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Teacher Professional Learning Communities for Sustainability: Supporting STEM in Learning Gardens in Low-Income Schools

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Abstract: In order to address the ecological and social problems of sustainability in our modern times, citizens need to be empowered with an understanding of science, technology, engineering, and math (STEM) concepts and practices. Furthermore, STEM must be democratized and taught in life-giving and life-sustaining ways that include *all* students instead of the small fraction of “high achievers” and limited to the “potential” scientists, engineers, and mathematicians. At present, K-12 students and their teachers rarely have the opportunity to learn beyond their concrete school walls and to reconnect with nature, exacerbating their disconnection of STEM from real life and hence sustainability. We believe that engagement with school grounds and gardens and the very soils on which learning takes place can provide simple yet authentic day-to-day educational experiences that can bring mindfulness of lessons related to the cycles of life and death and to the interplay of justice and power in our communities. To transform teaching and learning in the classroom, teachers need different learning experiences that provide them with the time, space, and appropriate supports to translate their learning into teaching practice making education relevant to life. School gardens provide a rich context for learning both for teachers and students by embracing experiential, integrated, and collaborative learning. This study highlights an example of a summer program that involved teachers in hands-on education related to STEM in the learning gardens at four low-income schools in southeast Portland representing the growing ethnic, linguistic, and cultural diversity of the districts in the metropolitan area. Teacher voices capture the essence of learning STEM in the learning gardens, and also address issues of social and environmental justice.

Keywords: Learning gardens, professional learning community, STEM, low-income schools, teacher education, educational justice

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Sustainability... cannot be simply a 'green' or 'environmental' concern, important though 'environmental' aspects of sustainability are. A truly sustainable society is one where wider questions of social needs and welfare and economic opportunity are integrally related to environmental limits imposed by supporting ecosystems.

Agyeman, Bullard, & Evans (2002, 78)

Three recent trends provide context for this project: (1) National interest in Science, Technology, Engineering, and Mathematics (STEM) with efforts to enhance K-16 education in these subjects as proposed by the President's Council of Advisors on Science and Technology (PCAST, 2010; NRC, 2012) among others; (2) Disproportionate under-representation of racial and ethnic minorities in STEM-related careers (Museus et al., 2011); and (3) Sustainability imperatives and related STEM concerns given the increasingly complex environmental issues confronting the present and future generations (Williams & Brown, 2012). Unprecedented global environmental and social problems of our modern times require literacy in STEM. For instance, the realities of climate change, clean water shortage, air pollution, food insecurity, perpetuation of a monoculture across the globe, and increasing rates of obesity and diabetes among children and youth, are intensifying social injustices everywhere. As Agyeman et al. (2002) point out, environmental concerns are intricately woven with social and economic concerns. Sustainability, thus, has a broader domain where power and privilege also must be attended to.

An important component of the renewed emphasis on STEM is concern for the participation of populations who are typically under-represented in STEM fields. Achievement gaps continue to exist for ethnic and racial minorities. While some progress has been made to increase STEM literacy in the past four years, achievement gaps in Science between minority and low-income students and their white, middle-class peers are persistent and significant (National Center for Education Statistics [NCES], 2012). According to the 2011 National Assessment of Educational Progress (NAEP), there was a 35 point difference in assessment scores between black and white students, with only 32 percent of black students at or above the proficient level (NCES, 2012). In 2000, approximately 6% of all white 24 year olds held a bachelor's degree in a STEM field compared to just under 3% of those 24 year olds who were black or Hispanic (Museus et al., 2011).

If we wish to seriously address equity and close the achievement gap, then we also need to focus on excellence in teaching and simultaneously address preparation of the next generation of students for knowledge, skills, and attitude to live sustainably (Sterling, 2001). Outstanding teachers are essential in high-poverty and high-minority schools. Unfortunately, such high-needs schools employ a disproportionate number of inexperienced and under qualified teachers compared with schools serving other students (Kelley, 2009; Penske & Haycock, 2006). Notwithstanding evidence that new teachers require several years of classroom experience to reach their full potential, high-poverty and high-minority schools are twice as likely to have new teachers as are more affluent schools (Penske & Haycock, 2006). Teachers' needs in under-privileged and inner-city schools require attention, especially since their students are more vulnerable to problems impacting their health and neighborhood environments.

