Elementary Science Specialists: A Pilot Study of Current Models And a Call for Participation in The Research

The authors report an empirical pilot study of current models of elementary science instruction that utilize science specialists, and make a call for the participation of schools and districts that use a specialist model to assist in collecting the descriptive data needed to create the foundation for future research on the use and impact of elementary science specialists.

What learning experiences do elementary students need to achieve scientific literacy? How are these experiences best provided? These questions have long been the focus of research and reform (AAAS, 1993; Appleton, 2007; NRC, 1996). Paramount among the recommendations is that children should be active learners, constructing science understanding through hands-on/minds-on inquiry experiences. Young learners should engage in science investigations wherein they ask questions, collect and make sense of data, and come to conclusions that are supported by evidence (NRC, 2000; 2007). Students should investigate "authentic questions generated from student experiences" (NRC, 2000, p. 31). Students should experience science inquiry such that they develop positive attitudes, skills, and knowledge about science and the relationship between science and society. These experiences should involve collaboration and communication among students as they build expertise and confidence.

This inquiry instructional approach places demands on the elementary teacher beyond science content knowledge and traditional pedagogical knowledge. Gess-Newsome (1999) describes four attributes required of teachers to provide effective science instruction:

(1) *Content knowledge and attitudes*: "… understanding of the four elements of scientific literacy: conceptual knowledge, nature of science, integration, and relevance. Attitudes that support science teaching include an enthusiasm and a willingness to create time for science instruction and recognize that all students have the right to be engaged in meaningful science instruction. Teachers with positive attitudes toward science will encourage similar attitudes in their students by modeling curiosity, using problem solving approaches when answering questions, relying on data, being skeptical of explanations while being open to new ideas, and respecting reason and honesty." (p. 2)

(2) *Pedagogical knowledge and skill*: Teachers need to plan, implement, and assess student active involvement in science instruction. "Activities should be inquiry-oriented, support the social construction of accurate science knowledge, and develop classroom community" (p. 2).

(3) *Knowledge of students:* This category includes knowledge of student development; student misconceptions; and students in one's class such that the teacher recognizes opportunities to garner interest and make relevant connections (p. 2).

(4) *Knowledge of curriculum:* "… allows a teacher to select, adapt, or create instructional materials to meet

student needs and recognize how these materials combine to create a coordinated program of science both across grade levels … and across the curriculum …" (p. 2)

Teachers are not only expected to have expertise in all these areas regarding science, elementary teachers are also expected to have expertise in all these areas regarding the other subjects they teach. Few would doubt the importance of science education for today's society. However, in the age of No Child Left Behind, elementary science instruction has been given lower priority than reading and mathematics, resulting in even less time devoted to science (Griffith & Scharmann, 2008; Sandler, 2003). The importance of early quality science learning experiences and demands from high-stakes testing has created a dilemma in elementary settings. What type of elementary science instructional model will help meet the needs of today's learner?

Most elementary classroom teachers have limited experience with science in general, let alone scientific investigations (Smith & Anderson, 1999). Lack of content knowledge and investigation experience has been linked to teachers' lack of self-confidence in teaching science and, in turn, lack of science emphasis in their elementary classroom (Appleton, 2007; Ramsey-Gassert et al., 1996; Schwartz, Abd-El-Khalick, & Lederman, & 2000; Tilgner, 1990). The 2000 National Survey of Science and Mathematics Education (Weiss, Banilower, McMahon, & Smith, 2001) revealed that 40% of K-5 teachers have had four or fewer semesters of college level science. The survey also showed that K-5 teachers' perceptions of their own preparedness reflected their minimal science background, with more than two-thirds of their sample reporting they did not feel well prepared to teach science; whereas 77% reported feeling well prepared to teach language arts and reading. Other constraints of poor facilities, overcrowded curriculum, limited time and resources, and limited administrative support contribute to the de-emphasis of science at the elementary levels (Appleton, 2007; Ramsey-Gassert et al., 1996; Rhoton, Field, & Prather, 1992; Tilgner, 1990). The persistence of these constraints, and the added constraints due to No Child Left Behind (Griffith & Scharmann, 2008), cannot be overlooked in the planning and implementation of quality elementary science instruction.

