ABSTRACT

REFVEM, EMMA JANE. Science Instructional Coaches: Content Expertise, Beliefs, Motivation, and Contexts. (Under the direction of Dr. M. Gail Jones).

Instructional coaching is emerging as an effective form of professional development for teachers. However, there is a dearth of research about school-based instructional coaches' influence on science teaching. This dissertation includes two studies investigating science instructional coaches' roles, goals, beliefs, and motivations to provide more insight into this burgeoning professional development model. Study one examined the roles, contexts, beliefs, and goals of instructional coaches that work with secondary science teachers. Findings showed three types of instructional coaches that work with science teachers: science coaches, general instructional coaches with a background in science, and general instructional coaches without a science background. Results also indicated that while all these coaches were involved in working directly with teachers to support pedagogy, the science coaches were better equipped and spent more time supporting the development of science-specific pedagogical skills. Results suggested that the coaches also did not hold reform-based beliefs about science teaching, which provides insight to limitations to their support of science teachers. In addition, coaches' primary goal was building relationships with teachers, which sometimes conflicted with their supervisors' goals. The second study examined the instructional coaches' teaching motivation through time and their motivation to become instructional coaches and continue in that role. Findings indicated that coaches' teaching motivation was influenced by the school culture and the autonomy they experienced as educators. For teachers who felt unsupported or unmotivated as classroom teachers, the opportunity to enter a coaching position allowed these educators opportunities to stay in education and make positive contributions working with other teachers. Overall, the results suggest that science coaches are instrumental in the support of science education. The

coaching role is a potentially fruitful career path for science teachers to remain in the education sector.

Science Instructional Coaches: Content Expertise, Beliefs, Motivation, and Contexts

by
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DEDICATION

To all the teachers who have brought me here.

BIOGRAPHY

Emma Jane Refvem was born in San Antonio, Texas, then spent her early childhood in Vacaville, California, before settling in Mount Airy, North Carolina. She loved being outside and spent her summers as a camper and counselor at Camp Cheerio in Roaring Gap, North Carolina. She graduated as valedictorian from Mount Airy High School in 2005. Her favorite science teacher was Mr. Bretz, who started the photosynthesis unit by dedicating his work to the beautiful tree outside the classroom window. She attended the University of North Carolina at Chapel Hill in 2009 with a Bachelor of Science in Environmental Science. Despite the pleas of her Geology professor to study rocks for a living, her time as a counselor at Camp Cheerio inspired her to pursue a career as a teacher. She graduated in 2010 with a Master of Arts in Teaching from UNC-Chapel Hill, completing her student teaching in Mrs. Boyarsky's Advanced Placement Environmental Science classes. She started her teaching career at Riverside High School in 2010, teaching Earth and Environmental Science and AP Environmental Science. She is a National Board Certified Teacher for Adolescent and Young Adulthood Science. In addition, she has spent many years partnering with the UNC-Chapel Hill Institute for the Environment for student camps and professional development programs. In the fall of 2017, at the North Carolina Science Teacher Association conference, a former Camp Cheerio colleague recruited her from the North Carolina State College of Education booth to apply to graduate school. In the fall of 2018, she started her Ph.D. program at NC State. She now works for Durham Public Schools as the 6-12 Science Specialist in the department of Curriculum and Instruction. She lives in Durham with her husband, Byron, her son, Bats, and four cats. She enjoys spending time outside with her family, reading novels, and doing textile crafts like knitting and sewing. She is looking forward to applying her new expertise to support science teachers in Durham and beyond.

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CHAPTER 1: INTRODUCTION

This dissertation examines the beliefs, instructional practices, and perceptions of science instructional coaches who work with teachers to improve science instruction in middle and high schools. The use of coaches as a form of professional development for teachers has grown significantly in recent years. However, little is known about who becomes a coach, their beliefs, and their motivations. The series of studies presented here addresses this gap in research.

The research described here includes two stand-alone studies, an introduction, and a final concluding chapter. Each study highlights different facets of the instructional coaching role in science education. In the following sections, a description of the studies, the context for the research, and the methods used are provided.

Background and Study Rationale

To build the capacity of classroom teachers, we rely on professional development (PD). Research suggests that when PD includes job-embedded practice and intense and sustained duration, the outcome improves teacher practice and student achievement (Scher & O'Reilly, 2009). One type of PD that has emerged in recent years is instructional coaching, which can be loosely defined as "in-service PD programs where coaches or peers observe teachers' instruction and provide feedback to help them improve" (Kraft et al., 2018, p. 548). Coaching has grown in popularity as a PD model due to policies allowing school districts to use funding from federal initiatives such as the Every Student Succeeds Act (ESSA), which explicitly recommends hiring and training instructional coaches to improve instruction (Every Student Succeeds Act, 2015).

Advocates of instructional coaching suggest that coaches can provide high-quality, job-embedded PD (Knight, 2006), help teachers engage in reflective practices to enhance teaching strategies and student learning (Datnow & Hubbard, 2016), and support teachers as they enact

reform, such as implementing the Next Generation Science Standards (NGSS Lead States, 2013). Schools' most prevalent form of coaching has been associated with elementary literacy (Kraft et al., 2018). The research foci for many of these elementary studies have concentrated on whether coaching improves teacher practice or student achievement.

Research Problem

Despite positive research about the impacts of coaching on teacher instruction and student achievement, the role of coaching is ill-defined. It has been described as "inherently multifaceted and ambiguous" (Gallucci et al., 2010, p. 922). Though research studies provide examples of successful programs, the professional responsibilities of the coach remain inadequately described in the literature. This ambiguity is even more pronounced for coaching in the context of science education; science has only been the focus of very few studies (Kraft et al., 2018). This emphasis on science is critical because of the significant role that disciplinary knowledge plays in instructional practice.

This study sought to understand who is coaching science teachers, how science coaching is enacted, and how the coaching role supports the motivation of educators—exploring this role from three perspectives allowed for depth and nuance in understanding science coaching. First, this study defines the role of the science coach to guide those interested in utilizing instructional coaching as a PD model for their science teachers. Few studies of science teachers' instructional contexts have included science coaching in their analyses (e.g., Luft et al., 2018; Whitworth & Chiu, 2015), which may be due to a lack of definition for the role of a science coach. Second, this study aimed to understand what beliefs this sample of coaches held about effective science teaching, which sheds light on the content expertise these coaches bring to the role and strengthens the use of coaching as a form of PD to support science education reform. Third, this

study provides a more detailed picture of how coaching can fit into the career of science teachers who may seek career advancement. Understanding why these participants entered coaching positions can help schools and districts design more effective experiences that increase the motivation of their best science educators and help retain teachers within the education sector. Altogether, this research has the potential to further strengthen our understanding of a burgeoning role with a potentially significant impact on the development of teacher practice and the retention of excellent science educators.

Literature Review

Teacher Retention

Many teachers are leaving the profession (García & Weiss, 2019), and this is particularly pronounced for STEM teachers (Ingersoll & May, 2012). Teachers leave because of personal factors, like higher academic ability and less experience teaching, or school factors, including working conditions and salary (Nguyen et al., 2020). Borman and Dowling (2008) found that science teachers leave because they receive underdeveloped support in the form of instructional materials (i.e., Banilower et al., 2019) or administrative discipline support from their institutions. Other school working conditions, such as teacher workload, cooperation, and perceptions of student discipline, contribute to lower teacher job satisfaction (Toropova et al., 2021). External policy factors like low teacher pay also contribute to science teacher attrition (Nguyen et al., 2020). A national study by Ingersoll & May (2012) revealed salary to be the most influential factor for science teachers to leave the classroom. Though much is known about why teachers leave, little is known about why they stay. What little research has been done on science teacher retention points to the culmination of the teacher's own school experiences that impact their

student-centered belief system that contributes to that teacher's likelihood to persist in the classroom (Wong & Luft, 2015).

The context in which a teacher or instructional coach works can support or frustrate their basic psychological needs for autonomy, competence, or relatedness (Ryan & Deci, 2020), influencing their desire to continue in the education field. Evidence shows that relatedness plays a vital role in teacher well-being (Hascher & Waber, 2021). Understanding the motivational factors that support teachers' choices to stay in education and become a coach can help us understand ways to create working conditions that support these psychological needs and increase teacher retention.

Teacher Leadership

Though science teachers may be leaving the classroom, they are more likely than teachers from other disciplines to continue to work in education through jobs in administration or leadership (Ingersoll & May, 2012). As a result, some researchers are attempting to understand such science teacher career trajectories to better understand the options available to teachers to help encourage them to remain within the education system (Luft et al., 2018).

Allowing teachers to act as science leaders can provide them with growth options as they move through different career phases. Research on such trajectories (e.g., Luft et al., 2018) has included department head, teacher leader, curriculum development, or master teacher – but with a better understanding of what is involved in the role, instructional coaching could be added as a viable career possibility for ambitious science teachers. The development of this pathway is recognized in ESSA, citing the funds being used to provide "career opportunities and advancement initiatives that promote professional growth and emphasize multiple career paths, such as instructional coaching and mentoring (including hybrid roles that allow instructional

coaching and mentoring while remaining in the classroom)" (Every Student Succeeds Act, 2015, p. 129 STAT. 1921).

Science Teacher Professional Development

Professional development is an important avenue to improve teacher practice and help teachers persevere in classroom contexts (Fives & Buehl, 2016). Effective PD should be (a) intensive, ongoing, and connected to practice, (b) focused on student learning and addresses the teaching of specific curriculum content, (c) aligned with school improvement priorities and goals, and (d) set up to build strong working relationships among teachers (Darling-Hammond et al., 2009). Research suggests that coaching reflects these core components of successful PD (Desimone & Pak, 2017).

However, the PD that science teachers need is different from that required by teachers of other disciplines. Science PD is recommended to support teachers' instruction where students are "actively involved in investigating phenomena, interpreting results, and sense-making practices" (Whitworth & Chiu, 2015, p. 124). Some educators argue that PD is critical for successful systemic reform efforts designed to enhance teachers' abilities to teach high standards" (Sancar et al., 2021, p. 9). Science teachers need support through professional development to enact new and possibly challenging instructional techniques that are called for in science education reform efforts (Fives & Buehl, 2016). School-based PD has been connected to teachers' use of NGSS practices (Park et al., 2022), and this study seeks to understand further how school-based instructional coaches may also contribute to this improvement of teacher practice.

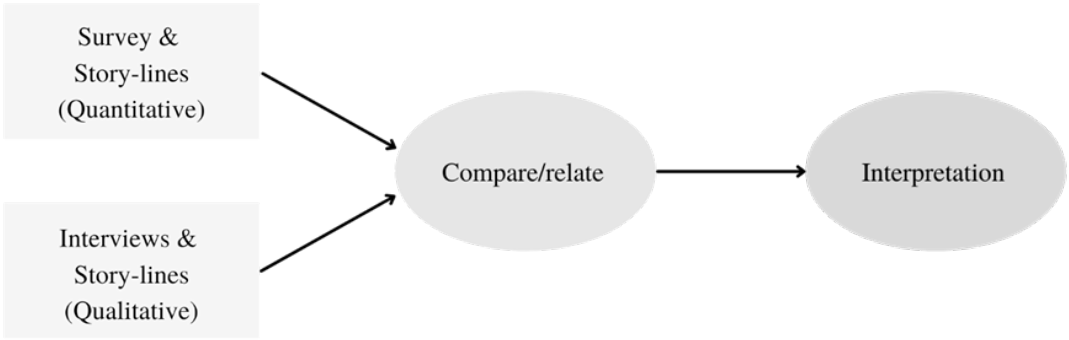
Overview of Methods

To document science coaches' motivation and perceptions, a mixed-methods design (Creswell, 2014) was used with quantitative data (Coaching for Science Survey, developed for

this study, see Appendix A), qualitative data (Coaching for Science Interview, developed for this study, see Appendix B), and storylines. These data were analyzed together to inform both papers' analyses. A convergent parallel mixed-methods design (Creswell, 2014) was selected for this study (Figure 1) to include a modest sample size with the survey and provide a rich context for the results. The quantitative data allowed for the documentation of perspectives from a wide range of participants who worked across geographic locations, providing a breadth of data to help define the science coach's role and understand the motivations of a broad range of coaches. The qualitative approach was adopted to allow for a deeper understanding and to provide nuance to the results. This research also employed a story-line methodology (Beijaard et al., 1999) to understand how the coaches' motivation for their professional work shifted throughout their teaching and coaching careers.

Figure 1

Study Methodological Design



Recruitment for the study was aimed at "instructional and science coaches" across the United States. A flyer was created and distributed through social media, at research and practitioner conferences, and through direct contacts of the researcher. The survey was completed by 59 participants (N = 59), and there were 21 interview participants (n = 21). All participants indicated coaching secondary science teachers.

Limitations

This study was bounded by the perspectives of the participants available to participate in the research and may not be generalizable to every school setting. Understanding the specific political landscape of each state from which participants were drawn was outside the scope of this research. Each state and district has its own political landscape that influences the enactment of federal funding initiatives and the approach to staffing. Another limitation was the use of the term "coach" for recruitment. Individuals who work similarly with teachers may not always be called "coaches" and may have been missed when recruitment occurred. Since there was a higher sample size for the quantitative portion of this mixed-methods study, there may have been possible validity issues in that the results may provide less of a complete picture of the results on the qualitative side with the smaller sample size. Since the constructs used in both types of methods are the same, this was not an issue.

Overview of Studies

Study One

The first study examined the roles, contexts, and goals of instructional coaches that work with secondary science teachers. It reviewed the literature on the instructional coaching model and the importance of relationships and trust in PD. It drew on Kraft et al.'s (2018) theory of action for teaching coaching and Scher and O'Reilly's (2009) theoretical sequence for PD outcomes in mathematics and science. This study used a mixed-methods design, drawing on data from the Coaching for Science Survey, the Coaching for Science Interview, and the Teacher Beliefs Interview (Luft & Roehrig, 2007). This study sought to understand who the coaches are, their support for science teachers, their beliefs about science teaching, and their primary goals for their coaching work.

Study Two

The second paper examined the participants' motivation for teaching through time and during the coaching role. It reviewed the literature on motivating factors for teachers and draws on Self-Determination Theory (Deci & Ryan, 2000) as a theoretical framework. This study utilized qualitative methods, including interview questions and a storyline methodology (Beijaard et al., 1999), to investigate the factors contributing to increased and decreased motivation through their teaching careers and how the coaching role impacted their motivation to stay in education.

Each stand-alone study is identified in the following chapters by its title and a brief abstract. This set of studies sheds critical light on the under-researched topic of science coaching that can support effective professional development and retention of science educators.

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CHAPTER 2: SCIENCE COACHING CHARACTERISTICS, CONTEXTS, BELIEFS, AND COMMUNITY

Abstract

Instructional coaching has emerged as a promising form of professional development for teachers. However, little is known about the background, contexts, professional responsibilities, and beliefs of instructional coaches that work with science teachers. This mixed-methods study focused on instructional coaches in secondary schools across the United States to understand what experience these coaches bring to the role and what activities they participate in that support science teaching. Coaches' goals for their work and tensions with the institution's goals were also explored, as well as their beliefs about science teaching. Results suggest that three types of coaches may support science teaching, depending on the content expertise of the coach (science or not) and the focus of their role (content-specific or general). Instructional coaches' support of science teaching is evident through their support of effective science teaching strategies. The results showed that most of these instructional coaches did not hold reform-based views of science teaching, which highlights limitations to their ability to support teacher enactment of reform-based science teaching practices. The goal of relationship building and the coaches' work as trust-builders emerged as a critical factor in the coaches' abilities to support teachers' pedagogical development. Implications for the field are discussed.

Introduction

Effective science teaching is crucial to developing scientifically literate students who can participate in science as citizens and future scientists. Teachers are increasingly viewed as "the most promising agent of change for improving student achievement" (Scher & O'Reilly, 2009, p. 209). They are also pivotal in supporting student pursuit of STEM careers later in life (Lee & Mamerow, 2019). Understanding effective professional development (PD) is essential to building strong science teaching practices to support science learning. In recent years, instructional coaching has proliferated as a way for school districts to provide effective PD (Kraft et al., 2018). Federal funding offered to districts through the Every Student Succeeds Act (ESSA) allows districts to utilize instructional coaches to support student achievement (*Every Student Succeeds Act*, 2015). Furthermore, instructional coaching is becoming more prevalent as school districts are increasingly developing coaching models to increase achievement and provide teachers with PD (Kraft et al., 2018).

The Framework for K-12 Education (National Research Council, 2012, henceforth referred to as the *Framework*) calls for PD as one of the four primary avenues through which a vision of reformed science teaching can be enacted. In the present study, "reform-based" teaching involves practices that center students' sensemaking around encountering phenomena. PD can influence positive change in teacher beliefs (Jones & Leagon, 2014) and support the development of teacher knowledge and skills for such reformed practices (Fischer et al., 2018). Since instructional coaching reflects the core components of successful PD – content focus, active learning, sustained duration, coherence, and collective participation (Desimone & Pak, 2017) – there is real potential for coaches to significantly impact teachers' instructional practices.

The most prevalent form of coaching has been associated with elementary literacy (Kraft et al., 2018). However, there is a dearth of research focused on coaching specifically for science teachers (Kraft et al., 2018). Content-specific coaching has been shown to be more impactful on student achievement than general coaching in the context of reading and literacy (Kraft et al., 2018). However, the literature does not describe the formalized support of *science* teaching provided through instructional coaching at the school or district level. In addition, little is known about coaches' backgrounds, the contexts in which they work, or the support they provide to secondary science teachers. Leaders and policymakers owe teachers access to meaningful support and models of desired instruction if they are to obtain the goals desired for science education. The goal of this study is to explore how the support of science teachers is enacted through instructional coaches that work with secondary science teachers.

Literature Review

Instructional Coaching as a Form of PD

Instructional coaching is challenging to define, as it is a role described as "multifaceted and ambiguous" (Gallucci et al., 2010, p. 922). Depending on its design, instructional coaching is set up to be able to provide effective PD that is (a) intensive, ongoing, and connected to practice, (b) focused on student learning within the specific curriculum content, (c) aligned with school improvement priorities and goals, and (d) set up to build strong working relationships among teachers (Darling-Hammond et al., 2009) by providing support that is individualized, intensive, sustained, context-specific, and focused (Kraft et al., 2018).

Typically, coaches are non-supervisory, content-based, and focused on supporting teachers in enacting reform (Gallucci et al., 2010). Coaches are usually embedded in schools or districts and carry out classroom observations, demonstrate model practices, and conduct cycles

of pre- and post-conferences with teachers (Gallucci et al., 2010). School administrators typically frame coaches as curriculum specialists, data analysts, and mentors (Mangin & Dunsmore, 2015). Most research on instructional coaching effectiveness is focused on literacy coaching, so there needs to be a well-established understanding of how coaching is enacted in content areas like science (Kraft et al., 2018). The challenges of secondary science coaching are complex because teachers need support with science pedagogical content knowledge (PCK), effective use of laboratories, instruction that utilizes inquiry, and general pedagogical support (e.g., Appleton, 2008; Barnett & Friedrichsen, 2015).

