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School farms and STEM: using institutional resources to promote deeper learning

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Abstract

Given the structural problems in education laid bare by the recent pandemic, we as a community of educators need to re-evaluate goals for secondary science education. Specifically, classrooms and course content must evolve to become more socially responsive, inclusive, and interdisciplinary. Agricultural education is a demonstrably effective way to boost STEM (science, technology, engineering, and mathematics) comprehension as well as SEL (social-emotional learning) skills building. In this study, I use qualitative interview methods to assess current agricultural coursework at independent schools around New England. Results show intriguing themes stemming from designing and implementing farm-based courses, although there are logistical barriers to development. Overall, participants reported that with thoughtful administrative structuring, agricultural STEM education can be a promising pedagogy for improving student experiences in secondary science classrooms.

Keywords

"STEM education," "go-along interview," "social-emotional learning," "experiential education"

Introduction

Pandemic resiliency

Education is at a crossroads right now. As a researcher with experience teaching neurodiverse students, it is clear to me both personally and professionally that reexamining methods for innovative STEM curriculum will help both educators and students. The recent COVID-19 pandemic has laid bare the inadequacies of educational resources available to children and families as well as the unrealistic expectations placed upon teachers. After school closures and widespread confusion about the best practices to keep children and teachers safe in their surroundings, we need to rethink how we "do" school.

Growth opportunities presented by agricultural education

The current need for more professional development in agriculture is supported by demographic trends noted by the United States Department of Agriculture (USDA). Considering the average age of U.S. farmers is 57.5 years, it is critical that educators work to engage young people soon to strengthen local food systems resilience over the long term (National Agricultural Statistics Service, 2017). Examining gender breakdowns in the farming profession is also important: based on the 2017 agricultural census, between 2012 and 2017 the total number of US producers increased 7%, but the number of female producers increased 27%. Female farmers were on average slightly younger than male farmers, which points to a potential trend of younger women stepping into predominantly male production roles (National Agricultural Statistics Service, 2017). With current data showing that between 95-96% of farmers are white, there is progress to be made by supporting better science education and land access for historically marginalized groups. Training young people (particularly women and students of color) in land

management and food systems knowledge is an important first step towards preparing a diverse new generation of farmers and food activists.

Running a farm or garden operation in the context of a residential school presents opportunities to integrate crop production, local soil conservation, physical skills-building, and heightened STEM comprehension among high school students. Based on existing literature, there is strong evidence for the efficacy of experiential classes that take the learner into a new environment – or place - rather than simply exposing them to secondary classroom material (Francis et al. 2013). Taking the idea of place a step further, there is recent research that supports better uptake of new information presented as part of a movement-based activity – our brains absorb material better when our bodies are interacting kinetically with a learning activity (Malinverni & Pares, 2014). Research shows that experiential (physical and/or outdoor) science curriculum has the potential to boost learning outcomes, build social-emotional skills in children of all ages, and support responsive school communities (Garner et al., 2017). Additionally, outdoor classrooms are not a novel idea, and were widespread in New England during the influenza pandemic of 1918 (Bellafante, 2020). One compelling iteration of outdoor life science curriculum can be found in agricultural education.

The promise of agricultural, place-based education extends beyond science content to include aspects of social-emotional learning (SEL). In a study of after-school and summer science programming, Garner et al. (2017) found a serious lack of community resources for active development of relational skills in younger children. They posit that developing curriculum along parallel tracks of STEAM (science, technology, engineering, arts, and math) content and SEL will boost students' ability to navigate relationships and build social skills. In a separate intervention study undertaken in Colombia, Castano (2012) examines the impact of

including farm and livestock animals in coursework designed to decrease violence and promote "pro-social behaviors" in 4th graders. The survey-based results indicated that working outdoors with farm animals increased compassion and social skills towards both animals and other humans.