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Elementary Science Specialists

In response, many schools and school districts across the United States have sought the expertise of *elementary science specialists*. In 2000, as many as 15% of elementary students in the United States received some science instruction from science specialists in addition to their regular classroom teacher, and 12% received instruction solely from a science specialist (Weiss et al., 2001). Specialists have many roles and faces, but typically they have greater science content background, perhaps even holding a degree in a science area and specialize in science teaching (Abell, 1990). A specialist's main emphasis in a school or district is science instruction. They could develop curriculum, provide resources, offer professional development, deliver science instruction alone or in a co-teaching model, and serve as coach or mentor to classroom generalists to enhance science instruction. Advocates for elementary science specialists argue that the more substantial science content and pedagogical knowledge and high priority and support for science teaching will result in higher quality science learning experiences for elementary children (Abell, 1990; Gess-Newsome, 1999; Hounshell & Swartz, 1987; Jones & Edmunds, 2006; Nelson & Landel, 2007; Neuman, 1981; Schwartz et al., 2000; Williams, 1990).

Even though specialist-led models have been in place for decades, there have been few published descriptions of models (e.g. Abell, 1990; Gess-Newsome, 1999; Hounshell & Swartz, 1987; Jones & Edmunds, 2006; Nelson & Landel, 2007; Neuman, 1981; Schwartz et al., 2000; Williams, 1990), and even fewer empirical studies of existing models and their effectiveness on student achievement (Jones & Edmunds, 2006; Schwartz et al., 2000). Schwartz et al. (2000) provides one empirical study that compared instructional planning between science specialists and generalists; and student achievement between a specialist-led district and a non-specialist district. This study demonstrated the science instructional planning of the science specialists better aligned with reform-based practices in comparison with the regular classroom teachers in the same district. Further, students taught by the elementary science specialists were engaged in inquiry-oriented activities and demonstrated critical thinking abilities. In comparison to students in the non-specialist district, students taught by the science specialists were *not* significantly different in achievement on state science tests. The study lends support to the effectiveness of the district's science specialist model in enhancing learners' inquiry and critical thinking skills, while maintaining content achievement as measured on state tests. The study also demonstrated the exclusive use of science specialists for all science instruction, the model implemented in the targeted district, may have diminished science teaching abilities of the regular classroom teachers in that district. In their study of three schools employing science specialists, Jones and Edmunds (2006) found similar results regarding instructional approach employed by science specialists. These results were consistent whether the specialist was the sole deliverer of science instruction or if the specialist was a curriculum leader who worked with the classroom generalists on science instruction.

Developing a Research Agenda

Policy, curricular, and instructional decisions regarding elementary science must be informed by research. The studies described above suggest that science specialists can enhance elementary science learning experiences. To date, however, sufficient research on current practices and effectiveness of elementary science specialists is sorely lacking. In response to the interest and need for understanding and research, the Center for Science Education at the Education Development Center, Inc. (EDC) organized an invitational conference "*Exploring the impact of elementary science specialists,*" funded by the National Science Foundation. The conference was held in Boston, MA, in the fall of 2007. The purpose of the conference was to discuss the current state of affairs regarding how elementary science specialists are utilized and to set a research agenda to study the effectiveness of these programs. In this issue of the *Science Educator*, (EDC, 2008) presents the findings from the conference and has organized the more than 50 research questions generated at the conference in a proposed research agenda. At the close of the conference, we proposed to conduct an initial descriptive study of science specialist programs represented at the conference. The findings of this study are reported here, along with a call for participation in a larger comprehensive study. Before we can begin addressing the practical issues of impact on student achievement, we must have an understanding of how elementary science specialists are currently being utilized in various districts and schools. We must develop common language as well as common understanding of the phenomena related to elementary science specialists (see also the article by Century in this issue of the *Science Educator*). The discussion during the conference made it abundantly clear that there are multiple models, multiple roles, and multiple descriptions of elementary science specialists. The purpose of this paper is to begin clarifying some of these features by examining current practices.