Coach Backgrounds & Professional Responsibilities

Little is known about the content expertise of coaches, whether they are general or science-specific coaches (Kraft et al., 2018). Administrators (school principals) view coaches as agents to develop shared understandings of reform (i.e., help get the messaging from higher up into classrooms with more fidelity), model practices, and broker ideas (i.e., serve as a mediator of ideas from teacher to administration and vice versa) (Woulfin & Rigby, 2017). Coaches may also work with teachers to lead their professional learning communities (PLCs), analyze data (Houston, 2015), and promote school improvement and instructional practice (Datnow & Hubbard, 2015). Coaches must form relationships with teachers, act as trust-builders (Anderson et al., 2014), and help teachers develop their leadership skills (Luft et al., 2016). However, more clarity is needed on coaching, as many coaches "enter into positions without a thorough understanding of coaching practice or even a clear vision of their role as a coach" (Stoetzel & Shedrow, 2020, p. 1).

The work of science coaches can be informed by science best practices and the work of district science coordinators. The National Survey of Science and Mathematics Education

(NSSME+) (Banilower et al., 2018) investigated science teachers' preparedness to implement science instructional activities. Few science teachers felt prepared "to provide science instruction based on students' ideas, develop students' awareness of STEM careers, and incorporate students' cultural backgrounds into science instruction" (Banilower et al., 2018, p. 37). Utilizing items from this survey with science coaches allows for the examination of whether coaching support overlaps with areas where science teachers feel less prepared. Whitworth et al. (2017) examined the professional responsibilities of district science coordinators and identified a list of the support activities science coordinators offer teachers and schools. Items from both surveys were used in the current study to add science-specific contexts to our understanding of the roles of instructional coaches.

Science Education Reform

The present study uses the Luft & Roehrig (2007) definition of "reform-based beliefs" as those beliefs that focus on students and center student understanding and knowledge of the world in their science instruction design and implementation. Since the development of Luft & Roehrig's (2007) Teacher Beliefs Interview (used for this study), science education reforms have aimed to develop scientifically literate students by giving students a three-dimensional experience with learning, including scientific practices and crosscutting concepts to core disciplinary ideas (National Research Council, 2012). Learning under this vision includes students constructing science knowledge, developing the skills of scientists, implementing practices such as developing questions about phenomena, and engaging in argumentation from evidence.

Reform-based teaching distinctly differs from traditional science classroom instruction (McFadden & Roehrig, 2020), as most classrooms involve students participating in daily,

disconnected science activities (e.g., Banilower, 2019; Laxton, 2016). Sensemaking and critiquing practices (i.e., developing and using models, constructing explanations, and engaging in argument from evidence) differ from current traditional science instruction (McNeill et al., 2018). The approaches needed to teach practices such as argumentation effectively are difficult for teachers and may require a shift in beliefs (Fives & Buehl, 2016). Science education reform calls for teachers to move beyond the "sage on the stage" and become co-inquirers with students (Fives & Buehl, 2016, p. 117).

Instructional Coaching and Reform

PD has the potential to support enacting this reform, as it has been shown that teacher PD can influence beliefs and instruction (Jones & Leagon, 2014). A recent study found that teachers who attended PD provided by their school districts more frequently implemented NGSS practices in their instruction (Park et al., 2022). Indeed, school contexts and administrative support are increasingly being recognized as factors that shape teachers' implementation of reform-based practices (e.g., Wenner & Settlage, 2015), as "focusing solely on teachers and students can limit the usability, scalability, and sensibility of reforms" (McNeill et al., 2018, p. 453) (McNeill et al., 2018, p. 453). Laxton (2016) found that "restructuring PD to a job-embedded [science] coaching model supported teachers in learning new reform-related instructional practice" (p. 3).

As noted above, most studies on the impact of instructional coaching have focused on literacy and reading at the elementary level (Kraft et al., 2018). While these studies show that content-based coaching supports change in teacher practice (Kraft et al., 2018), little is known about whether this is true in a science context or whether coaches working outside their content specialty can provide the content expertise required to support change in teacher practice.

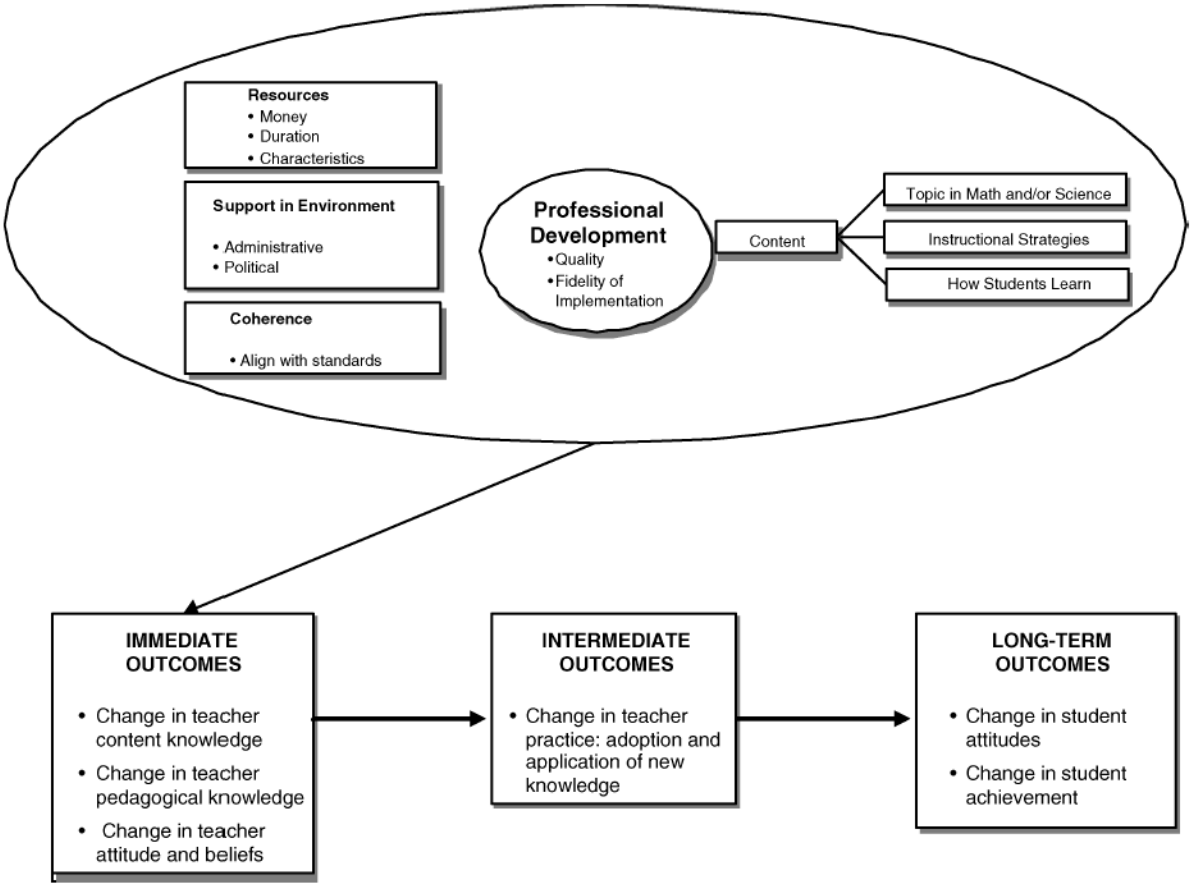
Teacher pedagogical content knowledge (PCK) is highly connected to the degree to which their instruction is reform-oriented (Park et al., 2011). It is unclear whether general instructional coaches who work with science teachers and teachers of other disciplines at their school can positively impact science instruction and science teachers.

The Goals of Coaching as PD and Possible Goal Tensions

Though the overarching goal of PD may be conceptualized as student learning (Desimone, 2009), there are intermediary goals that need to be met that fall within the focus and agency of instructional coaches. For example, Scher and O'Reilly (2009) presented a theoretical sequence showing how features of PD influence outcomes in mathematics and science (Figure 1). Within this framework, coaches can provide PD and support, which can directly impact immediate outcomes such as a change in teacher content and pedagogical knowledge as well as teacher attitude and beliefs. However, the intermediate outcomes of change in teacher practice or adoption of new knowledge and the long-term outcomes of change in student attitudes and achievement are outside the direct influence of the coach's actions.

Figure 1

Scher and O'Reilly's (2009) Theoretical Sequence Showing How Features of Professional Development Influence Outcomes in Mathematics and Science.



The relative newness of using instructional coaches raises questions about whether coaches see their goals as congruent with their supervisor's or administrators' goals. The day-to-day responsibilities of a coach may be unclear, and coaches' clarity about their role can be related to the fidelity with which they help carry out the administration's goals (Stoetzel & Shedrow, 2020). However, just as teachers often do not share the same goals as their administrators, coaches may hold different goals than administrators for their coaching work. Coaches must work within their school-based contexts and negotiate the differing tensions and

relationships between teachers, principals, their own goals, and the broader school climate (Sam & Caliendo, 2018). Thus, they may have to deal with friction if there is a misalignment between the goals of teachers and the administration (Woulfin & Rigby, 2017).

Relationships in PD and Coaching

Mediating tensions between teachers and administrators relies on relationship-building, which has been identified as an essential component of instructional coaching (e.g., Anderson et al., 2014). There have recently been calls for sociocultural approaches to science teacher PD that "create space where inquiry is looked at as socially constructed discourse" (Avraamidou, 2014, p. 162). Teacher inquiry within a supported team can create more meaningful science teaching PD opportunities with long-term results (Deneroff, 2016).

One of the few empirical studies of science coaching at the secondary level (Anderson et al., 2014) showed how science coaching is mediated by relationships and provided an interpretive framework. Anderson et al.'s (2014) study supports the broader body of coaching research, suggesting that coaching can improve teacher practice with sustained time and a narrow, consistent approach. Furthermore, the coach-teacher relationship was shown to mediate these positive effects on teaching. This study analyzed coaching relationships through the lens of relational trust (Bryk & Schneider, 2002), which describes four aspects of a trusting relationship: personal regard, respect, competence, and integrity. When viewed through this lens, coaches work as trust builders, continuing to foster their relationships with teachers even when they do not see the trust returned (Anderson et al., 2014).

Given the need to understand more about the role of science coaching as a form of PD, this study was designed to investigate the backgrounds, contexts, and professional roles of instructional coaches that work to support science teaching, as well as an understanding of what

coaches believe about effective science teaching, which may inform the content expertise they bring to this support of science teaching. In addition, of interest was how the goals of the instructional coaches and their perceptions of their administrators' goals define and characterize coaching enacted with science teachers. We need to know more about who becomes a science coach, how coaches work to improve science instruction, and the degree to which coaches' goals are congruent with those of the school's administration.

Research Questions

The following research questions guided this study:

1. What are the backgrounds and contexts of instructional coaches that work with science teachers?
2. How do instructional coaches support science teaching?
3. What are instructional coaches' beliefs about effective science teaching?
4. What are the goals of instructional coaches working with science teachers, and do they perceive these goals to align with their supervisors?

Methods

This study utilized a convergent parallel mixed-methods design (Creswell, 2014) in which quantitative data from the *Coaching for Science Survey* (Appendix A, developed for this study) was interpreted alongside qualitative data from the *Coaching for Science Interview* (Appendix B, developed for this study). The survey was designed document the coaches' backgrounds, contexts, and roles (RQs 1 and 2). The interview protocol explored a subsample of coaches' beliefs about science teaching (RQ 3) and goals and documented perceived tensions with supervisors (RQ 4).

Recruitment

A snowball method was used to recruit instructional coaches across the United States. Recruitment was targeted at "instructional and science coaches." A promotional flier with a link to the survey was distributed on social media, at science education and science education research conferences, and through direct email communication with the researcher's contacts. The survey's first question asked participants to indicate whether they coached only science teachers or science teachers and teachers of other disciplines. If the participant selected neither, they were exited from the survey. Since the study was focused on secondary science teachers, coaches who only worked with elementary school teachers were omitted. Upon completing the survey, participants were asked to participate in an optional interview. Fifty-nine participants completed the survey ($N = 59$). All volunteers were invited to participate in an interview ($n = 27$), and 21 interviews were completed ($n = 21$). After connecting survey data to interview data, the survey results and the interview transcripts were deidentified.

Participants

Based on their reported professional responsibilities, three categories of coaches emerged. Participants were categorized based on whom they coached (only science teachers or additional teachers) and their teaching background (experience teaching science or not). Coaches who only worked with science teachers and had a science teaching background were categorized as "*Science Coaches*" ($n = 20$). Those who indicated coaching science teachers and teachers of other disciplines were categorized as "general coaches." Those general coaches with a science teaching background were classified as "*General Coach - Science*" ($n = 32$), and those with teaching experience outside of science were categorized as "*General Coach - Non-Science*" ($n = 7$). Survey participant characteristics are described further below and can be seen in Table 1.

Table 1

Participant Coach Characteristics

Relevant Personal Characteristic	Science Coach		General Coach Science		General Coach Non-Science		Full Sample	
	n	%	*n*	%	*n*	%	*n*	%
Gender								
Woman	16	80	25	78	5	71	46	78
Man	4	20	5	16	2	29	11	19
Undisclosed	0	0	2	6	0	0	2	3
Race								
Black or African American	1	5	4	13	1	14	6	10
White	17	85	25	78	6	86	48	81
Hispanic, Latinx, or Spanish	1	5	0	0	0	0	1	2
Mixed	1	5	2	6	0	0	3	5
Region of the US								
Northeast	2	10	4	13	2	29	8	14
Midwest	1	5	1	3	0	0	2	3
South	14	70	22	69	4	57	40	68
West	3	15	4	13	1	14	8	14
Degree Level								
Bachelor of Science	11	55	15	47	1	14	27	46
Bachelor of Arts	2	10	7	22	4	57	13	22
Another Bachelor's Degree	0	0	1	3	0	0	1	2
Master's Degree	14	70	22	69	7	100	43	73
Doctoral Degree	3	15	10	31	1	14	14	24
Degree Area								
Science Education	13	65	15	47	0	0	28	47
Other Education Degree	5	25	16	50	5	71	26	44
Specific Science Discipline	12	60	14	44	0	0	26	44
Another Discipline degree	4	20	9	28	5	71	18	31
Previous Years Teaching								
0 to 5	0	0	2	6	0	0	2	3
6 to 10	8	40	8	25	4	57	20	34
More than 11	12	60	22	69	3	43	37	63
Years Coaching								
0 to 5	13	65	18	56	5	71	36	61
6 to 10	6	30	10	31	1	14	17	29
More than 11	1	5	4	13	1	14	6	10
Previous Subjects Taught								
Science	20	100	32	100	0	0	52	88
Mathematics	4	20	11	34	1	14	16	27
English and Language Arts (ELA)	1	5	6	19	3	43	10	17
Social Studies	3	15	9	28	2	29	14	24
Other	0	0	5	16	3	43	8	14

Note: $N = 59$, $n = 20$ for Science Coach, $n = 32$ for General Coach: Science, $n = 7$ for General Coach: Non-Science

Interview participants (Table 2) included eight *science coaches*, eight *general coaches - science*, and five *general coaches - nonscience*. The interview participants coached in districts across the US, though mainly in the south (n = 17, 81%). Nine (43%) participants had 10 or fewer years of experience teaching, with one coach having only 0 to 5 years of classroom experience before the coaching role. Many interviewees (n = 13, 62%) were new to their coaching role, and one coach had over 11 years of experience. Ninety-one percent (n = 19) of the interviewees were white, and 81% (n = 17) were women. The participants had backgrounds in teaching science, engineering, social studies, English, mathematics, and music.

Data Collection and Analysis

Coaching for Science Survey

Instrument. The *Coaching for Science Survey*, developed for this study, was created and distributed via Qualtrics software. First, participants indicated their educational history and current job description. Next, they were asked to indicate what activities were involved in their coaching job (Table 6). The questions for this item were adapted from Whitworth's (2017) study of district science coordinators. Additional items were added to reflect other possible activities a coach might undertake. Participants were then asked to indicate how they spend their time by indicating how many hours they work directly with science teachers on science instruction compared to general pedagogy or teaching skills. Coaches were asked, "Coaches often facilitate science-specific instruction & other times general instruction. Given that, on an average day, how much time do you spend working [*directly on science instruction* or *general pedagogy or teaching skills*] with a science teacher and/or group of science teachers?"

Table 2

Interview Participant Characteristics

Participant*	Subject Area Experience	Years Teaching	Years Coaching	Grade Levels	Job Site	Region	Sex	Race
Science Coach								
Andy	Science	6 to 10	0 to 5	High	District	S	M	W
Anne	Science	over 11	0 to 5	K-12	District	S	F	W
April	Science	6 to 10	0 to 5	K-12	District	S	F	B
Donna	Science	over 11	6 to 10	Middle	District	S	F	W
Holly	Science	over 11	0 to 5	High	School	S	F	W
Laurel	Science	0 to 5	0 to 5	K-8	School	NE	F	B
Megan	Science	over 11	6 to 10	Middle	School	S	F	W
Savannah	Science	6 to 10	0 to 5	K-8	School	NE	F	W
General Coach Science								
Ben	Science, Social Studies	over 11	0 to 5	Secondary	Program	S	M	W
Jaclyn	Science	over 11	6 to 10	K-8	School	S	F	W
Jennie	Science, Engineering	6 to 10	0 to 5	Secondary	Program	S	F	W
Josie	Science	6 to 10	6 to 10	K-12	District	S	F	W
Leslie	Science	over 11	0 to 5	High	School	W	F	W
Maggie	Science, Mathematics, English	over 11	6 to 10	K-12	Program	S	F	W
Marcia	Science	over 11	6 to 10	K-12	Program	S	F	W
Patty	Science	over 11	6 to 10	High	School	S	F	W
General Coach Non-Science								
Bryan	English, Social Studies	6 to 10	0 to 5	Middle	School	S	M	W
Chris	Music	over 11	over 11	K-12	District	NE	M	W
Colleen	Music	6 to 10	0 to 5	Secondary	Program	S	F	W
Katherine	English	over 11	0 to 5	High	School	S	F	W
Whitney	Social Studies	6 to 10	0 to 5	High	School	S	F	W

Note: Participant names are pseudonyms. For race, W refers to White, and B refers to Black. For sex, F refers to Female, and M refers to Male. Regions of the US reflect those defined by the US Census Bureau. *Laurel did not participate in the Teacher Beliefs Interview and is therefore excluded from results for RQ3.

Five survey questions were added to understand how coaches supported teacher use of different pedagogical tools. These items were adapted from questions on the NSSME+ (Banilower, 2019) survey by modifying the stems to add “helping science teachers…” and “how

often do you coach science teachers on their implementation of…" to the items as appropriate. The Likert scale for these questions included 1: Never, 2: Rarely (for example, a few times per year), 3: Sometimes (for example, once or twice a month), 4: Often (for example, once or twice a week), and 5: All or almost all the time.

