Rhemer, D., Lee, M. J., Gutierrez, & K., Kidd, J. (2024, March 17-20). *Uncovering a disconnect between Virginia administrators' understanding of the state of elementary engineering education and K-6 teacher professional development needs.* Poster presented at the 2022 National Association for Research in Science Teaching (NARST) Annual International Conference. Denver, Colorado.

Incoherence in Administrators' Perceptions of Elementary Engineering Education and Teacher Professional Development Needs

Purpose

The Framework for K-12 Science Education (National Research Council [NRC], 2012), as well as the *Next Generation Science Standards* [NGSS] (NGSS Lead States, 2013), describes an obligation to integrate engineering design into the structure of science education. Students engaged in the engineering design process should be tasked with defining, designing, and optimizing solutions to particular human problems (NRC, 2013). Almost 10 years after the NGSS was released, 44 states serving 71% of students in the US have either adopted the NGSS or developed their own standards based on the NRC Framework (NSTA, 2014). Nevertheless, most P-6 preservice teachers (PSTs) are not exposed to engineering as part of their academic training and, as a result, feel unprepared to integrate engineering into their instruction (Rose et al., 2017).

Previous research in the field highlights that opportunities for teachers to integrate engineering lessons have a positive impact on PSTs' (Cima et al., 2022) and in-service teachers' self-efficacy (Rich et al., 2017). However, PSTs and in-service teachers describe time and resources as perceived barriers to implementing engineering activities in their classrooms (Author, 2022; Hammock & Ivey, 2019). Findings from the field highlight the need for teachers to be provided with training, resources, and support in order for the vision of instruction described in the NGSS to become a reality (e.g., Hammack & Ivey, 2019; Nadelson et al., 2016). Due to this need for support, we chose to focus on school and division-level administrators who often are tasked with making decisions around required training, as well as what types of support are available for teachers (English, 2011). Specifically, our research questions attempted to understand: 1) What role, if any, do administrators see engineering concepts and practices playing in elementary students' science education? and 2) What barriers do administrators perceive for integrating engineering into elementary science education?

Design

Study Context and Sample

This study was embedded within a more extensive project focused on providing engineering education experiences to elementary PSTs. The overarching study investigates how participation in cross-disciplinary collaborations with undergraduate engineering students during PSTs' preparation affects their self-efficacy and beliefs about elementary engineering instruction and their intention to integrate engineering in their own classrooms. In order to learn more about the barriers and enablers PSTs could face in school systems post-graduation, principals and STEM/science division administrators across Virginia (VA) were sent a 50-question survey designed to 1) characterize the administrator's context, background, and demographics, 2) illustrate the landscape of elementary engineering education in Virginia, and 3) delineate the perceived barriers to integrating engineering into elementary education. Virginia does not follow

NGSS; however, the most recently adopted 2018 Standards of Learning (SOLs) for Science utilized NGSS in its creation, infusing engineering practices across the K-12 curriculum. The first academic year these science SOLs were fully implemented and assessed in 5th grade (only grade-level elementary science is tested) was 2022-2023.

Data Source & Analysis

In the Fall of 2022, 2000 administrators across the Commonwealth of Virginia were sent a survey that included both multiple-choice and open-ended responses. This survey was sent to building-level administrators, such as assistant principals and principals, and division-level administrators, such as STEM coordinators, gifted specialists, and directors of curriculum and instruction. 100 surveys were returned, resulting in a 5% return rate. This study unpacks 11 of those questions, which highlight how administrators view the landscape of elementary engineering education, as well as the perceived barriers to integrating engineering into elementary education. All data was then separated by administrator type (building or division), and the multiple-choice answers were tallied and averaged. Open-ended responses were examined using a constructivist grounded approach (Charmaz, 2017). Open codes were used to describe and characterize what administrators shared.

Findings

In the following section, the findings will be shared two-fold: (a) the role of engineering in elementary science education and (b) the challenges/barriers to integrating engineering education (Table 1).

Role of Engineering in Elementary Science Education

At the beginning of the first full implementation year of the SOLs, 77% of all administrators were aware of the addition of engineering concepts and practices to the standards (n = 85). 91% of division-level administrators described being *very aware* of the changes (n = 32, and 83% described an expectation for teachers to teach engineering (n = 92). However, over a quarter of building-level administrators were not fully aware of the changes (i.e., *I don't recall hearing about it* and *sounds familiar*, n = 23, 31%), and thus, 17% did not expect their teachers to teach engineering (n = 13). When asked how knowledge of the new standards and associated teaching expectations was disseminated to teachers, building-level administrators indicated that they communicated their expectations through *Professional Learning Communities (PLCs)/meetings* (25 instances, 20%) or *Professional Development (PD)* opportunities for their teachers (20 instances, 16%). Similarly, division-level administrators said they shared this information by providing *PD* (14 instances, 26%) and *instructional resources* (10 instances, 19%).

