SCIENCE LEADERSHIP: IMPACT OF THE NEW SCIENCE COORDINATORS ACADEMY

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Abstract

This article discusses the impact of the New Science Coordinators Academy (NSCA) on two cohorts of participants. The NSCA is one of four components of the Virginia Initiative for Science Teaching and Achievement (VISTA), a United States Department of Education (USED) science education reform grant. The NSCA is designed to support new school district science coordinators (with less than five years of experience) and to continue building the state science education infrastructure. Research in education leadership traditionally focuses on teacher leaders, principals, and district office personnel. Interestingly, research on district office personnel rarely distinguishes between the different roles of district personnel. This article seeks to inform the field by sharing the impact of an academy designed for new science coordinators on their learning, and to begin to understand their role and impact in their district. The five-day Academy engaged participants in a variety of experiences designed to facilitate the following: 1) build leadership skills; 2) build a common understanding and vision for hands-on science, inquiry, problem-based learning, and nature of science in the science classroom; 3) investigate data to improve student learning goals; 4) and, develop a science strategic plan. The data indicate that the NSCA was successful at meeting its goals to support the participants and to build a common language among these new coordinators. Initial data also support the variety of responsibilities of these participants and the positive impact of the Academy on their district work.

As education professionals continue to investigate strategies to improve teaching and learning in schools, an important question arises: Does leadership matter? According to Leithwood and Wahlstrom, leadership does matter [1]. Another important question arises as to the types of leadership needed to make the desired improvements. Studies of leadership typically

The Journal of Mathematics and Science: Collaborative Explorations Volume 15 (2015) 53-94

focus on teacher leaders, principals, and central/district office leadership [2-7]. Studies in science education typically focus on the role and impact of science teacher leaders.

Research examining principals and central/district office leadership has occurred predominately in the field of education leadership, and focuses on their activities and their role as an aggregate group when examining their impact on schools. Reports, such as those by Bottoms and Schmidt-Davis, do not distinguish between leadership levels or job responsibilities [3, 8, 9].

The lack of research on the various leadership levels raises an important question for educators of science and other content areas. Is pedagogical expertise sufficient, or is specific content and pedagogical content support necessary to impact student learning in particular content areas, such as science [10]? The literature provides no insight into the importance of content expertise for district leaders. As science educators, we believe that content knowledge is important for teachers. Like Spillane, Diamond, et al., we believe that science leaders in schools and at the district level must have a "sufficient" level of science content and science pedagogical content knowledge to provide the expertise and support teachers need [11].

The recently released *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*, as well as *Next Generation Science Standards*, call for science leaders to be active within their districts to support the changes proposed by these documents to curriculum, instruction, and assessment [12, 13]. The release of the 2011 "Trends in Mathematics and Science Study" shows that we are still not achieving at the levels of many countries [14]. As a nation, there is a strong push to increase the number of highly prepared Science, Technology, Engineering, and Mathematics (STEM) professionals. To improve student achievement and interest in science, we must have skilled science leaders at the district/central office level working with principals and teachers to improve instruction. In order to justify their positions and to support their work, we must understand their role and impact on improving student learning which is currently missing from educational research. Without an understanding of their role and impact on improving student achievement, we cannot justify their work and the necessity of their expertise.

Individuals in these positions come from a variety of backgrounds. They may be trained in science or assigned science as an area of focus for the district. The positions also range from district office positions, such as science coordinators and science directors, to school-level science leaders or science liaisons. To advance work on the role of science coordinators, this article will examine the impact of a five-day science leadership academy on a group of new science coordinators from district/central offices across the Commonwealth of Virginia. Our focus is the work accomplished inside the Academy and in the districts because of the Academy.

The Virginia Initiative for Science Teaching and Achievement_(VISTA) is a five-year Investing in Innovation (i3) grant funded by the U.S. Department of Education. One component of the project is a five-day leadership academy to build, support, and sustain district-level staff for district/central office personnel newly designated (under five years in their position) as the science coordinator.

Review of the Literature—Overview of Educational Leadership Research since the 1970s

Over the last forty to fifty years, the focus of research in the educational leadership arena has shifted. In the 1970s and 1980s, Fullan characterized the role of district leadership as assisting with the "innovation implementation" era of change [15]. The research during this time focused on how districts could support the implementation of new programs and practices. As some schools within a district showed improvement and others did not, the focus of research shifted to the school level. District-level impact was seen as minimal on implementing new practices and programs.

This ushered in a period of research on effective schools. The "effective schools" movement focused on the school as the unit of change for impact on teaching practice and student achievement. Studies during this time, such as Floden, Porter, et al., indicated that district influence on instructional decisions and classroom practices were minor [16]. Only a few studies highlighted the role of school districts on educational change [17]. However, the research did not focus on linking student interventions and student learning. Case studies conducted by researchers in the late 1990s on school district transformation (such as Spillane in Michigan and by Elmore and Burney in New York City) brought the role of the district back to the forefront [18-20]. As noted by Leithwood, Louis, Anderson and Wahlstrom, some districts can and do have a positive impact on schools, teachers, and student achievement [21].

Review of the Literature—Characteristics of Effective or Successful School Districts

Two studies of effective or successful school districts provide insight into characteristics or features common across the districts. The first study, a 2005 review of the research by the American Institute for Research (AIR), identified seven primary themes (see Table 1) based on analyzing twenty studies [22]. They found that effective districts focused on student achievement and learning. This focus was supported by having a theory of action, committing to professional development, and using data to improve and consider policies that are comprehensive and coherent.

Table 1
Comparison of Characteristics of Effective Districts from 2005 AIR Report

Successful districts focus first and foremost on student achievement and learning. All leadership is instructional leadership.
Successful districts have a theory of action for how to effect improvements, and they establish clear goals.
Commit to professional learning at all levels and provide multiple, meaningful learning opportunities.
Use data to guide improvement strategies.
Enact comprehensive, coherent reform policies.
Have educators who accept personal responsibility for improving student learning and receive support to help them succeed.
Monitor progress regularly and intervene if necessary.