Professional Learning Communities for Teachers: Engaging in Experiential Learning

What is critical to advancing STEM education in ways that also address sustainability and attend to the education of low-income, ethnic and racial minority students is to provide teachers with opportunities to engage with issues of sustainability and STEM in simple yet profound ways. While there is not a dearth of approaches, resources, and recent funding to advance STEM in our schools including designing sophisticated laboratories and advanced technologies to engage students, we take a rather non-traditional approach: actually engaging teachers with the school grounds and dirt right outside their classrooms thereby interrogating the very soils on which the enterprise of teaching is conducted. Bringing mindfulness to the teaching enterprise, our intention is to help educators and students understand ways that they can engage themselves and their students in simple, down-to-earth teaching and learning through the learning gardens and foster wonder and curiosity (Opdal, 2001). Mueller (2011) persuasively uses the metaphor of “leaving the classroom” in order to bring “ecojustice perspectives in science education and the ways that a dialogical conversation addressed the world rather than focusing narrowly on science education” (p. 351). In low income schools, often with large percentages of linguistically and racially diverse student populations, the living soil of learning gardens provides connections to life and hence to life-giving education for children and youth (Williams & Brown, 2012). One does not have to go far when leaving the classroom.

Yet, to improve teaching and learning in STEM, teachers need support as learners so they can provide the educational experiences their students deserve. Therefore, teacher preparation and their continuing professional development need to incorporate time for teachers to learn content and to apply their new understandings into curricular plans. Teachers need to be active participants in their learning as they develop knowledge, skills, and dispositions related to students, learning, curriculum, pedagogy, and assessment (Marx et al., 2004). By providing relevant and meaningful learning experiences teachers can develop competencies in STEM with particular focus on sustainability. An important aspect of this process involves time and structure for reflection (Bransford, Brown, & Cocking, 2000; Lambert & McCombs, 1998; Marzano, 1992).

In STEM and sustainability education, inquiry-based, project-based, experiential, place-based (Smith & Sobel, 2010), and interdisciplinary learning (Brand & Triplett, 2012) approaches align with what is known about how students learn, and can provide opportunities to engage students who are often marginalized in more traditional models of education. Experiential education, championed by John Dewey (1912) over a century ago, is a philosophy where educators purposely engage learners in direct experience. However, reflection is an important component of learning from experience in order for students to be able to not only increase knowledge but also develop skills and clarify values (Collier & Williams, 2005). Kellert (2005) proposes direct experience with nature for children and youth who are increasingly distanced from natural environments and rooted within concrete structures and walls of schools. There is a growing body of evidence suggesting that experiences associated with unstructured activity and play in a natural setting positively influence environmental behaviors and beliefs later in life (Chawla, 1988; Lekies & Sheavly, 2007; Louv, 2005). This manner of the child experiencing the world around her helps her to form ideas and perceptions of how the natural world works and helps to create bonds that are meaningful over time. Kellert (2005), in describing the lack of “natural” experiences in today’s children, says:

Children today too often confront a contrived, artificial nature in place of an actual, ordinary experience. Confronting nature as fantasy creatures in story and film or as herds of exotic wildlife on television may be entertaining and sometimes instructive, but it can never adequately substitute for direct and real contact. The contrived experience of nature rarely provokes in children strong and lasting emotional responses, such as wonder, joy, surprise, challenge, and discovery. (p.74)

In keeping with these sentiments, numerous examples of project-based science programs, aligned with national science standards, have shown positive impacts on students, including addressing the achievement gap between white students and their low-income and minority peers (e.g. Marx et al., 2004; Schneider, Krajcik, Marx, & Soloway, 2002). In many cases, particularly at the elementary level where teachers do not often have strong grounding in STEM disciplines, teachers have benefited from support in developing pedagogical content knowledge and improving their teaching practices related to STEM (Schneider et al., 2002).

