Aligning Elementary School Garden Curricula to Education Standards

by

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April 24, 2015

Masters project submitted in partial fulfillment of the requirements for the Master of Environmental Management degree in the Nicholas School of the Environment of Duke University

Adviser Signature: ___________________________  Date: April 24, 2015
ACKNOWLEDGEMENTS

I would like to express my most sincere thanks to Dr. Charlotte Clark, who provided exceptionally detailed reviews, resources, wisdom, and support throughout the course of this project;

Angela Zoss of the Duke Library Data and Visualization department, who spent hours helping me troubleshoot database issues and introduced me to Tableau software, the backbone of this project;

And to my clients, Liz Driscoll and Pete Caldwell, for being passionate about garden education and providing me with the opportunity to work on a meaningful project so in line with my interests.
EXECUTIVE SUMMARY

The purpose of this project was to review and analyze the literature to determine the impacts of garden-based learning on students, obtain an understanding of the prevalence of school gardens in the state of North Carolina, and create a tool to assist elementary school teachers find applicable resources to improve access and efficacy of school gardens for their classes. Garden education programs have the academic documentation to prove that they are a creative, viable, and successful way to enhance learning. As the number of school gardens in the United States grows, formal and nonformal educators look for resources that can turn these outdoor spaces into valuable learning tools. Through exploratory research and information provided by my clients, I found that a key limitation to using school gardens to their full potential was the lack of garden education resources correlated to the applicable standards for learning. Based on these findings, I produced a database that will allow educators in North Carolina to identify and locate lesson plans that are directly aligned with specific science standards from the North Carolina Essential Standards (NCES).

This master’s project resulted in two key deliverables to my clients, Liz Driscoll, NC Extension Associate at NC State University, and Pete Caldwell, former PTA President and involved parent at A.B. Combs Elementary School in Raleigh. A summary report accompanied the primary deliverable - a user-friendly, online database of garden-based lesson descriptions and sources for North Carolina elementary school educators. The database primarily needed to be freely and easily accessible, contain the proper information pertinent to teachers, and have a search or filter feature that allowed the user to narrow results by certain criteria. The database does not include the full lesson plans to protect copyright integrity, but allows the user to explore the variety of lessons by a number of categories, including grade level, keywords, North Carolina Science Essential Standards, and curriculum.

Curricula included in the database are: The Growing Classroom, Junior Master Gardener, Got Veggies?, and Eat Think Grow. To ensure that the database was accessible to as many educators as possible, two of the resources require the purchase of a materials book while the other two are freely accessible on the web. Additionally, The Growing Classroom and Eat Think Grow have existing correlations to the nationwide Common Core
English language arts and mathematics standards, allowing for even broader educational applications.

The decision to use software to create the database was to ensure the database was both usable and updateable. In some instances, like with the existing correlations of *Junior Master Gardener* to state standards, the results are shown in a static table and the user must look through individual rows and columns to find the lessons they are searching for. Especially for large amounts of data, using a database structure makes it easier for educators to locate lessons based on one or more criteria. I chose to use Tableau, a data analysis and visualization software, to host the database due to its public software availability, free online hosting, and robust filtering feature.

The resulting database consists of over 350 lesson plans specifically geared toward garden education. The final database will be hosted by my client Liz Driscoll on the North Carolina 4-H “Grow For It” ([www.growforit.org](http://www.growforit.org)) webpage as a freely available resource for educators. In the future, there are a number of ways to use my framework to improve the scope and expand the scale of this database. Providing Common Core alignment for the remaining curricula, as well as correlating to other subjects within the NC Essential standards (including Social Studies, Arts Education, and Healthful Living) would make for a more robust resource that would allow educators to expand the subject matter they teach in the garden. Furthermore, it would be valuable to identify additional resources that would assist educators with presenting topics and lessons to the class and engaging students. Resources could include interactive websites, relevant books and readings, or local (North Carolina) museums, parks, or education centers. The potential for this database to continue to grow and expand is huge, and building upon this platform could expand to an even bigger multi-dimensional resource base for North Carolina-based educators.
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INTRODUCTION

Garden education programs have the academic documentation to prove that they are a creative, viable, and successful way to enhance learning. As the number of school gardens in the United States grows, formal and nonformal educators look for resources that can turn these outdoor spaces into valuable learning tools. The purpose of this project was to review and analyze the literature to determine the impacts of garden-based learning on students, obtain an understanding of the prevalence of school gardens in the state of North Carolina, and create a tool to assist elementary school teachers find applicable resources to improve access and efficacy of school gardens for their classes. Through exploratory research and information provided by my clients, I found that a key limitation to using school gardens to their full potential was the lack of garden education resources correlated to the applicable standards for learning. Based on these findings, I produced a database that will allow educators in North Carolina to identify and locate lesson plans that are directly aligned with specific science standards from the North Carolina Essential Standards (NCES).