Analysis. Data were imported to Stata for cleaning and quantitative analysis. Descriptive statistics, including frequencies and means, were collected. To determine the mismatch in grade-level licensure reported in Table 5, the reported grade levels of coached teachers were compared to each coach's reported grade level of licensure. Each coach's answer to the questions about time spent coaching science was compared to the time spent coaching general pedagogy (Table 7). Likert scores were averaged to determine a mean score for each science pedagogical tool; these means are reported in Table 8.

Coaching for Science Interview

Instrument: Participants were interviewed through the Zoom platform using the *Coaching for Science Interview* (Appendix B), developed for this study, and the Teacher Beliefs Interview, described further below (TBI, Luft & Roehrig, 2007). The *Coaching for Science Interview* was a semi-structured interview protocol that included questions about coaching activities, needs and challenges, goals, and motivation. Interview questions were reviewed for validity and clarity by a panel of stakeholders, including one current science coach and three science education researchers. In addition, the questions were piloted with a current science instructional coach for clarity and timing. The primary survey questions for analysis in this paper included: *What do you think is the most important part of your job?*; *What is your goal for your work?*; *What do you think is your supervisor's goal for your work?*; and *Do you feel any tensions between your goals and your supervisor's goals? If so, can you describe them?*

Analysis. Transcripts were open-coded (Strauss & Corbin, 1998). Two coders independently read 20% of the interview transcripts (n = 5) to identify codes and create a codebook (Table 3). Once the codebook was established, the coders re-read the five interviews to establish interrater reliability of 82%. The remainder of the interviews were coded by the primary researcher. The codes (Table 3) included: student factors, including student learning, practice, emotions, access (i.e., upper-level science course enrollment), and achievement; teacher factors, including general support, practice, PLCs, emotions, resources, and relationships; district factors; personal factors; and other administrative factors, including bureaucracy and school accountability.

Table 3

Goals Codebook

Category	Code	Example
Student	Learning	"My administration wants students to have authentic learning experiences."
	Student Practice	"Getting students to understand how to ask questions and how to find answers."
	Student Emotions	"I want students to look forward to my class every day. I want them to love science."
	Access	"As a team, our goal is to make sure every student in our district has access to high quality, culturally relevant science instruction."
	Achievement	"My administrative team is very concerned with test scores."
Teacher	General Support	"My goal is to support teachers to help them be their best in there."
	Teacher Practice	"My goal is to have conversations with teachers about how they're teaching, like how we can get kids to talk more to each other, or how we can get kids to write and read more."
	PLCs	"Our goal is to move towards a more data-driven PLC model where we're actually looking at data to see what the students are learning and then figuring out how we need to reteach it."
	Teacher Emotions	"I think it's for teachers to enjoy and feel successful at teaching."
	Resources	"My goal is to provide resources and to provide strategies."
	Relationships	"Building relationships with teachers in order to reach students."
Other	District	"My goal is to make sure our school is compliant with the district's expectations for PD."
	Personal	"My goal for next year is to be in classrooms more often."
	Other Administrative	"My boss likes us to look good, like when we brought in the robot program for the middle schools that got a lot of publicity."

Teacher Beliefs Interview

Instrument. The interview ended with the questions from the validated Teacher Beliefs Interview (TBI, Luft & Roehrig, 2007), which included seven semi-structured interview questions to elicit the participants' beliefs about science teaching. Luft and Roehrig (2007) determined the validity of the survey by conducting pilot studies with mathematics teachers, whose answers were unique enough to support the reliability of these questions. This instrument has been used to study the development of beliefs in pre-service teachers (Luft & Roehrig, 2007), newly hired teachers (e.g., Luft et al., 2011; Luft & Zhang, 2014), and teachers in PD programs (e.g., Blanchard et al., 2016). Since the participants in this interview were no longer teaching, they were asked to answer the questions based on their *prior* experience in the classroom. The TBI questions can be seen in Table 4.

Table 4

TBI Questions and Categories

Category	Question
Learning Questions	
Student and standards	"How do you decide what to teach and what not to teach?"
Environment	"How do you maximize student learning in your classroom?"
Learning	"How do your students learn science best?"
Student response	"How do you know when learning is occurring in your classroom?"
Knowledge Questions	
Student knowledge	"How do you describe your role as a teacher?"
Assessment	"How do you decide when to move on to a new topic in your classroom?"
Understanding	"How do you know when your students understand?"

Note 1: Categories taken from Fletcher and Luft (Fletcher & Luft, 2011).
Note 2: Interview questions from the Teacher Beliefs Interview (Luft & Roehrig, 2007, p. 43*)*

The coaches' answers to these questions were used to classify whether the coach had traditional, instructive, transitional, reflective, or reform-based beliefs about science teaching. On this scale, teacher beliefs become increasingly student-focused rather than teacher-focused as they move from traditional to reform-based beliefs. These beliefs are categorized into three

epistemological categories: teachers with traditional and instructive beliefs (see science as a rule or fact); those with transitional beliefs (see science as consistent, connected, and objective); and those with responsive or reform-based beliefs (see science as a dynamic structure in a social and cultural context) (Luft & Roehrig, 2007). Teachers who hold reform-based beliefs about science focus on students and center student understanding and knowledge of the world in their design and implementation of science instruction.

Analysis. Each response was coded according to a coding map that categorized coaches' responses as traditional, instructive, transitional, responsive, or reform-based (Luft & Roehrig, 2007, p. 57). Two coders met to read 25% of the interviews (n = 5) and categorized each answer according to the coding maps. After independent coding, there was 82% agreement. The coders then met to discuss discrepancies and agreed on the codes that differed. One researcher then coded the remainder of the interviews. Each category was given a number (traditional: 1, instructive: 2, transitional: 3, responsive: 4, and reform-based: 5), and these numbers were used to quantitatively compare the groups of coaches from the interview. The total score from all seven questions was summed. Total scores indicate whether a participant holds traditional (0 to 7), instructive (8 to 14), transitional (15 to 21), responsive (22 to 28), or reform-based (29 to 35) views about science teaching. A Kruskall-Wallis test was performed to compare the beliefs of the three sub-groups of coaches.

Limitations. The coaches in the study were all volunteers, and the extent to which their perspectives and responses represent the larger population of coaches is not known. Furthermore, the data were self-reported and may not accurately represent beliefs and experiences.

Results

RQ1: Coach Backgrounds and Contexts

Coach Backgrounds

A description of the participants in this study provides a picture of the characteristics and experiences of individuals who become coaches (Table 1). In alignment with U.S. teaching population demographics (U.S. Department of Education, 2020), most participants were White women (n=38, 65%). Many participants held advanced degrees, with most having completed a Master's degree (*n* = 43, 73%) and 24% (*n* = 14) having completed a Doctoral degree. In addition, the participants held degrees in science education (*n* = 28, 47%), other education areas (*n* = 26, 44%), and specific science disciplines (*n* = 26, 44%). One hundred percent (*n* = 59) of the coaches in this study were previous teachers. Some participants previously held leadership roles such as department chair, administrator, or scientist. Most participants had taught for over 11 years (*n* = 37, 63%), though roughly one-third only had 6 to 10 years of teaching experience before their coaching role. Surprisingly, two participants (3%) were in their first five years of teaching. Most participants were new to the coaching role; sixty-one percent (*n* = 36) were in their first five years as a coach. Roughly one-third (*n* = 7, 29%) of the participants had been coaching between 6 and 10 years. Only 10% (*n* = 6) of the coaches had more than 11 years of experience coaching. The coaches came from a broad range of content areas; subjects taught by these coaches included mathematics, English and language arts (ELA), social studies, music, academically and intellectually gifted (AIG), English as a second language (ESL), and career and technical education (CTE).

Table 5

Coaching Context

Contextual Factor	Science Coach		General Coach Science		General Coach Non-Science		Full Sample	
	n	%	*n*	%	*n*	%	*n*	%
Job Site								
School District	13	65	10	31	1	14	24	41
K-8 School	2	10	2	6	0	0	4	7
Middle School	2	10	4	13	3	43	9	15
High School	0	0	7	22	1	14	8	14
Secondary School (6-12)	2	10	3	9	2	29	7	12
Other	1	5	6	19	0	0	7	12
District Size								
Small	2	10	12	38	1	14	16	27
Medium	5	25	12	38	1	14	18	31
Large	13	65	8	25	4	57	25	42
Number of Teachers Coached								
1 to 10	8	40	15	47	5	71	28	47
10 to 30	3	15	9	28	1	14	13	22
30 to 50	3	15	4	13	0	0	7	12
Over 50	6	30	4	13	1	14	11	19
Grade Levels of Coached Teachers								
Elementary and Middle	6	30	8	25	0	0	14	24
Middle School Only	4	20	2	6	2	29	8	14
Middle and High School	4	20	8	25	2	29	14	24
High School Only	2	10	7	22	2	29	11	19
All Grades (K-12)	4	20	7	22	1	14	12	20
Mismatch in Grade-level Licensure*								
Mismatch	6	30	15	47	0	0	21	36
No Mismatch	14	70	17	53	7	100	38	64

Note: $N = 59$, $n = 20$ for Science Coach, $n = 32$ for General Coach: Science, $n = 7$ for General Coach: Non-Science * Reflects those whose licensure area does not match the grade level of the teachers they currently coach, i.e., a coach licensed to teach middle school is coaching high school teachers.

Coach Contexts

The participants in this study worked in various contexts, the aspects of which can be seen in Table 5. The highest proportion of participants worked at the district level ($n = 24$, 41%), while

the remainder worked on-site at various schools. Some coaches are listed in Table 5 as having worked at "other" sites (n = 7, 12%). These participants indicated that they worked for a program that contracts with districts but is not based in a school system. The participants coached in three sizes of schools: small (n = 16, 27%), medium (n = 18, 31%), and large (n = 25, 42%). Most coaches were responsible for coaching 30 or fewer teachers (n = 41, 69%). Most participants coached teachers in the grade level they were licensed, though 36% (n = 21) coached teachers outside their licensure level.

RQ2: The Coaching Role & Support of Science Teachers

Professional Responsibilities

Participants were asked to report which activities were involved in their coaching job. They were given a list of activities and selected all that applied to their job; activities were not mutually exclusive. The frequencies and percentages are reported in Table 6. Participants most frequently reported working one-on-one with science teachers (n = 54, 92%), modeling activities or instruction for science teachers (n = 54, 92%), working with groups of science teachers in PD (n = 53, 90%), and in PLCs (n = 50, 85%). Participants also frequently reported helping science teachers with curriculum pacing (n = 52, 88%). There was a large drop-off in the frequency with which participants reported working directly with students (e.g., teaching K-12 students [n = 25, 42%]; working with small groups of students [n = 22], 37%; and working 1-on-1 with students [n = 16, 27%]).

Some differences were noted between subgroups of coaches. Science coaches were more likely than the average group of coaches to report that their job involved working with science teachers in groups (i.e., PD) (n = 19, 95%), helping science teachers with curriculum pacing (n = 18, 90%), planning with a group of science teachers (i.e., in a PLC) (n = 19, 95%), co-teaching

with science teachers (n = 17, 85%), and curriculum design (n = 16, 80%). General coaches without a science background were more likely than the average coaches to report working with administrators (n = 6, 86%) and analyzing test score data to inform science teaching (n = 7, 100%).

Table 6

Coaching Professional Responsibilities

Professional Responsibilities	Science Coach		General Coach Science		General Coach Non-Science		Full Sample	
	n	%	*n*	%	*n*	%	*n*	%
Working with science teachers one-on-one*	18	90	5	71	31	97	54	92
Modeling activities or instruction for science teachers	17	85	6	86	31	97	54	92
Working with science teachers in groups (i.e., professional development)*	19	95	5	71	29	91	53	90
Helping science teachers with curriculum pacing	18	90	4	57	30	94	52	88
Leading a professional development session	16	80	5	71	31	97	52	88
Planning with a group of science teachers (i.e., in a professional learning team or community)	19	95	5	71	26	81	50	85
Working with administrators*	14	70	6	86	29	91	49	83
Co-teaching with science teachers*	17	85	4	57	26	81	47	80
Analyzing test score data to inform science teaching	13	65	7	100	26	81	46	78
Working with science teacher leaders	15	75	5	71	25	78	45	76
Curriculum design*	16	80	5	71	23	72	44	75
Receiving your own professional development	15	75	5	71	23	72	43	73
Teaching K-12 Students*	9	45	2	29	14	44	25	42
Working with small groups of students	7	35	2	29	13	41	22	37
Working 1-on-1 with students	5	25	2	29	9	28	16	27
Other	0	0	0	0	2	6	2	3

Note: N = 59, n = 20 for Science Coach, n = 32 for General Coach: Science, n = 7 for General Coach: Non-Science. Each professional responsibility was not mutually exclusive; participants selected each activity that described a professional responsibility they partake in. The numbers here indicate the most-to-least often selected responsibilities.

* Indicates items directly adapted from Whitworth et al. (2017)

Time Spent Coaching Science Versus General Pedagogy

Participants were asked how much time they spent coaching teachers directly on science instruction and how much time was spent focused on general pedagogy and teaching skills. The results are reported in Table 7. A Kruskal-Wallis equality-of-populations rank test [H(2) = 8.31, p = 0.02] was significant, indicating that the coaches spent their time differently depending on the type of coach. Most science coaches spent more time coaching science-specific pedagogy (*n* = 11, 55%), while most of the general coaches with (*n* = 17, 53%) and without (*n* = 6, 86%) science experience spent the same amount of time coaching both science and general pedagogy. None of the general coaches without a science background reported spending more time on science than pedagogy.

Table 7

Time Spent Coaching

Time	Science Coach		General Coach Science		General Coach Non-Science		Full Sample	
	n	%	*n*	%	*n*	%	*n*	%
More time coaching science	11	55	5	16	0	0	16	11
Same with both	7	35	17	53	6	86	30	7
More time coaching general pedagogy	2	10	10	31	1	14	13	2

Note: *N* = 59, *n* = 20 for Science Coach, *n* = 32 for General Coach: Science, *n* = 7 for General Coach: Non-Science

Table 8 shows how coaches spent their time on science-related activities, with higher numbers indicating a higher frequency. Participants reported often helping science teachers encourage student participation in science (*M* = 4.1). Helping science teachers use formative assessment, differentiate instruction, and encourage student interest were also functions of their role from twice a month to twice a week (*M* = 3.7).

Table 8

Coach Time Spent on Science-Related Activities

Activity	Science Coach		General Coach Science		General Coach Non-Science		Full Sample	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Helping science teachers encourage participation of all students in science	4.1	0.2	4.3	0.1	3.3	0.5	4.1	0.1
Helping science teachers use formative assessment to monitor student learning	3.8	0.2	3.8	0.2	3.3	0.4	3.7	0.1
Helping science teachers differentiate science instruction to meet the needs of diverse learners	3.7	0.2	4.0	0.1	2.6	0.3	3.7	0.1
Helping science teachers encourage students' interest in science	3.9	0.2	3.8	0.2	2.4	0.4	3.7	0.1
Helping science teachers develop students' abilities to do science (for example: develop scientific questions; design and conduct investigations; analyze data; develop models, explanations, and scientific arguments)	3.8	0.2	3.7	0.2	2.6	0.4	3.6	0.1
Helping science teachers develop students' conceptual understanding of the science ideas they teach	3.7	0.2	3.7	0.2	2.9	0.3	3.6	0.1
Helping science teachers provide science instruction that is based on students' ideas (whether completely correct or not) about the topics they teach	3.3	0.2	3.3	0.2	2.4	0.4	3.2	0.1
Helping science teachers incorporate students' cultural backgrounds into science instruction	3.4	0.2	3.3	0.2	2.0	0.2	3.2	0.1
Helping science teachers develop students' awareness of STEM careers	2.6	0.2	3.0	0.2	1.7	0.3	2.7	0.1

Note: $N = 59$, $n = 20$ for Science Coach, $n = 32$ for General Coach: Science, $n = 7$ for General Coach: Non-Science * Likert scale ranged from 1: Never, 2: Rarely (for example, a few times per year), 3: sometimes (for example, once or twice a month), 4: Often (for example, once or twice a week), and 5: All or almost all of the time.

Of note was coaches' support of differentiating science instruction to meet the needs of diverse learners: coaches in this study reported spending time either monthly or weekly ($M = 3.7$) helping teachers with this strategy. Coaches with science backgrounds reported spending *much*

more time on differentiation support ($M = 3.7$ for science coaches, $M = 4.0$ for general coaches - science) than general coaches without a science background ($M = 2.6$). The general coaches reported *less* time on every science-related activity than science coaches and general coaches with a science background.

RQ3: Coach Beliefs

A Kruskal-Wallis equality-of-populations rank test [H(2) = 0.55, $p = 0.77$] was not significant, indicating that the different types of coaches did not hold significantly different beliefs about science teaching. The total TBI score for all groups was in the responsive range: *Science Coaches* averaged 25.1, *General Coaches – Non-Science* averaged 24, and *General Coaches - Science* averaged 24.

