Science Teacher Motivations for Repeat Attendance at University Outreach Center Professional Development Programs

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Abstract: This multiple case study analysis investigated the perceptions of four science teachers who were repeat attendees at professional development programs coordinated by a university center. Adult learning theory provided a lens to view the motivated participants of the study and each of the five assumptions were present. Semi-structured interviews were analyzed using the constant comparative method to allow themes to emerge. Findings revealed three themes: 1) these science teachers perceive dual identities as both an educator and a scientist; 2) relationships built during an immersive content program allow the development of trust between these science teachers and university program coordinators which facilitates continued participation; and 3) as professionals dedicated to their craft, these science teachers pursue content-rich professional development opportunities for their personal and professional enrichment despite contextual constraints. These three themes illustrate that repeat attendance at professional development programs coordinated by the same university center supports teacher professional learning and personal development and growth. The findings from this study were used to modify an existing post-program survey to capture the range of experiences of additional program participants.

INTRODUCTION

Science education reform documents and science education research have repeatedly called for improved professional development (PD) for the practicing educator, particularly encouraging reform oriented programs (Loucks-Horsley et al., 2010; Putnam and Borko, 2000). There are many recommendations and findings espousing the best practices and hallmarks of quality PD to maximize student outcomes, while limited scholarship discusses the personal, social, and professional development of the self-directed adult learner (Bell and Gilbert, 1994). Just as K-12 students have varying educational needs and abilities for which we create differentiated instruction, so to do learners of all ages, including science educators who have different personal and professional development needs as they move along the teaching continuum from a novice to a veteran educator (Luft et al., 2003). Additionally, and depending on the goals of a program, in-service teachers can benefit from a change in context for PD. For example, to assist in-service teachers in developing new content or pedagogical knowledge, removing them from their everyday classroom context can be beneficial (Putnam and Borko, 2000). It is this form of PD involving a change in context that served as the impetus for this investigation, and in particular teachers, who self-select

to attend multiple PD programs administered by the same university center. In the current study, we operationalize the definition of a repeat PD participant as a participant who has attended at least two university center programs that are spaced at least a year apart and are based upon the same teacher-scientist partnership (TSP) PD model, but with different content foci. Therefore, with the following re-search questions, this study aims to understand the motivation and subsequent perceptions of high school science teachers who are repeat PD participants in intensive content-focused PD programs co-ordinated by an outreach center situated in a large southeastern university (i.e. Center):

(RQ1) What motivations do these repeat PD participants describe for choosing to attend an in-tensive content-focused PD program?

(RQ2) What attributes of an intensive content-focused program encourage repeat PD participation?

(RQ3) What personal and professional benefits are derived from repeat PD participation?

Theoretical Framework. Adult learning theory provides a lens to view the motivated participants (Merriam, 2001)

of this study. Andragogy, as described by Knowles (1980) makes five assumptions of the adult learner as one who “(1) has an independent self-concept and who can direct his own learning, (2) has accumulated a reservoir of life experiences that is a rich resource for learning, (3) has learning needs closely related to changing social roles, (4) is problem-centered and interested in immediate application of knowledge, and (5) is motivated to learn by internal rather than external factors,” (Merriam, 2001). Many of these assumptions have grounding in other learning theories.

The first assumption, self-directed learning, was earlier described by Houle (1961) and elaborated by Tough (1967, 1971) as a separate form of study. Tough (1967) observed adults who self-planned their own learning projects without the influence of an instructor or a classroom setting and concluded that adults are capable of seeking out and managing their own learning experiences in a self-directed manner. The second assumption suggests the role of social, cultural, and historical experiences. Interestingly, Knowles’ interpretation of adult-learning in the 1980s often focused on the individual’s learning in an autonomous manner much like a “technically proficient droid,” (Grace, 1996). Here, like others in the scholarship of adult learning (e.g., Grace, 1996; Pratt, 1993), we diverge from Knowles’ original interpretation of andragogy and recognize the influence of external contexts on the individual learner (Lave, 1991; Lave and Wenger, 1991). The social, cultural, and historical context of the individual or “the reservoir of life experiences” (Merriam, 2001) together with the learning environment necessarily influences the acquisition of new knowledge. The third and fourth assumptions embrace a teacher’s need to translate and apply new content knowledge and pedagogical techniques to the classroom context while being mindful of the needs of the students as learners. Teachers have many different roles in the classroom which vary greatly as teachers implement new curriculum using different pedagogical methods in response to school, district, state, and national initiatives as well as tend to their students’ personal learning needs (Vermunt and Endedijk, 2011). Lastly, the fifth assumption speaks to Bandura’s (1989) social cognitive theory that acknowledges intrinsic and extrinsic factors in knowledge generation and emphasizes the agency of the learner by placing great emphasis on the power the individual has in their own learning. There is an intrinsic motivation within an individual to achieve self-efficacy through self-regulation of learning and goal setting, which when combined with external factors of the environment, contribute to learning outcomes (Bandura, 1997).