The conclusions of these studies indicate actionable opportunities to improve the teaching and learning process. Especially as children age into adolescent development, deeper connectivity between topics traditionally valued in high school curriculum becomes increasingly important. For example, studying algebra and biology separately prevents students from realizing that it is possible to apply algebra to model change over time when studying population dynamics. Interdisciplinarity is critical for students to develop an appreciation for the nuances of "wicked problems" such as climate change (Rittel & Weber, 1973). As science students think about complex systems problems throughout high school, success of the curriculum depends on the ability to both visualize and participate in the material (Rates et al. 2016). The ability to visualize and experience is inherently powerful in outdoor classroom spaces like farms and gardens. Further qualitative research is urgently needed to determine how students relate to the real-world implications of their science education (Shepardson, 2019).

Identity-based inequality in schools

Separate from the recent pandemic disruption, there is previous research demonstrating the devastating impact of identity-based inequities in educational experiences (Lewis & Diamond, 2015). Race, class, language, (dis)ability, and gender conspire to help or hinder students as they make their way through the traditional K-12 system. Continuing to rely on tracking, standardized test results, and white-dominated cultural "norms" surrounding students' work ethic perpetuates racial inequity (Lewis & Diamond, 2015). Refusing to think critically

about pedagogical delivery methods excludes students who have intellectual or learning disabilities, not to mention students who are in process of learning English as a second language (Jiménez-Castellanos & Garcia, 2017). The conflation between linguistic or behavioral "ability" and intellectual capacity is extremely harmful and must be dismantled through innovative course design. Agricultural education presents a more inclusive learning environment through decreasing emphasis on traditional assessment strategies and increasing focus on relational ability.

The specific needs of students of color hold an important place in curricular development. Martin & Hartmann's 2021 piece in Agricultural Education Magazine advocates for a three-pronged approach to racially responsive farm curriculum: 1) explore how the United States has been historically colonized through agriculture, 2) examine the Future Farmers of America (FFA) creed as a mentor text for student experience, and 3) support community and socially oriented farming experiences. Their article points to the long history of agricultural work serving as a mechanism for oppression – setting the stage for a white-dominated commercial industry that erases both Indigenous knowledge and the legacy of slavery. The authors state, "... you cannot plant a new crop without some tillage of the field. Similarly, you cannot create more inclusive agricultural education without explicitly addressing what made or what makes it exclusive to begin with," (23). Whether in a science classroom or an FFA chapter meeting, educators and mentors must step up to the complicated land history in this country to better construct safe spaces for students of color.

Outdoor science education has also proven effective for students with neurodiversity, or students who might otherwise be placed in a special education setting. Szczytko et al.'s 2018 study on the impact of outdoor education models for children with emotional, cognitive, and

behavioral disabilities is a great example of a foray specifically into special education teachers' experiences in the field. Results from the qualitative section of this paper showed that teachers noted a decrease in behavioral disruptions from their students when conducting outdoor classes, as well as an increase in comprehension and retention of new science material. As the comprehensive methods of this quantitative/qualitative study demonstrates, teacher perceptions can be examined "in place" through observational research. STEM curriculum is a specific area with significant growth potential for improving inclusivity through experiential pedagogy (Orson et al., 2020). The next step is clearly mapping parameters for outdoor, movement-based, and culturally responsive science curriculum in schools.

Research goals

These interviews aim to capture the wisdom and experience of innovative educators who have developed experiential agricultural science content. This study focuses on independent schools in New England, specifically those with on-campus farm, dairy, greenhouse, aquaponic, or garden facilities. I chose a highly specific type of school because they have campuses with extensive land resources, as well as a "captive audience" of residential students who not only attend class, but also participate in required extracurricular activities after the school day. Shadowing a farm educator as they move through a physical space is an effective way to observe how they relate to the role of environment in their current curriculum with both an intellectual and a social-emotional lens.

This study contributes to an intersectional conversation – encompassing post-Covid-19 educational reform, curriculum as a tool to develop SEL, and more inclusive STEM programming - by exploring the role of agricultural course development in both science learning and social-emotional development. The purpose of this study is to examine and understand how

these programs are being utilized in the independent school world. Specifically, it asks how teachers design and implement these programs. What are the factors that teachers perceive as supporting or impeding this type of programming? It will likely take a long time for transdisciplinary science practices like farm curriculum to permeate generalized science standards but collecting data on the design process and classroom experience is a critical first step in that journey. This project contributes to the literature across many areas of study: curriculum design, educational inequality, relationship between learning and physical environment, and qualitative interview methods.