Table 9

Beliefs by Coach Type

Category	Science Coach		General Coach Science		General Coach Non-Science		Full Sample	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Student and standards	5.0	0.0	4.3	1.4	4.4	0.9	4.55	1.0
Environment	3.7	1.0	3.6	0.7	3.8	0.8	3.7	0.8
Learning	3.4	0.8	3.4	0.5	3.2	0.8	3.35	0.7
Student response	3.1	0.7	3.5	0.8	3.4	0.5	3.35	0.7
Student knowledge	3.3	1.3	3.1	1.1	3.2	0.8	3.2	1.1
Assessment	2.9	1.3	2.9	1.2	3.6	0.9	3.05	1.2
Understanding	3.7	1.1	2.8	0.7	2.4	1.0	3	1.0

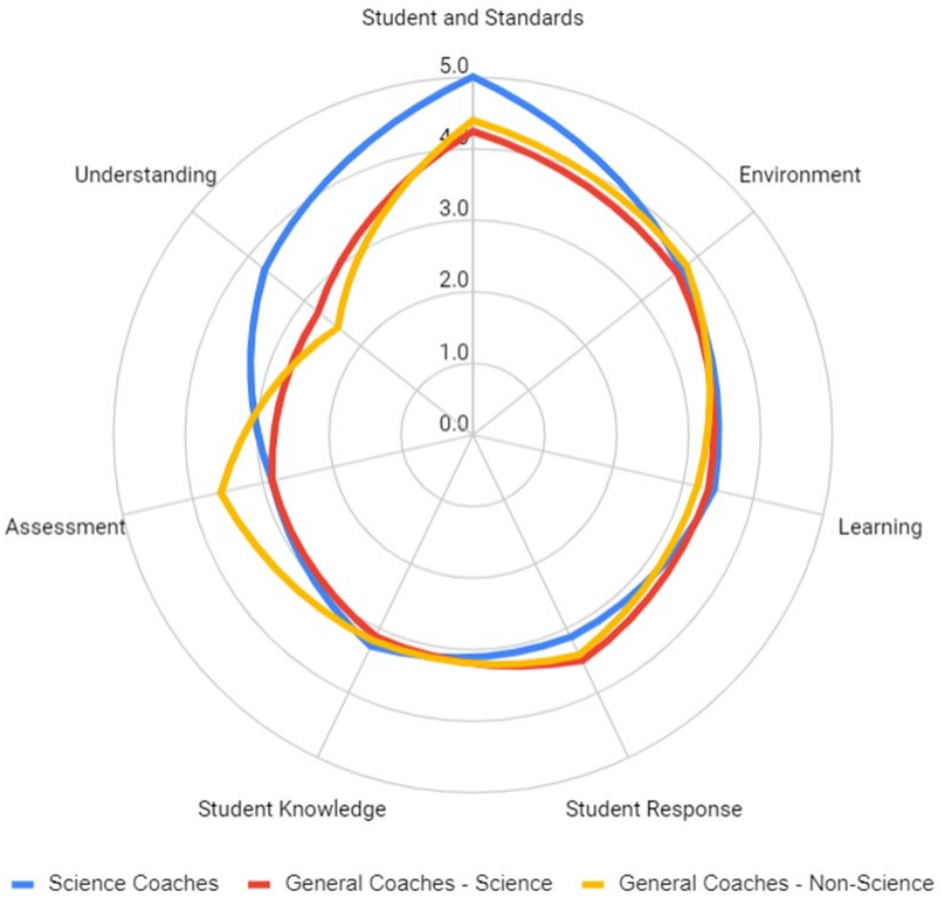
Note: $N = 20$, $n = 7$ for Science Coach, $n = 8$ for General Coach: Science, $n = 5$ for General Coach: Non-Science.
* Scale: 1 = Traditional, 2 = Instructive, 3 = Transitional, 4 = Responsive, 5 = Reform-based

Table 9 and Figure 2 show the results of the analyses for coaches' beliefs. The mean responses revealed that coaches generally held transitional to responsive beliefs about most areas of science teaching. The mean responses for the different categories of beliefs show that science coaches' beliefs about standards and understanding (how they decide what to teach and what not

to teach) were rated the most reform-based and that the general coaches' (without a science background) responses about assessment (how they decide when to move on to a new topic) were more reform-based than both other groups.

Figure 2

Beliefs by Coach Type



RQ4: Coach Goals and Tensions

While the survey results provided a broad overview of the activities that were involved in a coach's role, the semi-structured interviews provided a nuanced understanding of how those activities were prioritized. Interview participants were asked to indicate what they felt to be the most important part of their job and to reflect on their goal for their work.

Relationships

In the interviews, a new aspect of the coaches' work emerged: building relationships with and providing socio-emotional support for teachers. Participants saw themselves as advocates within the building, trusted friends, and someone on the teachers' support team. For example, Ben (*General Coach - Science*) stated that his job is about:

> Allowing teachers to really ask the questions that are making them feel like they're overwhelmed, making them feel like there's too much or like they're not effective at teaching. I think a lot of times we put that under that sort of emotional support [umbrella]- 'I'm here for you to ask all those questions.'

Five participants reported their role's non-evaluative nature as essential for this relationship-building. Marcia (*General Coach - Science*) reported that she was

> an advocate for teachers. Definitely part of my role as a coach, the beauty of it is that I'm not evaluating them. I'm not part of [that aspect], so I can become someone that they can lean on and whom they trust with talking about things that they probably would not be comfortable talking about with their [other] colleagues or their administration.

Donna (*Science Coach*) reported seeing herself as a safe space where teachers know she is "not evaluating them, not judging them, and not going to the principal." Not only did participants report that their coach role supported teachers as a safe space from school administration, but they also reported providing a sort of insulation from district-level bureaucracy. For example, Jaclyn, *General Coach* – Science, reported that she would 'try to insulate [teachers] from the stuff that comes down from central office that they really shouldn't have to worry about."

The coaches then used this foundational relationship to build teachers' practice. As Whitney (*General Coach - Non-Science*) stated,

> Often teachers are just looking for someone to bounce ideas off of - someone who knows what they're going through. They don't want one more box to check. They want someone to hear them out and help them understand a problem so they tackle it appropriately, not just check a box.

Several coaches reported supporting this change in practice through what they described as "servant leadership." For example, Maggie (*General Coach - Science*) described her role as "a servant leader. We're here to help teachers, not to tell them what they're doing wrong but to support them, help them, and bring them resources." This emerged in other participant interviews, like Savannah (*Science Coach*), who stated her vision:

> I just want to make sure teachers know that I'll take something off their plate so that their instruction is better and so that the kids can benefit. I think that's like the main thing I've been trying to build is [teachers knowing] 'I'll plan that field trip for you, here you go.' Then I send out an email that's like, 'Show up at this time and bring your kids in here, and I photocopied the activity for you.'

Coaching Goals

Participants were asked about their goals for their work, what they perceived their supervisor's goals to be for their work, and whether they felt a mismatch. Participants most frequently reported teacher-focused goals for themselves and their supervisors. Fifteen participants (71%) reported that one of their goals is to focus on teacher practice, including supporting teacher growth, improving practices and instruction, building teacher self-efficacy, encouraging data-driven instruction, and supporting curriculum fidelity. April (*Science Coach*) described this support: "There's no fancy equipment, no fancy curriculum that can replace the human capital. When you invest in people and get them trained on best practices to support

students, it builds teacher efficacy, and it helps with teacher retention." Participants more often included teacher factors in their list of goals (86%) than in their perception of their supervisor's goals (67%).

Only one coach (n = 1, 5%) reported their personal goal to be focused on student achievement. However, eight coaches (38%) reported their *supervisor's goal* was student achievement on standardized tests. Other student goals reported by coaches included helping students learn, supporting student emotions, and promoting equitable student access to upper-level science courses. This student support was reported as mediated through the support of teachers since none of the participants worked directly with students.

Other goals that emerged were personal goals for formalizing procedures for teacher support, for example, figuring out how to be in classrooms to observe teachers more often and how to scale their impact to many teachers, given the limited time available. Participants also reported other goals from their supervisors. Four coaches (19%) mentioned their supervisor's goal was appearances without follow-through. April (*Science Coach*) noted, "my supervisor wants us to look good, but I personally want us to *be* good. That takes a lot of work that may not be glamorous or high-profile." April described examples of "looking good" as her supervisor prioritizing programs like robotics that generated much favorable publicity.

Goal Tensions

April (*Science Coach*) was not the only coach to note tensions between her and her supervisor's goals. When asked whether they perceived tensions or misalignment between their goals and their perception of their supervisor's goals, 52% of coaches (n = 11) reported a conflict. Some coaches noted this misalignment in focus on student achievement. For example,

Katherine (*General Coach - Non-Science*) discussed how two people whose ultimate goal is student achievement differ in their more proximal goals:

> Increased student achievement is also my goal. That is what I believe I'm here for and what I believe all of us are here for. John Hattie says collective teacher advocacy is the number one factor in [increased] student achievement[1], so I see my role as building collective teacher advocacy. I think where we differ is that [my administrator] believes students come first. I believe teachers come first because I believe the way Richard Branson did. He always said, if my customers don't come first, my employees come first because if my employees are happy, then my customers are happy. And that's how I feel. If my teachers don't come first, if they don't feel supported, or if they don't feel appreciated, and they don't feel that sense of agency, then there won't be student achievement. It's going to impact the students in a negative way. The best thing we can do for our students is to make sure that we have strong teachers who feel supported.

Participants also noted tensions related to district bureaucracy, such as April (*Science Coach*), who felt her supervisors were more concerned with providing experiences that generated positive publicity. Another science coach, Laurel, reported other systemic barriers to student learning that she felt needed to be addressed, noting: "there are moments when we need to be disruptors to meet the goal, and people who are in positions of leadership and power want to stay in those positions, which means they have to 'play ball' to some degree" (Laurel, *Science Coach*). Laurel described feeling that her supervisors may prioritize keeping the status quo in

[1] (Hattie, 2008)

order to maintain their positions of power, which Laurel felt could get in the way of needed progress.

The other 48% (n = 10) of participants who reported no mismatch mentioned supportive and trusting administrators with many goal-setting meetings during which they could align their goals with their supervisors. Some who did not feel a mismatch noted subtle differences, such as Colleen (*General Coach - Non-Science*), who noted, "I don't feel like our goals are against each other. I am more patient in the process. [I believe] these experiences will lead to good test scores. Just give it time."

Discussion

RQ1: Background, Contexts, and Support for Science Teaching

The results from this study provide insight into the characteristics of coaches that work with science teachers. For this sample, science teachers with access to a coach may have had different experiences based on the coaching model employed in their school or district. Some science teachers were supported by Science Coaches - individuals with a science background whose job is focused on improving science teaching practice. This coaching model is similar to the few studies on science coaching (e.g., Anderson et al., 2014). The survey responses from the present study revealed that one type of coach supporting secondary science teachers was a General Coach whose role involved coaching teachers of many disciplines besides science. The fact that these general coaches work with science teachers despite their lack of personal science content expertise has implications for the depth of science support available to science teachers whose coach does not have a science background. Though coaching is an effective PD method to impact student achievement, the coaching models studied have mostly been content-specific (Kraft et al., 2018). One feature of effective coaching and PD is the focus on teaching specific

curriculum content (Darling-Hammond et al., 2009). Whether these general instructional coaches are prepared to enact content-specific support outside their content area is yet to be seen.

RQ2: Support of Science Teaching

Despite the different content focus of some categories of coaches, all of these coaches worked directly with teachers. They supported their enactment of science and general pedagogy by encouraging the participation of all students, supporting formative assessment and differentiation, helping teachers bolster student interest, and supporting teachers utilizing instructional strategies of having students working in small groups and doing hands-on or laboratory activities. The NSSME+ survey results indicated that lectures and discussions are pervasive in science instruction (Banilower et al., 2019). The finding that the coaches reported more time supporting teachers in implementing student-focused strategies shows promise for developing more reform-based, student-focused science teaching.

However, this study's results indicate that coaches with science backgrounds were better equipped to support the development of science-specific pedagogical skills. This support can be seen through their responsibilities: science coaches reported working with groups of science teachers in PD, helping with pacing and co-teaching, and designing science curricula. Individuals with science backgrounds may be more comfortable with this content-heavy support. This support can also be seen through how the coaches spent their time: science coaches reported spending more time on science-specific skills. General coaches reported doing fewer science-related activities and working more with the administration.

Additionally, the results presented here further illuminate areas where science coaches support science teachers with practices for which they do not feel prepared. The 2018 NSSME+ reported that 33% of middle school and 35% of high school science teachers did not feel

prepared to differentiate science instruction to meet the needs of diverse learners (Banilower et al., 2018, p. 37). Coaches in this study reported working on this strategy monthly or weekly, showing good support for science teachers' pedagogy. This study provided evidence that coaches, particularly those with a science background, filled an important gap in pedagogical support in much-needed areas. This data suggests that science coaches and general coaches with science backgrounds are best set up to support the work of science teachers in developing skills to teach science rather than general pedagogical skills.

RQ3: Beliefs

Though the coaches' reported job responsibilities indicate that they have the potential to meaningfully impact science instruction positively, their reported beliefs about science teaching indicate that they may not be able to fully support science teachers in enacting student-focused science instruction. The coaches in this study expressed transitional and responsive beliefs about science teaching (see Table 9), indicating that they may not be equipped to support teachers in pushing their instruction in a more student-centered direction. How the coaches' beliefs are enacted in their coaching is still unknown. One can speculate that the doubts and incomplete skills that some coaches may have for scientific practices get communicated to teachers with more teacher-centered or developing beliefs. The results presented here highlight the need for future research into how the beliefs of instructional coaches impact science teachers' practices and instruction-related beliefs. The evidence from this present study suggests that science coaches may need significant PD themselves if they are to support teachers in developing more student-focused instructional practices.

RQ4: Goals and tensions

The interview data provided nuance to the results from the survey by allowing coaches to situate their professional responsibilities within the larger goal of their work. During interviews, coaches did not name specific activities but focused on the importance of relationship-building in the development of teacher practice. This result supports research that suggests the importance of relationships in coaching (cited in Anderson et al., 2014).

The relationship-building and trust-building support described by the coaches can be conceptualized as a pyramid with coaches' work as focusing on relationships at the bottom before building up to changes in student learning at the top. The coaches indicated these relationships as an essential part of their work. The coaches in this present study described themselves as servant leaders whose work relied on the trust they could build by being supportive, non-evaluative figures in teachers' working lives. These results support research that coaches place value on individualized support (Mangin & Dunsmore, 2015) which is supported through trust-building bolstered by the fact that the coaches are in a non-evaluative role (Sam & Caliendo, 2018). Results here show that this goal did not always match what their supervisors might have in mind for their position. The coaches reported feeling that their supervisor's ultimate goal of student achievement was sometimes at odds with the daily goals, including creating safe spaces for positive relationships with teachers to form and support development and teacher learning. This study suggests that coaches are positioned to build positive school culture and that instructional coaches' relationship focus aligns with science education research about effective PD (Deneroff, 2016).

Implications and Future Research

Missing from this study was the perspective of teachers and administration. The tensions reported were only the coaches' perspectives of those tensions. In addition, while the coaches in this study stressed the importance of relationship-building, the complexities of how they build these relationships and how teachers respond to those relationship-building efforts are missing. Teacher resistance to instructional coaching has been documented in science teachers working with a literacy coach (Jacobs et al., 2018). However, it has not been well-documented for science or general pedagogical coaching. Case studies that combine an understanding of the entire coaching context and include the three different types of coaches that may interact with science teachers would provide a deeper understanding of how to best structure coaching supports for science teaching. For example, using activity systems to explore the complex contexts in which coaches do their work and the degree to which they can support a shift in the organizational culture of schools (e.g., Lofthouse et al., 2021; Sam & Caliendo, 2018). Results presented here show that individuals with science backgrounds may be better equipped to support effective science teaching. Instructional coaching programs in schools and districts are becoming established as everyday PD support for teachers. Further studies should investigate how to leverage the relationship-building power of coaches to support science education reform and improve science teaching in all schools.

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CHAPTER 3: MOTIVATION OF INSTRUCTIONAL COACHES: A SELF-DETERMINATION PERSPECTIVE

Abstract

Evidence shows that highly motivated teachers positively impact student motivation, school culture, and teacher job satisfaction. One strategy being adopted widely is the use of instructional coaches as a tool to motivate and support teachers. However, the instructional coach role is under-researched, and we know little about which individuals choose to coach and why. This study explored teacher motivation by examining the motivational changes of teachers who left the classroom but persevered within education and took on the role of instructional coach. Situated within a self-determination theoretical framework, the study included interviews and a storyline task documenting participants' past motivation for teaching. Twenty-one instructional coaches were interviewed about their professional motivation throughout their teaching career and as instructional coaches. Results indicated that school structure and culture were essential elements that contributed to the motivation of instructional coaches and that the coaching role satisfied the participants' needs related to competence, relatedness, and autonomy. Implications for the development of teacher leadership roles such as coaching are discussed.

Introduction

There is a growing teacher shortage in the United States (García & Weiss, 2019), and 46 percent of teachers leave the classroom within their first 5 years (Gray & Taie, 2015). This attrition leads to a workforce with less teacher expertise, which is "harmful to student achievement and may have a disruptive effect schoolwide" (Rinke & Mawhinney, 2017, p. 360). The high attrition rates seen in recent years argue for more research on factors contributing to teacher retention and strategies to develop new teacher leaders who can help combat the loss of expertise in the K-12 educational ecosystem.

When trying to create educational environments in which all individuals are thriving and students succeed, it is vital to support the psychological needs of teachers (Ryan & Deci, 2020). Teacher motivation is connected to student motivation (Roth et al., 2001), school culture (Han & Yin, 2016), and teacher job satisfaction (Nguyen et al., 2020). Various factors influence teachers' psychological well-being that may affect their decisions to leave the classroom (Bardach & Klassen, 2021). One primary motivational factor that has emerged is the importance of teacher autonomy; teachers feel more motivated when they control their day-to-day job duties (Han & Yin, 2016).

This exploratory study sought to gain insight into the motivational influences experienced by instructional coaches, who were all previously employed as teachers. While the instructional coaching role differs widely based on context, instructional coaches are typically non-supervisory content-based specialists embedded in schools and districts tasked with supporting reform-based teaching practices (Gallucci et al., 2010). The coaches' role typically includes cycles of classroom observations of teaching that include pre- and post-conferences with teachers (Gallucci et al., 2010). Since coaching has recently proliferated as a model of PD (Kraft et al.,

2018), the characteristics and motivations of instructional coaches are under-researched. Using qualitative methods of interviews and storylines (Beijaard et al., 1999), this study explored the different motivational factors that influenced teacher motivation through time and how the coaching role contributed to the motivation of educators. For teachers who may seek new professional challenges, coaching can be a viable career path for those teachers who want to continue as educators working with other teachers and students.

Literature Review

Theoretical Framework: Self-Determination Theory

This study is situated within a Self-Determination Theoretical (SDT) framework, which suggests that individuals (such as the teachers studied here) seek competence, relatedness, and autonomy to satisfy their basic psychological needs (Deci et al., 1991). Competence includes understanding how to attain goals and perform actions to reach goals and has roots in successful experiences in achieving goals (such as those that contribute to self-efficacy). Relatedness refers to developing interpersonal connections with others. The third component of SDT is autonomy, the progression toward being self-initiating and self-regulating. According to Deci et al. (1991), these components of self-determination are fundamentally innate needs that influence motivation, performance, and development. While not always grounded in SDT, studies about teacher motivation shed light on the factors related to autonomy, relatedness, and competence that influence teachers' motivation to teach.

Influence of Autonomy, Competence, and Relatedness on Teachers' Motivation

Autonomy. Autonomy can be further categorized as intrinsic or extrinsic motivation, conceptualized in SDT as a spectrum from amotivation to extrinsic motivation and, finally, to intrinsic motivation (Ryan & Deci, 2020). Intrinsic motivation is an internal interest in the

inherent satisfaction of the task, often associated with tasks like play and curiosity (Ryan & Deci, 2020). Extrinsic motivation is conceptualized in SDT with four subcategories, ranging from external regulation, where motivation comes from external rewards or punishments, to integration, in which an individual may be motivated by the value they see from an activity. When individuals become more intrinsically motivated or integrated, they increase their relative autonomy. In educational settings, "greater relative autonomy for learning (or teaching) predicts a variety of key educational outcomes" (Ryan & Deci, 2020, p. 3).