Teaching STEM in the Learning Gardens: Theory to Practice

To address the needs for increasing teacher confidence (Gunning & Mensah, 2011) in STEM fields we offered courses in the summer of 2012. Our intention was to provide hands-on experiences in the learning gardens at schools in low-income communities by having teachers actually engage with students enrolled in a summer program through Schools Uniting Neighborhoods (SUN, 2013). SUN schools in Multnomah county are full-service neighborhood hubs where the school and partners across the community come together to provide holistic support to families and their children for success.

Why Learning Gardens?

Since the early 1990s, school grounds that were previously covered with asphalt or grass are instead increasingly becoming sites for growing school gardens. Thousands of school gardens have sprouted across rural and urban areas in the United States of America, with newly designed garden curricula being aligned with subject standards (Blair, 2009; Ozer, 2006; Williams & Dixon, 2013). First Lady Michelle Obama (2012) has further validated the school garden movement by joining children from local public schools in planting and harvesting organic vegetables at the White House. Moreover, garden-based learning is at the convergence of two overlapping and significant strands of public concern:

- (a) Obesity, Health, and Food Insecurity: There is heightened interest in teaching students how to grow food, and school grounds are considered prime places for local food production and garden-based learning. The following trends give a sense of urgency to this interest: all-time high childhood obesity rates; waves of salmonella, *E. Coli* and other bacterial outbreaks related to industrial agricultural processes and practices; and increase in Type II diabetes among children (Azuma & Fisher, 2001; Ozer, 2006; Vivian, Carrel, & Becker, 2011; Williams & Dixon, 2013).

(b) No Child Left Inside Coalition: Louv's (2005) best seller *Last Child in the Woods: Saving Our Children from Nature-Deficit Disorder* has spurred the formation of a large national Children and Nature Network (2009) with a sense of urgency to offer children outdoor spaces to play and experience nature. As an antidote to the No Child Left Behind Act of 2001, seen as narrowly defining curriculum and restricting children, a No Child Left Inside Coalition (2009) has emerged. School gardens are seen as common denominators for children to gain "outdoor" learning experiences on school grounds.

Given these trends and the national interest in gardens at school sites, the school garden movement and garden-based learning continue to gain legitimacy.

Course Overview

In the summer of 2012, we offered two interrelated STEM courses entitled *Theory to Practice in School Gardens* and *Connect to Science through Learning Gardens* to teachers in the Portland metropolitan area, most of whom were from the Portland Public School (PPS) District, along with coordinators of the SUN program in PPS (See Appendix A for content, readings, and objectives). Thirty teachers and educators of the SUN program from various contexts and in various stages of professional development (in-service teachers, pre-service teachers, extended-day/SUN school teachers, informal science educators, etc.) joined forces to put research-based science education into practice. Each day, educators worked with K-8 students at one of four partnering SUN schools in outer southeast Portland (Lane, Kelly, Lent, or Woodmere schools), collaboratively enacting a co-designed STEM program at the school's garden. The garden-based STEM program provided teachers and community-based educators with the opportunity to implement a standards and place-based curriculum that incorporated the effective use of formative assessments, and hands-on, inquiry-based activities with elementary students, all in the fun and engaging context of a summer garden program. Utilizing the garden as a context for teaching and learning, this summer program provided the foundation for aligning learning and enrichment activities across the regular school day and the extended-SUN school program.

Teacher Reflections, Teacher Voices: Teaching and Learning in a Garden-Based Context

Two intensive weeks of the course were spent working with the educational team at each of the four sites, and getting to know the students enrolled in the summer garden program. Teachers met in the afternoon as a larger class to develop curriculum and authentic assessments. We asked the teachers to reflect on their experiences and address several questions that also included the following: (1) What have you learned about teaching and learning in a garden-based context?; and (2) How has working with a team of educators shaped your experience? We have clustered their responses in three broad categories below. We have deliberately chosen to use extensive quotes without further comments for each of the three categories in order to honor the teachers' understandings and voices. In the final section, *Conclusion*, we capture the essence of what emerges in the teachers' voices.

