RUNNING HEAD: Science Education Faculty Professional Development

Strand 8: In-service Science Teacher Education

Related Paper Set - Virginia Initiative for Science Teaching and Achievement –

Second Year Statewide Implementation

Paper 4: Science Education Faculty Professional Development

National Association for Research in Science Teaching Annual International Conference

Rio Grande, Puerto Rico

Tuesday, April 9, 2013, 1:00pm-2:30pm, Sea Gull Room

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The contents of this paper were developed under a grant from the U.S. Department of Education, Investing in Innovation (i3) Program. However, they do not necessarily represent the policy of the U.S. Department of Education, and you should not assume endorsement by the Federal government.

Abstract

Historically science teacher educators have existed as lone wolves in education programs or on the fringes of science content departments at the university level. As a consequence, faculty have often found themselves isolated within their institutions and have limited access to the support of colleagues with similar responsibilities and interests. Their access to professional development specific to science education is also limited. The goal of the VISTA's Science Education Faculty Academy (SEFA) is to provide an environment in which science teacher educators collaborate, learn and share new research, and establish a support network for science teacher education. One component of a four-pronged effort to build systematic capacity for improving science teaching and learning, SEFA is a five-day academy that works to increase science education faculty's access to current science teacher education research and support structures for scholarship by situating them in a collaborative learning environment that includes networking in a community of their peers via Johnston & Settlage's (2008) *Science Education at the Crossroads* format and participating in seminar-style professional development modules. Based on data from two cohorts, preliminary results indicate that providing opportunities for faculty to experience new science teaching strategies and network with peers can have far-reaching impact on participants' professional growth and their preservice teachers' future effectiveness.

KEY WORDS: science education faculty, professional development, networking, community of practice

The Virginia Initiative for Science Teaching and Achievement (VISTA) is a statewide partnership among 60+ Virginia school districts, six Virginia universities, and the Virginia Department of Education. Its goals are to translate research-based best teaching practices into improved science teaching and student learning for all students at all levels and to build a community of practice across the Commonwealth. The goal of the Science Education Faculty Academy (SEFA), one of VISTA's four program components, is to provide an environment in which science teacher educators collaborate, learn and share new research, and establish a support network. Because science teacher educators historically have existed as lone wolves in education programs or on the fringes of science content departments at the university level, faculty have often found themselves isolated within their institutions and have limited access to the support of colleagues with similar responsibilities and interests. Their access to professional development specific to science education is also limited. SEFA hopes to increase science education faculty's access to current science teacher education research and support structures for scholarship by situating science teacher educators in a collaborative learning environment that includes networking in a community of their peers via Johnston & Settlage's (2008) *Science Education at the Crossroads* format and participating in seminar-style professional development modules.

Literature Review

The landscape for higher education (HE) institutions has evolved considerably over the last 20 years (Becher & Trowler, 2001). HEs have had to adapt to changes wrought by rapid advances in technology and globalization, along with increases in both numbers and diversity of student populations. In responding to those changes, faculty at these institutions have had to grapple with greater levels of accountability and, in Becher & Trowler's (2001)

words, "surveillance" of their work. As a result, the role of faculty in these institutions continues to evolve.

Additionally, the position of science teacher educators within higher education is enmeshed with the status of education schools or colleges within the university structure. The perceived low status of education schools relative to other units within the university often relegates their faculty to fringe status within the institution. Compounding the issue of low status, science teacher educators come to their roles from a variety of paths, thus making it difficult to identify and meet their continuing education needs. In a study of science education doctoral programs, Jablon's (2002) found that 10% of faculty had been elementary teachers, 15% middle school teachers, 43% high school teachers,28% faculty in two- or four-year colleges, and 3.5% informal science educators, while 13% had no teaching experience. Furthermore, at the time of the study there seemed to be an increase in doctoral candidates coming from two- and four-year colleges. Such variability in faculty background, coupled with calls for increased numbers of well prepared science teachers (NRC,2007), brings to mind the question,“What are the professional development needs of science education faculty?”