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Problem

As described in the EDC article (this issue) articulating the research agenda, descriptive studies about the use of elementary science specialists are needed in order to develop a common vocabulary and to act as a foundation for an empirical literature base. This descriptive study is an initial attempt to provide some of the needed information. The purpose of this study was to test the validity of the elementary science specialist model descriptors as developed from the literature, educational practice, and discussion at the EDC conference. As a result of this investigation, we anticipate three outcomes: 1) the pilot testing of a set of questions that can be used in surveys and interviews to capture information about the use of elementary science specialists, 2) the identification of a set of potential school or district sites for further and more in-depth investigation, and 3) an initial trial of data analysis strategies for use with an expanded data base. The ultimate purpose of this article is to invite the participation of elementary schools and districts that use a science specialist model to assist us in collecting the descriptive data that we need to create the foundation for future research on the use and impact of elementary science specialists.

Method

This study was conducted in three phases. First, the elementary science specialist models discussed in the literature were synthesized, vetted at the EDC science specialists conference (EDC, this issue), and then organized as an initial framework for capturing the use of specialists in schools. This synthesis was built upon a model initially proposed by Gess-Newsome (1999), with the added reference to Nelson and Landel (2007) who used the term "collaborative specialist" as a model consistent with the departmentalized model. Based on the discussion at the EDC conference, the specialist-led models were categorized as Student Instructional Models or Teacher Mentoring Models, depending upon the focus of the program. For instance, the Student Instructional Models all relate to variations in the use of specialists in the direct teaching of students, where the Teacher Mentoring Models use specialists to assist classroom teachers in science instruction as opposed to direct instruction. Programs utilizing classroom generalists only, without hiring of a specialist, are classified under "Generalist Models." The conceptual organization for this study can be found in Table 1.

In order to test the conceptual organization, in the second phase, 34 school-based participants who attended the EDC conference were e-mailed a survey listing the model types and asking them to indicate the models that most closely-match their school or district. They were also asked to provide information about model variation within their district and the number of hours dedicated to elementary science instruction. Answers were received from 12 respondents, representing six large urban districts.

In the third phase of the study, an initial descriptive analysis of the data was conducted, resulting in Table 1 and the qualitative results that are presented in this paper. Based on this analysis, a second e-mail survey was sent to the 12 respondents (see note 1 for web access to the survey). The second survey sought to clarify the initial responses with questions focused on the variation in model use within a district, the variation in time spent in science instruction, and the perceived challenges to implementation (organized around the themes of financial support, school-level support, district-level administrative support, the impact of state testing, and issues related to implementation such as scheduling and curriculum materials). Six of the respondents, representing three of the districts, responded to this e-mail. This data was qualitatively analyzed using open coding (Krathwohl, 1998), looking for themes across the respondents that might illuminate further refinement of survey questions or prompt additional forms of data collection and analysis.

Results and Discussion

Elementary Science Specialist Models

Answers to the initial survey were received from 12 respondents representing six large urban districts in six different states (California, Illinois, Massachusetts, Nevada, New York, and Washington). The individuals who responded fulfilled the following roles: six were school-based science specialists, four were district-level science specialists, and two were elementary school principals.

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All indicated a willingness to be interviewed or to provide additional information.

All six of our predetermined instructional models were represented in the sample (Table 1), lending support for the conceptual organization. We were initially surprised to find districts indicating that they used several of the models described and were concerned that the multiple indications were a result of a poor conceptual organization or insufficient model descriptors. The second survey helped clarify this issue: districts often used different models in different schools. For instance, within a single district, some schools followed a generalist model while others used one of the specialist models. District 1 described a slight variation of the science specialist pull-out model whereby the classroom teachers signed up for a 4-6 week block of time to take their students to the science laboratory where the science specialist engaged the students in an extended unit. Other times during the year the classroom teacher was responsible for science instruction, with support from the specialist (support team model). This finding suggests that it will be important to determine, beyond the science specialist model in use, the level of responsibility for science instruction retained by the classroom teacher in addition to instruction provided by the specialist. Such information will help determine if the prevalence of the classroom generalist model is isolated from or in addition to a science specialist. In looking at the Teacher Mentoring Models, the level of organizational support (school or district) varied with our sample, indicating a need to specifically ask about the level at which the specialist is employed. Based on this initial analysis, the conceptual organization of elementary specialist models was supported by this pilot sample and, with minor modifications and clarification, will be used for further data collection efforts.