(a) Experiential and Engaged Learning: Embracing Practical Experience

Teachers clearly expressed how the opportunity to learn through hands-on experiences in the gardens, both as teachers and learners, profoundly impacted their confidence and sense of self-efficacy using the gardens as a context for STEM education. Furthermore, teachers shared their observations of how engaged students were as they investigated the gardens, dug in the dirt, and made sense of their explorations.

I am surprised at how easily students are engaged in the garden—the first day we gave students trowels and they dug for 45 minutes straight! I shouldn't be surprised—I have been an educator for seven years—but it was just so simple. They were so happy to use their hands, to find bugs, to dig up rocks...It is a shame we keep them sequestered to a desk for so much of their educational experience when we could take them 15 feet outside of our classrooms and let them learn in the schoolyard! (Sandy)

Teaching is downright fun when the subject matter is engaging. That little point can get lost in the onslaught of curriculum standards and time constraints. (Jason).

I was most struck by how engaged the children have been in the garden. I was surprised the first day by how long the students spent happily digging in the dirt. I was also surprised that some of the students had great knowledge about soil already from the SUN after-school program. It was great to see students excitedly discussing soil and insects with each other. One group was discussing what would happen to a worm if it were cut in half. Another group was debating if a spider was a bug, arachnid, or both. (Gwen).



Figure 1: 2nd-5th grade students work alongside teachers, exploring soil composition, searching for worms and insects, and recording their observations and insights in their garden journals.

I really appreciate the hands-on learning experience I had in the morning class at Kelly Elementary. Thanks to the encouragement from teacher peers, I used a power drill and helped build a garden bed. I also used a rototiller for the first time. Like other inexperienced students, I felt so empowered by learning a new skill and successfully building something! I can now go back to my students, model how to build an easy garden bed, and help them to do the work. The students at Kelly were really proud of their beds and took ownership over them, especially when they gave 1st graders a tour of the garden, answering their questions and teaching them about what they had built. Talk about a heart-warming experience! (Sandy)

The big idea that I have gained is that soil is alive and is an inseparable part of interconnectedness with humans and we together are part of a web of life; but also, that children really respond to opportunities to touch the garden. I can call to mind right now one little guy...who is bilingual. He is very shy and as a result reluctant to involve himself in most of the verbal interactions throughout our gardening day...As I was walking with the garden students to the where they would receive their lunch (he said): "I want to show you something in my journal." ...As I reflected on it later I was reminded that many of the children we teach need that scaffolding that grants them access to express their ideas,

excitement for what they are experiencing and sincere appreciation (or confusion) alongside their fellow students, which likewise speaks to an ability to feel socially able to interact in a way that feels satisfying. (Rhonda)

(b) Integrated Learning

Seeing how gardens could provide a meaningful context for teaching STEM was impactful for teachers; and many of them were struck by the interdisciplinary opportunities that school gardens provide. Numerous teachers shared their observations of students writing extensively in their garden journals. These observations were especially insightful when students who had been disengaged, “problem” children during the regular school year were suddenly transformed into engaged, cooperative learners. Finally, teachers were inspired by the holistic, interconnected nature of learning in the gardens, recognizing how important out-of-class experiences are for children (and adults).

The traditional educational culture we teach in rarely focuses on the needs of the whole child—emotional, psychological, spiritual, physical, social, and intellectual. I have learned through these courses that learning gardens are magical places where connections to the heart and the soil are natural and almost easy to make. . . . It is such a relief to have the permission to address that emotional, social and spiritual component of ecological education. (Sandy)

The past two weeks have been an eye opener for me. Most of my teaching career has been in preschool and kindergarten. I was a little apprehensive about working with older elementary school students. I discovered that the older children were just as curious as the kindergarteners I work with and just as in early childhood education settings, older children thrive when they can learn hands on. One day in the garden a small group made a mountain of dirt and then poured water down it. . . . They were fascinated by the hole that broke through on the side of their mountain and continued to pour water down it. One teacher took the opportunity to point out that erosion was taking place. Another pointed out that it was creating a delta and yet another teacher pointed out that an oxbow was being created. I myself learned what the term oxbow meant when speaking of rivers. This spontaneous activity ended up being a rich learning experience for all involved. (Gwen).