Researchers have demonstrated that individuals who experience autonomy also have higher motivation. At every level, an individual's autonomy can impact those in their circle of influence. For example, autonomous leadership styles contribute to autonomous teaching (Eyal & Roth, 2011), higher teacher autonomy leads to higher student autonomy (Roth et al., 2001), and student autonomy leads to higher achievement motivation and academic persistence (Bardach & Klassen, 2021; Tan et al., 2022). Autonomous motivation is also linked to a heightened sense of personal accomplishment and lower emotional exhaustion (Gorozidis & Papaioannou, 2014). In addition, "teachers with more classroom autonomy are less likely to switch schools, as they are more inclined to stay in schools where they have more independence" (Nguyen et al., 2020, p. 11). Therefore, higher autonomy is a crucial element of teacher retention and well-being.

Competence. There is also a clear relationship between self-efficacy and competence. Teacher self-efficacy is related to teacher effectiveness (Klassen & Tze, 2014), well-being (Bardach et al., 2022), practice (Thoonen et al., 2011), and intention to persevere in classroom contexts (Fives & Buehl, 2016). Thus, understanding self-reported competence, or self-efficacy, can inform programs that focus on teacher development.

Relatedness. Many teachers are drawn to the teaching profession because of their desire to build relationships with students (Spilt et al., 2011). Situations challenging these teacher-student relationships can cause teacher stress and negatively impact their well-being (Spilt et al., 2011). Furthermore, teachers' sense of belonging and job satisfaction is associated with positive relationships with colleagues and parents (Skaalvik & Skaalvik, 2011). More recently, social support was an important motivating influence for teachers during the COVID-19 pandemic when teachers' mental health and well-being declined (e.g., Kim et al., 2022; Klusmann et al., 2023).

Other Motivational Influences

Structure and Culture. School characteristics and external policy have been shown to contribute to teacher motivation and retention (e.g., Borman & Dowling, 2008; Nguyen et al., 2020). Furthermore, one component of educational structural and cultural influences is the administration. As noted by Ryan and Deci (2020), "the ways in which teachers and administrators are supported and motivated 'from above' affects their capacities to support and optimally motivate the students and teachers 'below' them" (p. 7). Teachers are often motivated by the sense that their administration trusts them (Thoonen et al., 2011). This type of trusting environment highly depends on principals' leadership styles, which have been shown to play a significant role in teachers' motivation and well-being (Eyal & Roth, 2011). Closely related to administrative support is the sense of school community. How teachers interact and cooperate with other teachers and whether they feel a part of participative decision-making within a climate of trust can contribute to teachers' motivation to learn and grow in their practice (Thoonen et al., 2011). School culture is a crucial factor that contributes to whether beginning teachers grow professionally and continue in the profession (Whitworth & Chiu, 2015). An emerging aspect of

school culture is the culture of accountability via standardized tests, which has been shown to lower teacher motivation and autonomy (Jones et al., 2003; Tye & O'Brien, 2002).

Burnout. Teacher workload has continued to increase in recent years (Ballet & Kelchtermans, 2009), leading to decreased teacher motivation (e.g., Rinke & Mawhinney, 2017; Toropova et al., 2021). Furthermore, in the difficult time of the COVID-19 pandemic, teachers reported feeling demotivated by the increased workload associated with the shift in their roles (e.g., Kim et al., 2022; Klusmann et al., 2023). This increased workload increases teachers' emotional stress and burnout (Madigan & Kim, 2021). Burnout is mitigated by self-efficacy and affiliation with colleagues (Bottiani et al., 2019), as well as higher job autonomy and supportive working environments (Yin et al., 2019). Because burnout may become more prevalent, educators need strategies to reduce burnout and the accompanying teacher attrition (Madigan & Kim, 2021) that often follows.

Teacher Leaders

Teachers' motivation is also influenced by limited opportunities for job advancement (Amitai & Houtte, 2022). In recent years, there has been a growing focus on strategies to develop new career pathways for teachers. For example, Luft et al. (2018) noted that "teachers also need the opportunity to grow professionally into new educational roles, such as master teachers, curriculum specialists, or even academics" (p. 64). Teacher careers are not linear, and their trajectories are often constructed "not in response to singular factors but through a complex designing process that integrates pushes and pulls from within as well as outside of education" (Rinke & Mawhinney, 2017, p. 371). This study investigated instructional coaching as a possible career for teachers. Understanding the motivations for individuals to become coaches can provide insight for new programs designed for teacher career advancement and for school

administrators who seek ways to support teachers' leadership development. A recent study investigating critical incidents in mathematics teachers' careers revealed that instructional coaching was an effective option for teachers to remain in the district (Hurst, 2022). The present study seeks insight into the motivations of instructional coaches working within schools and districts.

Research Questions

The following research questions guided this study:

1. How did the motivation of instructional coaches change throughout their teaching careers?
2. What motivated these instructional coaches to enter the coaching role?
3. How does working as a coach influence the motivation of instructional coaches?

Methods

The data presented in this study comprise interviews and storylines from twenty-one school- and district-based instructional coaches ($N = 20$) selected for the study based on their work with secondary science teachers. Participants were interviewed using the *Coaching for Science Interview* (developed for the study) as a part of a more extensive study of instructional coaches' roles, beliefs, and motivations. Here, the study focuses on career motivations that led teachers to enter coaching positions. The study also examined instructional coaches' motivation for their coaching work.

Participants

Recruitment was targeted at "Instructional and Science Coaches" via a promotional flier with a link to a survey distributed nationally via social media, at science education and science education research conferences, and through direct email communication with the researchers'

contacts. The recruitment utilized a snowball method where participants were asked to identify other potential coaches for the study. Demographic information and context for their jobs was collected in the recruitment form completed by volunteers. Participants indicated whether they coached only science teachers or science teachers and teachers of other disciplines. If the participant selected neither, they were not included in the study. Participants who only worked with elementary school teachers were omitted. Data from this study are drawn from the 21 completed interviews (n = 21). All coaches who volunteered for the study were interviewed.

Table 1

Interview Participant Characteristics

Participant*	Subject Area Experience	Years Teaching	Years Coaching	Grade Levels	Job Site	Region	Sex	Race
Andy	Science	6 to 10	0 to 5	High	District	S	M	W
Anne	Science	over 11	0 to 5	K-12	District	S	F	W
April	Science	6 to 10	0 to 5	K-12	District	S	F	B
Ben	Science, Social Studies	over 11	0 to 5	Secondary	Program	S	M	W
Bryan	English, Social Studies	6 to 10	0 to 5	Middle	School	S	M	W
Chris	Music	over 11	over 11	K-12	District	NE	M	W
Colleen	Music	6 to 10	0 to 5	Secondary	Program	S	F	W
Donna	Science	over 11	6 to 10	Middle	District	S	F	W
Holly	Science	over 11	0 to 5	High	School	S	F	W
Jaclyn	Science	over 11	6 to 10	K-8	School	S	F	W
Jennie	Science, Engineering	6 to 10	0 to 5	Secondary	Program	S	F	W
Josie	Science	6 to 10	6 to 10	K-12	District	S	F	W
Katherine	English	over 11	0 to 5	High	School	S	F	W
Laurel	Science	0 to 5	0 to 5	K-8	School	NE	F	B
Leslie	Science	over 11	0 to 5	High	School	W	F	W
Maggie	Science, Mathematics, English	over 11	6 to 10	K-12	Program	S	F	W
Marcia	Science	over 11	6 to 10	K-12	Program	S	F	W
Megan	Science	over 11	6 to 10	Middle	School	S	F	W
Patty	Science	over 11	6 to 10	High	School	S	F	W
Savannah	Science	6 to 10	0 to 5	K-8	School	NE	F	W
Whitney	Social Studies	6 to 10	0 to 5	High	School	S	F	W

Note 1: Participant names are pseudonyms.
Note 2: For race, W refers to White, and B refers to Black. For sex, F refers to Female, and M refers to Male.

Demographic and job information about the participants is shown in Table 1. Ninety-one percent (n = 19) of the interviewees were white, and 81% (n = 17) were women. The participants coached in districts across the US, though mainly in the south (n = 17, 81%). Nine (43%) participants had 10 or fewer years of experience teaching, with one coach having only 0 to 5 years of classroom experience before the coaching role. Most coaches (n = 13, 62%) were new to their coaching role, and one coach had over 11 years of experience. The coaches had backgrounds in teaching science, engineering, social studies, English, mathematics, and music.

Coaches worked in different contexts, including school-based coaches (n = 10, 48%), school district-based coaches (n = 6, 29%), or coaches that worked for an external program that partnered with school districts (n = 5, 24%). All the coaches in this study worked with secondary science teachers, though some also worked with elementary teachers in a K-12 (n = 6, 29%) or K-8 (n = 3, 14%) school setting.

Data Collection

Coaches' motivation and experiences were documented with the *Coaching for Science Interview* and storyline methodology (described below). Interviews were conducted via the Zoom platform, were recorded, and took approximately 45 minutes to complete. The interview protocol consisted of semi-structured questions and a storyline activity (described below) given midway through the interview process.

Interview Protocol

The semi-structured interview protocol (Appendix B) developed for this study included questions about coaching activities, needs and challenges, goals, beliefs, and motivation. Interview questions were reviewed for validity and clarity by a panel of stakeholders, including a current science coach and science education researchers. Further, the interview was piloted with

a current science coach for clarity and timing. Interview questions used for analysis in this study included: *Why did you decide to become a coach?,* and questions guided by SDT: *Do you feel competent as a coach?* (competence), *Do you feel connected to others in this role?* (relatedness), and *Can you discuss the autonomy you feel in this role compared to your teaching role?* (autonomy).

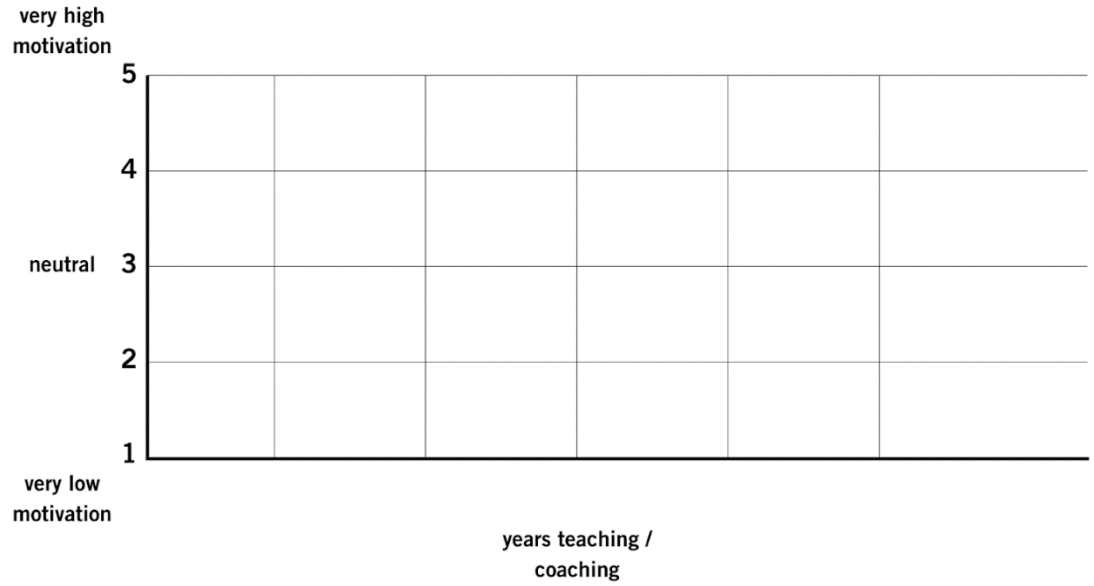
Story-Line Methodology

To capture participants' changes in motivation across time, participants were asked to create a storyline (Beijaard et al., 1999) that described their motivation throughout their education career, including their time teaching and coaching. Midway through the interview, participants were asked to think about relevant events in their teaching and coaching careers that pertained to their teaching- and coaching-related. The interviewer then defined the concept of motivation as "the desire or willingness to continue being a teacher." The participant and interviewer conferred to ensure that the participant fully understood the motivation construct. Next, the participating coach was sent a link to an encrypted software, Excalidraw™, on which a blank graph and axis were provided (see Figure 1). This software allowed the participant and interviewer to collaborate on an online whiteboard so that the coach could draw their storyline and the interviewer could add clarifying markers for discussion. Participants were asked to add years to the x-axis on the provided blank graph to reflect their teaching and coaching years. Since each participant came to the interview with different years of teaching experience, the interviewer did not provide the number of years on the graph. The participants were then asked to draw a line on a graph, starting with their most recent year of teaching and going back in time. The y-axis was a 5-point scale reflecting the participant's motivation: one is very negative, three

is neutral, and five is very positive. Finally, the participants were asked to describe notable high and low points and explain what impacted that motivation (See example in Figure 2).

Figure 1

Blank Graph on Which Storylines Were Drawn.



Storylines were prepared for analysis (described below) by compiling all image files and applying similar color and size formatting. All drawings represented in this paper reflect the exact drawing by the participant; no edits were made beyond changing the color and adding a star to indicate the beginning of the coaching role.

Analysis

The interview transcripts, including participant descriptions of their storyline drawings, were open-coded (Strauss & Corbin, 1998). Two coders independently read the transcripts to identify codes and create a codebook (Table 2). Once the codebook was established, the two

coders independently coded 20% of the interviews (n = 5) and reached 93% agreement. One researcher then coded the remainder of the interviews.

Table 2

Motivation Codes

Code	Description	Example
Autonomy*	Self-initiating and self-regulating within the teaching or coaching role.	"I'm able to make decisions that make sense, and I don't have to really run them by anyone."
Competence*	Feelings of self-efficacy or growth mindset.	"I'm always learning, I'm competent in the way I feel I am well-suited for the position but still have plenty to learn about content and coaching."
Relatedness*	Interpersonal connections with others.	"Building relationships with the staff is so important, and it makes me feel included in the community."
Personal	Related to intrinsic factors such as passion and vision, the chance to be a learner, career advancement, and leaving negative situations	"I love talking about the craft of teaching and thinking about it and helping teachers think about how we can get students to think more deeply about their work."
Administration	Related to the positive or negative influence of their school administration, like principals.	"I did not feel like administrators were making great choices about teaching and learning."
Structure and Culture	Professionalism, accountability, school culture, and structural supports like pay and the number of courses they were required to teach	"The lack of funding, the standardized tests, and respect of us as professionals has made it hard for us."
Burnout	Chronic workplace stress that leads to decreased motivation.	"I felt absolutely no motivation, and I was just trying to survive. I guess burnout is the only way I can describe it."
New Job	Taking on a new role within education by switching schools, taking on a more advanced role, or moving to a new location. (including, but not limited to, the coaching role)	"I got a new job so my motivation went super high really fast."
COVID-19	Description of motivation impacts due to the COVID-19 pandemic lockdowns that began in March 2020.	"When COVID-19 hit, it was horrible, and I think everybody wanted to leave."
Push**	Incidents that pushed teachers out of the classroom, motivating them to seek new jobs.	"I was in shock at how awful my time in the classroom was after COVID-19, and I needed a change."
Pull**	Incidents that drew teachers into the new role of coaching.	"If I can support this new teacher and spread my knowledge amongst the school, then I feel like that's a success."

Note 1: * Self-Determination Theory
Note 2: ** Rinke and Mawhinney 2017

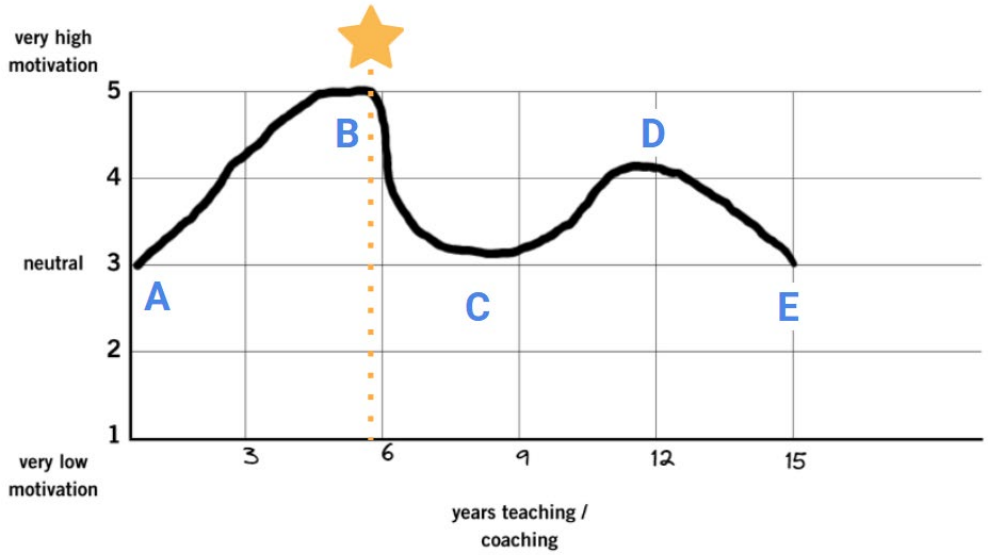
Description of codes. The codes listed in Table 2 are further described here. *Autonomy* was coded when participants autonomy in their teaching and coaching roles, comments made about adjusting to the new autonomy in the coaching role, establishing a work/life balance, and time flexibility. Participants discussed components of *competence* related to whether they felt they had the appropriate content expertise for the teachers they coached, comments about their job performance, learning new techniques for interpersonal leadership skills, and feelings of imposter syndrome. Their *relatedness* was coded for comments that referenced relationships within their school, with other coaches, teachers, and administration, and feelings of loneliness in their coaching role. *Personal* factors included comments related to coaches' passion and vision, enjoying the chance to be a learner, career advancement, and leaving negative work situations. Participants talked about positive and negative aspects of their connection to *administration* and *structural and cultural* aspects of their school job, such as professionalism, accountability, school culture, and structural supports like pay and the number of courses they were required to teach. Additional codes included *burnout, new job*, and *COVID-19*, all coded based on directly mentioning these words. The codes for *push* and *pull* related to how coaches felt *pushed* out of teaching, for example leaving due to bad working conditions, or *pulled* into the coaching role, for example seeking a leadership role to expand impact on teachers.

Coding the Storylines. In addition to the open coding of the transcripts, the storylines were analyzed with a frequency count of the number of times and reasons for the increases and decreases on each graph. Each coder analyzed five storylines using the established codebook to establish interrater reliability. The two coders reached 88% agreement on the five storylines; one researcher then coded the remainder.

An example of the coding process is given using Anne's storyline. Anne's storyline (see Figure 2) showed two decreases and two increases. The increase from point A to point B was coded as "relatedness" because Anne noted her motivation "steadily increased over those first few years through the interactions that I had with the people that I worked with." She started her coaching career in year six, then experienced a decrease in motivation between points B and C, coded as "competence," because she noted: "when I moved, I was like 'I know what I'm doing! I'm awesome!' And then it was like – 'Oh wait, I don't know what I'm doing. This is really hard." Then, an increase from points C to D was coded as "unknown," since Anne did not give a specific reason why her motivation increased in her interview – she said, "it got better." The decrease from points D to E was coded as "COVID-19" because Anne noted that she thought COVID-19 "affected all teachers and their desire to stay in the classroom and there was a lot of weighing the pros and the cons and how do I manage everything going on."