In this initial survey, we also sought to gain insight on the amount of time spent in science instruction. With variation by school in the use of a model, it was quickly apparent that more categories were needed to accurately capture this information. In Table 1, we modified our original question to assess the amount of time spent in science on average across the district, and asked for a comparison of time spent on science when a specialist model was in use. Based on the information provided by our informants, we also included a grade level breakdown, with time spent on science varying between grades K-2, and grades 3-5. In reflection, a more accurate set of questions may be to ask about the time spent on science in schools with and without specialists (as opposed to an average) and to break these estimates down by grade level bands. As can be seen from this pilot data, the instructional time devoted to science varied widely within and across districts, with the suggestion that schools with science specialists *may* devote more time to science instruction.

The follow up survey (see note 1 for web access to the survey) attempted to clarify the reasons for variation in the use of specialists within districts, as well as identify obstacles and facilitating factors associated with specialist-led models, and elicit perceived impacts of the models on teachers and students. Six of the initial 12 volunteers responded to our follow up request, representing three of the districts (Districts 1, 2, & 6). The results presented below are based on both sets of surveys.

Source of Variation: Site-based Decision-making

Within district variance in the use of specialist models was attributed to administrative decisions and funding issues at the school level. In general, schools were empowered to make site-based decisions in terms of the use of specialists. Funding constraints, however, seem to be the controlling factor in the hiring of specialists and the breadth of their service responsibility (a single school versus multiple schools in a district), as can be seen in the following quotes:

> Within our district, decisions are made on a site-by-site basis. This largely depends on the funding they have or the beliefs of the administrator. I happen to be at a Title [I] school where the administrator believes that science is important and allocates Title money towards my position. For the entire district there is one coordinator and project facilitator to service over 200 elementary schools. This is most likely due to a lack of funding support. (science specialist)

> It is up to the individual site administrator to decide whether or not to use school funds (Title I funds, grant money, other staff allotment funds) for a specialist. Reading and math specialist positions are funded by the district. Each school gets at least two reading positions and one math position. (science specialist)

> Funding, I think, is the major cause [of variation across the district]. While I am officially the science specialist at our school, our administrator can not afford to use any more discretionary funds for a math specialist, so I now fill both roles as best I can. Some schools can not afford either of these positions so in lieu, develop a lead teacher, lab teacher, or other such support role that would see more students and have less "free" time to work with individual teachers on their own implementation of science. (science specialist)

Within our pilot sample, only two districts employed district-level science resource specialists; all other science specialists were hired and funded on the school level. As a larger data set is collected across more schools, it will be interesting to see how funding issues and administrative commitments to science come into play in the selection of a specialist model.

Obstacles and Facilitators

Respondents were asked about specific obstacles and facilitators associated with their elementary science specialist models. We sought to identify factors leading to implementation and sustainability of the existing programs. As was true for the selection of a specialist

Table 1. Models of science instruction represented in the sample.