In a synthesis study of districts serving a high proportion of underserved students, Leithwood found ten characteristics across thirty-one studies of high-performing districts (see Table 2) [5]. No one characteristic was overwhelmingly identified or significant in its impact. While there are limitations to this study, it does provide suggestions for districts to consider while realizing that systemic reform is complex, nonlinear, and requires leaders who are flexible, with the advantage of feedback loops that allow for alterations in alignment and changes in roles within the district [5].

Table 2
Comparison of Characteristics of Effective Districts from Leithwood Study

Districtwide focus on student achievement.
Identified approaches to curriculum and instruction.
Use of evidence for planning, organizational learning, and accountability.
Districtwide sense of efficacy.
Building and maintaining good communications and relations, learning communities, district culture.
Investing in instructional leadership.
Targeted and phased orientation to school improvement (targeting interventions on low performing schools/students).
Districtwide, job-embedded professional development for leaders and teachers.
Strategic engagement with the government's agenda for change and associated resources.
Infrastructure alignment.

The two studies point to the need for districts to have a unified focus on student learning and achievement, have professional development across all levels, monitor progress, and use data.

Review of the Literature—Science Coordinators as Leaders

St. John and Pratt in 1997 reported on the characteristics of the "best" cases of science education reform in states and districts [23]. In these "best cases," they found leadership that committed to long-term work, connected to many sources of support (local, state, and national), focused on educational substance, and used standards as a vision to guide their reform efforts. Few studies can be found that examined the impact of science-specific coordinators on the work of principals, teachers, and student achievement. This finding is confirmed by other researchers who have noted this missing area in the literature [24, 25]. The lack of knowledge on the impact of content specificity—science in this case—on principals, teachers, and students may be a critical missing link in improving student achievement.

Structure of the Academy

The Academy was designed to occur over a five-day period. This article will report on the second and third years of the Academy. Participants convened for three days in the fall and then again for two days in the spring, with additional networking and support at the Virginia Science Education Leadership Association (VSELA) meeting in the fall (two days) and spring (two days). The New Science Coordinators Academy (NSCA) has six goals for participants:

1) Learn to make improvements in leadership, teacher learning, quality teaching, and student learning.

2) Develop a common understanding of hands-on science, inquiry, problem-based learning, and nature of science.

3) Identify aspects of effective science teaching and learning.

4) Compare district models of creating standards-based science curricula.

5) Investigate data sources available to use in order to provide a focus to improve district science programs.

6) Develop a science program strategic plan.

Our aim is to meet the needs of new science coordinators. These goals also match those identified by research on supporting policy implementation and instructional reform conducted by Marsh and colleagues, as well as the National Science Teachers Association's "Position Statement: Leadership in Science Education" [26-28]. The facilitators address these goals by weaving a variety of activities and opportunities to revisit the goals throughout the five days.

The sequence of activities during Year Two and Year Three were almost identical (see Appendix A). Day 1 of the NSCA engaged the participants in an introduction to VISTA, an introduction to the other participants and VISTA staff, and then a daylong simulation, "Building Systems for Science Literacy." Kathy Stiles of WestEd facilitated this simulation, which is under development by WestEd. The game is based on the ideas and principles of *Designing Professional Development for Teachers of Science and Mathematics* [29]. The simulation allows players to "discover what activities and resources have the greatest impact on teacher and student learning, why some teachers struggle to improve their instructional practices, and how much it 'costs' in time, materials, and commitment to provide effective professional development" [30]. These activities promote Goals 1, 5, and 6.

Day 2 of the NSCA began by engaging the participants in a model Problem-Based Learning lesson. After participating as learners in the lesson, the participants discussed the question, "How can we identify effective teaching?" This led to the introduction of the VISTA definitions for Hands-on Science, Inquiry, Problem-Based Learning (PBL), and Nature of Science (NOS). Science educators in Virginia developed the definitions for Hands-on Science and PBL to be used in common across the VISTA program. The definition for Inquiry came from *Inquiry and the National Science Education Standards*, and focuses on the five essential features of inquiry [31]. Virginia has added specific aspects on the NOS into its state standards, hence an increased interest in NOS since it now can be tested on state standardized tests. These aspects are the focus of the discussion and work of VISTA. The second half of the afternoon focused on examining different data sources and developing an action plan. The participants examined data from TIMSS, NAEP, AAAS, as well as school district data [14]. This examination of data led to a discussion of what the data tells us are gaps in student learning. The participants received a multistep strategic planning tool to identify and organize the gaps from their data. From this tool, the participants began to identify actions to take in the future. Then, these actions were organized and prioritized into tasks on a timeline. These activities promote Goals 1, 2, 3, 5, and 6.

Day 3 focused on engaging participants in expanding the action plan into a more detailed teacher professional development plan. In addition, we wanted to provide the participants with the opportunity to get ideas from other science coordinators from across Virginia. To accomplish this, we brought a group of experienced science coordinators, from districts of varying sizes, to share their insights as science coordinators and to help the participants with their strategic plan. These activities promote Goals 5 and 6.

When they returned in the spring, Day 4 began with small groups of participants sharing how they were progressing with their strategic plan by considering what was going well, what needed improvement, and what components they need for the future. Afterward, participants were provided an introduction to the basics of the NSTA "Science Program Improvement Review" (SPIR) tool to help with evaluation of their work [32]. The coordinators were then given an opportunity to explore classroom discourse, misconceptions in science, and the nature of science or engineering practices. This provided the coordinators with an opportunity to consider additional instructional strategies and supports for use in their districts. The day finished with an update presentation by the state science supervisor. These activities promote Goals 1, 2, 3, and 6.

Day 5 began with the introduction of a protocol for analyzing student work. The participants requested this professional development approach at the end of Day 3 in the fall. The participants examined several different protocols and then practiced using a common set of work, as well as work that they brought with them from their districts. A session on the development of curriculum followed the student work analysis session. The participants looked at their curriculum guides, and were provided analysis prompts that had them map their curriculum to determine whether it was aligned to the *SOL* and supported instruction and assessment. Next, the participants revisited inquiry by examining a tool developed by Volkman and Abell to convert cookbook labs into inquiry labs [33]. The last session of the day dealt with the evaluation of strategic plans and professional development using the SPIR results and the introduction of Thomas Guskey's book, *Evaluating Professional Development* [34]. As a final task, the participants completed an evaluation survey by the outside evaluator. These activities promote Goals 1-6.