Figure 2

Anne's Storyline



Note: The star marks the point in the storyline where the participant became a coach.

Limitations. One of the limitations of the study was the small sample size. Though the participants' gender profile matches nationwide statistics, this study is limited by the few male participants. Furthermore, the coaches in the study were all volunteers, and the extent to which their perspectives and responses represent the views of most coaches across the US is unknown. Another limitation was the use of the term "coach" for recruitment. Individuals who work similarly with teachers may not always be called "coaches" and may have been missed when recruitment occurred. Finally, because each coach interviewed had different amounts of teaching experience, directly comparing motivation by years in the classroom was challenging. However, the storylines allowed for a broad examination of events and variables that influenced the rise and fall of motivation over time.

Results

The storylines, interviews, and survey results (described further in the sections below) revealed there were personal challenges, issues with school administration or working conditions, and a desire to expand their impact on teachers that impacted the participants' motivation throughout their careers that ultimately brought them into the instructional coaching role they held at the time of the interview. As described in the cases below, participants were either *pushed* out of their current role or *pulled* into coaching (Rinke & Mawhinney, 2017), at which point most coaches reported increasing motivation for the new position. Interview data revealed that since they became a coach, participants experienced enhanced perceptions of educational competence, relatedness to teachers and administrators, and work-related autonomy that contributed to their increased motivation. These findings are described below.

RQ 1: Increases and Decreases in Motivation

Analysis of the coaches' storylines revealed eight thematic patterns associated with decreasing or increasing motivation (see Table 3). Examples of motivational patterns are described in the sections that follow.

Table 3

Reasons for increases and decreases in motivation.

Code	Decreases		Increases	
	n	%	*n*	%
Structure & Culture	12	33	2	5
Admin	6	17	2	5
Covid	6	17	4	10
Competence	4	11	6	15
Burnout	3	8	0	0
Personal	2	6	1	2
New Job	2	6	16	39
Relatedness	1	3	6	15
Autonomy	0	0	4	10
Total	36	100	41	100

Note: There were 36 total increases and 41 total increases throughout participant storylines.

Decreases In Motivation

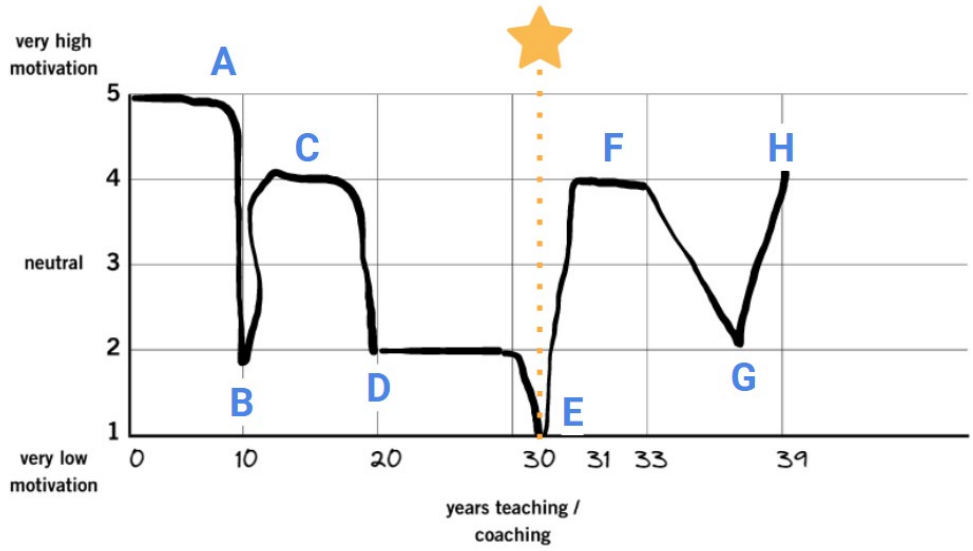
Structure and Culture. The most frequent reason coaches reported decreased motivation was the structure of the school environment and institutional culture at their school. Twelve of the reported motivational decreases (33%) reported by participants related to teacher pay, school culture, and school schedules that limited meeting time with other teachers. For example, Holly indicated that a pay cut when she moved to a different district and a lack of support for handling student misbehavior contributed to her reported decreased motivation. Patty, another coach, indicated her motivation decreased when she moved to work in a school where she was in charge of three grades and was told the administration planned to add four more grades for her to teach, effectively asking her to teach all science classes in grades six

through twelve, leaving her overwhelmed. When teaching, there were times when Patty reported she had to work as a "floater" without a dedicated classroom and was required to transport science materials to different classrooms throughout the day.

Another example of motivational changes due to the school structure and culture was reported by Donna (see Figure 3). Donna has served as an educator for 30 years as a teacher and 9 additional years working in schools as a mentor and coach. Donna described how her motivation decreased from points A to B, C to D, and D to E, primarily citing low pay. She referenced the many years when her state "froze" the pay scales for teachers, which meant she could not get a raise for her years of experience. She described feeling stressed, having difficulties with her administration, and that by the end of her years working as a classroom teacher, she "was just getting ready to get out. So those last years were just like - I'm going to clock in and clock out."

Figure 3

Donna's Storyline



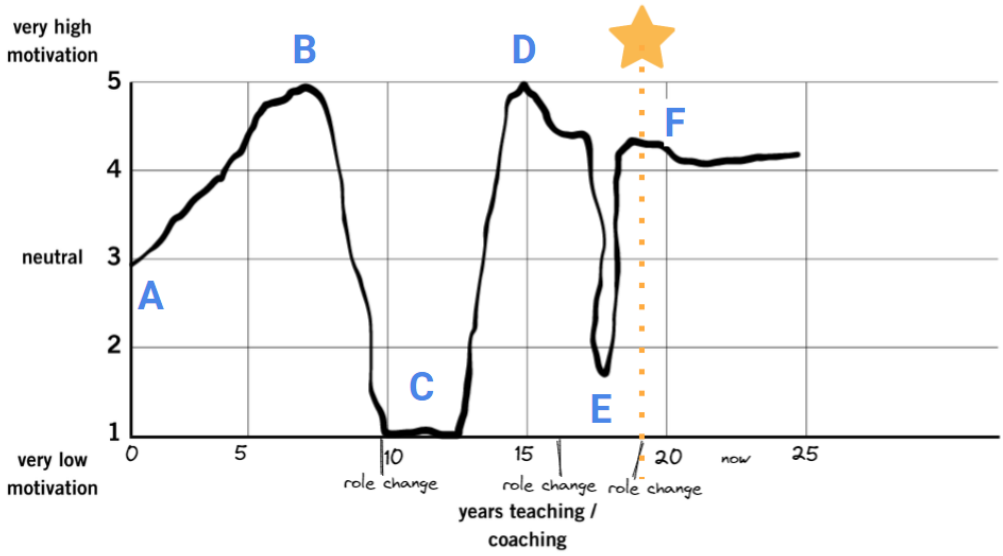
Note: The star marks the point in the storyline where the participant became a coach.

Administration. Other coaches reported feeling demotivated by issues with administrators at their schools. Five coaches (24%) credited motivational decreases to their school's administration, some citing adjustment issues when the administration changed, also noting that they did not thrive under the new leadership style. For example, Jennie talked about how the administration "tanked," which made her question "the state of where education was" because of the difficulties she saw in her classroom. Savannah was frustrated with an administrative staff who "told you everything you were doing wrong and never told you what you were doing right. They didn't want to help you succeed; you just had to sink or swim." This sink-or-swim leadership style led to a decrease in Savannah's motivation.

Ben (see Figure 4) was the only coach to credit more than one *decrease* in motivation to administration. His first *decrease* from points B to C, which he reported dropping from very high motivation to very low, was due to a new administration team that was "very 'gotcha,' very untrusting teachers to do what they needed to do, very much 'my way or the highway." Though this administration recognized him as a highly effective teacher, the focus on student achievement above relationships contrasted his first years of teaching that involved administration that gave him "a lot of trust and encouragement that really motivated me to learn more and kind of drive myself to be better." His second dip in motivation from points D to E was also due to an administrator he described as "very gotcha." Ben's interview revealed "gotcha" as his way of describing how the administration found ways to chastise teachers for not following the exact procedures put forth by the administrative team. For Ben and many other coaches, the administration defined their experiences in the school, and for these teachers, interactions with administrators resulted in extreme lows in motivation.

Figure 4

Ben's Storyline



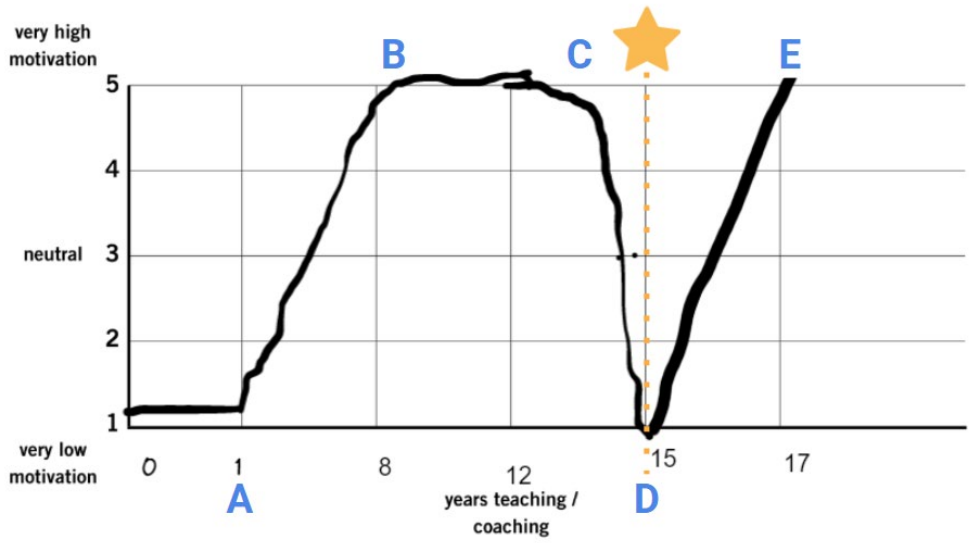
Note: The star marks the point in the storyline where the participant became a coach.

COVID-19. Many of the motivational *decreases* seen in the storylines of participants were attributed to factors related to the COVID-19 pandemic. Participants who were teachers during the pandemic reported feeling burnt out and stressed by the new workload. When COVID-19 lockdowns began in the US, those already in a coaching position reported feeling that although their job was challenging, they also acknowledged that it was not as bad for them as it was for the teachers they were coaching.

Katherine (see Figure 5) reported feeling mistreated as a teacher during the pandemic, noting, "we are not treating teachers right anymore in this country. Nobody should be treated this way if we want public education to succeed." The disrespect she felt caused her motivation to plummet from very high to very low (points C to D), and she reported considering leaving teaching altogether.

Figure 5

Katherine's Storyline



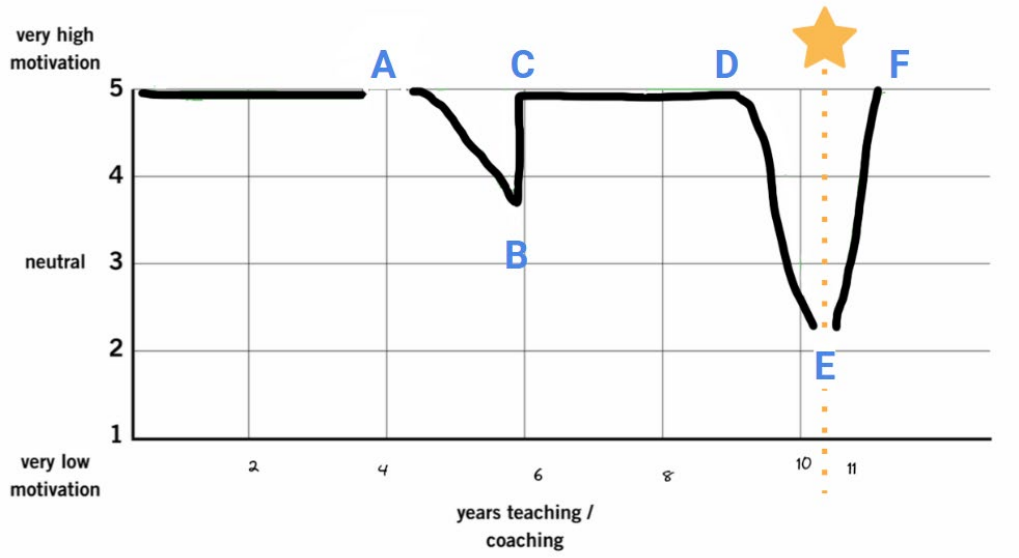
Note: The star marks the point in the storyline where the participant became a coach.

Increases in Motivation

New Role. Sixteen (39%) of the motivational *increases* reported by ten (48%) coaches coincided with taking on a new role within the school system. These new roles often included teaching at a new school but also involved entrance into the coaching role (discussed further below). As a result, coaches felt reinvigorated – their new job more closely aligned with their professional vision for teaching. For example, changing roles allowed Bryan (see Figure 6) to flourish after experiencing motivational decreases. (Note Bryan's reported increases from points B to C and E to F.) These new schools allowed him to apply his pedagogical knowledge in a unique setting and feel more competent in teaching. Coaches reported feeling invigorated, challenged, and respected in their new roles, leading to increased or reinvigorated motivation for education.

Figure 6

Bryan's Storyline

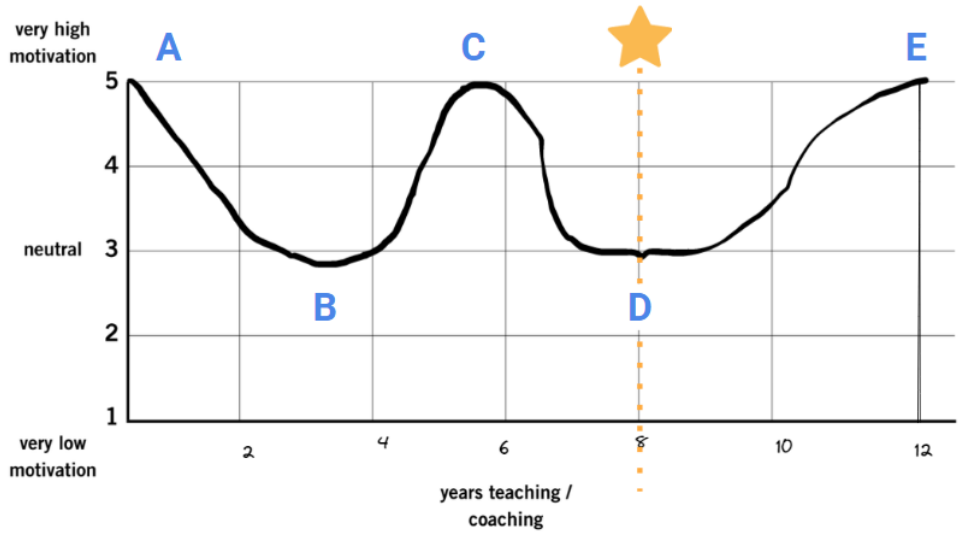


Note: The star marks the point in the storyline where the participant became a coach.

Competence. Six of the *increases* (15%) reported by five coaches (24%) had to do with slowly gaining competence in teaching or coaching. Given supportive environments, coaches felt they grew in their competence, making them more motivated to teach or coach. Leslie (see Figure 7), whose first *decrease* in motivation from points A to B was credited to a lack of competence in classroom management, began to experience an *increase* in motivation from points B to C as she began to gain competence in teaching and classroom management. She finished a master's degree and felt like she "figured out" her management skills and thus felt more motivated to teach.

Figure 7

Leslie's Storyline

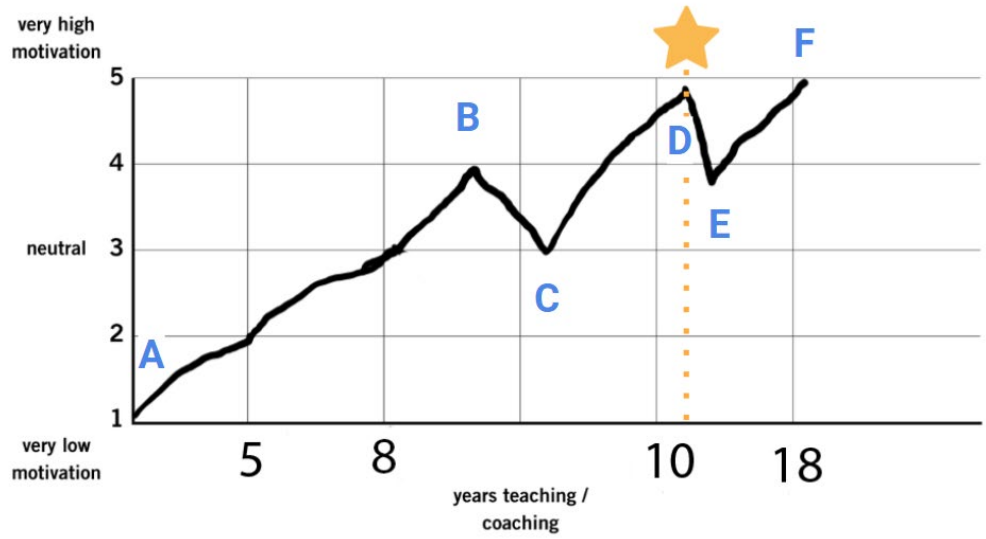


Note: The star marks the point in the storyline where the participant became a coach.

Marcia (see Figure 8) reported a relatively stable increase in her motivation throughout her years as a teacher and coach. Her motivation increased throughout her first years of teaching (points A to B) as she was given opportunities to be mentored and attended professional development, resulting in increased competence. After that, she experienced a *decrease* from points B to C due to being asked to teach a tested subject that was new to her. Still, she also reported being encouraged by her students' positive results on state assessment tests, so her motivation grew once more (points C to D). Her feelings of competence and being recognized by her coworkers and administration contributed to increased teaching motivation.

Figure 8

Marcia's Storyline



Note: The star marks the point in the storyline where the participant became a coach.

Relatedness. Many coaches noted motivation increases due to increased feelings of relatedness or connection to students or coworkers. Six (15%) of the *increases* reported across the storylines were credited to relatedness or feeling connected to students or coworkers. These coaches noted thriving in situations where they had a sense of community with other teachers.