Professional development within higher education is a continuing, often context-specific, process (Boice, 2002). The professional development needs of science education faculty is influenced by their previous experience in K-12 classrooms, course work encountered in their doctoral programs, science content backgrounds, and emerging knowledge in the field. The components of professional development for science teacher education was outlined by an ad hoc committee of the Association for Science Teacher Education (ASTE, *n.d.*) and include knowledge of science; science pedagogy; curriculum,

instruction, and assessment; knowledge of learning and cognition; research/scholarly activity; and professional developmentactivities. Due to the small number of science education faculty at any one college or university (Jablon, 2002) those professional development needs are usually not offered onsite. Some of these professional development needs are filled during attendance at regional and national meetings of science education professional organizations such as Association for Science Teacher Education, National Association for Research in Science Teaching, and National Science Teachers Association. At these meetings, attendees have the opportunity to present papers and workshops of their current work, attend presentations and workshops by their peers, and network. These meetings offer opportunities to build relationships with a community of peers leading to opportunities for collaboration on scholarly pursuits. Although these meetings are a firmly entrenched tradition in academia, they have not always meet the professional development needs of science education faculty.

One attempt to respond to that unmet need was the *Science Education at the Crossroads* (2008) conference format pioneered by Johnston & Settlage (2008). In addition to providing a collaborative learning environment through the presentation of papers and networking in a community of their peers, the professional development format offered each participant an in-depth focus on a science education issue they have had to confront. In the Johnston & Settlage model the first factor is papers written as short "problem/solution" pieces called "vexation/ventures." This professional development framework delineates three factors: critical review, practice community, and joint responsibility. Papers were solicited from a wide range of science education faculty with the stipulation that they were no longer than 1500 words and presented a vexation and possible venture towards its solution. Critical review occurred when both Johnston and Settlege reviewed the papers in the context of a

conversation with the author and themselves. Feedback was given which included strengths, suggestions for improvement, and sometimes references for further research. Such feedback proved to be valuable especially to novice faculty members who had limited access to critical review outside of the highly stressful publication process.

The second factor of the Crossroads experience is the practice community in which groups of eight to ten individuals assemble around a table for an incubator session to discuss the papers. The incubation session is divided into timed segments with definitive rules of engagement. Initially, the author has a few minutes to tell about the venture and vexation. The group has a chance to ask clarifying questions. The group then discusses the work while the author remains silent. This part of the incubation is usually highly affirming and instructive for the author. It presents an opportunity to have one's work intensely dissected. In the final segment, the author has an opportunity to comment on what was shared and have a conversation with the group. These incubator sessions promote a community of practice through the development of communal relationships. By the end of an incubator session, which lasts for 90 minutes and involves the sharing of three papers, participants come to "know" each person's work, and a certain amount of bonding occurs.

The third factor in the Crossroads framework, joint responsibility, is a by product of the two other factors. The reviewers, Johnston and Settlege in the original model, share responsibility for the final outcome of each paper as they engage in a critical review with each author. Additionally, within the incubation sessions the group members have a responsibility to the author to discuss the work with sufficient depth to make the process valuable. This responsibility forces the group members to truly listen and intellectually engage with each author as they form a practice community.

The Crossroads experience provides space for faculty to share vexing issues related to their practice, feedback on their scholarly ventures, and opportunities to build community. It is one move towards filling the professional development needs of science teacher educators, yet it is not sufficient. Science education faculty require expanded, sustained opportunities to meet their professional development needs.

Structure of the Science Education Faculty Academy (SEFA)

The goal of the Virginia Initiative for Science Teaching and Achievement (VISTA) is to build systematic capacity for improving science teaching and learning throughout the Commonwealth of Virginia. One of VISTA's four program components, the Science Education Faculty Academy (SEFA) builds an infrastructure to support effective science teaching and learning by providing an environment in which science teacher educators collaborate, learn about and share new research, and establish a support network for science teacher education. The research study questions formulated to determine the impact of SEFA are:

1) To what extent did the Academy provide opportunities for collaboration/network building among science education faculty?