Methods—Participants

Thirty-four individuals have participated in the Academy. The participants included ten males and twenty-four females ranging in age from 28-59 years of age from thirty different school districts in Virginia. There were 5 African-American and 29 Caucasian participants. All of the participants held a M.Ed. or M.S. degree, and fourteen participants held or are in the process of earning an Ed.D. or Ph.D. in Education. All participants are currently in leadership positions in their respective school divisions (K-12 science coordinator, science lead teacher, science specialist, instructional coach, vertical team leader, beginning teacher advisor coordinator, elementary principal), and all of the participants have led science professional development. Participants' years of experience in their current leadership roles ranged from two months to five years.

Methods—Measures

For this article, we collected four types of data: 1) participant exit slips; 2) demographic data; 3) agenda and handouts; and, 4) participant activity logs. The daily exit slips were developed by the VISTA NSCA implementation team to align with the goals of the Academy. The questions on the daily exit slips asked participants to reflect on the sessions presented each day, to link their learning to their work, and to track the impact of the sessions. The responses were examined by the lead author to determine the impact of the NSCA on their work. Grounded theory drove the determination of themes or categories from the participant reflections [35]. The exit slips were read several times. Then, each question was read and the responses were categorized by emergent themes [36]. Next, a comparison of the themes to the NSCA goals for alignment occurred. Finally, the themes and their alignment to the goals allowed us to develop answers to the research questions.

The participant logs were participant self-reports of their activities outside of the Academy that involved using their new understandings and resources, and their continued efforts on their strategic plans. These logs were analyzed using the same strategies described for the exit slips. The analysis allowed us to learn from the participants the extent to which the science coordinators used their new knowledge in their district work and to answer research question 5.

Artifacts such as the agenda and handouts from daily activities were collected. In order to analyze if the goals were met, the agenda was correlated with the activities that were conducted, exit slips, and the goals.

Research Questions

The following questions guided assessment of the impact of the New Science Coordinators Academy (NSCA):

1) To what extent do the science coordinators gain knowledge with respect to each of the NSCA goals during the five-day Academy?

2) Which goals of the NSCA were viewed by science coordinators as most beneficial to the science coordinators?

3) What science coordinator needs are not met by the NSCA?

4) To what extent do the science coordinators use the new knowledge in their district work?

Results/Findings

In this section, we are not able to report on findings from the first cohort, since we had not had the opportunity to develop research questions and feedback questions to provide insight into those research questions. These findings will reflect those of participants in Cohorts II and III. To better understand their roles in their districts, we asked the Cohort II and III participants several questions. The science coordinators have a wide variety of roles, including coordinating professional development of science teachers, working in classrooms with teachers, and working on district science curricula. Not all coordinators had the same responsibilities (see Table 3).

Table 3
Potential Impact on Science Instruction in District

Role of Participant in the School District	**Cohort II** **Number of responses (n=15)**	**Cohort III** **Number of responses (n=17)**
Professional and staff development	10	12
Working directly w/teachers	9	2
Curriculum development	6	5
Instructional coaching	4	0
Working directly w/administrators	3	1
Ordering supplies and textbooks	2	3
Hiring and recruitment	2	0
Teacher evaluations	2	0
Teaching in the classroom	2	0
Working w/supervisors	1	0
School improvement planning	1	1
Creating shared mission and goals	1	2
Vague or unclear	3	0

We asked Cohort III to share their perceptions of needs within their district to achieve an exemplary program. Collaborating across grade levels, finding funds for science materials, helping teachers find time to teach science, and providing opportunities for all students to learn science were the most frequently identified needs (see Table 4).

Table 4
Perceptions of Needs to Achieve an Exemplary Program

Perceptions of Needs	Cohort III Number of Responses (n= 17)
Collaboration across grade levels	6
Additional funds for science materials	6
Time to consistently teach science	5
Opportunities for all students	5
Additional technology	2
Building and keeping great teachers	2
Incorporation of critical thinking skills	1
Alignment of assessment to instruction	1
Empowerment of school leads for science	1
Evaluation of what we have and what we need	1
Need a coordinator position	1
Plan for sustainability	1
Development of a strategic plan	1

We also asked Cohort III their perceptions of challenges that could impact their work in their district. A variety of challenges emerged: a focus by districts on mathematics, reading and language arts, their needs for a deeper science content background, time to do the work they believe is needed, and funds for classrooms (see Table 5).

Table 5
Variables Challenging Coordinators' Impact on Science Programs

Variables Challenging Coordinators' Impact	Cohort III Number of Responses (n=17)
Math and English/language arts focus	5
Need content expertise in science	3
Time to do the work	3
Availability of funds	3
Pressures teachers face	2
My ability to foster "buy-in"	2
Communication within district and with schools	2
Other competing focal areas for the district	1
Size of district	1

Daily Exit Slips

The impact of the daily activities on the coordinators was collected via exit slips. Analysis of the coordinators' responses follows.

Day 1 — The first day of the Academy provided participants with an introduction to VISTA, a discussion of their role as science leaders, and participation in a simulation which allowed the participants to consider the various factors within a school district impacting student learning. The simulation, "Building Systems for Science Literacy" from WestEd, examines the various factors within a district that can impact student achievement. The simulation addresses the following goals: 1) learning how to connect professional development designs to the specific learning needs of students and teachers; 2) learning the inputs necessary for designing effective professional development; 3) encountering the constraints and the supports for effective professional development; 4) learning what is needed to sustain teacher professional development; and, 5) understanding the role of leaders in planning professional development.

The simulation offered a common learning experience, and framed the work for the next four days. The participants felt that the simulation was a very beneficial part of their experience. Participants shared how they will implement new science programs, how they will handle resistance to change, and how the simulation helped them understand the process of change. Three responses stand out as exemplar responses for the group:

- "Developing a sense of community goes a long way. So does celebrating success and hearing everyone's voice and seeing needs. The game told me to build a foundation and community before attempting change."