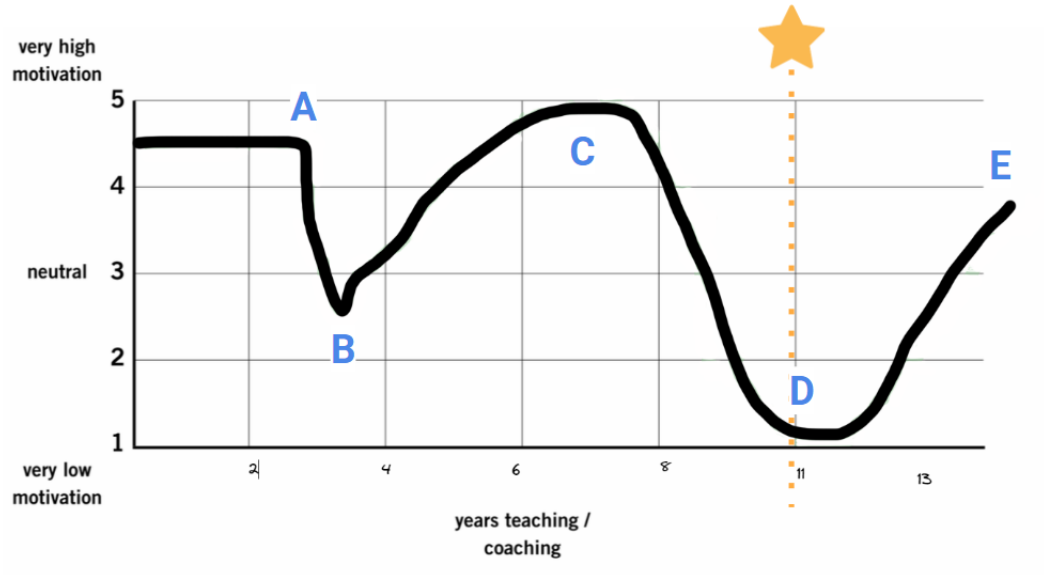
For example, Savannah (see Figure 9) reported a strong school culture associated with her *increases*. At her highest motivation point in years six through eight of her career (point C), she worked at a school that

> had a very strong culture, very warm, very welcoming. Everybody there was a whole mixture of age ranges and expertise, and everyone was a learner. I felt like I had so much learning to do, so it was very motivating to be around all the smart people all the time, and it made me want to be smart.

She reported having her coworkers' support and an instructional coach who worked with her to improve her teaching.

Figure 9

Savannah's Storyline



Note: The star marks the point in the storyline where the participant became a coach.

RQ2: Becoming a Coach: Push and Pull

Coaches reported many reasons for becoming a coach. However, these can be generally categorized as why they were pushed into the role, e.g., leaving a bad situation, or pulled into coaching, e.g., building on an already positive career.

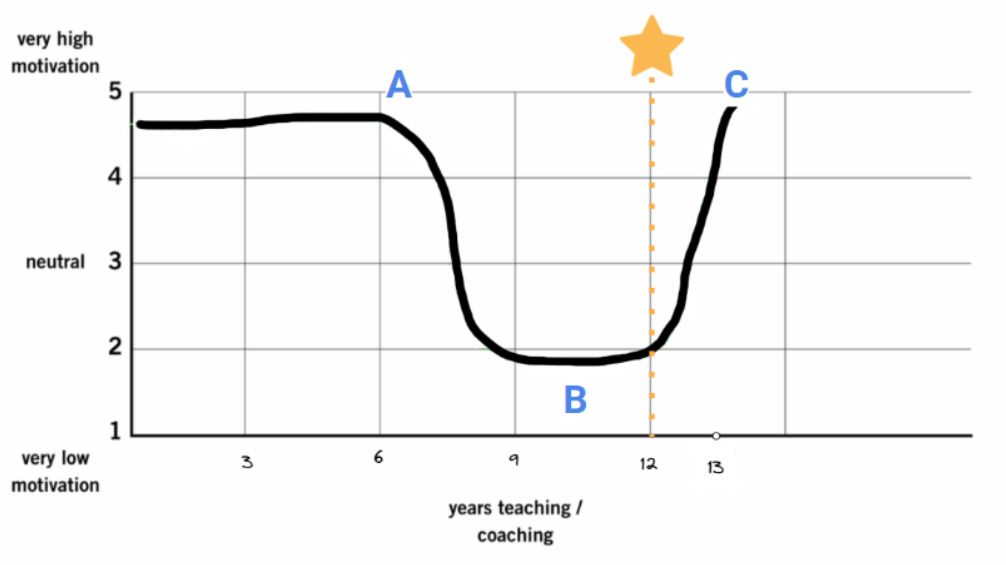
Push

Many coaches were *pushed* into the coaching role because they were leaving a difficult situation. For example, Holly (see Figure 10) entered coaching because she experienced two very different levels of motivation through her years of teaching and wanted to leave an unsupportive work environment at her most recent school. Her first school "had a very community feel," and she reported having "really strong district leadership that supported us as teachers." After

moving to a new district, she felt a lack of support and took a pay cut. She was frustrated with student behavior in her new school, and she felt this *pushed* her out of her work as a teacher in search of a new role that offered higher pay and a lower stress load.

Figure 10

Holly's Storyline

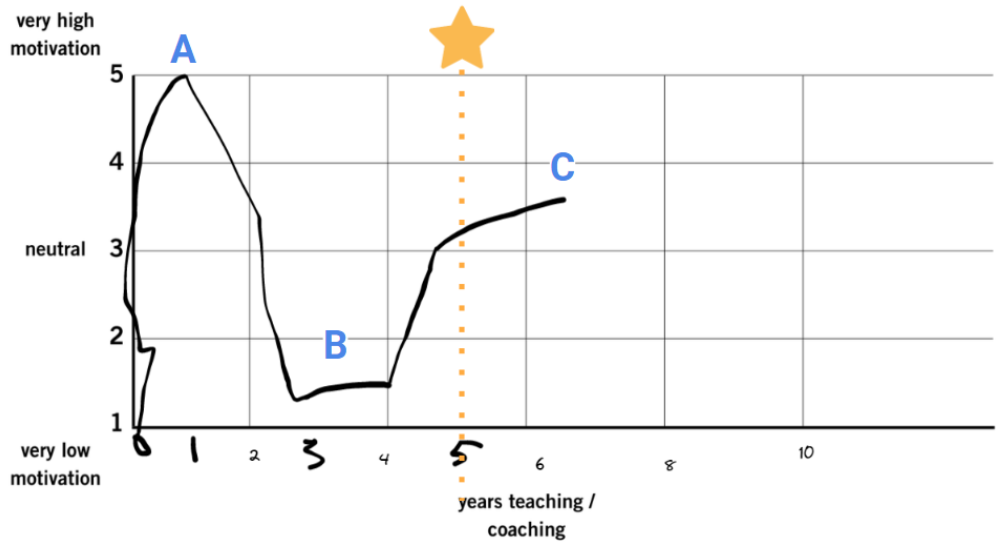


Note: The star marks the point in the storyline where the participant became a coach.

Laurel (see Figure 11) was another coach pushed out of teaching and into a coaching role due to burnout (point B). She reported that her teaching role at a charter school required 50-hour work weeks and a nonexistent work/life balance. As a result, she felt pushed out of the classroom into coaching to have a more sustainable workload.

Figure 11

Laurel's Storyline



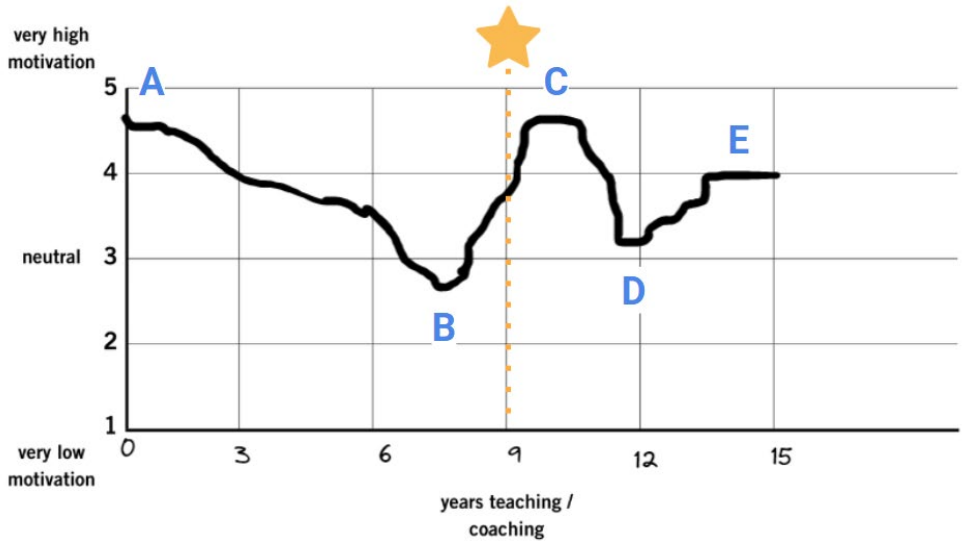
Note: The star indicates the point at which the participant became a coach.

Pull

Other coaches reported being pulled into the coaching role. Andy (see Figure 12) was recruited as a coach after participating in a leadership internship recommended by his superintendent. His students' achievements on standardized tests stood out to his administrative team, so he was allowed to shadow a science coach for another district. After completing his internship, this science coach offered him a coaching position. He reported feeling "cherry-picked" or *pulled* into the role.

Figure 12

Andy's Storyline

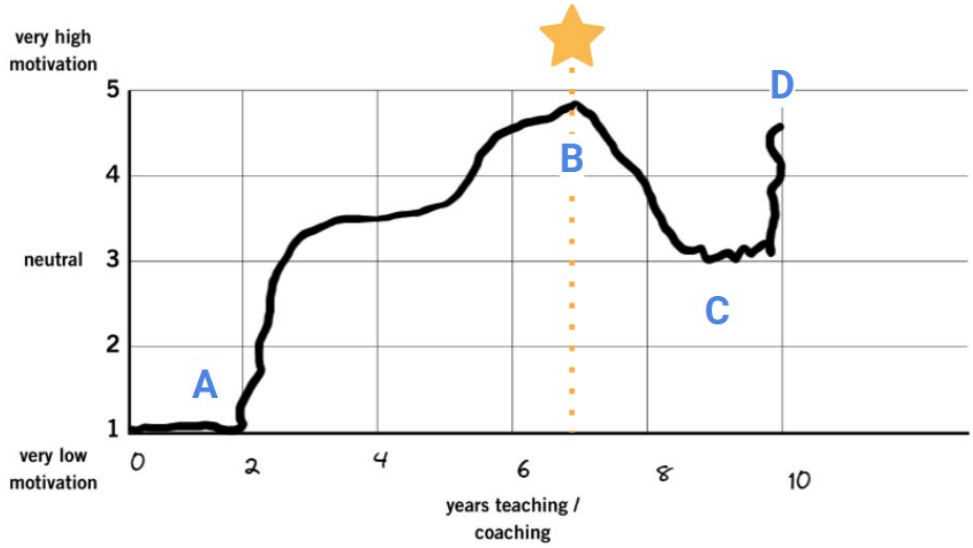


Note: The star marks the point in the storyline where the participant became a coach.

Many coaches like April (see Figure 13) were *pulled* into coaching by a desire to impact other teachers. April reported seeing herself in struggling young teachers. She noted, "when I had that struggle early on, it's like, gosh, if somebody had just pulled me to the side, maybe they could have saved me." For April, coaching was a way for her to help "keep teachers in the field and keep teachers feeling good about themselves as professionals." Participants were pulled into a role that sparked their passion and creativity and gave them a chance to be a learner. Participants reported being excited about the new challenge coaching provided that allowed them to learn about teaching and talk about the craft of teaching with teachers daily.

Figure 13

April's Storyline



Note: The star marks the point in the storyline where the participant became a coach.

RQ3: Motivation within the coaching role

To answer research question three, coaches' interviews and discussions of their storylines revealed that they experienced high motivation in the coaching role. Fifteen (71%) coaches reported higher motivation after becoming a coach. Many of the coaches noted that coaching reinvigorated their careers. The three (14%) coaches who reported decreased motivation after becoming a coach experienced a difficult transition out of the classroom.

Marcia, for example, reported experiencing a temporary "mourning period. I kind of mourned not being a teacher anymore." However, most coaches reported feeling very motivated after adjusting to the new role. Storyline analyses revealed that all but one coach (n = 20, 95%) had neutral to very high motivation when they were interviewed (and working as a coach). Insights into how the coaching role impacted their self-determination (competence, relatedness, and autonomy) are discussed below.

When viewed through a self-determination theoretical lens, a clearer picture of how aspects of the coaching role contributed to coaches' intrinsic motivation emerged. First, the coaches often reported feeling not as confident when coaching teachers outside of their content area, particularly for coaches who worked at the high school level and coached teachers in disciplines outside their expertise. Some coaches called this "imposter syndrome" and felt that they often wanted to second-guess themselves. For example, Ben noted that he suffered from imposter syndrome because if you ask if he feels competent, he will initially say:

> no, of course not. There are so many coaches that I work with on a daily basis that are so much better than me. I have my moments where I feel successful, but it's hard for me to say 'yeah, I'm totally competent.'

Many coaches reported feeling less competent with the aspects of coaching that differed from their role as a teacher, namely working with adults and interpersonal leadership skills. For example, Anne generally felt competent in her work except for "helping people identify where they need to improve. That was difficult for me, because I am not an assertive person. I don't like confrontation."

This lack of competence did not seem to cause a decrease in motivation. Instead, a focus on a growth mindset emerged as some coaches reported feeling there was always room to grow and commented that they felt comfortable growing within their coach position. For example, Colleen noted she was "afraid to ever feel competent, because I think you should always be refining your practice." Similarly, Holly expressed this growth mindset: "I feel like I'm always learning too. I'm competent in the way that I think I'm really well suited for this position, but I still have plenty to learn about content and about coaching."

Coaching, as described by the participants in this study, was heavily connected to their ability to foster positive relationships at their schools. These positive relationships were connected to their job responsibilities and fostered their own relatedness in their workspace, contributing to their high motivation. Many coaches indicated they felt connected to their teachers or administrative team. They thought they contributed to and benefited from strong relationships within their schools. For example, Patty reported feeling connected with "the other instructional coaches, our admin[istrative] team, the teachers, so I think we had a pretty good cohesive group at the school." Three coaches mentioned isolation or loneliness as a downside due to coaches' unique roles within a school or district. Those at a district level reported feeling geographic isolation or being outsiders when entering teachers' classrooms. Maggie, a recently retired coach, reported feeling sad that her retirement looked different as a coach than it would have as a teacher. "There was no party. I had no family." Some coaches reported seeking community on social media to combat this isolation or loneliness. For those coaches that were part of a small group of coaches, whether in a professional learning community (PLC) or whose school or district had multiple coaches at the site, this sense of community was noted as important to their feelings of relatedness and increased motivation.

Autonomy was the most frequently reported influential factor in the motivation of the coaches in their current role. Eighteen (86%) of the coaches described the autonomy in their current role positively. Many coaches said they had more autonomy in their coaching role than they did as a teacher, though many reported that their teaching role did afford them some autonomy. In their current roles, many coaches had to figure out the boundaries of their autonomy within their roles. For example, Chris noted that "I can do whatever I need to get the

job done, but I still have a box, I still have rules." This idea of a "box" within which the coaches had to navigate their role also appeared in Whitney's discussion of autonomy. She noted that

> When I was a teacher, I felt like I had autonomy within my class, but there were, it was a box, as long as everything I did fit within this box, I was good to go. And now, in this role, I see that the box is much bigger than I thought it was.

The coaches reported that the autonomy of choosing how to delegate their time allowed for a more sustainable stress load. Some coaches reported escaping the "toxic productivity" they experienced in their classrooms when they were teachers, in which their school's culture favored an approach to the work that led to burnout. While most examples of autonomy led to increases in motivation, coaches reported feeling constrained in their autonomy when their supervisors or administration micromanaged them. The coaches, who were not in charge of students anymore, also felt helpless. As a coach could see students' mental health issues or deeper structural issues for which they felt powerless to change. However, the coaches also reported feeling the coach role offered flexibility which led to positive motivation.

Discussion

The storyline methodology utilized in this study provided insight into the factors contributing to increases and decreases in motivation throughout an educator's career. The individual details provided context for why teachers may feel motivated to leave education altogether and described environments that supported their retention. The main reasons these coaches experienced motivational decreases align with previous studies of educators' motivation; school culture is critical in teachers' decisions to continue in the profession (Whitworth & Chiu, 2015). Furthermore, these results related to school culture are congruent with other studies that have reported that school culture is critical in teachers' decisions to continue in the profession

(Whitworth & Chiu, 2015). In addition, the results presented here explain how the school culture met or frustrated their needs for competence, relatedness, and autonomy (Ryan & Deci, 2020).

The results presented here also reinforce findings that school administrators influence teachers' decisions to leave the profession. Coaches specifically noted problems with administration, indicating that they perceived administration as an additional constraining factor on their motivation. The evidence presented here supports the growing body of research investigating the negative impacts of COVID-19 on teacher motivation (e.g., Kim et al., 2022; Klusmann et al., 2023). Those who were already coaches during the COVID-19 shutdown did not report as many negative impacts on their motivation as the coaches from this study who were still teaching in 2020, further outlining how difficult the pandemic was for teachers working directly with students.

The importance of moving as teachers to other positions or from teaching into new roles as coaches, growing competence, and expanded perceptions of relatedness emerged as factors that helped these coaches stay in their careers and cope with burnout. These results support other motivational research highlighting the importance of relationships and school culture (Han & Yin, 2016). In addition, the coaching role heavily relies on relationship-building (e.g., Anderson et al., 2014), so it makes sense that this contributed to motivational increases throughout their careers and participants' high motivation within the coaching role.

While these participants may be technically categorized as teacher "leavers" (Nguyen et al., 2020), they left the teaching profession to enter a role that works directly with teachers on pedagogical practice (Gallucci et al., 2010). Thus, this research expands our understanding beyond the perspective of those who leave education altogether, which is often the focus of research related to teacher retention (Nguyen et al., 2020). Teachers who became coaches could

move on from the stressful situations that pushed them out of the classroom into a role where they felt they could directly support teachers, continue learning about teaching, and positively impact students. Coaching provided a career opportunity for these participants that satisfied their need for career advancement while also developing strong teacher leadership, a crucial aspect in teacher retention (Nguyen et al., 2020).

Results indicated that the coaching role positively influenced the psychological needs for competence, relatedness, and, most importantly, autonomy. The participants in this study reported that their coaching role's autonomy was highly influential on their satisfaction and motivation. Findings from this study underscore the importance of autonomy in career satisfaction for teacher leaders (Han & Yin, 2016). For these teachers, the opportunity to lead other teachers supported their interest in education and kept them from leaving education altogether. The development of teacher leaders is crucial to strengthening K-12 education. Evidence showed that allowing teachers access to coaching positions increased the likelihood that these educators remained in schools supporting instructional improvement.

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CHAPTER 4: CONCLUSION

Instructional coaching is an essential form of professional development (PD) increasingly being provided to science teachers in their schools or districts. The studies in this dissertation build on our understanding of instructional coaches' roles, goals, beliefs, and motivations. Major themes seen across the two articles deepen our knowledge of the support that instructional coaches provide to teachers and give insight into future research and ways to leverage instructional coaching to support the development of teachers' instructional practices.