Methods

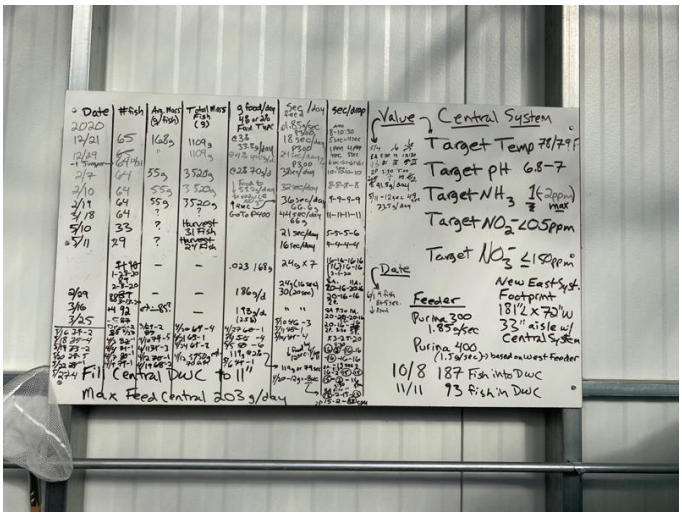
This study seeks to understand the role of the on-campus farm or garden ecosystem in the development of farm-based science curriculum. To examine the relationship between space and teacher decision-making, I conducted on-site "go-along" interviews with farm directors at a variety of New England independent residential schools in Vermont, New Hampshire, and Connecticut.

Figure 1

On-campus field during the fall 2021 season

Note: credit C Knowlton

Figure 2. *Aquaponics system classroom notes*



Note: credit C Knowlton

Figure 3

View from rotational grazing fields

Note: credit C Knowlton

"Go-along" interviews

I conducted go-along interviews to include the environment itself in the interview. Go-along interviews involve asking a series of loosely scripted questions while walking or otherwise interacting with a target environment – in this case, an on-campus farm or grow space (DeLeón & Cohen, 2005). While specific interview questions focus on the pedagogical process the teacher experienced during curriculum development, being situated "in place" helped both the researcher and the teacher be thoughtful in our conversation in response to the environment around us.

Evans and Jones (2011) state that "a major advantage of walking interviews is their capacity to access people's attitudes and knowledge about the surrounding environment." This strategy of locating interviews in an environment of interest is often applied to studies exploring well-being, human health, and geography (Bell et al., 2014). Using this methodology to assess a multi-disciplinary educational space is a creative application of the strategy and yielded useful information about the experiences of both students and teachers.

Interview questions (see Appendix 1) focused on the creative process of curriculum building from the teacher's perspective. In this context, the use of go-along interviewing allowed the growing space itself to function as a material probe. DeLeón and Cohen (2005) define the use of material probes as intrinsic to an in-place interview. They summarize their strategy by saying, "the goal is not to learn about the object or place but instead to learn about the informant through the object or place," (DeLeón & Cohen, 2005). By situating the conversation in the outdoor learning space, the instructor had a "home field advantage" and was able to speak to the process of developing the infrastructure in a relaxed manner. During the interviews, we moved around the space to look at different components of the grow space as the teacher talked about how development decisions were made. Interview recordings were transcribed and coded after each visit was over.

Sampling and recruitment

To address my research questions, I conducted five semi-structured interviews with key informants. The first stage of this study was to identify a set of independent schools that fall within three parameters: a) are residential in nature, b) have an on-campus garden, farm, or other growing operations for crop and/or livestock outputs, and c) are geographically located in New England. The geographical focus came from both a logistical and a personal perspective: as a

single-person research team, proximity to home was necessary to access the campuses. Additionally, independent schools in New England are spaces with long histories of land ownership, management, and socio-economic dynamics within the human community. Having been a student at a New England independent school, and later having taught life science at another, I have both a personal and professional knowledge and interest in such schools.