- "I think one of the greatest pieces to the game was using a cohort of people to make informed decisions for the district. Putting time and energy on the front end is extremely important. I will gradually move those that are resistant along through professional development tailored to their needs."

- "I will be more aware not to offer 'one size fits all' professional development experiences. The simulation game helped me focus on ways to motivate reluctant teacher learners and the importance of creating or developing teacher leaders."

These responses indicate that participants learned and/or took away the key goals and outcomes of the simulation. Themes and number of similar responses in Table 6 provide further insight into the overall benefits of the simulation for the participants. Overall, the participants felt that investing in research and planning of professional development, as well as building in opportunities for collaboration and communication, were important. Some outcomes of the simulation resonated more strongly with some cohorts than others, such as a build-in of sustainability opportunities (Cohort II) and multiple areas that must be addressed simultaneously (Cohort III). The diverse personal needs and experiences, in addition to the needs of the district, are reflected in the data.

Table 6
Implementing New Programs and Dealing with Individuals Resistant to Change

Themes	Cohort II n=15	Cohort III n=17
Invest in research and planning of professional development	4	13
Need to know staff needs	0	0
Student learning comes from teacher learning	0	0
Build in collaboration and communication	2	6
Build in rewards and incentives	1	0
Requires time to change practice	0	11
Create buy-in	8	8
Engage teachers in professional development	6	8
Build community/relationships	2	1
Evaluate and monitor progress	1	0
Build in sustainability opportunities	1	0
Must address multiple areas simultaneously	0	6
Work toward a critical mass	0	3

Day 2 — The focus of this day was on recognizing and assessing quality teaching, using available data for planning, and introducing strategic planning. The exit slip focused on recognizing quality teaching and the use of data for planning. To determine participant understanding of the sessions focused on recognizing and assessing quality teaching time, the participants were asked to select one of the introduced terms—Hands-on, Inquiry, or Problem-Based Learning—from the day's discussion and elaborate upon it (see Tables 7-9). The participants indicated their reasons for selecting their term, and how they envisioned improving their efforts to assist teachers in their practice. Their reasons for selecting terms to define ranged from their personal and their districts' needs to fostering twenty-first century skills. Their strategies for assisting teachers in their practice ranged from professional development to embedding in curriculum. The different participant backgrounds are again reflected in the reasons for selecting specific definitions over others. In Cohort II, six of the 15 chose Hands-on, five chose Inquiry, and six chose Problem-Based Learning. In Cohort III, six of the 17 chose Hands-on, eight chose Inquiry, and three chose Problem-Based Learning.

Table 7
Use of the Term "Hands-on"

Reason	Responses for Cohort II/ Cohort III		Use in Practice	Responses for Cohort II/ Cohort III
Identified need at site	2/5		"Teaching teachers"	2/0
Most familiar of the three	2/0		Professional development	1/3
Least familiar of the three	1/1		Increase student involvement	1/1
Desires to become an expert	1/0		Budget to provide materials to teachers	0/1
Science should be taught this way	0/1		No answer provided	0/2

Table 8
Use of the Term "Inquiry"

Reason	Responses for Cohort II/ Cohort III		Use in Practice	Responses for Cohort II/ Cohort III
Identified area of weakness at site	3/3		Assist teachers in skills development	1/2
Feel comfortable, already use this	1/0		Use as a tool for evaluation and feedback	1/0
Previous encounter with idea	1/0		Professional development	1/3
Driving force for the other two	0/2		Meetings with teachers	1/0
Students are the focus here	0/2		Incorporate into district philosophy (mission)	1/0
			Inclusion of science fair	0/1

Table 9
Use of the Term "Problem-Based Learning"

Reason	Responses for Cohort II/ Cohort III		Use in Practice	Responses for Cohort II/ Cohort III
Actively trying to build this skill currently	1/1		Develop curriculum (lessons and units)	2/1
STEM focus	1/0		Need to develop professional development	0/1
Potential for student motivation	1/0		No answer	2/1

Fosters 21st century skills	1/0			
Relevance is important	1/1			
Part of division strategic plan	0/1			
No reason	1/0			

The second focal area for Day 2 was on the use of data by teachers to understand student thinking and to plan their science instruction. Participants responded to this question by considering their role, the needs of their districts, and the needs of their teachers (see Table 10). Not all participants responded to both parts of the question. Responses for Cohort II reflect consideration of district and teacher needs. The participants in Cohort III focused their thoughts on the needs of their teachers. Interestingly, most of the Cohort III responses fell under the theme of identifying trends, weaknesses, and areas of challenge. One participant's response summarizes all of the responses: "The data can unveil gaps in the curriculum, the instructional practices, and lesson plans that must be improved in order to improve/increase student achievement. The data should drive all instructional aspects."

Table 10
Use of Data in Understanding Student Thinking and Planning Instruction

Themes for Use of Data by District Administrators	Responses for Cohort II/ Cohort III	Themes for Use of Data by Teachers	Responses for Cohort II/ Cohort III
Provide teachers with appropriate strategies for use	1/0	Drive instruction	2/0
Broader view, specific insight	1/0	World rankings	4/1
Big picture for decision-making	2/0	Access, review, and discuss	1/0
Planning and Budgeting	1/0	Understand achievement gaps	2/0

Plans for improvement	1/0	Reflecting and improving/raise rigor and expectations	1/0
Don't know	1/0	Identify trends and weaknesses/areas of challenge	1/13
		Develop best practices	1/0
		Identify curricular weaknesses	1/0
		Needed changes in science programs	0/2
		Reinforce the need to make connections in our instruction	0/2
		Areas of student misconceptions	0/3
		Guide instructional planning	0/2

Day 3 — During Day 3, participants focused on developing an action and strategic plan. Both Cohorts II and III identified at least one major priority for their plan once they had an understanding of strategic planning. The participants had a wide range of priorities within each cohort and between the two cohorts, based on their needs and those of their districts. These priorities focused on planning professional development, working on specific areas (such as Nature of Science) building teacher buy-in, and gaining buy-in from district leadership (see Table 11). With the responses being different with little overlap among districts, it points to the unique needs of each district.