Key Project Objectives:

- Align existing garden-based curricula with North Carolina Science Essential Standards.
- Create a useful tool for teachers to be able to find garden-based lessons that fit their educational needs.
- Increase accessibility of gardens as a learning environment for elementary school students in North Carolina.

BACKGROUND

The use of alternative learning environments, such as school gardens, must be viewed in the context of the required state and national education standards that influence their applicability within the public school system. For the purpose of this project, I use the terms “teacher” and “educator” interchangeably to refer to adults leading educational activities for elementary-aged children in grades K-5 unless otherwise specified. Standardized testing in the United States requires millions of students to take evaluative exams across core subjects each year and has become “the central focus of most teachers in American schools,” particularly with the adoption of the Common Core standards for
English language arts and mathematics in 43 states by 2015 (Common Core State Standards Initiative 2015; Merrick 2015, p. 1). The standards drive the concepts that must be taught, but often the strategies that classroom teachers choose to employ to communicate the material are flexible (Merrick 2015). School gardens and other environmental education initiatives can work as “a natural extension of the curriculum” to offer engaging and hands-on options for students to learn the necessary concepts (Merrick 2015, p. 3).

In addition to a growing focus on “teaching to the test,” educators have increasingly neglected general science education due to the increased emphasis on language arts and mathematics resulting from the No Child Left Behind Act of 2001 (Frontline 2002; Milner et al. 2012). Partially in response to the declining emphasis on science, a partnership of state education leaders and science organizations started an initiative to create a set of national science education standards that would create cohesive learning objectives for adopting states across the country. The first draft of these voluntary standards, dubbed the Next Generation Science Standards (NGSS), was released in July 2010, with the final Framework released one year later in 2011 (Next Generation Science Standards 2015a). Twenty-six states, including North Carolina, comprised a team of “lead state partners” that actively collaborated with the standards writing team. Despite their involvement in the development of the new national standards, North Carolina adopted their own set of science standards in 2010 with implementation in the fall of 2012 as part of the North Carolina Essential Standards (NCES) (Next Generation Science Standards 2015b). Why North Carolina’s leaders chose to adopt their own standards rather than the NGSS is not clear, but some speculate that decision makers were adverse to adding another national set of standards due to the backlash against the recent adoption of Common Core standards (Yelton 2015). Because the new North Carolina Science Essential Standards are “based off of many of the documents that helped to inform the National Research Council’s A Framework for K-12 Science Education,” the standards are robust and similar in content to the NGSS (Next Generation Science Standards 2015b, p. 1). Additionally, the North Carolina Department of Public Instruction has “no immediate plans to implement” the NGSS, and are unlikely to be adopted before 2018 (Driscoll 2014, p. 1). Therefore, having access to curricula aligned with the NC Essential Standards remains important and
relevant for NC educators, particularly for activities and learning environments that are not within the status quo.

Utilizing school gardens for learning can be applied beyond conventional science subjects and can have a greater impact on how students connect to nature and environmental principles. The core principles of environmental education, as defined by the Belgrade Charter in 1975, involve creating a population “aware of, and concerned about, the environment and its associated problems” that is also willing to “work individually and collectively toward solutions of current problems and the prevention of new ones” (NAAEE 2004, p. 1). When speaking in broad terms, academics separate the field of environmental education (EE) into two key factions. The first, often referred to as environmental literacy or environmental information, involves equipping the audience with the knowledge, skills, and capacity to make positive behavior change, but doesn’t actually include performing the behavior. The focus of environmental literacy is mainly to communicate facts, values, and attitudes about the environment and environmental issues to the audience. The second faction is called environmental education (EE), and is defined in a more narrow sense. In this context, EE aims to create environmentally literate citizens who have the knowledge and capacity to act on their beliefs, and includes an additional goal of changing behaviors due to the acquisition of new information and skills (NAAEE 2004; US EPA 2015). A characteristic of both environmental literacy and environmental education is the large focus on teaching students critical thinking, problem solving, and decision-making skills, which are an important part of the increased focus on 21st century skills through the Partnership for 21st Century Learning. North Carolina is one of 19 partner states working to increase the focus on 21st Century Skills through education (Partnership for 21st Century Learning, 2015; US EPA 2015).