Although the theory of adult learning is grounded in behaviorism, a constructivist approach is more consistent with our current understanding. Increasingly, collaborative learning and critical thinking skills are emphasized to better prepare learners for academic and career success in the 21st

century. Additionally, situated learning theory draws attention to the role of time and place of the learning context as well as the others the learner interacts with as knowledge is co-constructed (Lave, 1991). This study is temporally and situationally located on a university campus in authentic research laboratories where teachers work collaboratively with: 1) science researchers, 2) motivated high school educators, and 3) education re-searchers and curriculum writers. As such, the authentic and situated nature of the Center PD programs allows teachers to develop a deeper understanding of the science content as well as develop pedagogical content knowledge as self-directed adult learners.

Design and Procedure. The four individuals at the focus of this exploratory study have participated in multiple Center PD programs and were selected through convenience sampling while taking part in an additional summer PD experience with the Center. We recognize this small, selected sample is a limitation; however, our goal was to use the results of this study to inform the development of a survey instrument that could be administered to all 198 past program participants who attended one of the two select content-intensive PD programs between 2008-2013 in order to better understand the range of experiences with this particular PD model coordinated by the Center (IRB protocol #2013-U-0744). This study was completed during the final program year of this PD model, funded for multiple years by two precollege awards. Our aim is to use the results of this study to inform future program development by better understanding the unique and shared experiences of participating teachers.

The participants included four high school science teachers representing the maximum variation of gender, school setting, and years of experience among the teachers attending the research program during summer, 2013. Each teacher voluntarily participated in multiple Center PD programs coordinated by the same staff using the same philosophy and model for PD as described below. As such, the programs were similar in structure and expectations. All study participants attended at least one intensive Center PD program and one three-week internship program (see Table 1).

Two intensive PD programs were offered by the Center: an emerging pathogens focused program (i.e., pathogens program) from 2008-2013 and a biomedical focused program (i.e., biomedical program) from 2010-2012. As described previously, the pathogens program began with a two-week summer residential institute during which up to 30 secondary science teachers participated in authentic laboratory investigations (Brown, et al., 2014). Each teacher created a proposal and lesson plan to incorporate new content and techniques into their classroom curriculum based on the PD experience. Teachers implemented their new lesson and reported their outcomes at an annual statewide science symposium. The biomedical program was similar in struc-

Table 1. Participant profiles highlighting education and professional practice

Participant	Gender	Teaching Experience	Education	Other Professional Experience	Current School Setting	Current Subjects Teaching	Center Program Name and Year	Would you participate in another internship opportunity through the Center?
Anna	Female	10 years	BS Biology	Undergrad research	Catholic high school for girls	Biology	Biomedical 2010; Research 2012, 2013	“YES!!!!!! This was one of the best (and most challenging) professional development opportunities I have had (along with bench to bedside) I really want to work on improving other areas of my curriculum.” (Post program survey)
			MS Secondary Education			Physical Science		
Allison	Female	7 years	BS Biology	Clinical laboratory research	Suburban public high school	AP Biology , Chemistry I Honors	Biomedical 2010; Pathogens 2011; Research 2012, 2013	“200% yes! Through my previous experience I have realized how much I truly enjoy the process of writing and editing curriculum.” (Post program survey)
Alex	Male	10 years	BS Biology	Week-long lab experience with publication	Suburban public high school	AP Biology	Pathogens 2010; Biomedical 2011; Research 2012, 2013	“Absolutely. My summers would not be the same without them. I love the immersion into the content.” (Post program survey)
			MA Microbiology					
Andrea	Female	14 years	BS Microbiology	National Board Certified Teacher	Urban public high school	AP Biology , Anatomy/Physiology Honors	Pathogens 2008; Biomedical 2012; Research 2013	“The personal benefits and the benefits for my students are so big that I would take any opportunity to participate in more [Center] programs.” (Post program survey)
			DC Chiropractic Medicine					

ture, but focused on the theme of clinical and translational medicine and engaged participants more deeply in action research. After successful completion in one of the two-week programs with school year implementation, teachers were invited to apply for the three-week long research program (i.e., research program) to provide an in-depth laboratory and curriculum writing experience.