Table 11
Action and Strategic Plans: Priorities

Major Priority	Responses for Cohort II/ Cohort III
Include plans for professional development	2/1
Include training in Nature of Science	2/0

Include building buy-in among leadership	1/4
Plan to address threats to student achievement	1/1
Engage teachers in building science literacy and help for working with English Language Learners	1/0
Include building buy-in among teachers	1/0
Include science in division plans	1/0
Build a vision for science with teachers	1/0
Build a common vision and mission	1/0
Include the needs of new secondary science teachers	1/0
Vertical alignment of curriculum, communication, and collaboration	0/2
Professional Learning Communities and curriculum	0/2
Collect baseline data via observations and talking with others	0/1
Materials part of strategic plan and budget	0/1
Curriculum and Pacing Guides	0/1
Improve elementary scores, especially sub-groups	0/1
Instructional materials adoption	0/1
Authentic assessment	0/1

For Cohort II, a panel of experienced science coordinators from around Virginia shared their experiences and answered questions posed by these new district science leaders. The participants reflected on the discussion to identify insights gained from the coordinators about their work and to identify questions they still had for them and other coordinators. Several insights indicate the range and depth of the participants' learning:

- "…. some of the issues shared were very interesting and also seen in other districts."

•"I learned that large districts operate a lot differently than smaller districts and would like to learn more about their curricula K-12."

•"It's interesting how we are all so different, yet [have] many of the same challenges."

This last quote exemplifies the feeling of over half of the participants as they were surprised by the similarity in obstacles and challenges. This served as a unifying point for all of the participants.

Cohort III had the opportunity to interact with the Virginia state department science director. This session provided the participants with information about state initiatives and how the Virginia Department of Education could help them. Their reflection question asked them to consider how this session and working with VISTA staff and other participants impacted their experience. Some participants did not share responses to this question. Again, Cohort III has a wide range of insights into their role based on their conversations with the different groups (see Table 12).

Table 12
Themes on Insights into Their Roles

We wear many hats and many different responsibilities and roles (district office to classroom). (4)
Leadership in science requires knowledge of pedagogy, curriculum, and content. (3)
Not all school divisions have the same stance on science instruction and also have varying contributing factors. (2)
Networking is single most important. (2)
Need to take small steps with teachers, get their buy-in. (2)
Need to communicate more with principals and teachers.
Funding is major obstacle.

Day 4 and 5 — At the beginning of Day 4 in the spring, participants were asked to think back to their first three days in the fall and to share what ideas they had taken back to use in their districts, as well as what new insights they had gained since then about the program. The most common component of the program that participants continued to have insights into and to use was their learning and work with the VISTA definitions for Hands-on Science, Inquiry, and the Nature of Science (NOS) (see Table 13). Other insights focused on science education in the United States, the need for focused, data-driven professional development, and the implementation of inquiry and NOS in the classroom. The participants also had strategic planning as a focus and used activities from the program, such as the "apple activity" which focuses on the definition of Hands-on Science. A number of other ideas and program components were of value to other participants (see Table 13). Again, we are finding a range of insights that reflect the coordinators' needs and the needs of their districts.

Table 13
Reflecting on Insights from Day 1-3 and on "What Have I Used?"

Themes for New Insights	Responses for Cohort II/ Cohort III		Themes for "What Have I Used?"	Responses for Cohort II/ Cohort III
Notable definitions: Hands-on, NOS, Inquiry	7/2		Conducted professional development on definitions (NOS, Inquiry, Hands-on)	8/5
Professional development-needs, planning, conducting	2/4		Used the "apple activity"—sharing the activity with new teachers	3
Strategic planning for science and within the district	2/2		Using strategic planning as a district focus	3/2
District work and coordination takes time and is hard	1/3		Creating a vision for incorporating inquiry	1/1

Role of myself as a science coordinator	1/1		Baseline data collection	2/0
Data analysis and student assessment	3/0		Network and planning	0/1

(Cohort II = 14; Cohort III = 13)

Day 4 and 5 focused upon strategic planning, the examination of several instructional strategies/approaches, and the analysis of student work. The instructional strategies that were focused on were classroom discourse, the use of student misconceptions, the Nature of Science (NOS), and the "E" in STEM. They were asked to reflect on the sessions, select up to two they envisioned using with their teachers, and to explain why they selected those (see Tables 14 and 15). Participants selected discourse and misconceptions most frequently. Several participants indicated that these two areas "merge at a point if our goal is to create a science-literate community." The NOS session introduced new strategies, but had been discussed previously, so its impact may have been lessened.

Table 14
Strategy Sessions That Resonated with Participants

Discourse	Responses for Cohort II/ Cohort III		Misconceptions	Responses for Cohort II/ Cohort III		STEM	Responses for Cohort II/ Cohort III
Ease of integration	3/0		Importance to learning	2/4		Relevance to district needs	2/0
Value in classroom	2/4		Ease of integration	1/0		Identified need by teachers	1/0
Familiar with this strategy	1/0		Similar to what they know	1/0		Direct impact on teaching	1/0
Current district	0/1		I grew the most	0/1		Planning and	0/2

initiative			here			conducting professional development on this	
I grew here	0/2		Workshops planned to embed this	0/3		Need to link to curriculum guides	0/1
Other	1/3		Everyone has them	0/2		Goes hand-in-hand with differentiatio n	0/1

(Cohort II = 14 participants; Cohort III = 17)

Table 15
Day 5: Strategy Sessions

Analyzing Student Work	**Responses for Cohort II/ Cohort III**		**Curriculum**	**Responses for Cohort II/ Cohort III**
Value of activity to meeting objectives	1/0		Identified need by teachers	4/0
Identified need for improving student learning outcomes	1/3		Process would help teachers teach beyond the *SOL*	1/0
Direct impact on teaching	1/1		Relevance to district needs	1/1
			Need to expand our guides based on this	0/2

(Cohort II = 11 participant responses; Cohort III = 17)

The participants also shared how they planned to use these with teachers. They felt the discourse session would help promote a literate community, and the question prompts provided a framework for the introduction and support of student talk. The participants envisioned "going over" and "helping out teachers" with the different aspects of the Nature of Science. The participants planned to share how both the web resources and the American Association for the Advancement of Science assessment items correlated to the misconceptions of middle and high school students [37]. Some participants were comfortable with inquiry so they focused on student work and curriculum. They shared that all sessions filled a need in their district and were relevant to their work in their districts.