Environmental education made a larger move into the national and international sphere when 2005-2014 was declared a Decade of Education for Sustainable Development, also referred to as Education for Sustainability (EfS) (US Partnership 2009). The goal of the EfS framework is to use real-world context to engage students across all subjects (US Partnership 2009). Implementing environmental education techniques plays a major role in drawing connections between students and the world around them (Lorinc 1994). The NCES clearly state that experimentation, “hands-on/minds-on activities,” and inquiry-based learning are crucial to obtain true understanding of scientific principles (NC
Environmental education, whether employed in a classroom or alternative outdoor setting, can provide the backbone for learning about and understanding systems, interdependence, and the importance of where one lives (NAAEE 2004). School gardens are a good fit for this model, because they provide an accessible resource for teachers to expand student engagement in natural environments and take advantage of the benefits of using outdoor spaces for learning.

The definition of school gardens is generally flexible, but they usually have two characteristics in common: that students are active in the creating and maintaining of the space, and that they continue to use the garden for learning, recreation, and eating the harvest (FAO 2006). Some schools or school systems have gardens intended for student use that are located at an off-campus location, such as with the Durham County Public Schools Hub Farm, which is located next to a local elementary school but is intended for use by the entire district (The Hub Farm 2014). The gardens themselves can have varying features depending on the nature of the resources available to them, and can be made up of edible and non-edible plants, in-ground plantings, raised beds, outdoor potted plants, habitat and butterfly gardens, composting areas, and even greenhouses.

Numerous studies have looked into the specific benefits of garden education programs, spanning from improved school performance to easier classroom management. Key findings are listed below:

- School gardens employ effective learning styles, including:
  - Active, hands-on, experiential learning and engagement opportunities, and
  - Providing a hub for place-based and community-based learning (Blair 2009; Tampa Bay School Gardening Network 2014).
- School gardens contribute to improved school performance and standardized test scores (Klemmer, Waliczek, and Zajicek 2005; Ozer 2007).
- Garden education leads to increases in environmental stewardship (Chen-Hsuan Cheng and Monroe 2012; Louv 2008; Tampa Bay School Gardening Network 2014).
- Using gardens allows for the integration of nutrition and lifestyle information as its own subject or within other subjects (Collective School Garden Network 2014; Morris and Zidenberg-Cherr 2002; Tampa Bay School Gardening Network 2014).
- Improvements in cognitive skills, such as critical thinking and decision making, have been documented alongside the use of educational gardens (Blair 2009).

These studies and findings show that not only do school gardens offer an alternative classroom setting in which students can learn through hands-on and engaging
opportunities, but they also illustrate the connection between students and the world around them.

The number of public elementary schools in the US with garden programs increased 15.2 percent from 2006 to 2013 (Turner 2014). North Carolina has 22 school gardens, and an additional 18 listed as “community-school gardens,” registered with the North Carolina Community Garden Partners (NCCGP). Fifteen of the listed 22 school gardens are located at elementary schools. However, gardens on the NCCGP list are submitted voluntarily, and the list is not a comprehensive count of all existing gardens in NC. For example, existing and active school gardens at A.B. Combs Elementary (Raleigh), E.K. Powe Elementary (Durham), Forest View Elementary (Durham), George Watts Elementary (Durham), Lakewood Elementary (Durham), and the Durham Public Schools Hub Farm are not listed on the site (North Carolina Community Garden Partners 2014). Therefore, while these estimates and counts are useful in evaluating overall trends, they are not completely accurate measures of the school garden movement.

Gardens have been shown to be valuable alternative spaces for learning, but can be under-utilized due to a number of barriers. In the specific case of elementary science education, NC K-5 teachers are only responsible for completing the requirements of an approved teacher education program. Additionally, they are only required to pass Praxis teacher certification exams for reading, writing, mathematics, and elementary education instructional practice (Educational Testing Service 2015). Because elementary teachers are not required to have a specific science background, they often have less familiarity with the subject matter, resulting in teachers lacking the “confidence to teach science effectively to their students” (Milner et al. 2012, p. 113). In turn, this can influence their willingness to utilize unfamiliar environments to teach the subject (Milner et al. 2012). Taking children out of the familiar four walls of the classroom can also be a daunting task for teachers (Dyment 2005). A new level of responsibility is added, including scheduling, permissions, additional supervision, and safety in addition to finding “the time, somewhere, to integrate [environmental education] lessons into the curriculum” (Simmons 1993, p. 23). Due to the current focus on standardizing learning objectives, correlating curricula with national and state education standards is an important way to encourage educators to utilize available resources (Ernst 2007; David 2008). In this study, I use the terms “correlate” and “align”
interchangeably to refer to the process of determining which science Essential Standards (ES) and sub-objectives, referred to as Clarifying Objectives (CO), each lesson satisfies.