The overarching goal of each of the Center's PD programs was to facilitate the translation of university research into classroom practice and thereby infuse current science content and research findings in the secondary science setting. Teacher participants were encouraged to develop lessons that embrace an inquiry approach to science learning by engaging their students in developing higher order thinking through student-centered active learning strategies that encourage reflection and argumentation. These practices were modeled during each professional development program through content modules. Teachers were challenged to deepen their pedagogical content knowledge through the process of developing their own science lessons and curricular modules for classroom implementation. During the programs, teachers were not explicitly asked to change their teaching practices, but rather to expand their current understanding and practice.

METHODS

A multiple case study design (Creswell, 2013; Yin, 2013) was used to understand the perceptions of four repeat participants of Center PD programs. Semi-structured interviews took the form of interactive conversations between the first author and each of four participants. To address RQ1 and RQ2, the interview protocol (Appendix A in Supplemental) was constructed as a means to understand each participant's reason for attending a Center PD program as well as their perceived affordances and constraints of attendance. The co-constructed format of the interviews allowed participants to share information related to the five assumptions described by Knowles (1980) in a manner that did not explicitly ask the participants to frame their responses related to these constructs and potentially bias their answers. These interviews serve as the primary data source for this exploratory study. Program-specific artifacts including applications, reflective journals, and program evaluations were utilized to add to the depth of the case descriptions. Constant comparative method (Creswell, 2013) was employed to describe emergent themes both within and across cases. Inductive codes were those previously identified to correspond to the hallmarks of high-quality PD as well as those identified in our previous work (Brown, et al., 2014). Additionally, both in-vivo and deductive codes were used during axial coding of each interview transcript. During selective coding, codes were reordered and combined both within and across cases to eventually allow themes to emerge. Cases are presented

using pseudonyms to maintain anonymity.

FINDINGS AND ANALYSIS

Case 1: Anna. Our first interaction with Anna was during the 2009/2010 school year when she brought a group of AP Biology students to the University campus during a different Center program. She was made aware of the opportunity to do so by her predecessor. As a result of exploring the Center website, she applied and was accepted to attend the Center's biomedical program that summer. Anna developed and successfully implemented a three-week unit incorporating multiple biotechnology applications to facilitate student understanding of evolution and natural selection with the support of Center resources. She returned to participate in the research program during the summer 2012. Partnering with a colleague from the biomedical program (Allison), they developed an extensive curricular unit on the cell cycle with cancer serving as the disease model. Anna and Allison both successfully implemented their new unit with very different classes, and came back together during summer 2013 to refine their unit which they presented at a national conference in fall 2013. Anna attended three Center summer PD programs from 2010 – 2013.

Anna places a great deal of importance on two factors that seem to encourage her initial and repeat participation: science content and professionalism. While she was primarily drawn to the content, she was also excited to be offered a stipend for her participation. She views this as an indication of professionalism and the University valuing her expertise. Additionally, Anna is very drawn to the social aspects of the programs, which supports the importance of collective participation as a hallmark of high quality PD (Garet, et al., 2001). Living on campus with other like-minded teachers was refreshing and reinvigorating for her to share ideas and not feel isolated in her school: "I think a big part of it is that we stayed in a dorm together and had so much time together and you put a bunch of teachers together they are naturally going to talk about what they do and most of them that come to these programs are awesome." (-interview). She credits the Center programs for nurturing her development as a science educator: "When I look back at my first two years of teaching before I started doing professional development, I was ok," (-interview) to one much more focused and concerned about her students' learning.

Case 2: Allison. Allison attended her first professional development program with the Center in the summer 2010 as part of the inaugural cohort of the biomedical program. Her motivation for applying was actually an "accident" (-interview) as she re-counts that she applied thinking it was a different program at the University that her school wanted her to attend. Working with students in a rural school who she perceives as traditionally disinterested in science, she sought

to enhance her curriculum with wet-lab experiences using Center resources. She re-turned the following summer 2011 and participated in the pathogens program. Allison developed an integrated plan to explore bacterial protein fingerprinting with both her biology and chemistry classes. She was paired with Anna in a research laboratory during the 2012 research program, and together they created a multi-lesson curriculum. Allison successfully implemented the novel curriculum, made modifications based on pilot testing with her students, and presented the final curriculum at a national practitioner conference with Anna as well as independently at a state-wide in-service program. Allison has attended four Center summer PD programs from 2010 – 2013.

Allison is very confident in her teaching abilities: “There’s becoming more and more of us that are re-ally stellar teachers that do above and beyond,” (-interview). Before embarking on her teaching career, Allison worked as a laboratory technician, skills and knowledge she feels have aided her success in the science classroom. She credits former teachers for providing exemplar teaching methods which she emulates in her own classroom echoing the hallmark of quality PD, modeling instruction (Loucks-Horsley, et al., 2010). Allison is quite invested in her students and felt she “was leaving them vulnerable” (-interview) when she moved from her rural school and would no longer be able to encourage them to think beyond their small county lines and explore the vast academic and career opportunities available. She makes the most of all PD opportunities, including those focused on pedagogy or new initiatives at the district and state level, but finds the most meaning in PD situated in her content area.