The participants reflected on the strategic planning process over the entire Academy. They were asked to describe how they envisioned their plan helping them with their district work. The two themes identified more than once were that the plan would provide focus and future direction, and the plan would help to "overhaul the curriculum in the district" (see Table 16). The coordinators' responsibilities vary in their districts which is reflected in their responses.

Table 16
Themes for Envisioning How the Strategic Plan Will Help Their Work

Themes	Responses for Cohort II/Cohort III
Focus and direction, framework for work	7/12
Need to revisit, revise, improve the plan	2/1
Need to rethink evaluation of PD	0/2
Possibly establish plan next year	1/0
District shot down plan so now I will work at my school	0/1

(Cohort II = 10 participants responding; Cohort III = 16)

Activity Logs

To earn a stipend, participants had to document at least forty hours of work across the year related to their job and the Academy, but outside of the Institute. To document their work, the participants provided a log of their activities outside of the five days in the Academy that indicated their use of ideas from the Academy. The participants reported from 40-73 hours of work outside of the Academy and their normal work. On average, participants reported fifty-three hours of work related to the Academy. The coordinators impacted from 1-250 teachers and from 20-12,000 students, partially indicating the varying size of their school districts. While these hours and the impact on teachers and students were reported in order to receive a stipend, they provide insight into the components of the Academy that the participants valued or felt they needed to support their work. The participants reported reading from the resources provided, such as *Designing Professional Development for Teachers of Science and Mathematics*, incorporating activities used in the Academy into their professional development, and developing other types of professional development (see Table 17) [29].

Table 17
Summary of Log of Application of Learning

Daily Themes	**Resource**	**Responses for Cohort II/ Cohort III**
Leadership – Leading School-Based PD: Building Capacity for Science Learning Simulation (Day 1)	Reading of:	
	Articles	NA/10
	PD Design Framework	3/7
	Ready, Set, Science!	2/0
Leadership – Recognizing and Assessing Quality Teaching (Day 2, 4, 5)	Hands-on Science	5/2
	Inquiry-Based Science	7/8
	Problem-Based Learning	2/5
	Nature of Science	9/2
Leadership Planning – Your School Division- Data (Day 2, 3, 5)	Data Analysis	1/2
	Use of Data Websites	4/0
Strategic Plan for Science (Day 3, 4, 5)	Development of plan continued	9/10
Professional Development Planning	Development of	11/17

and Sharing (Day 3, 4, 5)	professional development sessions and delivery to district teachers	
Other	Benchmark development and analysis Textbook Adoption Science Fair Curriculum Alignment	NA/7 NA/2 NA/4 NA/2

(Cohort II = 11 responses; Cohort III = 17)

Professional Development Impact on Participants

As shared earlier, the NSCA has six goals for participants. This section will describe the impact on participants of the various NSCA program components aligned to each goal. Each goal was correlated to the sessions conducted each day and to the exit slip questions (see Appendix B). Examining the themes identified from the daily exit slip questions allowed us to assess whether the NSCA achieved each goal.

Each day of the NSCA had a component that helped participants deepen their understanding of the ideas in Goal 1, "improvements in leadership, teacher learning, quality teaching, and student learning." Table 18 identifies the activity each day matching the goal. Weaving this goal into each day provided participants with time to learn, reflect, and grow in their understanding and skill.

Table 18
Goal 1 Correlated to Daily Sessions

Day 1: "Building Systems for Science Literacy" simulation from WestEd Day 2: Update from State, Recognizing and Assessing Quality Teaching (State and District Data), and Strategic Planning Day 3: Teacher Professional Development Planning and Sharing of Plans and Expert

Panel/VA State Science Director Day 4: Strategic Planning I and Update from State; Discourse, Misconceptions, Nature of Science Day 5: Strategic Planning II and Curriculum; Analyzing Student Work, Inquiry, Curriculum

Goal 1 is that participants learned and/or took away the key goals and outcomes of the simulation. They gained new insights into teacher and student learning from participating in the activities designed to share the VISTA definitions for Hands-on Science, Inquiry, and Problem-Based Learning, as well as participating in the sessions on discourse, misconceptions, curriculum, and analyzing student work. Reflecting on the emerging themes shared in the daily analysis allowed us to assess whether this goal was achieved. Goal 1 was achieved based on the following overarching themes identified:

- Teacher buy-in and professional development are essential for the definitions to be adopted by teachers. (Cohorts II and III)

- Collaboration and building community support improvements. (Cohorts II and III)

- VISTA definitions for Inquiry, Hands-on Science, and Problem-Based Learning support these improvements. Needs are different at each district and personally for the science coordinators. They envision using these ideas in professional development, as a feedback tool for classroom observations, and to develop curriculum. The definitions provide the coordinators with a support structure for working with teachers. (Cohorts II and III)

- Classroom discourse strategies, identification and use of student misconceptions are important components for making improvements. (Cohorts II and III)

- Analyzing student work and the development of curriculum by teachers are important strategies for helping districts improve. (Cohorts II and III)

Goal 2 was "developing a common understanding of hands-on science, inquiry, problem-based learning, and the nature of science." Reflecting on the emerging themes shared in the daily analysis allowed us to assess whether this goal was achieved. Goal 2 was achieved based on the following overarching themes identified:

- As indicated for Goal 1, the sessions focused on the VISTA definitions for Inquiry, Hands-on Science, and Problem-Based Learning and supported their development of a common understanding. (Cohorts II and III)

- Some of the participants were less familiar with these terms than others, so the sessions helped to develop understanding. (Cohorts II and III)

- The definitions support their district work and provide a support structure for working with teachers. (Cohorts II and III)