		District					
	Model (Gess-Newsome, 1999)	**1**	**2**	**3**	**4**	**5**	**6**
Generalist Models	**Classroom generalist model (Traditional model)**: The classroom teacher has a self-contained class and is responsible for all the science instruction.	√	√	√	√	√	√
	Classroom science specialist model: One of the classroom teachers in the school takes the lead with science curriculum selection, obtaining supplies, and planning science instruction. All classroom teachers are responsible for delivery of science instruction within their self-contained classrooms.	√					
Specialist: Student Instructional Models	**Departmentalized model, or Collaborative specialist** (Nelson & Landel, 2007) (within grade levels): Science instruction is delivered by one of the classroom teachers who has specific interest and expertise in science. The teachers (or students) rotate for certain classes, such as science, mathematics, or social studies. The "science teacher" is also responsible for the other academic subjects within the otherwise self-contained classroom.	√	√	√	√		
	Science specialist (pull-out model): The science specialist is responsible for planning and delivery of all science instruction, which typically takes place in a science laboratory or dedicated classroom.	√	√	√			
Specialist: Teacher Mentoring Models	**Resource/Coaching model**: The science specialist provides leadership and resources for science instruction, but is not responsible for delivery. The specialist aids in curriculum development, professional development, and leadership for the science program. Instruction takes place in the regular classroom by the classroom teacher.					√	√
	Science support team model: The science specialist works with the classroom teacher to assist with planning and delivering science instruction within the regular classroom. Instruction is the shared responsibility of the specialist and classroom teachers.	√	√ (d)		√	√ (d)	
	Other	√					
	Science Instructional Time in Minutes						
	District Average	0-250	150	60-		0-250	60
	Specialist schools: Average of All Grade Levels	250	80-300				
	Specialist Schools: Grades K-2				135		60-120
	Specialist Schools: Grades 3-5				180		450

(d) indicates district-level personnel fulfill this role of specialist. All others are school-based personnel.

model, the most common themes were *administrative support* and *financial support*. Interestingly, these features were considered to be obstacles as well as facilitators.

School-level Administration. When decision-making about personnel and curriculum emphasis occurred at the school level, the school administration played a critical role in setting the expectations and providing opportunities for a science emphasis. Those who understood the value of science instruction and had the leadership skills to extend those values to their teachers promoted an atmosphere conducive to science learning.

> [School administrators] are essential in most cases and most often follow district and region leadership/focus. We found that teachers' level of implementation closely followed the principals' level of interest, knowledge, and excitement for science. (science specialist)

> [School administration] has a huge impact. In some buildings, administrators tell teachers not to worry about science. (science specialist)

When considering the role of a science specialist, the administration often determined the purpose of the position and the model employed. If the role of the specialist was to provide support and leadership to enhance science instruction, and if the administrator provided the necessary leadership and support, the employed model was likely to be described as successful. In some cases, however, the use of science specialists was compromised by other influences. For instance, one informant described an administrative contractual obligation to provide a preparation time for each classroom teacher. This prep time was accomplished through the use of a pull out model for science instruction. Unfortunately, without an accompanying philosophical commitment to, support of, or expectations for science instruction, the pullout model failed to promote a science focus across the school and resulted in disconnected and limited exposure to science. As described by one specialist:

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> The support of site administrators in securing the necessary funding is critical to the success of a specialist model. Without the money and space needed to implement and maintain any model, the program dies. Furthermore, the site administrator's vision of the role of science in the elementary curriculum can promote or discourage science instruction at the school. … If the specialist is providing prep time for teachers at a particular school, then they are helping teachers get the time they need to plan, grade papers, contact parents, etc. However, programs built around this organization present science instruction in such a way that it very often becomes a series of shallow, discrete "activities" designed to address specific district grade-level objectives. Because every student … in the school gets a 40-50 minute shot of science once a week outside of the regular classroom context, there is almost no room for meaningful experiences that develop over time or that develop as an integral part of the curriculum. This organization serves to reinforce the notion of science as an unconnected, unimportant part of the elementary curriculum … Having science "covered" in this way may give classroom teachers at the school an excuse for not taking time to do science as part of their regular program, a practice that further impedes their development as teachers of elementary science. Site administrators may point to this kind of science specialist program as proof that they support science instruction at their site, when the reality of the situation is much different. (science specialist)

In contrast, a school principal who values science instruction for all students can build on the positive momentum provided by specialists:

> In [our district], each elementary school had a trained science specialist and most schools use this specialist to train other elementary teachers within that school. This was done so that all students would receive improved science instruction. However, at [our school] we felt like that model was not getting quality science to students quickly enough. Therefore, in addition to having our science specialist work with teachers in first and second grade, we changed our structure so that all students in grades 3-5 would receive daily instruction from the science

specialist … .I provide resources to support a science professional learning community. (elementary school principal)

Clearly, the school principal has a tremendous influence on the level of science instruction at the school level (Appleton, 2007). With the opportunity for site-based decision making, principals can dedicate funds for specialists, determine the model that best meets their needs, and create an academic atmosphere that promotes science teaching and learning by all.

