Administrator's perspectives on an engineering program aimed at broadening participation.

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High School Administrator's Perspectives on an Engineering Program Aimed at Broadening Participation (Fundamental)

Abstract

This work explores the experiences of administrators supporting teachers in the e4usa program which emphasizes broadening participation in engineering at the high school level to explore efforts to broaden participation that leverage multiple levels of the school system. Two rounds of convenience samples of administrators in public and independent schools occurred in spring and fall of 2022. During these conversations, administrators were asked to reflect on the implementation of the e4usa program at their school, their personal experiences with this process, and barriers or suggestions in expanding this program both locally and more broadly. The transcripts of these interviews and focus groups were analyzed using descriptive coding [1] by two researchers. During this process the codes were categorized and then emergent themes were identified. The findings indicate that administrators have a range of personal experience with implementing this engineering program, and that often these experiences were reported as a benefit to the entire school. For instance, administrators often referred to connections made to local universities by or as a result of the program, which then served as a positive outcome for the school at large. This suggests that a multifaceted approach to implementing engineering courses at the high school level which includes curriculum as well as human connections is seen as a benefit by administrators. Administrators also refer to the coursework and teacher actions as supporting the goal of broadening participation by speaking about specific engineering projects that engage a variety of learners, mostly through the type of project employed within the course. Finally, the administrators identified potential barriers to implementing engineering programs on their campus, with most barriers relating to teacher staffing issues, such as the need to engage in professional development to train these teachers externally. The themes that emerged from these various administrators perspectives provide an understanding of how to approach broadening participation through leveraging the role of administrators. Additionally, this work points to a need to encourage communication within the school system to create more access for students both to enroll in the engineering courses and to see a future self within engineering.

Introduction

Throughout the past decade, several large-scale efforts have been made to increase student engagement with engineering through direct outreach efforts as well as incorporation of engineering into state and national standards. The National Science Foundation has funded Research Experiences for Teachers (RET) programs since 2003 to support "authentic summer research experiences for K-14 educators to foster long-term collaborations between universities, community colleges, school districts, and industry partners [2]." Though long-standing and meaningful in their impact, the RET program is limited in size because of the intense nature of

the program from a facilities and personnel standpoint. The Next Generation Science Standards (NGSS), released in 2013, include some engineering practices across all grade levels. These standards have been adopted in about half of the fifty states, with many other states creating similar standards [3]. However, there is still a need to understand best practices in supporting student engagement in engineering education systemically through a greater understanding of school environments that support engineering experiences for students. This work explores the experiences of high school administrators as participants in e4usa, a national project aimed at broadening participation in engineering at the high school level.

High school administrators serve an important role in establishing school climate and goals and can have a positive influence on student outcomes [4]. Prior work has also explored the influence of administrators in teacher decision making with regard to their classroom and adoption of curriculum [5,6]. While few studies have explored adoption of engineering initiatives explicitly from administrator's perspectives, e4usa [7] found that administrators from a single school site reported a desire for a more holistic approach to adopting engineering at the high school level than simply providing a curriculum. This included reporting a desire for professional development for teachers, connections to larger curricular and standards movements, and connections to industry or community.

Several studies have also explored the role of administrators within STEM integration and broader STEM initiatives in order to understand how administrators can facilitate or hinder the success of such initiatives [8,9]. For instance, in an evaluation of a state-wide multi-year initiative to increase the use of STEM integration in high schools, Havice et al. (2019) found that school teachers and leaders both found ways to implement integrated STEM within their school systems as a result of participation in the professional development offered on STEM integration. Additionally, the authors found that participants increased their self-efficacy for STEM integration, but the emphasis of the work from Havice et al. (2019) was on classroom implementation and teacher experiences. Therefore, while administrators were included in the professional development and the study data for some measures, they were excluded for measures of classroom implementation and there was a lack of measures directly related to administrator outcomes specifically, suggesting a need to explore administrator experiences further as they seek to bring STEM-related initiatives to their schools. In an effort to support developing school leaders, Geesa et al. (2022) developed and piloted an integrative STEM course within a graduate program for pre-service school leaders. This was in response to their identified needs to prepare leaders to help support the integration of STEM subjects and to connect to career pathways. While integrated STEM is certainly distinct from engineering-specific programs, these two studies speak to a need for further training and exploration of the needs of high school administrators in supporting teachers within STEM fields.

Concerns Based Adoption Models

To understand how adoption of the e4usa curriculum was adopted by school administrators, we utilized the concerns-based adoption model [10]. We sought to identify what concerns the administrator's expressed according to the stages of concern and the processes that administrators [11] describe regarding adoption of the e4usa program at their school site. The stages of the model begin at level 0 and range to level 7; Kapustka and Damore (2009) then identified dimensions of these stages within the initial stages representing concerns related to oneself, the middle stages of concerns relating to the larger task at hand, and the final stages relating to the impact of the adopted process [11]. In this work we analyzed the concerns of administrators to determine the themes within each of these dimensions of the stages and investigate whether the concerns and actions of the administrators represented the range of these dimensions.