Case 3: Alex. Alex attended his first Center PD program in summer 2010 joining the pathogens program and developed a series of experiences for his AP Biology students to grow bacteria under different conditions and determine protein expression patterns via gel electrophoresis and mass spectrometry. It is this lesson that Allison modified for her classroom the following year as a result of Alex presenting his lesson during the 2011 pathogens program. Alex re-turned in summer 2011 and participated in the biomedical program. Additionally, Alex spent a week in a proteomics research laboratory to further test and refine the unit he developed during the pathogens program. This collaboration resulted in a manuscript published in a practitioner journal with the scientist partner. During summer 2012, Alex returned once again to the University and participated in the research program, this time in the laboratory of a biochemist investigating HIV. The resulting curriculum challenged Alex to create a more student-centered series of activities not dependent on a wet-lab experimental sequence. Always looking for more professional experiences, Alex completed a summer long (seven-week) research experience in summer 2013 where he once again created a multi-day unit introducing genetic vari-

ation into bacteria via error-prone polymerase chain reaction followed by transformation to observe phenotypic changes. Alex attended four Center summer PD programs from 2010 – 2013.

Alex’s initial motivation for attending was simply because he “was bored and just wanted something mentally stimulating to do over the summer and it seemed like a good opportunity overall,” (-interview). He continued that “just the content information was the biggest draw for me,” and

“Additional knowledge that I could take into the classroom overall, and at the same time, I had no idea what you guys had to offer. So, it was kind of an investigation on my side.... I don’t know what [University] does. I don’t know what they offer. It was a good opportunity to find out.” (-interview).

For Alex, specific pedagogical instruction is less important and engagement in activities that are not intellectually stimulating for him are tedious, suggesting learning new content is of primary importance. He references sessions related to conducting action research as being

“...just too drawn out. For me specifically, I am all about the content and understanding it, and like I said I’m not really about the pedagogy or anything like that. For me, sitting through that thing is just so painful where the information about a topic, I would rather hear.” (-interview).

He highly values science researchers for their content expertise and being “experts in the field” (-interview) whereas a fellow teacher might be knowledgeable in teaching a specific course, but they do not hold the same rank of content expert that Alex trusts.

Case 4: Andrea. Andrea was in the first cohort of the pathogens program in 2008. She was encouraged by her district science coordinator to apply. Andrea developed a unit to engage her anatomy/physiology students in the study of emerging pathogens and infectious diseases while incorporating biotechnology applications such as microarrays and anti-body/antigen assays. She successfully implemented her new curriculum in her urban school and subsequently has utilized Center resources each year since maintaining a relationship with Center staff. In summer 2012 Andrea returned to participate in the biomedical program and developed a new lesson sequence on stem cell research to consider not only the basic science but also the clinical and ethical aspects. She then participated in the research program in summer 2013 in a wound healing laboratory investigating biofilms. Her resulting curriculum challenged her to create a unit that conveyed the content along with a passion for science while very mindful of her classroom context and her need to maintain order during an open inquiry investigation.

Andrea has attended three Center summer PD programs from 2008 – 2013.

Andrea describes herself as preferring to work alone when discussing curriculum development for her classroom: “I’m a loner; I like to do my own work.” (-interview). However, during her most recent experience she acknowledged that without her colleagues, she would not have been able to develop her final curriculum, one which she was quite proud of and excited to implement. She credits her fellow teachers and the program staff for helping her embrace the fun in science and to trust her students to explore with less structure from her:

“I have to credit them for changing my plan to making it a lot more fun. And some of it was a lot easier to write because I saw in your face that it wasn’t put together. I said, okay, I need to do this differently, and then the idea came. Let’s make this a little bit more playful, yet still have the rigor. That got it there.” (-interview).

She also values the informal conversations with fellow teachers much more than the structured sharing sessions and places great emphasis on current science content as her motivation for attending.

Cross Case Themes. Considering the four cases, three themes emerged across the cases: (1) these science teachers perceive dual identities as both an educator and a scientist: as professional educators they are focused on developing new lessons to bring relevant and engaging materials to their students while at the same time they place ultimate importance on the accuracy and validity of the content delivered; (2) relationships built during an immersive content program allow the development of trust between these science teachers and Center program coordinators, which facilitates continued participation; and (3) as professionals dedicated to their craft, these science teachers pursue content-rich professional development opportunities for their personal and professional enrichment despite and because of contextual constraints. Each theme is elaborated below with codes italicized and specific examples from the cases (Table 2).