District-level Administration. The apparent role and impact of district-level administration varied across districts in our sample. Some report that district level administrators provide nominal support through affirming that science should be taught, but fail to take action or provide supportive measures. In these cases, unless school-level personnel take initiative, science instruction remains unchanged. Others state that without district support, science specialists would not exist. Regardless, the decision-maker, be it at the district level or building level, must be supportive of science and establish support structures for the effective utilization of a science specialist. As one science coordinator elaborated:

> In the late 1980s, one of the five regional superintendents started a focus on science … . He hired an excellent university science education professor who was an early advocate for a "doing science approach." She worked with six teachers … . They became region teacher leaders who worked with teachers during the school day … . This region started slowly and with the superintendent's leadership, science became a respected subject over time. Other regions started a science focus, following his lead … . Science was on the map and some principals became advocates for science. Principals picked teachers who taught science to become the science specialists … . (retired district science coordinator)

> Some principals are better than others at using their budget. … They attract/hire staff that can handle new structures, [including] teachers better prepared to teach science. More important is the principal that values science and makes it a school priority. Region superintendents also have an impact when they value science. It also helps when these leaders know and understand what it takes to improve science teaching and learning. (science specialist)

This respondent reported that when teachers and administrators left schools where science was a focus, the science priority diminished. This finding highlights the fragile position held by science in many elementary schools, and the centralization of science enthusiasm in a small number of individuals rather than across dispersed leadership capacity. A similar situation was reported by a district science coordinator, who was also an elementary school principal. In her case, she had been responsible for setting schedules, refurbishing and distributing science instructional kits, and working with school administrators and resource teachers on building science instruction. When budget cuts resulted in loss of financial support for resource teachers and supplies, science instruction diminished. However, she saw possibilities for change with a change in personnel:

> We now have a new superintendent and he would like to see the science come back to more like it used to be. I am working with him and community partners to see what will be possible in the next few years. So the bottom line is that without the supervision of classroom instruction or science support people to help the classroom teacher, very little science is being taught. (elementary principal & district science coordinator)

Funding constraints, however, seem to be the controlling factor in the hiring of specialists and the breadth of their service responsibility.

Financial Support. Financial support is necessary for all curricular programs. Employing a science specialist may require additional funding or a reallocation of existing monies. Two of the six districts in our sample reported that federal grant funds were used to initiate their specialist model by providing support for new hires and professional development. The momentum built through participation in the science grants, however, only lasted as long as the administration's advocacy for science instruction.

> When we had the [grants], schools involved became committed to the project goal of improving/enhancing teacher knowledge of science, how children learn, instructional strategies, and leadership potential. Multiple changes

> during and after the grant ended contributed to mixed messages and areas of focus: new superintendents, reconfiguration of district management, NCLB. The new superintendent commented that there was no time for science. (retired science coordinator)

> The district has cut the budget for many resource teachers, materials people, or kit builders, and doesn't have a way to really monitor science instruction. This means most of the schools have a classroom teacher, and if it gets taught, great. Some schools have teacher teams … . (elementary principal & district science coordinator)

One school (from District 1) reported that their science specialists were supported through Title I funds:

> We are able to use some of our textbook money to participate in our district's kit replenishment program, so that helps tremendously, as we get fully stocked kits and all teachers at a grade level have the same kit at the same time (within the school). In terms of funding for a science specialist, [funding] is huge. The only reason I have my job [as science mentor] is because we are a Title school. (science specialist)

Of the 13 elementary schools in District 6, two used a collaborative specialist model where a team of three teachers each teach in their area of expertise (science, mathematics, or literacy). This model was adopted following professional development of the teachers in their respective areas. The professional development was provided through an NSF-funded grant program run by a local university. The benefit of this model was that it did not require additional funding by the school or district to initiate or sustain. The administration, however, supported the model through the allocation of existing funds and sought additional funds for resources and additional professional development for the teachers involved. A principal at one of these schools commented on his need to be flexible and supportive of the program. Key school-based changes championed by the principal included establishing a science professional learning community that met twice a month, moving to block scheduling to enable extended time for specialist classes, and garnering the support of parents and the community for science instruction.