Methods

High school administrators in private, independent schools and one public charter school working within the e4usa project were recruited through convenience sampling in the spring and fall of 2022. Five administrators participated in focus groups and interviews about their experiences supporting the e4usa project at their school site. The administrators had a minimum of one year working with the e4usa project and worked in different regions across the United States and its territories, as detailed in Table 1. One focus group and one individual interview occurred in spring 2022 with independent school administrators, and a second focus group with one independent school administrator and one charter school administrator occurred in fall 2022. Two raters coded the first focus group using *in vivo* coding. The raters then met to compare codes and establish a codebook and re-coded the first focus group. The codebook was then used to code the single individual interview. At this point the rater agreement was over 80% agreement and a single rater then coded the final focus group. After coding was finished, the raters then met again to determine emergent themes.

Table 1. Administrator pseudonyms and school demographic information

Pseudonym	Region	Independent or Charter	Gender	Racial Demographics
Connie	Southwest	Independent	13% F, 87% M	17% Hispanic 7% Native American 7% Asian 3% Black/African American 80% White 3% Two more More
Elaine	Mid-Atlantic	Independent	55% F, 44% M	0% Hispanic 0% Native American 0% Asian 11% Black/African American 88% White
Jenny	US Territory	Independent	50% F, 50% M	0% Hispanic 0% Native American 0% Asian 0% Black/African American 50% White 50% Two or More
Amelia	Mid-Atlantic	Independent	100% F, 0% M	0% Hispanic 0% Native American 17% Asian 17% Black/African American 67% White
Steve	Mid-Atlantic	Charter	28% F, 72% M	41% Hispanic 0% Native American 3% Asian 31% Black/African American 24% White 0% Two or More

Development of focus group questions

These focus groups are a part of a larger effort to understand the beliefs and experiences of multiple community members within e4usa schools in order to better understand how engineering education is perceived by school communities. Additional work has also explored the experiences of counselors [7] and university liaisons who play supportive roles in the

program [12]. The questions that were created, listed in Table 2, specifically sought to understand the processes that administrators engaged in throughout the implementation of the course, as well as external and internal pressures or supports that influence current and future course implementation.

Table 2. Focus group questions

Implementation Timeline Addressed	Questions
Before Implementation	What was your motivation to offer and/or allow the e4usa course to be taught at your school or within your district?
Before and during Implementation	In what ways have you been involved with e4usa at your school or within your district?
During Implementation	How have you supported the adoption of e4usa at your school or within your district?
	Do you feel that e4usa staff have provided sufficient help and resources to support your school/district to successfully implement the e4usa course? Do you have any suggestions for ways to improve support for school/district implementation?
After Implementation	Have you provided any support to align e4usa with the local school district and/or state requirements/standards?
	What, if anything, do you see as outcomes of the e4usa course being taught at your school or within your district?
	Do you see e4usa growing at your school or within your district? Why or why not?
	What concerns do you have about e4usa continuing to be offered at your school or within your district?
	What advice would you give to a program like e4usa as we look to scale and sustain?

Results

There were six key themes that emerged from the analysis of the transcripts. Within each theme, it is apparent that the administrator was describing actions they took or beliefs that they held related to the project. We have chosen to present the themes in the order in which an administrator would have experienced them, from initial decisions regarding the program to future suggestions. We also present the dimensions of change within the stages of concern addressed in each theme [11].

Motivations to begin the program

The administrators' motivations to begin the e4usa project varied widely. While some administrators described seeing a need for a course to prepare students to enter the field of engineering, others described hearing of the course from a teacher at the school. For example Steve described how the teacher he works with brought the course in, saying "I'm the teacher coach for Mr. Stein, who got into the program on his own interest." Indeed, this variety was so great that while most administrators reported at least some interest in the program, Connie described being hesitant to adopt the curriculum stating "anything that comes sort of prescribed, I'm always very suspicious of" and describing how the teacher at her school had to keep detailing that the program was what the school needed. Connie described adopting the course for the first year, saying "so with great hesitation and I said alright, but this is probation, I don't know if we're going to keep it, but of course we have because it's phenomenal." This hesitation, while not as explicitly expressed by all administrators, is important in that while discussing the hesitation Connie also revealed what other factors were important for her to balance, such as the ability to meet multiple academic levels/grades, and a possibility for college credit at the local university.

School system-wide desire for engineering

As the administrators described both the initiation of the e4usa project at their school, they often spoke of multiple members of the school community who were interested or excited to see the project. This included parents, students, and teachers of multiple courses.

Involvement of administrators in course activities

When the administrators were asked about their role in regard to e4usa, administrators reported several levels of engagement. This included the role of cheerleader or champion, which involved promoting the course to students, staff, parents, and the community. Administrators also reported serving as a liaison for community engagement, working to recruit community members to support the students within the course or connecting with local universities. Elaine also described benefits of exposure to engineering beyond connection to college, stating "certainly getting them well prepared for engineering programs at the college level and acceptance into those programs. Also, the logistics of being an engineer and just understanding what that's all

about." Additionally, the administrators described their interactions with students in the course and observing presentations of engineering designs or serving as a client for the design projects.

The importance of teachers

As administrators spoke of their own role within e4usa, they often also spoke of the specific actions that the teacher took to support student learning. This included a description of how teachers worked with the students and community or universities. Ellen described how the teacher in her school worked with a local farm.

> You know [e4usa teacher] has done an amazing job with the class and the kids and I think really worked with them to identify real world problems to work on you know the kids have been I think it was last year they went and worked with a local farm where there was an animal that needed a prosthetic device, and so they were trying to engineer something for that, that animal. So just identifying really amazing things. So I think she's done a lot with you know with the curriculum, but then also taking it out into our community and then even the larger community to connect the students with the community.

Reported outcomes for the school and students

Administrators were asked to describe the outcomes of bringing e4usa to their school and often the administrators described outcomes both to the school at large as well as to students individually. The most-reported benefit to students was through associations with universities, either through engagement via field trips, communications with researchers or through receiving credit for having completed the course. Administrators also described how the school benefited by being associated with e4usa as it improved their reputation and widened the course offerings which was enticing to parents.

Future needs and suggestions

There were several concerns related to future implementation of e4usa expressed by administrators, with teacher staffing being the largest concern. The administrators reported the training and professional development provided by the project as beneficial for teachers and thus they feared that having a teacher leave the school would mean re-starting with the program. Administrators also expressed a need to balance teachers' schedules and that adding additional sections was desirable but also might require additional considerations, such as whether a second teacher would be needed or whether one teacher might be able to take on all courses. While many of the administrators reported that these staffing barriers could be overcome, they did acknowledge it as a source of difficulty.

Discussion

Throughout the entire adoption and implementation process, the administrators interviewed collectively spoke of their active engagement with, appreciation for, and intent to continue e4usa at their school. While these administrators varied in how they engaged in the program, they each spoke positively about their experiences and expressed hope to continue, and in several cases a desire for expanded programs. Interestingly, while some administrators spoke of how program features allowed them to reduce their direct efforts in some aspects (such as outreach to universities), it also provided opportunities to connect with students about their projects and created new connections with the community through efforts of the teachers and e4usa staff and structure. The administrators also spoke of how their observations and interactions with students and teachers in the e4usa supported their own understanding of engineering and engineering education.

When discussing their initial motivations, the administrators were often speaking of the dimension of self [11] in the stages of concern in the concerns-based model in that the administrators reference personal concerns both negatively for Connie and positively for Steve. The expanded understanding and desire to continue offering the course suggests that e4usa has created additional opportunities to create space for students to engage in engineering at the high school level and might represent an additional opportunity for further introduction to the field.

The greatest concerns associated with future implementation related to ongoing staff needs, such as a need to provide additional training for new teachers that might be necessary to replace current teachers or to expand. This is not an insignificant task for programs such as e4usa given that such a process could necessitate future funding and training. Such considerations are important for administrators as they perceive this training to be a benefit of the e4usa but also represent a concern as administrators fear that such training will not be available in perpetuity. In particular, administrators valued that the program provided additional support beyond just a curriculum, including both professional development for teachers and connections to engineers at universities or in industry and they worried this support might disappear. This demonstrates that administrators are moving beyond concerns related to self and into concerns related to the dimensions of task and impact, which are deeper dimensions within the adoption model [11], suggesting that the administrators have deeply engaged in the adoption of the e4usa program at their school site.

This research study represents a small sample of administrators from independent private schools and charters, which may differ from public school administrators in their views on the e4usa. While previous work has also explored the experiences of administrators within the same district [7], this work sought to identify common experiences of administrators in different geographical regions. In the current study the findings identified aspects of the program which were seen as beneficial to administrators and areas of future concern. While the administrators did not express concern about implementation at the moment, they did indicate that as independent schools they did not feel a pressure to align to standards. Future work will explore

the experiences of public school administrators and other school leaders as they implement the e4usa in an effort to understand how such programs can effectively support community members beyond teachers and students in support of democratizing engineering.

Conclusion and Implications

We found that while administrators and school teams in the independent schools interviewed had various motivations to bring the course to their school, the activities and outcomes reported by administrators were similar. The main external pressure was parent interest, and administrators reported that they were able to use the course to promote their school, alleviating the pressure to provide highly-sought courses for students. The most reported internal pressure was related to current and future teacher staffing, with administrators concerned over the need to train new teachers. In the concerns-based adoption model, this suggests that the greatest amount of concern was focused on the task, rather than concerns related to self or impact. For programs such as e4usa to be sustainable, it is important to understand these pressures in order to take steps to address them in longer term capacities. In identifying that the concerns of administrators are related to processes specific to the task of implementing the e4usa program on their campus, it further identifies potential for support by limiting the focus.

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