Figure 2: A somewhat shy 5th grader shares the work that she and her friends accomplished during the summer garden club to curious 1st graders and their teachers. While leading this tour, she and other 2nd-5th grade students proudly explained square foot gardening and vegetable choices, while also (unbeknownst to them) practiced their speaking and communication skills, deepening their own learning experience.

Possibly what I found most exciting about teaching through the context of a garden was the ease with which you can connect the experience to different standards. I am not familiar with the standards from many other grades, but in third grade I was thrilled to find such perfect connections to our study of Portland and its history (place-based learning!) and math (measuring and fractions). Language, reading and writing standards are easily related to multiple concepts and subjects. I am so grateful to have had the time to sit down and piece together a unit and see firsthand just how relevant learning through the garden can be, not to mention to have the related standards on hand as proof of this relevance. (Kathy)

It was a thrill to see that when we turned the garden over to the children and asked them to develop a plan to improve the space they came up with all of the ideas that we had hoped to cover. By handing the challenge over to them they got to be the creative problem solvers. I believe this really heightened their motivation to work hard on their garden improvement projects. This was a good reminder to me of how rewarding it is to let go of some of the control and to trust the children as learners. (Gwen).

Here are some of the ideas that I will be incorporating next year:

Sit Spots- I am drawn to this activity for so many reasons; mostly because children are being stimulated at such a deafening rate by watching cartoons and playing video games that they are in need of a break and to practice being mindful. We are so lucky to live in a place where we can watch and feel the seasons change, and I am excited to make these observations a regular part of our learning throughout the year...

Technical Drawings- So often, students are opposed to the idea of drawing because they feel insecure about their skills. But I truly believe that by slowing down and focusing on the details of an object, even those that struggle with fine motor skills can be successful. Our discussion about technical drawings brought me back to a moment in fifth grade when our class went outside to draw something up close. I chose the bark of a birch tree that was growing near my school. While I have never considered myself an artist and tend to struggle with spatial concepts, I can still remember feeling proud of the work that I'd done because it was small-scale and I took the time to really concentrate on the tiniest of elements of the tree's bark. (Kathy)

This week with the students has been all about teaching science, but the children are doing amazing writing and even some math this week. In order for me integrate science into my writing more I need to be more planful and make sure that I am fitting science into my daily schedule. I can see how I can blend it more with writing; the students are so motivated to write when they are given those meaningful, rich, and engaging experiences. I just need to figure out how to have them do more than just write, but to focus on skills as they are writing. (Karen)

Unfortunately, too often teachers feel trapped by the core [curriculum] and its isolated approach, but simply from observation alone, let alone research, this can be so disengaging for our students. There is no connection and sometimes little relevance to our students. At Title 1, zone schools we have little opportunity to stray from this, but we are really doing a disservice to our students if we do not begin to integrate the curriculum and use a more student-centered, inquiry based approach in which STEM education is considered vital. The underrepresentation of minorities in STEM careers makes it clear that those of us working with these students need to create a more equal playing field. (Margaret).

(c) Collaborative Professional Learning

Perhaps the most transformative aspect of these courses for teachers was the opportunity to collaborate and learn with a group of peers. With a few exceptions, most of the teachers had at least one colleague from their school, but also worked with teachers from other schools and districts, as well as with SUN program educators. Nearly all of them commented on how rich their own learning was as a result of working with teachers having very diverse perspectives and approaches. As instructors, we tried to provide an environment where teachers were nudged out of their typical comfort zone, while still providing a safe, collegial atmosphere. Many teachers indicated that they learned more because of this.

I think the way the teachers have learned in the garden very closely parallels the experience the school children have also had in the garden. We have all collaborated, problem-solved, and worked as a team toward a common goal. (Gwen).