Goal 3 was "identifying aspects of effective science teaching and learning." As with Goals 1 and 2, reflecting on the emerging themes shared in the daily analysis allowed us to assess whether this goal was achieved. Goal 3 was achieved based on the following overarching themes identified:

- Professional development and collaboration are important for a common vision to develop. (Cohorts II and III)

- The VISTA definitions provide support for teachers and themselves. (Cohorts II and III)

- Professional development focused on these definitions is planned or has occurred. (Cohorts II and III)

- Baseline data for "hands-on" is being collected to better understand the supports needed by teachers. (Cohort II)

- Classroom discourse is easy to integrate and decreases teacher talk. (Cohorts II and III)

Goal 4, "comparing district models of creating standards-based science curricula," was achieved based on the following overarching themes identified:

- It is an identified need by district. (Cohorts II and III)

- Good curriculum helps teachers go beyond Virginia's *Standards of Learning* (*SOL*). (Cohorts II and III)

- The strategy for analysis of curriculum shared by the facilitators from their former districts will be used in professional development. (Cohorts II and III)

Goal 5, "investigating data sources available to use to provide a focus to improve district science programs," was achieved based on the following overarching themes identified:

- Data help to identify gaps in instruction and assist with decision-making. (Cohorts II and III)

- Data will help determine which strategies are most effective. (Cohorts II and III)

- There is a need for focused, data-driven professional development. (Cohorts II and III)

Goal 6, "developing a science program strategic plan," was achieved based on the following overarching themes identified:

- Participants were comfortable with identifying district strengths and weaknesses.

- Strategic plan priorities varied based on the needs of each participant and their district. Some of the priorities included the following: planning for professional development in general, planning for Nature of Science professional development, providing science literacy for all students, addressing threats to student achievement, building a common science vision among teachers, and several others.

An examination of the themes identified from the participant responses allowed for answers to the research questions guiding this study. We used each question as the lens for reviewing and selecting themes. Guiding the study of the impact of the New Science Coordinators Academy are the following questions:

1) To what extent do the science coordinators gain knowledge about each of the NSCA goals during the five-day Academy?

2) Which goals of the NSCA were viewed as most beneficial to the science coordinators?

3) What needs do the science coordinators express to facilitators that are not met by the NSCA?

4) To what extent do the science coordinators use the new knowledge in their district work?

For question 1, the extent to which the coordinators gained new knowledge about each of the goals, it is important to remember that the coordinators came to the Academy with a wide range of prior experiences. Their reflections (see Tables 3-17) indicate that they learned from the activities designed to match each goal of the NSCA. The insights took many forms, from learning new information to considering new perspectives. Overall, the science coordinators gained new knowledge from the NSCA.

For question 2, which goals were most beneficial, it is difficult to determine from this data whether one component was more beneficial than another. The various backgrounds of the coordinators resulted in different components resonating more strongly with some than others. All activities were highly regarded by some of the participants and no activities were disavowed by all. All of the goals in some way improved participants' understanding or reminded them of the importance of considering all of the ideas or components presented as they build their programs.

For question 3, needs not addressed by the facilitators, the science coordinators were very honest about areas in which they need help. They made the following requests:

- "Additional research to support goals";
- "Needing data protocols for working with data and teachers";
- "If I don't see results, what next?";
- "More on developing curriculum"; and,
- "More information on how other districts work."

The answer to question 4, the extent of participant learning used by them in their own districts, is informed by the data logs the participants submitted at the end of the spring (see Table

17). These logs indicate that the participants read and used the publications shared with them. They incorporated some of the activities into their own professional development with teachers, incorporated the VISTA definitions in professional development, and continued working to analyze data and develop their strategic plans. In conversations with the coordinators at the various meetings, the coordinators have reiterated that the NSCA was beneficial to their work. In addition, they have asked for opportunities to work together again with the VISTA team to further develop and improve their strategic plans.

Discussion and Limitations

Research on the learning of science coordinators, and their impact on the teaching and learning of science in their districts, is very limited. This is unfortunate, as they can play a critical role in how their districts view the teaching of science and how science instructional materials are developed, selected, and implemented. In addition, their role can extend to the instructional practices teachers learn about, are encouraged to use, and feel supported in their efforts to implement. These areas all support the outcomes of effective science leaders as outlined in the NSTA "Position Statement: Leadership in Science Education" [28]. Successful implementation of reform is dependent upon science leaders working in five areas: science teaching and learning, professional development, science curriculum, and assessment.

Each NSCA provides participants with an opportunity to build a network with other science leaders across Virginia, build a common vision for science instruction, and obtain tools to support their work in their own districts. Participant reflections indicate that they learned from their experiences and intend to use this knowledge. Overall, the reflections indicate that the NSCA successfully addressed its goals and met the needs of the participants. The reflections also indicate that all participants believed the tools and support of the group to be important to their work.

The participants came to the Academy with diverse prior experiences and diverse roles and responsibilities as science leaders. The components of the Academy were important to all participants; it is no surprise that different components of the program resonated more strongly with some participants than with others. The program allowed participants to enter successfully from different places, and to develop new understandings and skills for use in their positions. The simulation, "Building Systems for Science Literacy," provided an important common experience allowing participants to consider their current understanding, to learn other participant strengths, and to begin building collegial networks. The model Problem-Based Learning and Inquiry activities (on Day 2 and 5) provided a common experience for the participants to discuss best instructional practices, and to consider their roles in working with teachers to improve hands-on, inquiry-based science instruction. They indicated that these activities and definitions would be very helpful in their district work. The development of individual strategic plans allowed participants to meet their needs and the needs of their districts. These different components support the needs of these learners as they provide multiple entry points and opportunities to grow [22, 38, 39]. The skills and opportunities provided in the NSCA align with the dimensions and components identified and shared in the literature review [3, 9]. The activities of the NSCA can help the participants take on a role within their district that impacts teacher practice and student learning. According to participants, the NSCA empowered them to take a leadership role, because they had a well-developed plan and activities to carry it out.

This study's strong linkage among the agenda, goals, activities, and daily evaluation suggests that the New Science Coordinators Academy is a well-planned professional development. Eight of 11 (73%) Cohort II participants and 17 of 19 (89%) Cohort III participants thought that all components of the program were applicable. The effectiveness of the professional development for the coordinators is evidenced by the responses of the participants regarding their comfort with the program, their use of various aspects of the program, and their confidence (i.e., not needing further help).

An innovative aspect of the program was to provide further planning, in addition to the planning during the Academy, by providing a stipend for the participants to create and implement professional development. This aspect of the program seems to be an effective method of having the participants carry through with the intent of the Academy to increase effective professional development for teachers.

This study faces several limitations. First, the sample size is small (n=32), but it is growing. The data continues to reflect the participants' learning and specific needs. The data available for analysis (Participant Reflections and Logs) is limited, but does provide insight into participant perceptions. In the future, responses from the final two cohorts will allow for more reliability as to perceptions and use in the short term in participant work. Second, additional study of how the participants continue to use their learning is needed. The ability to track these individuals is essential, as it will provide science educators insight into the impact of the Academy on their role as district leaders and the impact they have on student learning.

The overall purpose of this Academy, as identified in the grant proposal, is to support the development of the state infrastructure necessary to bring improvement to classroom instruction and student achievement. Developing statewide definitions for important common science terms furthers building a cohesive infrastructure. The data shared in this article support this purpose as the Academy provided learning opportunities for new science coordinators, and they left with new insights matching their needs. Future studies need to consider their impact on classroom instruction and student achievement.

Acknowledgment

The contents of this article were developed under a grant from the U.S. Department of Education Investing in Innovation (i3) Program. However, the contents do not necessarily represent the policy of the U.S. Department of Education, and no endorsement by the federal government should be assumed.

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Appendix A
Agenda for Each Day

Day 1	Day 2	Day 3
UVA Data Collection Introduction of Staff Program Overview and Goals Brief Introduction of VISTA Introduction to the Science Landscape in VA Introduction to VA Science Organizations and Their Role as a Science Leader Leadership- Leading School-Based PD: Building Capacity for Science Learning through the "Building Systems for Science Literacy" Simulation (WestEd) The Building Systems Simulation Debrief Wrap-up and Homework Exit Slip	Goals for the Day Leadership- Recognizing and Assessing Quality Teaching; engaging participants in a PBL lesson Definitions and Instruments- Hands-on Science, Inquiry, PBL, and the Nature of Science Leadership Planning- Your School Division and Data (TIMSS, NAEP, AAAS, and School Division Data) Strategic Planning for Science Wrap-up and Homework Exit Slip	Goals for the Day Leadership Planning- Teacher Professional Development Interactive Roundtable Teacher Professional Development Planning and Consult with Experts Sharing Professional Development Plans Planning for Day 4 and 5 Wrap-up Exit Slip

Day 4	Day 5
Welcome Back Strategic Planning I Focusing on Effective Science Instruction: Classroom Discourse Focusing on Effective Science Instruction: Misconceptions Nature of Science Update from the State Wrap-up Exit Slip	Reflections Focusing on Effective Science Instruction: Analyzing Student Work Focusing on Effective Science Instruction: The Role of Curriculum Focusing on Effective Science Instruction: Inquiry II Strategic Planning II Wrap-up UVA Evaluation

Appendix B
Correlation of Goals to Academy Sessions

Goal 1 — improvements in leadership, teacher learning, quality teaching, and student learning. The following sessions and exit slip questions addressed this goal:

Daily Sessions Correlated to This Goal	Exit Slip Questions Correlated to This Goal
Day 1: "Building Systems for Science Literacy" simulation from WestEd Day 2: Update from State, Recognizing and Assessing Quality Teaching (State and District Data), and Strategic Planning Day 3: Teacher Professional Development Planning and Sharing of Plans and Expert Panel Day 4: Strategic Planning I and Update from State, Discourse, Misconceptions, Nature of Science Day 5: Strategic Planning II and Curriculum, Analyzing Student Work, Inquiry, Curriculum	Day 1 Question 1 and 2 Day 2 Question 1 Day 4 Question 1 and 2 Day 5 Question 1

Goal 2 — developing a common understanding of Hands-on Science, Inquiry, Problem-Based Learning, and Nature of Science. The following sessions and exit slip questions addressed this goal:

Daily Sessions Correlated to This Goal	Exit Slip Questions Correlated to This Goal
Day 2: VISTA Definitions and Instruments Day 4: Nature of Science (NOS) Day 5: Analyzing Student Work and Inquiry	Day 2 Question 1 Day 4 Question 1 Day 5 Question 1

Goal 3 — identifying aspects of effective science teaching and learning. The following sessions and exit slip questions addressed this goal:

Daily Sessions Correlated to this Goal	Exit Slip Questions Correlated to this Goal
Day 1: *Building Systems for Science Literacy* simulation from WestEd Day 2: VISTA Definitions and Instruments Day 4: Discourse, Misconceptions, NOS Day 5: Analyzing Student Work, Inquiry, Curriculum	Day 1 Question 2 Day 2 Question 1 Day 4 Question 1 and 2 Day 5 Question 1

Goal 4 — comparing district models of creating standards-based science curricula. The following sessions and exit slip questions addressed this goal:

Daily Sessions Correlated to This Goal	Exit Slip Questions Correlated to This Goal
Day 5: Curriculum	Day 5 Question 1

Goal 5 — investigating data sources available to use in order to provide a focus to improve district science programs. The following sessions and exit slip questions addressed this goal:

Daily Sessions Correlated to this Goal	Exit Slip Questions Correlated to this Goal
Day 2: Recognizing and Assessing Quality Teaching (State and District Data)	Day 2 Question 2 Day 4 Question 1

Goal 6 — developing a science program strategic plan. The following sessions and exit slip questions addressed this goal:

Daily Sessions Correlated to This Goal	**Exit Slip Questions Correlated to This Goal**
Day 2: Recognizing and Assessing Quality Teaching (State and District Data), Strategic Plan, Day 3: Teacher Professional Development Planning, Day 3: Sharing of Plans and Expert Panel Day 4: Strategic Planning I Day 5: Strategic Planning II	Day 3 Question 1 and 2 Day 5 Question 2