In terms of enactment, 49% of all administrators believed that teachers were engaging their students in engineering lessons *4-10 times a school year* (n = 54). And yet, it is important to note that 28% of all administrators did not answer this question (n = 31). Given building administrators' expected familiarity with their staff, they were asked how many of their teachers taught engineering. 27% *did not respond* (n = 27). Of those who did answer, 34% believed that *0-25%* of their teachers were teaching engineering (n = 34). When asked why these teachers were teaching engineering, 43% believed that teachers teach engineering because it is *required or expected of them,* either through standards or their job requirements (n = 29). The second most common response was that teachers are motivated to teach engineering *for the benefit of their students* (29%, n = 20). They described a belief that teachers engage their students in engineering because the tasks are designed (i.e., hands-on or Project-based learning) to be highly engaging

for students. Interestingly, one of the administrators shared that "Not all of [the teachers] realize that they are doing [engineering] with the engineering design process."

Challenges/Barriers to Integrating Engineering Education

Most administrators, regardless of the type, said they had a plan to help support teachers in incorporating engineering (*n* = 70, 63% total). Building-level administrators stated expectations for teachers to engage in PD (described in the previous section); however, 61% have not provided any PD and instead have focused on providing instructional resources (*n* = 41, 54%). In contrast, most division-level administrators have provided PD (*n* = 22, 63%) and instructional resources (*n* = 24, 69%). This aligns with the methods they reported using to disseminate their expectations (described in the previous section) for teachers to incorporate engineering into their instruction.

The biggest barrier all administrators, regardless of the type, described was *lack of time for teaching engineering* (*n* = 67, 60% total). However, division-level administrators described a *lack of instructional resources for teaching engineering* at almost the same rate (*n* = 13 vs. *n* = 12). This highlights that division-level administrators believe that additional resources for teaching engineering are necessary for teachers to engage their students in engineering. In order to reduce barriers, all administrators agreed that *PD on engineering practices and pedagogy* would best support teachers' integration of engineering concepts and practices (*n* =56, 50% total). Though division-level administrators emphasized the need for *PD on interdisciplinary instruction focused on integrating engineering into subjects beyond science* at a similar rate (*n* = 12 vs. *n* =11). This suggests that division-level administrators saw not only a need for teachers to learn pedagogy related to engineering practices but a need for teachers to learn how to integrate engineering into other subject areas.

Conclusions, Implications, and Scholarly Significance

Ten years after the release of the NGSS (2013) and five years after the release of the Virginia 2018 Science SOLs, it is problematic to consider that some building and division-level administrators do not know about the requirements surrounding the integration of engineering design into the structure of elementary science education. Considering that engineering practices are included at every grade level, all administrators should be knowledgeable about these changes. However, our findings show this is not the case. This lack of understanding was emphasized in their explicit responses and in their choice not to answer questions. Thus, more training is needed to support administrators in conceptualizing the profound changes in teaching and learning described in the reforms, as well as the ways that engineering practices must be integrated into classroom instruction to meet that vision and Virginia's new standards. This is especially crucial given teachers are not given proper preparation (Hammack & Ivey, 2019) or support (Author, 2022) to teach engineering.

It is crucial that administrators understand why engineering education is important beyond it being a requirement, as well as what engineering in K-12 classrooms looks like because they are responsible for providing teachers with the support they need. If administrators believe that teachers are already engaging students in engineering but just do not "realize that they are," they may be less willing to provide additional support. Also, if teachers are engaging their students in engineering without describing it to their students as such, the instruction will not help students understand what engineering is or how the design process works and, accordingly, will not be as effective. Thus, future research might explore how administrators conceptualize engineering, what they envision it to look like in practice in an elementary science

classroom, and how they believe they can support teachers to engage in engineering instruction aligned with the NGSS and VA SOLs for Science.