Mandated science testing drives much of what is taught, and how science is taught.

Professional Development Opportunities. A majority of the respondents felt there were insufficient professional development opportunities for science specialists as well as generalists. For example, while the school in District 6 that followed the collaborative specialist model had established a science professional learning community for its teachers, they reported that professional development for the generalists in the schools not following a specialist model was sorely lacking. Those teachers received one half-day kit training each time a new kit was adopted by the district. They and others attributed the situation to insufficient district and state funds, lack of science priority, and lack of leadership to initiate and pursue opportunities. With just a few exceptions, most reported that the science specialists have district-sponsored meetings for dispensing information about kits or curricular materials. A couple of districts offered workshops for pay or university credit, but space and time were limited such that relatively few teachers were able to take advantage of the opportunities.

> There is little to no funding allocated for after school professional development for our teachers. If I want to provide something after school, I must go to outside sources to look for forms of compensation. If we need extra materials, I must find resources for those as well. (science specialist)

> Space in the workshops is limited, and we are a rather large district, so there are many individuals who are going without professional development in the area of science. The fact that the district actually offers very little professional development opportunities for teachers is also troublesome. (science specialist)

District 2 is divided into regions that provide science professional development. These opportunities occur once a month for some areas, fewer for others. Curriculum workshops are also provided throughout the year. As with other districts in our sample, it is reported that the science specialists tend to take advantage of the professional development opportunities more often than the classroom generalists. District-level support in District 2 is demonstrated through the provision of specified district-level personnel and professional development. Each

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region has its own Math/Science Coach that coaches the specialists within each school.

> Our area meets once a month and looks at the math and science curriculum. We meet in different schools each time to see what/how others are implementing the program. We also discuss focus points to address with teachers within our individual schools. Citywide there used to be more specialist meetings than there are now. (science specialist)

For our pilot sample, district level support most often evinced itself as professional development opportunities for specialists as well as generalists and, in some cases, district level personnel to facilitate such opportunities. Overall, support for specialists appears to be concentrated at the school level.

State Testing. We cannot ignore the realities that pressure and prioritize K-12 education. Mandated science testing drives much of what is taught, and how science is taught. For schools that have science specialists, there is some indication that the methods of instruction are more likely to engage students in meaningful learning, though such tendencies are not guaranteed. It will be important to monitor the ongoing impacts of mandated testing on the use of specialists, as is noted below:

> Mandated testing in science is viewed by the fifth grade teachers as just punishment for teaching at the intermediate level. They use [standards] … lists of things that are going to appear on the test … as the basis of their science instruction. They see the use of science texts and worksheets as the most efficient tools for teaching to these tests and are using them as the core of their science program … . Because the science test is really a reading test (no teacher help with directions or translations allowed with test items), these [instructional] practices often lead to passing test scores … . [The fear is that] test scores will be used to illustrate that science specialists, professional development in science, and reform-based instructional practices, are not necessary to the success of elementary students in learning science. (science specialist)

Impact of Science Specialist Models

While the impacts of the various specialist models are anecdotal, they provide a glimpse into the perceptions of those most closely involved. The most common impacts relate to teacher attitudes toward science, instructional style, instructional time, and state test achievement. These impacts are most closely associated with the benefits of the resource/coaching, support team, and collaborative specialist models. For instance:

> I believe the teachers at my school feel fortunate to have a specialist within their building and teach more science as a result. This [attitude] ultimately impacts the students because they are actually getting science [instruction]. Our students love science and talk with me about science each day in the lunch room. We also have a high daily rate of attendance (around 96%) that we attribute at least in part to the excitement of science. Students have said they don't want to miss because they will miss out and not know what happens next. (science specialist)

For a school-based resource/coach within District 2, the impact of the specialists across the district was seen in science pedagogy.