From the initial list, I conducted purposeful sampling to identify a faculty member from each school who is embedded in the farm facility and was able to speak to the day-to-day experience of teaching in these environments. I chose to utilize key informants both to expedite the time invested in the interview process and to access the diverse knowledge of someone working within both a traditional educational institution and a non-traditional farm-based "classroom" (Lindlof & Taylor, 2011).

Working off the list of independent schools accredited through the National Association of Independent Schools (NAIS), I applied several limitations to filter the final list of possible target schools. I used the following parameters to refine my search: 1) boarding + day schools, 2) New England region (MA/CT/VT/NH/RI/ME), 3) grades 9-12, and 4) all possible gender-specific options (all-girls, all-boys, and co-educational). I did not filter for enrollment demographics or religious affiliation, although those were options on the NAIS database (NAIS). From an initial list of 81 accredited schools, I used their websites to identify 19 with on-campus farm facilities. Following IRB approval for human subject research, I reached out via email to faculty members involved in running the farm to gauge interest (See Appendix 1). Out of 19 possible schools, I contacted 11 initially. One school replied to decline the invitation, six did not respond, and four agreed to participate.

Sample

Five teachers from four different schools participated in the study. There were two male-identified participants, three female-identified participants, and 0 nonbinary-identified participants. All had at minimum a Bachelor's degree, and 40% had an advanced degree or certificate. One was working through a Master's program at the time of the interview. Participants averaged 12.6 years of experience at their current school. Their ages ranged from 28 - 62, with an average age of 47.4. Each faculty member served in multiple roles throughout the school day: science teacher, dorm parent, advisor, and coach, among other responsibilities. Target schools ranged from 140 - 600 in student enrollment, with an average enrollment of 331. All are in semi-rural towns and have been open for an average of 121 years. New England states represented include Vermont, New Hampshire, and Connecticut. Each school has a stated mission that supports concepts like global learning and a tight-knit school community. According to the NAIS homepage, the shared mission of such institutions is for "all learners [to] find pathways to success through the independence, innovation, and diversity of our schools, creating a more equitable world."

Table 2. Demographic Information on Participating Schools

School Name	**Total Student Enrollment**	**Financial Aid Awarded Annually**	**Number of Countries Represented**	**Annual Tuition Cost (Boarding)**
Chestnut Academy	600	$12.9 million	31	$65, 490
The Howell School	350	$5 million	21	$66, 900
Wildwood Academy	232	$2.9 million	30	$69, 400
The Kilsythe School	140	$2 million	10	$71,620

Study Location

My observations during this study took place on the grounds of the campuses, in the learning/teaching/growing spaces specifically. Each teacher led a tour of the premises, concurrent with the interview in all but one case – this being an interview scheduled during January when staying outdoors for the duration of the interview was not feasible due to weather. Interview questions focused on the teacher's professional experience working as an agricultural science educator and sought to collect their reflections on creating and implementing farm-based curriculum with their students (See Appendix 1).

Analytical Strategy

To analyze the interview data, I used constant comparative analysis - an ongoing process of data examination that allows the researcher to pivot in their approach from one interview to the next (Boetije, 2002). A constant comparative method allows the researcher to enter a research space with some initial questions but maintain the ability to flex data collection in response to interactions with participants (Robert Wood Johnson Foundation, 2008). This approach allowed me to draw out important similarities and differences between the interviews in a way that lends context to the results (Boetije, 2002). I transcribed the interviews by hand and organized the resulting themes into multiple "buckets" for further analysis. Interview durations ranged from 37 minutes to 50 minutes.

Comparative analysis is especially useful in this study because, while the structure of a selective New England boarding school is quite formulaic in many ways, innovative programming piloted by different educators is highly diversified. Assessing my methods as I went promoted the organic discovery of new and interesting thought processes through more

fluid conversations with educators. To code the results, I used an open coding method to identify common terms and themes within and across the interviews (Lindlof & Taylor, 2011). Using this analytical strategy, my data will be useful in understanding both existing science curriculum frameworks and opportunities for future growth in this area as it relates to secondary education.