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Tables and Figures

Table 1

Administrator Survey Responses

	Building	Division	Total
	Count (%)	Count (%)	Count (%)
A) The Role Engineering Plays in Elementary Science Education			
1) Were you aware the SOLs include engineering prior to taking this survey? KOS			
I don't recall hearing about it	5 (7%)	0 (0%)	5 (5%)
Sounds familiar	18 (24%)	1 (3%)	19 (17%)
Yes, very aware	***53 (70%)***	***32 (91%)***	***85 (77%)***
No response	0 (0%)	2 (6%)	2 (2)
2) Are teachers expected to teach engineering? KOS			
No	13 (17%)	4 (11%)	17 (15%)

Yes	***63 (83%)***	***29 (83%)***	***92 (83%)***
No response	0 (0%)	2 (6%)	2 (2%)
3) How has the expectation of incorporating engineering been communicated to teachers?			
Building Level Admin	1 (1%)	5 (9%)	6 (3%)
Instructional Resources	19 (15%)	10 (19%)	29 (16%)
District Level Admin	18 (14%)	7 (13%)	25 (14%)
Email	15 (12%)	3 (6%)	18 (10%)
PD	20 (16%)	***14 (26%)***	***34 (19%)***
PLC/Meeting	***25 (20%)***	6 (11%)	31 (17%)
Science Teacher/Instructional Coach	9 (7%)	2 (4%)	11 (6%)
No Response	18 (14%)	7 (13%)	25 (14%)
4) How often do teachers teach engineering? APT			
0-3 a year	10 (13%)	2 (6%)	12 (11%)
4-10 a year	**37 (49%)**	**17 (49%)**	**54 (49%)**
Once a week	5 (7%)	9 (26%)	14 (13%)
No response	24 (32%)	7 (20%)	31 (28%)
5) Last year, how many teachers taught a lesson that incorporated engineering? (Building Only) APT			
0-25%	***34 (34%)***	N/A	***34 (34%)***
25-50%	20 (20%)	N/A	20 (20%)
50-100%	20 (20%)	N/A	20 (20%)
No response	27 (27%)	N/A	27 (27%)
6) Why do teachers teach engineering focused lessons? (Building Only) APT			
For students	20 (29%)	N/A	20 (29%)
Related to science/other subjects	2 (3%)	N/A	2 (3%)
Standards/Required/Expectation	**29 (43%)**	N/A	**29 (43%)**
Support provided	9 (13%)	N/A	9 (13%)
Teacher-driven motivations	5 (7%)	N/A	5 (7%)
Other	3 (4%)	N/A	3 (4%)
B) The Challenges/Barriers to Integrating Engineering Education			
1) Does your school have plans to help teachers?			
No	24 (32%)	12 (34%)	36 (32%)
Yes	***51 (67%)***	***19 (54%)***	***70 (63%)***
No response	1 (1)	4 (11%)	5 (5%)

2) Has your school provided any professional development?			
No	***46 (61%)***	9 (26%)	***55 (50%)***
Yes	28 (37%)	***22 (63%)***	50 (45%)
No response	2 (3%)	4 (11%)	6 (5%)
3) Has your school provided any Instructional Resources?			
No	33 (43%)	7 (20%)	40 (36%)
Yes	***41 (54%)***	***24 (69%)***	***65 (59%)***
No response	2 (3%)	4 (11%)	6 (%)
4) What are the biggest barriers to elementary teachers incorporating engineering?			
Classroom management concerns	2 (3%)	1 (3%)	3 (3%)
Engineering is not prioritized on SOL testing	4 (5%)	0 (0%)	4 (4%)
Lack of instructional resources for teaching engineering	9 (12%)	***12 (34%)***	21 (19%)
Lack of teacher interest	1 (1%)	0 (0%)	1 (1%)
Lack of teacher know-how	5 (7%)	9 (26%)	14 (13%)
Lack of time for teaching engineering	***54 (71%)***	***13 (37%)***	***67 (60%)***
Not a priority within the district	1 (1%)	0 (0%)	1 (1%)
6) What could best help teachers incorporate engineering into their instruction?			
PLCs to support engineering integration	1 (1%)	0 (0%)	1 (1%)
Incentives for teachers	9 (12%)	3 (9%)	12 (11%)
Lesson modeling/co-teaching from educators with experience with engineering	0 (0%)	5 (14%)	5 (5%)
PD for STEM/Science administrators/specialists	2 (3%)	3 (9%)	5 (5%)
PD on engineering practices and pedagogy	***44 (58%)***	***12 (34%)***	***56 (50%)***
Interdisciplinary PD focused on integrating engineering into subjects beyond science	18 (24%)	***11 (31%)***	29 (26%)
Providing teachers supplies/instructional resources	2 (3%)	1 (3%)	3 (3%)

Bold italicized text represents the most common response/responses for each group.