> Those schools with specialists seem to have a more consistent use of the science curriculum and a better understanding of what inquiry-based science looks like. Students are therefore exposed to a greater amount of hands-on science content. Schools in [our district] who have been implementing the program have seen gains in their science scores to a greater degree than those schools who have not used the program. (science specialist)

This statement is supported by our data on instructional time (Table 1) where science classroom instruction ranges from none to 7.5 hours per week. The participants in this study attributed the variation to science specialists who are thought to spend more time supporting quality science instruction in their schools. The explanation for this increase is attributed to teachers' amplified comfort with science content and pedagogy as a result of the collaboration with the science mentor. In schools using the resource/coach model, teachers reported spending more time in science instruction since the employment of the science specialist. For example, District 1 mandates 110 minutes per week of science instruction for grades 1-5, but the classroom teachers reportedly spend 250 minutes per week. Specialists at this school also reported improved science pedagogy. As one science specialist explained:

> Science specialists who function as responder mentors or coaches may serve as a valuable resource for the school's overall science program … . Because science instruction takes place in the regular classroom with the classroom teacher, this model can help to contribute to the overall development of teacher expertise in science teaching at the site. Limitations of this organization structure may stem from the ability of the specialist to work with individual teachers in an ongoing, systematic manner that supports their development. These specialists are often pulled to perform other duties at the site that impinge on the time they need to effectively mentor young or inexperienced teachers in science. This model serves the students to the extent that the specialist's expertise of science content and pedagogy informs the practice of the classroom teacher. (science specialist)

Despite this potential, we must remember that pull-out models have the potential to reduce the need for the regular classroom teacher to attend to science instruction, thus ultimately reducing a students' exposure to "meaningful experiences that develop over time or that develop as an integral part of the curriculum." Future research must explore the relative impacts of different models, as well as contexts, on science achievement, science attitudes, and science identities.

Next Steps – A Call for Participation

Based on the pilot data collected in this study, we believe that we have strong initial support for the organizational framework that we have developed to collect further descriptive data about elementary science specialists. In addition, follow-up surveys have greatly assisted us in understanding the nuances of selecting and implementing a specialist model, including administrative support, financial support, the impact of state testing mandates, and the potential benefits realized through the use of specialist models. All these areas warrant in-depth exploration.

Future research must explore the relative impacts of different models, as well as contexts, on science achievement, science attitudes, and science identities.

So where do we go from here? This pilot study provides an initial guide for a larger, more comprehensive descriptive study of elementary science specialist models. This is where we need your help and support. We have created an electronic survey based on these initial findings to collect data from a larger set of schools that employ science specialists. The survey can be found at the website listed in Note 1. We are requesting that all schools or districts that use a specialist model consider submitting information about their programs for analysis. We would like to have this data submitted to us by December 1, 2008. Widespread response to this call will do a number of things. First, it will provide additional information related to the validity of our conceptual organization of the use of elementary science specialists. If validated, both the fields of research and practice can move forward with a clarified understanding of the models that exist and a uniform vocabulary to describe specialists. Second, survey information will provide a critical conduit to sites of future research. While survey data provides an informative window into institutional practices, these reports need to be augmented by site visits, observations, and in depth interviews. Finally, the survey data generated will act to inform hypothesis generation for future research. For instance, even in the small data set examined in this study, there appears to be a relationship between the use of a specialist model and the time dedicated to science classroom instruction. Additional data will help us examine that assumption and design research to more fully investigate it. As described in the EDC article outlining the research agenda in this area (this issue), other fruitful questions across the spectrum from descriptive, causal, and process/mechanistic will be informed by this work, allowing us to better support schools and districts in their selection of models to support science instruction, to better prepare classroom generalists and specialists to teach science, and ultimately to advance a broad range of science learning outcomes in all our students. This is a call for your participation in the research agenda exploring the effectiveness of elementary science specialists. Can we count on your participation in this important work?

Note

1. To access the surveys discussed in this article, please visit <http://homepages.wmich.edu/%7Erschwart/research.htm>.

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