Working collaboratively with a team of educators has challenged me in both positive and productive ways. I have felt challenged to work outside myself (not always easy to do), to consider multiple perspectives, to seek for a (or the most) common proactive consensus on how to proceed with our group task; which I might say is a slower process than working independently (which is also my comfort level). That is, one can more quickly and easily agree with oneself and it's less painful. I think the most beneficial experience in having to work collaboratively is having had a problem-solving situation presented with which to work through together. I believe that if one is open to the "real" living experience that one must go through to accomplish this task (mind, emotions, and will and physical self), then it can only lead to a measure of human-social profit. Personally, I feel greatly benefited, especially because I have felt somewhat like an "odd ball" during this whole experience. (Rhonda)



Figure 3: Teachers had the rare opportunity to interact with students in very small groups, giving them the chance to see how students make sense of their observations. After each session with the students, teachers had time to debrief together, sharing their insights and making plans for increasing student engagement and learning.

Working with my group has been beneficial to me and helped shape my experience for two particular reasons. The first is simply the energy they have provided. They are a positive team who interact so well with the kids. I have learned quite a few techniques simply by observing their interactions with students. The second benefit to me is the ideas and insights that they have shared after the kids have gone for lunch. The perspective of others on specific situations definitely helps give a more well-rounded view of things. We have discussed student engagement and why we think at times it is high and at times not so much. We have talked about the needs of the ELL's [English Language Learners] in the class. We have talked about specific students who are having trouble engaging and strategies that seemed to have worked to help pull them in. We do not often get this opportunity in the classroom and it has been very insightful. (Margaret)

Working with this team of educators has been helpful and enlightening. It is really important to understand other perspectives and hear from other teachers about better ways to teach and ways to overcome strife in the classroom. (Desmond).

Over the past week, I have developed much stronger connections to the teachers ...and I have been reminded of how important it is for educators to collaborate with one another. (Carrie).

I love learning from young teachers, and they've had much to teach me about action research and data collection. At the same time, I have often felt left out as the "old fogey" who doesn't get all the electronic stuff and who longs for the old days of integrated curriculum and project teaching. What a shock it was to be regarded as an asset in terms of garden learning experience! (Brenda)

I have enjoyed collaborating with teachers from other school districts. I really appreciate the garden knowledge I am quickly gaining—when to plant what, how to build a garden bed, etc. My dirty little secret is that I am really a garden novice. My experience as a student has definitely been enriched by what knowledge and insight my team has shared, both professionally and personally. One of my peers is a self-proclaimed "Go big or go home" kind of person, and I am inspired by the ambition that I am often too tired or nervous to take on in my classroom. (Sandy).

Conclusion

Standards-based education does not have to equate with narrow, overly-scripted, and disconnected teaching and learning. On the contrary, standards should serve as a framework for designing integrated curriculum and instructional plans that use topics related to STEM, sustainability, and social justice as themes for authentic, real-world learning. School learning gardens provide an easily accessible entry point for teachers and children to connect to the natural world while learning important concepts and skills in an integrated, holistic manner. For teachers to feel confident and empowered to leave the classroom walls, they need to have similar experiences as learners themselves, as well as time, space, and support as they translate their own learning into their teaching practice and instructional design.

The stories highlighted by teachers participating in our summer, STEM-focused garden course emphasize ideas that have been well-supported in the literature. For instance, the importance of constructivism was clear. Learners inquired and co-constructed understandings through direct observations of phenomena they experienced together. This was especially important for teachers *as* learners. Several teachers expressed, they learned as much (perhaps more) from each other—drawing on their shared, collective expertise—as they did from the course instructors. In many cases, their knowledge and skills might not have seemed relevant in traditional settings but in a holistic, garden-based context, a wide array of knowledge and skills were invaluable to the overall learning experience.

This leads to another important aspect of teaching and learning: when any learner feels she has been successful, it builds confidence and self-efficacy. As Museus et al. (2011) articulate, this can often mean the difference between success or failure in school and participation in STEM fields, particularly for racial and ethnic minority students. For students who have not been successful in traditional settings, learning in school gardens can provide the opportunity for different ways of learning, communicating, and thinking. Learning in the garden is by nature multi-sensory, acknowledging diverse learning styles and ways of expressing ideas and understandings. Honoring different perspectives and approaches seems especially important for addressing the needs of today's diverse, multicultural student population reflecting the changing demographics in our country.