Theme one: Dual identities. These science teachers shared they have a love of science and want to convey their excitement of the subject to their students much like a professional scientist while implementing a relevant and current science curriculum that is responsive to their students’ learning needs. As such, they have two identities within their professional role as a science teacher: an educator and a scientist. This echoes calls for PD to have a dual focus on content knowledge as well as pedagogical content knowledge (Garet, et al., 2001) as teachers need to possess two kinds of knowledge (Hiebert, et al., 1996) or as we describe here,

dual identities. For Alex, the in vivo code proof of concept emerged and speaks to a process of development common in science and engineering disciplines. When asked if he would have been able to implement his lessons or write a manuscript without the use of Center resources or lab experiences, he shared:

“No, because of the proof of concept in the lab. We had samples that I brought from the classroom and being able to get the proof of concept in the lab and walk through it and be like, there it is.” (-interview).

Anna echoes this sentiment that as a teacher you hope to try activities and test experiments before implementing with your students to know that it works and anticipate student difficulties.

Whether they identify as a scientist or an educator first, they each give priority to accurate and current science content knowledge. Each of the four participants commented on the importance of science teachers staying current and understanding new science advances. They feel science is changing at a rapid pace and it is their responsibility to stay abreast of the most recent findings which participation in the Center PD programs allows them to do. Even while engaged in learning new content, the teachers are ever mindful of their students and their desire to translate the current science into classroom curriculum that will excite and engage. New pedagogical methods as well as science activities need to be tested and shown to be effective prior to implementation in their classroom, consistent with a scientist’s skepticism and need for empirical evidence. As Anna shares, she has converted her classroom to be more student-centered because she has seen evidence of success in her classroom first-hand:

“I thought that kind of a classroom wasn’t really something you could achieve in real life and now from all of the professional development...I see how well it works. I think having done some of the professional development has convinced me to slow down a little bit and spend more time on certain activities. Because I will say, one thing that has changed in my teaching from my first two years, three years, is I don’t cover as much but I think the students retain a lot more and I think it is because I have shifted the focus from we have to get through everything, take some more notes to let’s do some activities, let’s do some more labs, let’s do some more hands-on stuff. Let’s work on more time for reflection and I care more about student engagement.” (-interview)

Repeat participation in the Center PD programs has facilitated her change as an educator from a teacher-centered classroom to a student-center focus with more time for active learning and reflection.

Table 2. *Cross case themes with codes and examples related to assumptions from the theoretical framework.*

Theme One: Dual professional identities as educator and scientist.		
Code	Illustrative Example	Assumption
Content experts	Being able to take what I was trying to develop and work with him, an expert in the field, and him also being able to explain it to me step by step was very valuable for the final product overall. (Alex, interview)	Sit. learning
Focus on students	And I can give them stories from the lab too, you know, cause the different people would tell us personal stories that make it more real to the kids. (Anna, interview)	Four
Teaching practice	I'm able to do a lot more hands on stuff, do a lot more student-centered learning as opposed to teacher driven and a lot of those techniques I picked up from your [programs]. (Allison, interview)	One, Two
Excitement	So it was like the perfect combination of us doing labs, us listening to new content, and us getting excited about science again. (Anna, interview)	Five
Lab experience	I'm, in a good way, treated like a graduate student in that lab. I'm expected to present at every lab meeting, every Wednesday, just like all the graduate students. I'm expected to know what I'm talking about. So, that's been quite a bit different than previous lab experiences, where you kind of fade into the background. It's not like that at all in this lab. So, it's been really good. (Alex, interview)	One, Four
Love of science	I had forgotten how much I really loved science. (Anna, interview)	Sit. learning Five
Theme Two: Relationships built during an immersive content program allow the development of trust between science teachers and University personnel.		
Relationship with PD program staff	As a matter of fact, I would jump onto anything that comes from [the university], from you guys because I've been to three successful ones. (Andrea, interview)	One Sit. learning
Ongoing support	That was a really cool year because [center staff] came out and helped me do that. We double-blocked the kids and had two full classes. These were freshman doing protein extraction and exploring proteomics and genomics and that was really cool. That blew their minds and that was really awesome. That was a good project. (Allison, interview)	HQ PD
Modeling instruction	If you did not go home with at least ten new ways of presenting something, then you didn't take advantage of it, at least. (Andrea, interview)	HQ PD
Enhanced Univ/Sch communication	It's something that's pretty valuable that has led to a lot of connections along the way with professors, with you all, with other teachers. (Alex, interview)	HQ PD
Collective participation	I think one of the biggest benefits to [these programs], aside from having you guys as resources, is meeting each other and making these connections and having a network of teachers that you trust is so important. (Allison, interview)	HQ PD
Treated like a professional	And I've also noticed like between [the biomedical program] and some of the other workshops that I have gone to a difference in how teachers are treated. Big time. (Anna, interview)	One, Five
Theme Three: Science teachers pursue content-rich professional development opportunities for their personal and professional enrichment despite and because of contextual constraints.		
Burn out	...but then when it becomes fun again through these workshops and I think oh yeah, this is why I'm a teacher so it kinda helps maybe most importantly prevent or reverse burn out a little bit. (Anna, interview)	Two, Three
K-12 education as a whole system	I think that there is a lot more pressure on teachers today. I saw this funny quote at the institute. It was: common core: adapt or die. It was a joke, but some of the teachers take it really seriously and a lot of them don't want to put the time and energy into the adapting, and maybe if I have already been teaching for 25 years I'd feel that way too. (Allison, interview)	Four
Pressure from school	During the school year you get bogged down with all the other stuff whether it is student behavior or the administration, kinda the extra responsibilities or the paperwork, standards, and, meetings... (Anna, interview)	Three, Four
Time constraints	Ideally you have tried the labs before you do them but to be honest, if you have multiple preps and I teach on a block schedule, so I have to have a new hour and a half lesson for every day for every class, you don't have time. You want to try new things but it's too hard or it's too scary or you have a bad experience. (Anna, interview)	Three, Four
Not treated like a professional by school/district/other PD	I hate K-12 education when you try to put it together, I feel like I get talked down to a lot and that has never happened here. (Anna, interview)	Three, Four, Five
Personal pursuits	I'm going to present at the NABT conference. I would have never, like that has always been one of my goals, when I decided to go into education and not to get my PhD, that I still wanted to publish a paper, present at a conference, I wanted to be a professional. And so, just from a personal satisfaction, this is great. (Anna, interview)	Five

Key for Table 2. Assumption One: independent self-concept who can direct own learning; adults are capable of seeking out and managing their own learning experiences in a self-directed manner; Assumption Two: life experience serves as a reservoir of knowledge; the social, cultural, and historical context of the individual together with the learning environment necessarily influences the acquisition of new knowledge; Assumption Three: learning needs related to changing social roles; teachers have many different roles in the classroom as they tend to their students' personal learning needs as well as social growth; Assumption Four: problem-centered and focused on immediate application of knowledge; teachers implement new curriculum using different pedagogical methods in response to school, district, state, and national initiatives while giving priority to student learning; Assumption Five: motivated to learn by internal rather than external factors; social cognitive theory emphasizes intrinsic motivation with an individual to achieve self-efficacy through self-regulation of learning and goal setting; HQ PD: High quality professional development; Situated learning: knowledge is co-constructed.

Theme two: Developing relationships fosters trust and rapport. Available literature on the features of high-quality PD highlights the importance of on-going support, enhanced university/school communication, and collective participation for successful professional development. We found these factors to be important to our participants as well, but additionally, we believe superseding all of these factors were the relationships built during the immersive content program. These relationships enabled the development of trust between science teachers, Center staff, and scientist partners, which in-turn facilitated continued participation of teachers in Center PD programs. Through classroom visits, equipment loans, scientist emails, and assistance with conference and manuscript development, relationships continued to build between teachers and the University personal. For example, Allison shared:

"Don't leave. I hope to work with you guys in some capacity for a long time now. I even had crazy ideas of, oh, well, when I get my Masters, maybe I could be a part of [the Center] instead of just being a teacher with [the Center]. Your program has literally changed my teaching career. I'm glad I got in it right away. I wouldn't be the teacher I was if it wasn't for the program." (-interview)

However, we also recognize these relationships are unique between each participant and the Center. Results from our previous study suggest that each teacher has unique personal, social, and professional development needs that may not be adequately attended to if proper supports are not in place (Brown, et al., 2014).

Theme three: Personal and professional enrichment. Unfortunately, each teacher spoke about experiences within their home school district where they felt they were not treated professionally. As a result, they were more motivated to pursue content-rich professional development opportunities for their personal and professional enrichment both despite and because of contextual constraints (Authors, 2014). For example, Anna's pursuit of Center PD programs served to combat the pressure of high-stakes testing:

...it was the perfect combination of us doing labs, us listen-

ing to new content, and us get-ting excited about science again. Because I think too, I was a little burnt out, I was switching jobs and just a little beat up from teaching AP Bio for two years and with such pressure to get good scores and kinda that I had forgotten how much I really loved science. (-interview).

For all, the mere fact that they were paid for their participation was quite important as a sign that they were treated as professionals and valued for their expertise; however, they also valued the experience personally as Allison shared:

"I would come to these programs without being paid. I would do work, with you guys and for you guys, without being paid. It's nice, don't get me wrong, but I would do it without being paid. It's worth it." (-interview)

Fortunately, each of the teachers also spoke of examples of professionalism within their school or district: "The principal at the school I'm at now just thinks this is the coolest thing ever that I'm here," (Anna interview). This group of teachers exhibits dedication to their chosen profession and is motivated to direct their own learning to achieve personal and professional goals rather than allow external factors to influence their achievement.

DISCUSSION

Regarding RQ1, it seems the motivating factor for these teachers is science content, which aligns with Knowles' first assumption of self-directed learning and fifth assumption of internal motivation. Each of the teachers specifically cited science content as a reason for attending and continuing participation in subsequent programs. Although teachers expressed the importance of pedagogy, this was only impactful if used in the context of their science content area during the PD program. The general view of "content keeps you fresher" (Allison, interview) led these teachers to initially apply for the Center PD and then participate in subsequent Center programs. The importance of current science content also answers RQ2 as to why participants choose to attend another Center program. The focus on current science content and interactions with experts in the field deepens the participants' understanding and allows them to bring cutting-edge research into the classroom, a factor these teachers feel is important for their classroom practice and leads to repeat participation. Aligned with Knowles' second assumption of life experiences serving as a source of learning, these teachers combine new content with lived classroom experiences to create new curriculum they feel is appropriate for their students. These teachers are ever mindful of their students and return to Center PD programs not only for their personal learning, but also to respond to changing professional roles

in the classroom (Knowles' third assumption) as well as to keep their classroom curriculum current and respond to the immediate learning needs of their students (Knowles' fourth assumption). Additionally, the social aspects of the program including interactions with fellow teachers, science research partners, educational researchers, and Center program staff supported an environment that was comfortable and safe, allowing participants to engage in conversations and experiences that pushed them beyond their typical practices.

RQ3 focuses on the individual as the unit of analysis and considers each participant as a unique learner with individual personal and professional needs. Anna, Allison, and Alex shared the most explicit impacts. For Anna, participation in the programs has challenged her intellectually and allowed her to reflect on her own learning:

"...writing the curriculum was really hard, but it is probably...one of the best things I've ever done as far as my own learning about learning." (-interview).

Additionally, repeat participation allowed her to recognize that the curriculum she has developed is innovative, empowering her to present at practitioner conferences, something she thought was reserved only for veteran teachers:

"I probably never would have felt confident that my idea was novel enough or was new enough to go present. I also thought you had to have like 10 or 15 years of teaching experience before you started that." (-interview).

Likewise, Allison summarized the personal and professional importance of repeat Center PD participation.

"It's not just curriculum that we tested out, it's going beyond and, I kind of tagged on to Anna's dream of presenting at a big, national conference. I feel like it's just [the Center's] never-ending open doors. I opened that first door and there's so many more to open now." (-interview)

When asked if he would do another Center PD, Alex responded, "My summers would not be the same..." (-post-program survey). His interactions with content experts and the lab experiences ignited his passion as a science researcher. The underlying love of science that encouraged him to pursue teaching initially has manifest itself as a thirst for additional science knowledge and set him on a path to return to graduate school through a new online Master's program in microbiology offered by our University. Repeat participation in Center PD programs allowed Alex to realize a personal goal that otherwise would have been unfulfilled.

The findings from this study were used to inform the development of a post-program survey administered to all 198 past participants. The post-program survey was adapted from a previously developed instrument used to systematically evaluate the NSF funded Scientific Work Experiences Programs for Teachers (SWEPT; Russell and Hancock,

2007). The SWEPT post-program survey was updated to reflect more current technology and practices, customized for the two-week professional development model, and included items based on the findings of the current study as described below. (Appendix B in Supplemental).

Theme One highlighted the dual identities of teachers as educators and scientists but also revealed the on-going focus on student-centered versus teacher-centered learning experiences. Accordingly, this theme suggested survey questions probing types and frequency of pedagogical practices used in the program participants' classrooms. Additionally, survey prompts asked teachers to reflect on the "type of teacher" they are as well as confidence in their content knowledge and pedagogical methods with the hope of identifying teachers who view themselves more student-centered in their teaching methods as well as those who consider themselves to be science content experts.

The trust and rapport developed during repeat attendance was central to Theme Two. We recognize these relationships are unique between each participant and the Center (Brown, et al., 2014). Therefore, we sought to capture the range of experiences related to this theme on the larger survey by incorporating statements for participants to indicate the importance of elements of high quality PD in their participation during in-service learning activities as well as open-ended responses about reasons they chose to attend Center PD programs. Additionally, survey items asked participants about their use of Center resources and impacts on their curriculum implementation and classroom practice.

Theme Three highlighted the individual personal and professional motivations for attending Center PD programs. To better understand the range of motivations for attending PD across all 198 past-program participants, survey questions were developed asking the number of hours spent engaged in a variety of PD settings such as school-based or district-based and if they focused on new curricular initiatives, classroom management, pedagogy, or content. Additionally, questions regarding the flexibility teachers perceive in their curriculum as well as the extent to which their curriculum is governed by sequencing and pacing guides provides an indication of the contextual constraints of the teachers.

When constructing the larger post-program survey, we wanted to be particularly mindful of allowing each participant to share his or her unique experiences to understand not only the range of experiences but also each individual. Participants were provided both Likert scale items as well as open-response boxes to consider how impactful given attributes of the pathogens, biomedical, and research programs were to their personal and professional development. Additionally, teachers were invited to share their reflection on the program impacts over all or any other attributes that were not specifically listed. While a written survey may not provide the richness of experience like an interview, these

responses should provide an indication of the range of impacts Center PD attributes had on the diversity of participants and allow refinements to the current PD model used by the Center. Our future analysis of the post-program survey should provide a more comprehensive view of science teachers' perspectives on professional development particularly regarding motivations for attending, returning, and implications for classroom practice.

CONCLUSION

While there is some generalizability among the participants, ultimately each teacher learner constructs their own experience and assimilates the attributes of the program with their unique personal and professional learning needs, affirming the assumption that internal factors motivate adult learners. The teachers were valued as professionals by both the Center staff as well as the science researchers. Along with treatment as a professional was the personal relationship developed with the Center staff. Because of the mutual trust, rapport, and confidence in each other, the teachers and their students as well as the Center staff and scientist partners benefited. Repeat participation in programs allowed Center staff to tailor experiences to participants. For example, Anna and Allison work very well together, a relationship born from the 2010 biomedical program, and as a result, the Center staff knew they would work well sharing the same research program experience and writing curriculum together. Allison referred to their relationship as "We were like one brain in two separate bodies," (-interview).

Conversely, Alex works well in a solitary fashion, so his subsequent internship was in a research laboratory on his own, developing his own curriculum. These are factors that are borne from continued participation with the same Center and factors that can-not be attended to in one-shot PD programs. This finding did not directly influence the survey, but echoes findings by Bell and Gilbert (1994) as they followed the same group of teachers through a three-year PD program. They found that personal, professional, and social needs of the teachers varied as they progressed through stages of learning, but through the on-going and iterative fashion of the program which allowed program staff to be responsive to each teacher's needs, they all achieved their personal and professional goals.

IMPLICATIONS AND LIMITATIONS

This study identified several factors which encouraged continued participation in PD programs offered by a single Center that were consistent across cases including the priority of science content as the focus of the program, the rapport and trust in the Center staff that facilitates learning and sharing, and enabling each teacher's personal and professional enrichment. Science teachers consider themselves differ-

ent from other classroom teachers and believe their content mastery defines and dictates their success as an educator and therefore they believe they have different professional development needs that must be responsive to current research.

This study highlights that each teacher has different personal and professional needs and these motivated teachers are able to align those needs with the attributes of the programs. Likely these teachers had a desire to increase their content knowledge and placed primary importance on achieving this goal (Bell and Gilbert, 1994). The program description appealed to this need (Saka, 2013) and the structure of the Center facilitated continued PD participation for these educators. We acknowledge that this study highlights the experiences of a small group of motivated volunteers, but we believe it also speaks to the need to develop relationships with educators and foster their development over time, much like we attend to the learning needs of our students. Self-motivated learners need to have opportunities to experience personal and professional growth fostered by individuals that they trust. As adult learners, these teachers pursued professional development opportunities for their personal and professional learning to enhance their classroom practice and share with their students the love and excitement of science. Ever present in their minds is the need to translate their experiences, both new knowledge and pedagogy, into classroom practice and benefit the next generation of scientifically literate citizens. However, we also cannot exclude the external motivating factor of receiving a stipend for attendance, regardless of how minimal it was. The teachers re-marked that receipt of a stipend was a nice gesture and an indication of professionalism. Additional studies can investigate the role of compensation in motivation to attend a PD program. Our Center has several different PD programs with different levels of compensation. The interview data presented here and our practical experience suggests the motivated science teachers in this study are not repeat participants because of the stipend.

In order to achieve the goals of the *Framework for K12 Science Education*, we must nurture the continued growth of each science educator, and attend to individual needs by offering on-going content-rich PD opportunities that allow teachers to develop rapport and trust with University researchers and promote professionalism in the field of education while facilitating their personal development as self-directed adult learners. By doing this, we as educational re-searchers answer the call "to play a leadership role in providing high-quality professional development for all teachers," (Borko, 2004).

ASSOCIATED CONTENT

Supplemental information is available.

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Author Contributions

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