First, this study added to our understanding of instructional coaches. The results showed that three types of coaches with varying levels of science teaching expertise provide coaching support for science teachers. Research on content-based support via mentoring (e.g., Barnett & Friedrichsen, 2015) or peer coaching (e.g., Pearce et al., 2019) assumes a level of content expertise on the part of the mentor that may not be present in instructional coaches. Coaches in this study with a science background reported spending more time supporting science teachers with science-specific practices (Study 1). Furthermore, there was evidence that science coaches had more reform-based beliefs about science teaching than general coaches without a science background (Study 1). Though a study of how the coaches impacted teachers' instructional practices was outside the scope of this research, it can be speculated that the content expertise of science coaches is an essential component in science teacher professional development. Results presented here add to our understanding of how school-based PD in the form of instructional coaches can support teacher use of reform-based practices (Park et al., 2022) and highlight areas of research, such as more deeply understanding the support available to science teachers via instructional coaching.

Next, this study built on our understanding of the importance of relationship-building (Anderson et al., 2014) and how coaches may be able to act as more competent peers to support teacher learning (Shabani et al., 2010). Study 2 further highlighted how relationships and a strong school culture helped support the participants' motivation. An investigation of how coach-to-teacher relationships can support change in teachers' instructional practices was outside the scope of this research. However, it can be speculated that coaches can build on this relational support to create meaningful change and support the development of science teachers' practices and beliefs.

It has been suggested that the coaching relationship involves coaches articulating curricular reform goals to teachers, understanding differences and similarities between programs and initiatives, and motivating individuals and teams in a particular direction (Woulfin, 2018). However, the question of whose reform they are communicating is essential. Coaches in this study reported that their relationship-building goals conflicted with their perception of their administrators' goals, which were primarily focused on student achievement. Study 1 examined the goal of enhancing science teacher practice by supporting their use of reform-based practices. Science is not typically the focus of district reforms or organizational goals since accountability measures for science generally are less emphasized than those for reading and mathematics (Allen & Heredia, 2020). Therefore, coaches report being caught in the middle of conflicting priorities influencing their coaching practice.

Teachers have been shown to feel this type of goal tension within their school or district context; "even teachers with student-centered beliefs may have more difficulty consistently enacting those beliefs, maybe due to cultural norms or contextual influences beyond their control" (Fives & Buehl, 2016, p. 116). In addition, teachers often hear conflicting things from

their supervisors, and those supervisors' vision "can shape teachers' perceptions of and decisions about what of reform to focus on or implement" (Allen & Heredia, 2020, p. 7). Teachers and coaches must address these conflicting goals for science education when deciding how to implement new practices (Allen & Penuel, 2015). Results presented here highlight the need to communicate goals to coaches clearly, and for administrators to consistently check in with the coach to align their goals for their work. These results also highlight the importance for science educators to continue articulating goals for effective science teaching and support school leadership staff, such as instructional coaches, in implementing this reform within the complicated context of district reforms (Woulfin, 2018).

Finally, this study clarified what motivates individuals to move out of the classroom and into coaching and provides insight into an additional career pathway or trajectory for science teachers seeking career advancement (Luft et al., 2018). Results from Study 1 indicate that coaches see themselves as building up a strong school culture, which they reported (Study 2) as vital to their increased motivation. Instructional coaching is a role that can satisfy the psychological needs for competence, recognition, and autonomy and support the well-being and retention of effective educators.

The results presented here have implications for using science instructional coaching as a form of effective professional development (Desimone & Pak, 2017) that can strategically support the development of science teachers' practice. First, this study can support district and school leaders' efforts to develop coaches by showing that they can create a science coaching role that supports current science teacher development and promotes the retention of science educators in their district. Next, this research can support the science education community by highlighting the need to directly support the development of instructional coaches' beliefs about

science teaching so that they may be used to scale the support of effective science teaching practices to more teachers. Next, this study can inform science educators working to scale their efforts to reform science instructional practices. Coaches are embedded in schools and may be able to provide direct, sustained PD to teachers to help improve their practice. The evidence suggests that coaches may need science PD to fully understand science education reforms before supporting science teachers in their development. Instructional coaching is becoming more prevalent in schools. Using coaching as a tool to support science teaching may not only support student achievement but can also improve working conditions and promote the retention of excellent science educators.

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APPENDICES

Appendix A

The Coaching for Science Survey

Start of Block: Intro

Q1 We are interested in understanding more about the responsibilities, beliefs, and career motivations of individuals who are currently working as science or instructional coaches in a secondary setting. We need to hear from coaches like you to help us understand this new and interesting role in K-12 education. The information we learn from this study can help us shape policy and support practices for coaches.

Once you complete the survey, you can be entered into a drawing for one of five $25 gift cards. Thank you so much for partnering with us to make a difference for the future of science education!

End of Block: Intro

Start of Block: Consent

Q2
Consent Form
[NCSU eIRB consent form]
Consent to participate By electronically signing this consent form, I am affirming that I have read and understand the above information. All of the questions that I had about this research have been answered. I have chosen to participate in this study with the understanding that I may stop participating at any time without penalty or loss of benefits to which I am otherwise entitled. I am aware that I may revoke my consent at any time.

- ○ Yes, I want to be in this research study.
- ○ No, I do not want to be in this research study.

Skip To: End of Survey If Consent FormTitle of Study: Science Coaches: Context, Characteristics, Community (eIRB # 25021)P... = No, I do not want to be in this research study.

End of Block: Consent

Start of Block: Role Description

Q3 What is your job title?

_____

Q4 Which of the following describes the scope of your coaching role?

- ○ I only coach science teachers
- ○ I coach science teachers along with teachers of other disciplines
- ○ I do not coach science teachers

Display This Question:

If Which of the following describes the scope of your coaching role? = I do not coach science teachers

Q5 Thank you for participating, but this survey is intended for individuals whose jobs involve coaching science teachers.

Skip To: End of Survey If Thank you for participating, but this survey is intended for individuals whose jobs involve coach... Is Displayed

Q6 What grade level of teachers are you primarily responsible for?

- ☐ K-5
- ☐ 6-8
- ☐ 9-12
- ☐ Other _____

Q7 What was/were your role(s) prior to coaching?

_____

Q8 Were you previously a teacher?

- ○ Yes
- ○ No

Skip To: Q12 If Were you previously a teacher? = No

Q9 For what grade band(s) are/were you licensed?

- ☐ Elementary (grades K-5)
- ☐ Middle School (grades 6-8)
- ☐ High School (grades 9-12)
- ☐ None of these

Q10 What subjects did you teach?

- ☐ Science
- ☐ Math
- ☐ English or Language Arts
- ☐ Social Studies or History
- ☐ Other _____

Q11 How many years did you spend as a teacher?

- ○ 0 to 5
- ○ 6 to 10
- ○ more than 11

Q12 How many years have you spent as a coach?

- ○ 0 to 5
- ○ 6 to 10
- ○ more than 11

Q13 In which is your coaching job primarily based?

- ○ A school district
- ○ A middle (6-8) school
- ○ A high (9-12) school
- ○ A secondary (6-12) school
- ○ Other _____

Q14 How would you describe the size of the district you work for?

- ○ Small District
- ○ Medium District
- ○ Large District

Q15 Approximately how many total science teachers do you support with coaching?

- ○ 1 to 10
- ○ 10 to 30
- ○ 30 to 50
- ○ over 50

Q16 What is your direct supervisor's title?

- ☐ School Administrator
- ☐ District Specialist
- ☐ Other _____

End of Block: Role Description

Start of Block: Coaching Activities

Q17 Which of the following activities are involved in your job as a coach? (select all that apply) (Some items taken from Whitworth (2017))

- [ ] Teaching K-12 students
- [ ] Working 1-on-1 with students
- [ ] Working with small groups of students
- [ ] Working 1-on-1 with science teachers
- [ ] Modeling activities or instruction for science teachers
- [ ] Co-teaching with science teachers
- [ ] Working with science teachers one-on-one
- [ ] Working with science teachers in groups (i.e. professional development)
- [ ] Planning with a group of science teachers (i.e. in a professional learning team or community)
- [ ] Working with science teacher leaders
- [ ] Working with administrators
- [ ] Curriculum design
- [ ] Helping science teachers with curriculum pacing
- [ ] Leading a professional development session
- [ ] Analyzing test score data to inform science teaching
- [ ] Receiving your own professional development

☐ Other _____

Q18 Coaches often facilitate science-specific instruction & other times general instruction. Given that, on an average day, how much time you spend working ***directly on science instruction*** with a science teacher and/or group of science teachers?

- ○ 0 to 1 hour
- ○ 1 to 2 hours
- ○ 2 to 3 hours
- ○ 3 to 4 hours
- ○ over 5 hours

Q19 Coaches often facilitate science-specific instruction & other times general instruction. Given that, on an average day, how much time you spend working on ***general pedagogy or teaching skills*** with a science teacher and/or group of science teachers?

- ○ 0 to 1 hour
- ○ 1 to 2 hours
- ○ 2 to 3 hours
- ○ 3 to 4 hours
- ○ over 5 hours

Page Break

Q20 How often does your coaching role involve the following activities?

	Never	Rarely (for example: A few times per year)	Sometimes (for example: Once or twice a month)	Often (for example: Once or twice a week)	All or almost all of the time
Helping science teachers develop students' conceptual understanding of the science ideas they teach	○	○	○	○	○
Helping science teachers develop students' abilities to do science (for example: develop scientific questions; design and conduct investigations; analyze data; develop models, explanations, and scientific arguments)	○	○	○	○	○
Helping science teachers develop students' awareness of STEM careers	○	○	○	○	○
Helping science teachers provide science instruction that is based on students' ideas (whether completely correct or not) about the topics they teach	○	○	○	○	○

Q21 How often does your coaching role involve the following activities?

	Never	Rarely (for example: A few times per year)	Sometimes (for example: Once or twice a month)	Often (for example: Once or twice a week)	All or almost all of the time
Helping science teachers use formative assessment to monitor student learning	○	○	○	○	○
Helping science teachers differentiate science instruction to meet the needs of diverse learners	○	○	○	○	○
Helping science teachers incorporate students' cultural backgrounds into science instruction	○	○	○	○	○
Helping science teachers encourage students' interest in science	○	○	○	○	○
Helping science teachers encourage participation of all students in science	○	○	○	○	○

Q22 How often do you coach science teachers on their implementation of the following instructional strategies?

	Never	Rarely (for example: A few times per year)	Sometimes (for example: Once or twice a month)	Often (for example: Once or twice a week)	All or almost all of the time
Explain science ideas to the whole class	○	○	○	○	○
Engage the whole class in discussions	○	○	○	○	○
Have students work in small groups	○	○	○	○	○
Have students do hands-on/laboratory activities	○	○	○	○	○
Use flipped instruction (have students watch lectures/demonstrations outside of class to prepare for in-class activities)	○	○	○	○	○

Q23 How often do you coach science teachers on their implementation of the following instructional strategies?

	Never	Rarely (for example: A few times per year)	Sometimes (for example: Once or twice a month)	Often (for example: Once or twice a week)	All or almost all of the time
Have students read from a textbook, module, or other material in class, either aloud or to themselves	○	○	○	○	○
Engage the class in project-based learning (PBL) activities	○	○	○	○	○
Have students write their reflections (for example: in their journals, on exit tickets) in class or for homework	○	○	○	○	○
Focus on literacy skills (for example: informational reading or writing strategies)	○	○	○	○	○
Have students practice for standardized tests	○	○	○	○	○

Q24 How often do you coach science teachers on their implementation of the following instructional strategies?

	Never	Rarely (for example: A few times per year)	Sometimes (for example: Once or twice a month)	Often (for example: Once or twice a week)	All or almost all of the time
Anticipate difficulties that students may have with particular science ideas and procedures	○	○	○	○	○
Find out what students thought or already knew about the key science ideas	○	○	○	○	○
Implement the instructional materials (for example: textbook, module) to be used	○	○	○	○	○
Monitor student understanding	○	○	○	○	○
Assess student understanding at the conclusion of a unit	○	○	○	○	○

Q25 Please rate how each of the following affects your job of coaching science teachers.

	Inhibits Effective Coaching		Neutral or Mixed		Promotes Effective Coaching	N/A
Current state standards	○	○	○	○	○	○
District/diocese and/or school pacing guides	○	○	○	○	○	○
State/district/diocese testing/accountability policies	○	○	○	○	○	○
Textbook/module selection policies	○	○	○	○	○	○
Teacher evaluation policies	○	○	○	○	○	○
College entrance requirements	○	○	○	○	○	○
Students' prior knowledge and skills	○	○	○	○	○	○
Students' motivation, interest, and effort in science	○	○	○	○	○	○
Parent/guardian expectations and involvement	○	○	○	○	○	○
Principal support	○	○	○	○	○	○
Amount of time for you to plan, individually and with colleagues	○	○	○	○	○	○
Amount of time available for your professional development	○	○	○	○	○	○

Amount of instructional time devoted to science	○	○	○	○	○	○

End of Block: Coaching Activities

Start of Block: Motivation

Q26 Please indicate the degree to which you agree or disagree with the following statements.

	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
I put effort into learning pedagogical strategies that support science education.	○	○	○	○	○
I feel competent at my job as a coach.	○	○	○	○	○
I felt competent as a teacher before entering my role as a coach.	○	○	○	○	○

Q27 Please indicate the degree to which you agree or disagree with the following statements.

	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
I feel that I can freely ask teachers questions.	○	○	○	○	○
I feel a sense of community in my work as a coach.	○	○	○	○	○
I feel inspired by the teachers I coach.	○	○	○	○	○

Q28 Please indicate the degree to which you agree or disagree with the following statements.

	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
I feel that I am given freedom in my daily coaching tasks.	○	○	○	○	○
My opinions about what support should be given to the teachers are taken into consideration.	○	○	○	○	○
I can help other teachers improve their instruction.	○	○	○	○	○
I feel free to initiate a new approach or idea for teaching science with my teachers.	○	○	○	○	○
I choose which teachers to coach.	○	○	○	○	○
I choose how often to coach teachers.	○	○	○	○	○

End of Block: Motivation

Start of Block: Demographics

Q29 In which area of the country do you work?

- ○ Northeast
- ○ Midwest
- ○ South
- ○ West

Q30 What degrees do you hold? (select all that apply)

- [ ] Associate Degree
- [ ] Bachelor of Science
- [ ] Bachelor of Arts
- [ ] Other Bachelor's
- [ ] Master's Degree
- [ ] Doctoral Degree

Q31 Please indicate whether you hold a degree in the following areas.

- [ ] Science education
- [ ] A specific science discipline
- [ ] Other education
- [ ] Other discipline (please describe)

_____

- [ ] None of these

Q32 I identify as (select all that apply)

- ☐ Black or African American
- ☐ White
- ☐ Hispanic, Latinx, or Spanish
- ☐ Asian
- ☐ American Indian or Alaska Native
- ☐ Middle Eastern or North African
- ☐ Native Hawaiian or Other Pacific Islander
- ☐ Other _____

Q33 I most identify as...

- ☐ A woman
- ☐ A man
- ☐ Nonbinary/Gender Nonconforming
- ☐ Prefer not to disclose
- ☐ Other _____

End of Block: Demographics

Start of Block: Interview

Q34 We are looking for individuals to agree to participate in a more in-depth interview. Interview participants will be given a $25 gift card. If you would like to participate in an interview, you will be prompted to enter your contact information. We will use this information to contact you and connect your interview answers to your survey answers. After this matching process, your answers will be de-identified. Would you like to participate in an interview?

- ○ Yes
- ○ No

Display This Question:

If We are looking for individuals to agree to participate in a more in-depth interview. Interview pa... = Yes

Q35 Please enter your contact information below. We will use this information to contact you and connect your interview answers to your survey answers. After this matching process, your answers will be de-identified.

Display This Question:

If We are looking for individuals to agree to participate in a more in-depth interview. Interview pa... = Yes

Q36 What is your name?

_____

Display This Question:

If We are looking for individuals to agree to participate in a more in-depth interview. Interview pa... = Yes

*

Q37 What is your email address?

_____

End of Block: Interview

Start of Block: Gift Card

Q38 If you would like to be entered into a drawing for one of five $25 gift cards, please navigate to the link below to enter your information. This information will be collected separately and is not connected to your survey answers.

Gift Card Drawing

Please remember to **come back and click the arrow** on this screen to officially submit your survey answers.

End of Block: Gift Card

Appendix B

The Coaching for Science Interview Protocol

Coaching Activities

1. What does your coaching job entail? (probe: day-to-day, is there a particular model you follow?, who is your boss)
2. Describe the last time you worked with a science teacher.
3. Do you spend as much time as you want working directly on science/content instruction? (vs. management, probe for how much time)
4. What knowledge and skills do you think *teachers* need the most support with as they're developing expertise?
5. What knowledge and skills do you think *you* need the most support with as you're developing your coaching expertise?
6. What do you think is the most important part of your job?
7. How would you change your job if you could make changes?
8. What past experiences have helped you to be a coach? (probe to previous experiences)

Needs and Challenges

9. What are your current challenges?
10. Are there policies or procedures that get in the way of your being an effective coach?

Goals

11. What is your goal for your work?
12. What do you think is your supervisor's goal for your work?
13. Do you feel any tension between your goals and your supervisor's goals? If so, can you describe them? (alignment/misalignment)
14. What are your future career goals or aspirations?

Story Line

- Please think about relevant events in your teaching and coaching career that pertain to your motivation for the profession (of teaching and/or coaching)
- Motivation for this study means "the desire or willingness to continue to be a teacher"
- Draw a line on a graph, starting with your most recent year of teaching going back. The vertical axis is a 5-point scale with 1 being "very negative", 3 is "neutral", and 5 is "very positive."
- Examples will be shown.

15. Please describe the highest and lowest points on this graph you've just drawn.

Motivation

16. Why did you decide to become a coach? (How did the coaching role impact your motivation?)

SDT: Competence

17. Do you feel competent as a coach? Describe.
18. What have you been able to do to improve science learning through your work with one or more teachers? How did you accomplish this?

SDT: Relatedness

19. Do you feel connected to others in this role? (probe: with teachers, with other coaches, at your school)

SDT: Autonomy

20. Can you discuss the autonomy you feel in this role compared to your teaching role, compared to what you'd imagine it to be?

Overall

21. The last three questions I asked were about self determination theory. Do you think any one of them has been more influential on your career path thus far?

Beliefs (Teacher Beliefs Interview, Luft & Roehrig 2007)

22. How do you maximize student learning in your classroom? (learning)
23. How do you describe your role as a teacher? (knowledge)
24. How do you know when your students understand? (learning)
25. In the school setting, how do you decide what to teach and what not to teach? (knowledge)
26. How do you decide when to move on to a new topic in your classroom? (knowledge)
27. How do your students learn science best? (learning)
28. How do you know when learning is occurring in your classroom? (learning)