2) What evidence exists that science education faculty learned about new research related to science teaching?

3) What are the ways in which science education faculty plan to implement their new learning in their future professional efforts?

An overview of the agenda for the five day academy is found in Table 1.

Table 1: *Overview of SEFA*

Day 1	Day 2	Day 3	Day 4	Day 5
Introduction: • VISTA Overview • Developing a Professional Learning Community: Vexations & Ventures	Enrichment: • Exploring Hands-on, Inquiry, and PBL • Updating course syllabi	Enrichment: • Exploring NGSS, NOS, and Meeting the Needs of All Students • Updating course syllabi	Quest for Solutions: • Utilizing Effective Discourse • Grant-writing and Funding •State and National Perspectives	Quest for Solutions: • Collaborative Planning for VAST and VSELA

In order to identify challenges, begin to develop solutions, and start to establish an infrastructure of support within the science teacher education community, the facilitators begin the academy with an activity based onJohnston and Settlage's (2008) vexation and venture model. Prior to attending, participants submit a reflection on a specified topic. Academy leaders review their submissions and provide comments. On the first day of the academy, participants attend small group forums to present and receive additional feedback on their revised papers. In each "incubator session" one faculty member has ten minutes to describe his/her vexation and venture to a group of four to five people. The group has five minutes to ask clarifying questions and then, for fifteen minutes, discuss the situation without any input from the presenter. To wrap up each session, the presenting faculty member has five minutes to rejoin the discussion.

A non-participating academy leader moderates the process for each small group.Time is set aside during other activities throughout the remaining four days of the academy to continue the discussions that began during these sessions.

During the next few days,the academy focuses on research related to effective science teacher development and science teaching. Specifically, participants are immersed in hands-on, inquiry-based science activities that explicitly address nature of science (NOS) concepts and differentiation strategies in the context of a problem-based learning (PBL) experience. The effective use of classroom discourse, engineering design briefs, and the *Next Generation Science Standards* (NRC, 2012) are also explored. Embedded in each session is an opportunity for participants to share ways they could incorporate each respective topic into their science methods courses.

Building off of the community of practice established at the beginning of the academy, the last few days include sessions that further develop an infrastructure of support within the science teacher education community. Participants learn about funding opportunities, receive pointers about grant writing, hear about state and national science education organizations, obtain information about current and upcoming projects from state science education leaders, and make plans for the approaching state science teacher conference.

Methodology

Planned forms of data collection included participants' demographic information, Vextation and Venture papers, daily exit slips, and other artifacts. After the first academy, participants spontaneously created a closed Facebook group and granted the authors access to it, allowing the collection of useage and content data. The authors, who were also the academy instructors, read each response and, utilizing grounded theory (Glaser, 1978; Glaser & Strauss,

1967; Strauss & Corbin, 1998), analyzed the data for themes in order to answer the research questions.

Results

Participants

Over two years, participants included science and science education faculty from ten colleges and universities, representing 29% of the institutions within the Commonwealth of Virginia that offer teaching licensure in elementary and/or secondary science education. Table 2 provides demographic information on the first two cohorts of SEFA participants, and Map 1 shows their geographic distribution.

Table 2: *SEFA Participants' Demographic Information*

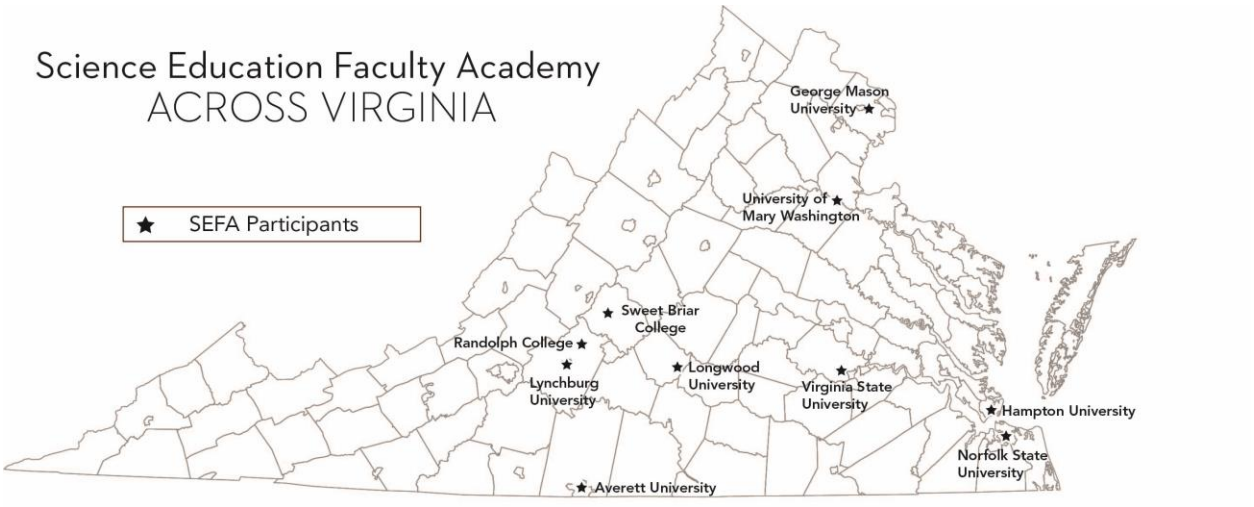
Demographic Category		Number in 2011 Cohort (n = 8)	Number in 2012 Cohort (n = 9*)
Gender			
	Male	4	2
	Female	4	7
Ethnicity			
	African-American	6	4
	Caucasian	2	4
	Multiracial	0	1
Institutional Rank			
	Adjunct Faculty (non-tenure track)	2	0
	Assistant Professor (tenure-track)	3	6

	Associate/FullProfessor (tenured)	3	3
Primary Institutional Affiliation			
	School/College of Education	6	7
	School/College of Science	2	2
K-12 Teaching Experience**			
	None	2	2
	Elementary (K-5th grade)	3	5
	Secondary (6th-12th grade)	5	4
Years of K-12 Teaching Experience			
	<5 years	3	2
	5-10 years	4	2
	11-15 years	1	2
	>15 years	0	3
College Courses Taught**			
	Science content courses	6	2
	Science teaching methods	6	7
	Other education courses	6	6
Years of College Teaching Experience			
	<5 years	1	3
	5-10 years	3	3
	11-15 years	2	1
	>15 years	2	2
Employed at a Doctoral Degree Granting University			

	Yes	3	6
	No	5	3
Undergraduate Student Enrollment at College/University Where Employed			
	>2,5000	3	2
	2,5000 to <5,000	4	3
	5,000 to < 10,000	1	3
	> 10,000	0	1
Location of College/University			
	Town, Remote	1	1
	City, Small	3	2
	City, Middle	3	3
	Suburban, Small	1	0
	Suburban, Large	0	3

*Four participants attended both years. **Multiple responses allowed

Map 1: *Geographic Distribution of SEFA Participants*



Vexation and Venture Papers

Vexations and Venture papers were submitted by 19 individual faculty members from institutions of higher education in Virginia, consisting of six VISTA faculty and 13 other faculty who attended the academy either in 2011 or 2012. In 2011, the first year of the SEFA, 13 faculty were asked to address "problem-based learning, inquiry-based learning and teaching, teaching the nature of science, hands-on science, establishing and using professional learning communities in college classrooms and/or in K-12 classrooms, teaching a science methods course, writing and/or managing a grant, or anything ranging from the personal to the global." In 2012, 15 faculty (nine repeaters from 2011) were asked to prepare a Vexation and Venture paper based on "the definition, teaching and learning of the nature of science." All of the 13 papers submitted in 2011 focused on teacher preparation, with several specifically targeting the lack of content knowledge in elementary teachers and others proposing strategies for more effective training in inquiry, problem and project-based learning, and time management. Many of the papers addressed the effect of the end-of-year standardized tests, and proposed that preservice and inservice teachers be trained in strategies to support hands-on investigations, including the incorporation of investigations into the methods courses. In 2012, the papers approached various aspects of the nature of science, ranging from general references to providing inquiry-based, stimulating experiences as models for preservice teachers to use, to explicit self-regulation strategies and critical moment dialogues. Several participants referred to the need for training teachers and administrators about the nature of science. One participant referred to the limitations of a worldview of science that was based on "the scientific method," noting that this worldview limited the recognition of the role of innovation and creativity in science. Another incorporated the available philosophies of the coming Next Generation Science Standards into a

vexation about engineering practices in K-12 science, closing with the venture that incorporation of the study of the nature of science would support the incorporation of engineering practices into science instruction. In 2012, the faculty participants also included collaborative lessons and integration of science with other content areas in their venture strategies.

Exit Slips

On the first day of the academy, participants were asked to reflect on the Vexation and Venture experience, including which aspects they found useful, how the activity influenced their sense of community with the other attendees, and how their written reflections helped the process. The overwhelming theme that emerged from the data was that the Vexation and Venture model provided a supportive environment in which to reflect and share ideas. Additionally, participants consistently noted that it was comforting to know that their concerns/issues were shared by their colleagues. Representative quotes include:

"I found my problems/vexations shared by my other colleagues so at least I know I am not imagining the issues."

"This day's activities helped me realize that we have similar concerns and potential solutions to the problems."

"[The process] supported collaborative dialogue that allowed me to see issues and concerns from multiple perspectives."

On the second day, participants were asked to reflect on the concepts of hands-on, inquiry teaching, problem-based learning (PBL), and question mapping. Their responses were very brief and mainly consisted of definitions (e.g., "a guide to help facilitate PBL," "organizes the questions," "ask questions," "real world," "doing").

On the third day, participants responded to questions about the nature of science (NOS) and high needs learners. Regarding what they learned about NOS, most participants mentioned that they previously were not aware of all the aspects presented or that the state science standards included specific aspects of NOS that students needed to know. A few participants indicated that the importance of being explicit about NOS was new to them. Related to how they would explicitly address NOS in their science methods courses, participants noted using historical science stories, environmental impact scenarios, and having pre-service teachers "conduct a science activity, then introduce NOS and have them identify components of the activity that address a NOS tenet. Then have students reflect on ways to a) improve/strengthen NOS in [the] activity and b) modify instruction for [a] different grade level." Regarding high needs learners, the main theme that emerged regarding the most significant strategy for addressing the needs of this population was to be culturally sensitive.

On the fourth day, participants reflected on engineering design briefs, grant writing, and classroom discourse. Participants indicated that design briefs "provide a working model," "[serve] as the engineering protocol," "[help] with the development of a specific project," "give engineers a plan for designing a prototype," "provide a structure to introduce engineering into the classroom," and are a "good foundational document to give clear parameters for the challenge." Related to grant-writing, participants noted that they would be sure to align with and follow RFP requirements, work in teams, and use appropriate language. Regarding discourse, participants identified questioning strategies, setting parameters, metacognition, and making cohesive lesson plans as critical strategies to help pre-service teachers improve classroom dialogue. Faculty indicated that they would use clue cards, video tape analysis, and in-class practice to help their students become more comfortable as a classroom facilitator.

On the last day of the academy, participants were asked to reflect back over the week and identify the most important thing they learned, what they still need clarification on, and what they intend to implement in their methods courses. Table 3 summarizes the most frequent responses.

Table 3: *SEFA Participant Last Day Reflections (Number of Responses)*

Most Important	**Need Clarification**	**Will Implement**
NOS (5)	Nothing (4)	PBL (3)
Design briefs (4)	Explicit NOS (2)	NOS (1)
PBL (3)	NGSS (2)	Design briefs (1)
NGSS (2)	Hands-on/inquiry in large classes (1)	Cultural competency (1)
		Grant writing (1)

Other Artifacts

Another source of data was the conference program for the Virignia Assocation of Science Teachers' (VAST) annual professional development institute (PDI). Although not a requirement, SEFA leaders encouraged participants to present at this conference. Members of the first cohort presented at four sessions during the 2011 VAST PDI that were directly related to what they learned during the academy. Four participants collaborated to share their experiences with infusing PBL into their elementary science methods courses. One of the participants shared his experience using PBL in an earth science course for pre-service teachers. A participant from a small rural teacher preparation program had her elementary science students share the curriculum-aligned PBL units they developed in their science methods course. A group of three participants shared products and reflections of their post-SEFA use of PBLs in their secondary

science methods courses. During the 2012 VAST PDI, members of the second cohort made five presentations on SEFA-related topics. Three of the presentations, which involved six participants, focused on integrating engineering into the science curriculum at various levels of K-16 curricula. A group of four faculty, including one member of the first cohort, presented on infusing PBL into their elementary science methods courses. Another group of three faculty presented on utilizing PBL in K-5 classrooms. Additionally, a member of the first cohort presented on incorporating PBL in secondary science classes.

Facebook Group

Immediately after the first Science Education Faculty Academy, participants decided to start a closed Facebook group. Currently, there are 19 participants, including eight VISTA staff members. In the 20 months since its inception, there have been 103 posts and 291 comments, which can be categorized into teaching (38.8% of posts, 26.8% of comments), personal (29.1% of posts, 42.6% of comments), research (15.5% of posts, 25.4% of comments), general science (8.8% of posts, 4.1% of comments), and administrative (7.8% of posts, 1.1% of comments). Teaching-related posts/comments included discussions about ideas for teaching ("Help! I have a total of 16 hours (2 hours per day for 8 days) with rising sophomores. The problem---my building/room is under renovation/no access to any materials of substance. I am thinking environmental experiences but need your ideas!"), arrangements to observe each other's classes, and the results of trying various strategies in a course ("Good morning: yesterday I had my grad students set up work stations that included a design brief centered on a nursery rhyme or fairy tale. The ideas were fabulous!"). Personal discussions related to awards and grants received, family and health situations, job changes, plans to meet at conferences, and the supportive nature of the SEFA group members ("Great evening out with SEFA buddies. We have some great new additions to our group---though we did miss our buds from last year who couldn't be with us!").

Research-related posts/comments included discussions about recommended research instruments and journals ("I am looking for a national journal that publishes qualitative science education research. Any ideas?"), suggested literature to read ("Hello Everyone! As you know, the book Flow has a section that speaks to the significance of our memory. Well, I am just completing a VERY interesting book about memory. It is titles Moonwalking with Einstein by Joshua Foer."), how to analyze data, grant opportunities ("Hi folks, I was looking for a funding opportunity and came across this…on page 6 it has something that looks like professors from across universities could do it together."), and upcoming conferences. General science posts/comments included information about various science topics that have been in the news ("This is a great series of videos on basic electronics - Sylvia's Mini Maker Show - scroll down from the product info to the videos and take a look at this one on making conductive dough for squishy circuits."). Administrative posts included recruitment announcements and notices about upcoming legislative action related to K-12 curricula.

Discussion

The findings indicate that SEFA successfully met its goal to provide an environment in which science teacher educators collaborate, learn and share new research, and establish a support network. Specifically related to the first research question regarding opportunities for collaboration/network building among science education faculty, participants indicated in their exit slips that using the vexation and venture model was extremely helpful. The incubator sessions provided an opportunity for participants to freely discuss ideas with the goal of helping each other move toward solutions for pressing issues expressed. The structure of the sessions created a safe environment for the group, where each member of the group was expected to contribute and others were expected to respond thoughtfully and productively. Additionally,

there are a number of participants who apply to return a second year. The second cohort included four repeating participants, and the third cohort currently has four slated to return for a second year. Another piece of evidence regarding successful network building is the number of conference presentations, research projects, and grants that have been co-authored by SEFA particpants at different institutions; colleagues that they likely would not have met without attending SEFA. Further, the new participants in the second cohort readily joined the Facebook group started by the first cohort and continued its use for professional collaboration and personal support throughout the year. The academy leaders found it an affirmation of the strong colleagial atmosphere developed during SEFA when they were invited to join the Facebook group, as it indicated that the participants felt everyone in attendance were professional, supportive colleagues.

Related to the second research question regarding science education faculty learning about new research related to science teaching, research related to effective science teaching was woven throughout the academy. On day one, the faculty read and discussed their colleagues' vexations and ventures (13 in year one and 15 in year two), through which they learned about current challenges facing their colleagues and the research being cited to support or refute these issues. This collaborative problem solving helped to set a supportive tone of continuous improvement for the academy. Daily exit slips provided evidence of the topics addressing areas of need in science teacher professional development such as when a teacher reported seeing "issues and concerns from multiple perspectives" or previously not being aware of all the aspects of NOS. The discussions of major pedagogical terms (hands-on, inquiry, PBL, NOS) on day two enabled the faculty to focus on important nuances of the terms which deepened understanding and provided a strong basis of support for the preservice science teachers they teach. Evidence of

the faculty's understanding of these aspects of effective science teaching is their inclusion in participants' science methods course syllabi and presentations at state science conferences. Evidence of the importance of the topics presented on days three and four to the faculty is their rating as most important the nature of science (now a testable area on the state science tests) and design briefs a strategy for implementing engineering into science teaching as called for in the Next Generation of Science Standards (NRC, 2012). Interestingly all topics taught were listed by at least one faculty member as a most important topic or one they will implement. This speaks to the relevance of the academy topics and the effectiveness of the professional development.

Related to the third research question regarding ways in which science education faculty plan to implement their new learning in their future professional efforts, participants noted that the intense focus on PBL and NOS helped them utilize hands-on, inquiry activities, and historical science stories to encourage pre-service teachers to remain "open to possible solutions that are different." Several particpants have incorporated PBL, inquiry-based teaching, and explicit NOS instruction into their course syllabi and summer camp curricula, which helps build coherence across science teacher preparation programs in Virginia. Additionally, several participating faculty have plans to continue to co-author grant proposals, conference papers, and research articles.

There are some limitations to this study. Although faculty from 29% of the institutions within the Commonwealth of Virginia that offer teaching licensure in elementary and/or secondary science education have attended SEFA to date, there are still several colleges/universities that have not been represented, so the impact of SEFA with those faculty cannot be addressed. Additionally, there are incomplete data currently available regarding how participants' syllabi and/or instruction have changed, how many joint research, presentation,

and/or publishing ventures there are among participants, what the long-term impacts of SEFA are, and if the SEFA model is sustainable beyond the grant-funded period.

As VISTA looks ahead to the remaining three cohorts of SEFA, the reserachers are interested in focusing more on how the academy impacts participants from different contexts. For example, compared to the second cohort, participants in the first cohort were more likely to be non-tenure track faculty who had fewer years of K-12 teaching experience and come from institutions that did not grant doctoral degrees, had smaller undergraduate populations, and were located in smaller cities and town. Do any of these factors impact a participant's experience? There is also a need to determine why science education faculty from some institutions have not attended SEFA. Are they busy with other commitments? Is there something regarding the structure or content of the academy that does not appeal to them? Additionally, there is a need to expand data collection to include more artifacts from the participants' courses (e.g., syllabi, assignments) and vitae (e.g., research presentations and publications) to determine the full scope of SEFA's influence. The academy leaders would also like to explore the possibility of obtaining more input from the participants regarding their professional development needs and tapping into their areas of expertise more (e.g., having them lead some of the seminars). Finally, there is a need to explore options for how to make the SEFA model sustainable without grant funding.

VISTA's Science Education Faculty Academy provided a forum in which science teacher educators in their many iterations came together to build community, learn and share research, and collaborate. Based on feedback from participants, especially faculty at non-research intensive instuitions, SEFA has served as a catalyst to improve their teaching and scholarship. The opportunity to meet with colleagues for a five day period where the focus is on reflection, learning, and community building is a luxury in the busy world of HE faculty. Based on the data

obtained to date, the professional development provided by SEFA can serve as a foundation for faculty development within an at-times fragmented science education community (Jablon, 2002).

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