We end the article with a quote from a teacher since it captures the essence of the transformation through action and reflection as she works with low-income and culturally diverse students:

This class has reminded me why I wanted to teach science in the first place: I want to help students of all backgrounds to be nature explorers. Every child should feel safe and encouraged to practice science, to see him- or her-self as a scientist, and to use his or her education to help others and our environment. I have gotten caught up more in planning curriculum and helping students to feel successful with their assessments than in nurturing their souls...most people would say, "um, yes, that is your job description." But this course has reminded me that as a teacher I have the ability to not only help students learn academic skills and content, but also to guide them towards the higher purposes of self-discovery, environmental justice and community-building. I have heard students at Kelly [School] talk about adding tables and flowers so more students will want to hang out and relax in the school gardens, or how one's uncle is an artist and could help make the garden prettier, or stop a student from digging because she didn't want a bug to get hurt. These are all authentic and natural outcomes of garden-based learning, and I feel they are far more important educational experiences than many of our standards that I spend so much time thinking about. (Sandy).

Notes

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Appendix A

COURSE: Theory to Practice in School Gardens

The purpose of this course is for teachers to:

1. Build professional learning communities among the entire group, spanning various schools and locations, that support the development of knowledge, skills, and dispositions necessary for reflective practice and action research;
2. Develop an understanding of theoretical frameworks for Science, Technology, Engineering, and Math (STEM) and Garden-based education (GBE); and
3. Apply STEM education research and GBE theory into practice, through the context of school and community-based learning gardens.

Course Objectives

Upon successful completion of this course, teachers will:

1. Build professional relationships as co-learners and co-teachers with colleagues from various locations;
2. Gain experience and confidence working with diverse, “at-risk” students in a garden-based (out-of-school) setting;
3. Develop proficiency utilizing gardens as a context for standards-based instruction;
4. Develop proficiency utilizing formative assessment strategies to identify students’ current understandings and to guide instruction.

Topics

Teachers and their students will engage collaboratively to cover the following topics:

1. Soil exploration/ investigation; Soil testing;
2. Types of soil: What type of soil is in your garden?
3. Composting/ decomposers
4. Plants in the garden; Parts of plants; Connection of plants to soil
5. Animals in the garden; Signs of animals scavenger hunt; Insects
6. Food web (connections of animals & plants to soil)
7. Mapping your garden; Measurements
8. Outside forces in the garden (humans, weather, etc.)
9. Exploration of our garden’s needs; Brainstorming solutions/ projects
10. Re-visioning your garden space; Mapping, art, project

Reflective Writing

Reflective Writing #1: Reflect on your experiences from this first week. In a 2-3 page, single-spaced reflection paper, please address the following questions:

1. What have you learned about teaching and learning in a garden-based context?
2. How has working with a team of educators shaped your experience?
3. What ideas have you had about integrating STEM (science, technology, engineering, and math) topics into your teaching?
4. Describe any ideas or inspiration you’ve gained from the readings. How do the readings connect to what you’ve been observing with students?
5. How has your comfort and/or confidence teaching STEM concepts changed?

6. Although classroom teaching rarely provides an opportunity for such low adult:student ratios, what insights have you gained from this experience? About young people? About learning? About your own ideas about teaching?
7. What do you hope we will accomplish next week and/or what modifications would you suggest?

Reflective Writing #2: Reflect on your experiences from this two-week program. In a 3-4 page, single-spaced reflection paper, please address the following questions:

1. What have you learned about teaching and learning in a garden-based context?
2. How has working with a team of educators shaped your experience?
3. What ideas have you had about integrating STEM (science, technology, engineering, and math) topics into your teaching?
4. How has your comfort and/or confidence teaching STEM topics changed?
5. How do you envision this experience influencing your teaching practice?
6. What suggestions do you have for this course in the future?

Text: Williams, D. R. & Brown, J. D. (2012). *Learning gardens and sustainability education: Bringing life to schools and schools to life*. New York, NY: Routledge.

Articles: Majority of the readings are articles from *Science & Children* and from *Science Scope*, the National Science Teachers' Association's journals for elementary school and middle school, respectively.

Sybil S. Kelley



Dilafuz R. Williams



Image for article:

