in their first years of teaching.

Future research will include a deeper and longer investigation. Triangulation of data is needed. Analyzing the curriculum materials, observing lessons, and probing further with more interviews, will be ways to use these initial results to direct the investigation toward more informative answers regarding the implementation of inquiry-based science in early-career teachers' classrooms.

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