Results

Table 1. Pseudonyms of Participants and Schools

School Name	Chestnut Academy	The Howell School	Wildwood Academy	Wildwood Academy	The Kilsythe School
Teacher's Name	Alicia	Brian	Paul	Katrina	Lillian
State	CT	CT	VT	VT	NH
Job Details	Farm education coordinator, dorm parent, head coach of farm team	Science faculty, coach of outdoor adventure program	Farm manager, history faculty, girls' basketball coach	Garden manager, barn crew, science faculty, dorm parent	Biology teacher & farm director, dorm parent, head of farm and forest team

The results of the constant comparative analysis revealed valuable information regarding the efficacy of agricultural education in these particular school environments. All respondents expressed a deep appreciation for their jobs, as well as a strong desire for such programs to expand and interact with more facets of school life. Important themes that emerged through these

interviews are as follows: 1) students' relationship to work, 2) time as a constraint, 3) assessing long-term impact, and 4) the future of farm education.

Students' Relationship to Work

The idea of cultivating students' relationships to work was a key theme in these interviews. As Katrina phrased it, students are becoming "less rugged and resilient" - a trend that several participants note was exacerbated by educational disruptions during the recent pandemic. The willingness to expand into the realm of physical labor presents a real challenge in attracting students to farm-based programs. Lillian commented, "... if it's a whole new world, even just the idea of spending time for fun outside, to start with... and on top of that, to have to get your hands dirty, maybe shovel some poop, maybe transplant stuff, at first those students are sort of resistant to it."

There are cross-cultural barriers involved in building a collective relationship to work – as Paul put it, "... we talk about being approachable, we talk about being inclusive. And there's some cultural norms that we need to be aware of. The New England ethos of all for one and one for all, and leadership is just working harder, doesn't necessarily translate across cultures." For example, cultural expectations that older students will achieve seniority and become exempt from non-academic work is an important lens for educators to keep in mind as they design programs. In residential schools that draw students from different countries around the world, applying cross-cultural analysis of methods and learning objectives is key to calling in the greatest number of students.

Specifically, the idea of laboring outdoors to produce a tangible deliverable is potentially fraught for students of color. Differing observations regarding students of color were noted

separately by two of the respondents. Alicia remarked, “We have students that are BIPOC, we have students that are LGBTQ+, and they really find their people here. And it becomes this place where they feel accepted and seen.” This points to a positive relationship between students of color (as well as LGBTQ+ students) and the farm facility, in that it fosters feelings of community and belonging. This is potentially a space where students who do not feel they fit into the “typical” mold can build team relationships. Such a community spirit may originate from the preppy, athletic ethos of Chestnut Academy – perhaps students who fall outside the dominant identities are able to find solidarity and friendship through non-competitive team activities.

Katrina, however, commented that she felt fewer students of color were interested in farm programming - perhaps due to complicated relationships with the idea of working the land. At Wildwood Academy, there is a full “work program” where all students participate in various responsibilities during their time at school – for example, cleaning classrooms, washing dishes, or maintaining hiking trails on campus. A strong community focus on the value of hard work perhaps brings about a reticence towards opting into further work, especially for students of color. Overall, it is critical for independent school educators to include restorative racial justice concepts in their experiential curriculum to avoid replicating the historical prioritization of students who embody a “prep” identity.

Given the variety of observations made by educators interviewed in this study, it is likely that racial, intellectual, and class-based identities are important factors in students’ willingness to try agricultural programming. Race and class factor heavily into historical land use in the US, and the variety in respondents’ observations points to a need for self-critical examination of coursework. More conscious attention must be paid in future to the intersection of personal identity and engagement with experiential curriculum. This need is underscored by the general

trends of race-based educational inequality across all types of school in the US but is perhaps especially pertinent at independent schools with institutional histories of educating predominantly white, wealthy, and male students. This presents a unique opportunity to incorporate social justice work into STEM curriculum through the lens of land management, given the heightened potential for SEL in outdoor classroom spaces.

Time as a Constraint

A critical barrier to implementation noted by respondents was the lack of time available for educators to create, workshop, and implement farm programming, specifically in science coursework. Educators universally commented on the rigors of the daily academic schedule, in relation to students' available energy as well as faculty time spent on program development. Alicia commented that even with a well-developed farm facility available, it was difficult to incentivize classroom teachers to bring their students outside the traditional classroom. She noted, "... I think that's something that teachers need to understand too, is it might seem like a fight to get out here, but then you open up students to an experience that they don't even know they're missing. And it's so deeply ingrained in us as humans to have a connection with nature."

All respondents pointed out the obvious time impediment of summer vacation. This presents a definite challenge to continuity, but this is a barrier that can be overcome with creative problem-solving. For instance, Brian's strategy is to transfer plants from his on-campus aquaponics greenhouse to a local community garden in late spring after students leave. This solution allows for an additional point of community engagement beyond the course itself. Lillian is interested in creating paid intern positions for local day students to keep the farm running smoothly during the summer. Even with the inherent disadvantage of an empty campus over vacation, there are creative solutions to the problem.

Assessing Long-term Impact

A third theme emerging from the respondents' interviews was uncertainty regarding the long-term outcomes of farm programming. This can be further separated into two sub-drivers: 1) the value assigned to the college process, and 2) a lack of programmatic tracking and assessment on the part of administrations. The interviews indicate that there is a lack of information on both the short-term and long-term ends of the spectrum – an issue that could be addressed at the administrative level by gathering feedback from alumni.

The importance of the college admissions process for independent school students is a driving factor in educational choices on the part of both the student and the parents. Each school represented in this study is considered a "college preparatory school," which, in the cultural landscape of New England, is often associated with high degrees of socioeconomic privilege. According to Alicia, the high expectations surrounding college admissions and quantifiable personal assessment can preclude students from following less traditional, more interdisciplinary academic interests like agriculture. Even among students Alicia has seen excel in a food systems/agroecology learning space, the pressure to attend the "right" college often drives decisions about the future. She comments, "... it's not all about going to Yale or Stanford. And unfortunately, some of the students and families are very much connected to that myth of success... I wonder if they'll find it later, you know, as they realize they want to go into farming, or the food system, or food justice." Given that food systems programs in higher education are fairly uncommon, the lack of name-brand recognition is likely preventing some students from pursuing their agricultural interests following graduation.

Lillian pointed out that there are also problems with the perception of farmer identity; agriculture is often included in the trade category and is looked down upon as not requiring a

high level of education or intellect. She commented, “I firmly believe that not every person needs to get a degree to be a successful person. Which, I would say, is a controversial view. And it’s still looked down upon if people don’t have undergrad degrees. But I’m hoping the rhetoric around that changes, and the importance of being a farmer goes up... that's just been something on my mind in recent times and has always been part of the reason I like doing agriculture and working with students in agriculture, because farmers need to happen.” This perceived binary between formal education and trade training is likely contributing to lower student and parent investment in such programming, despite the well-documented intellectual benefits. As Brian pointed out, there is ample space within experiential courses to emphasize broader life skills such as information literacy and problem-solving: “You need to be able, by the time you leave high school, to get some information accurately out of a book, out of a text, and apply it. Those are just fundamental life skills – it's like, this is not science, this is how you solve a problem. This is how you do a DIY project.”

As we emerge from the Covid-19 pandemic, there is growing interest in re-examining academic value systems in general. Lillian noted, “I think a lot of schools are going through a bit of a shifting identity, because of what education looks like right now, especially post-pandemic. I want to say – and I don’t know this for sure – but we are already a school that focuses on project-based learning, but I think schools, especially independent schools who have more flexibility with curriculum, will start to do that too.” The timing of these interviews (starting in October 2021 and finishing in January 2022) presented a snapshot of educator experience just as schools were returning to fully in-person participation following the disruptions of lockdown and school closures. Feedback from this group of educators is useful in that they had very recently had to

contend with a forced disruption to the "normal" classroom pedagogy – an inflection point in the career of any high school teacher.

Beyond the individual student experience with college admissions, there is room to grow at the institutional level through program assessment and long-term evaluation strategies. Several teachers interviewed expressed worries about the legacy of farm education, and the unpredictability of how students will carry their experiences into adult life. Katrina commented, "I think how it affects the broader community is harder to quantify. I do think the school could do a better job of looking at outcomes and tracking the outcomes of these programs. It's not always super obvious what those effects are, but I think it does affect students in the community that way – just having a sense of pride in where the food comes from. But then students still complain about the food, you know, they're teenagers." While the faculty members interviewed each had anecdotal evidence of farm programming making a positive impact on students' lives, missing out on collecting and analyzing that data is a loss for administrations interested in beneficial curricular evolution. As Paul noted, "Kids enjoy harvesting vegetables and seeing them come into the dining hall. So there's a pride in that, and it's probably something a lot of them can't articulate at this time. But it'll mean a lot to them when they're thirty."

While it is expected that students will move on eventually, faculty members also change jobs throughout their careers. Given the long-term investment of labor needed to keep a farm running, faculty turnover in agricultural education jobs can have program-level effects if there is not a succession plan in place. This presents another growth opportunity for school administrations: how can we structure farm education programs to prevent a loss of curricular integrity if the directing faculty member moves on? Several schools with farm facilities simply hire separate staff to operate the farm, rather than integrate the farm infrastructure into an

academic teaching position. Lillian commented, "... a teacher doesn't usually have the position. Although it has happened before, I think more commonly it's been someone else who's managing it, or they don't necessarily have someone who's the point person for it. But for right now, just because of our size, to have someone and pay someone to be full time, and just to be there... even teaching a couple sustainable ag classes or whatever, it's not super available for us right now." Although this requires a significant level of investment from the school, one existing solution is to endow the faculty position to ensure continuity of programming – a strategy that has already been applied to Alicia's position.

The future of farm education

A final theme emerging from these interviews is the hopefulness held by educators when they consider the full potential of their farm space. While it can be easy to focus on the structural impediments to realizing a program's full potential, many of the respondents also commented on the latent power they saw in their spaces to bridge academics, local food production, and community engagement – both internal to the school community and reaching outward to a wider audience. Lillian commented, "I'm hoping that the farm can be the go-to if it has anything to do with environment, or science, or relationship to the earth, or even social justice, food justice, land justice stuff, that that space is the first place people think of when they're like 'how can we make this project-based.'" The forward-thinking ethos all participants evinced made a tangible impression throughout the interview process.

Discussion

Statement of Purpose

The goal of this study was to gather information regarding agricultural science curriculum from key informants working at independent schools around New England. Feedback from this cohort of participants yields important information regarding structure, learning objectives, and the experiences of faculty as they develop their curriculum.

Using "go-along" interviews to assess a multi-disciplinary educational space was a novel application of methods and yielded useful information about the experiences of both students and teachers. While the "go-along" approach is frequently applied to studies measuring well-being and outside experiences, there is a gap in the literature concerning the hybrid SEL and intellectual benefits of outdoor academic programming specifically. These interviews provide insight into the experience of developing and implementing agricultural STEM programming in a niche type of school – the New England prep school.

Theoretical Implications

This study supports and continues a conversation that spans a diverse array of learning spaces – from Outward Bound trips for adolescents (Orson et al., 2020) to elementary special ed classrooms (Szczytko et al., 2018). There is a consensus that hands-on pedagogy increases both content comprehension and social-emotional development (Garner et al., 2017) One pathway to further developing hands-on learning is through farm and food-based coursework. This study examines a subset of educators (and their relevant curriculum) for more personalized insight into the design process. Understanding a) how educators come up with exciting ideas, b) what they value and prioritize, and c) what barriers stand in the way of realization can help educators and school administrations troubleshoot during the course design process.

Practical Implications

Themes from this study suggest several concrete steps schools could take to support and expand farm-based science education. At the administrative level, schools could create a freestanding position for a faculty member with both farm/garden and curriculum development skill sets. This employee could be "housed" in the science department and continue to teach in a classroom or could be considered a mid-level administrator similar to a sustainability coordinator or dean. Given the significant labor demands on both teachers and farmers, expecting one person to embody both roles is likely a heavy lift. Investing in a new position will attract applicants with diversified work experience and sustainability-minded values. This approach has the potential to address the issues of time constraint and curricular continuity.

Beyond the role of faculty in farm education, administrations could also dig into the impact of the college process on student academic experience. This is likely best suited to a simple dialogue to begin with: college counselors might participate in social justice oriented professional development in order to foster more holistic, interest-based conversations with both students and parents. Crystallizing an individual school's "mission" as it relates to college admissions will lend clarity to the broader question: what exactly should "prep school" be preparing students to tackle? Considerations of the full picture of student identity – encompassing race, class, neurodivergence, and life goals – should begin factoring organically into this evolving conversation.

Limitations

The inherent weakness of this study is the narrow scope of school structure; all participating schools have considerable financial and social capital, which opens the door to

curricular diversity. Despite the relevant critique that these schools can avoid the worst of possible financial constraints, there continue to be value-based barriers to implementation. Programs at financially stable schools can therefore be used as case studies to gain insight into pathways to developing highly effective agricultural STEM coursework, which could be scaled in size or cost to apply to a wider variety of school environments.

Future Research

Further research is needed to elucidate the connections between identity, content comprehension, and relational ability as they relate to curriculum construction. STEM classrooms specifically hold high potential for further curricular growth, a theme explored through this set of interviews. In future, conducting more studies using "go-along" methods could be instrumental to understanding the classroom experience in place. While this methodology is often applied to studies gauging human + green space interactions, it is underutilized in educational spaces. Additionally, future work comparing experiential STEM coursework at highly resourced schools versus lower-income schools would be useful in assessing how to scale up or down, based on realistically available resources.

Conclusion

The recent Covid-19 pandemic has disrupted the traditional routines in classrooms all over the world regardless of resource availability, prompting all educators to think critically and creatively about their curriculum and expectations. This historical moment of forced change begs deeper questions for secondary educators: What does it mean if the structure of the college admissions cycle causes a student to disengage from an academic field in which they had

previously excelled? How can individual educators, and administrators, work to reframe the importance of following interests while also promoting the best post-graduate educational opportunities?

Programs such as these four surveyed in this study can serve as a model for deeper thought – touchpoints to consider the fundamental goal of high school, ways to address social inequities through curriculum, or even simply how to create classrooms that better support success for faculty and students alike. Based on the voices of the educators represented in this study, there are actionable steps possible for both individual teachers and schools as institutions to create and support more experiential science education models.

Conflict of interest statement

While there were no conflicts of interest during the duration of the study, the author went on to work on the farm during the summer at a participating school following the completion of the study.

Appendix 1: Interview Questions (completed in person)

I'd like to begin by asking you about your experience in your current job.

1. Tell me a little bit about the different hats you wear in your role at this school!
    a. Probe: how did you get involved in running the farm program here?

2. What do you use the farm used for?
    a. What classes/activities/physical outputs etc are facilitated through the farm?

3. When have you felt most creative in developing your courses or materials?
    a. Probe: what would your dream class to teach be?

I'm also really interested in the effect an on-campus farm can have on the student experience – I'd like to shift gears and talk a bit about the results you've seen during your time here!

4. Can you tell me a story about a student who particularly excelled in this space?

    a. Probe: Can you tell me about any alumni who have gone on to study these topics in college, or in a workspace?

5. How do you feel your program impacts the wider school community?
    a. Probe: If you could dream big with no constraints, where do you see this program going in the future?

6. Are there any other highlights from your work here that you'd like to share with me today?

I'm going to turn off the recording now. Thank you for your time and energy!

Appendix 2: Demographic Survey (completed at the time of the interview)

1. What is your gender identity?
2. What is your age?
3. What is your position at this school?
4. How long have you worked in your current position?
5. What fields did you study or earn your degree(s) in?

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