The NC Department of Environment and Natural Resources (DENR) Office of Environmental Education and Public Affairs developed and distributed a survey in 2012 to determine barriers to environmental education experiences. In the survey, 827 classroom teachers from around North Carolina responded online and ranked barriers through multiple choice options, as well as what could be done to remove these barriers. Over 400 respondents stated that “Align[ing] to Essential Standards” was a key aspect of removing barriers to field trips and creative environmental education opportunities (Grant 2012). Additionally, free-form comments received from this survey highlighted that teachers were limited by existing curriculum requirements, time limits that inhibit finding and evaluating resources, and teacher accountability standards that put more pressure on test scores when evaluating teacher performance (Grant 2012). Providing easy access to standards-based learning in garden education appeals to teachers who feel pressure to “teach to the test.”

I worked on this project in conjunction with two external clients: Pete Caldwell, former PTA President and involved parent at A.B. Combs Elementary School in Raleigh, NC; and Liz Driscoll, NC Extension Associate at NC State University. The conception of the original idea for this project came from Caldwell and A.B. Combs Elementary teachers. The school is nestled into a suburban neighborhood with available outdoor space, and already had an engaged parent consortium that worked to construct a raised bed garden array as well as a wetland learning garden on school grounds. In addition, as of 2015 the school was approved to build an outdoor classroom space that will include a walking path with ‘learning nooks,’ a variety of different ecosystem spaces, rain garden, and natural play area (Webmaster 2013). Teachers at A.B. Combs have expressed enthusiasm for outdoor and garden education, but many of them do not have personal experience with gardening, know where to find reputable resources, or have the time to do the research themselves. Despite their interest, they are at a loss of where to begin (Caldwell 2014).

Caldwell brought this issue to the attention of NC Extension Associate Liz Driscoll. Driscoll works closely with 4-H, the youth development program of the national Cooperative Extension system and US Department of Agriculture, and FoodCorps, a national nonprofit focused on building and utilizing school gardens and creating farm-to-
school programs. Together, Caldwell and Driscoll worked to brainstorm a way to create a resource to address the needs not only of teachers at A.B. Combs but across the state. Initial steps were taken to create a resource for educators, but a lack of manpower meant that the project stalled for some time (Caldwell 2014). In March of 2014, I was introduced to Driscoll in my search for a master’s project that included both sustainable food and environmental education aspects.

METHODS

In addition to a summary report for my clients, another final output from this project is a user-friendly, online database of garden-based lesson descriptions and sources for North Carolina elementary school educators. My clients and I first spent time determining the ideal characteristics, format, and features of the completed database. The database primarily needed to be freely and easily accessible, contain the proper information pertinent to teachers, and have a search or filter feature that allowed the user to narrow results by certain criteria. These three requirements remained at the forefront of the planning and development of the final database. The database does not include the full lesson plans to protect copyright integrity, but allows the user to explore the variety of lessons by a number of categories, including grade level, short description, North Carolina Science Essential Standards, and curriculum. In this project, ‘curriculum’ refers to a set of materials and resources packaged together that outline organized experiences that introduce students to specific concepts, learning principles, or topics.

When choosing which curricula to include in the database, I used the North Carolina 4-H Curriculum Jury Review Checklist (see Appendix) at my client’s suggestion. While designed to evaluate all curricula used specifically with 4-H learners, this form evaluates lesson plans and curricula against a list of best practices. A few key checklist items are particularly relevant to the nature of this project. For example, the requirement that “the material is appropriate to use in the location/space I have available” will always be satisfied, because the intended audience is elementary school teachers that already have established access to school gardens in North Carolina. Furthermore, the teachers can determine from the short description of each lesson whether the activity fits with their specific classroom and school resources. In addition, other checklist criteria that have been
satisfied by this project include that all of the included curricula have “been created and vetted by a reliable source” and been “developed using a research-based approach” (see Appendix). The included curricula have been determined to be generally developmentally appropriate, but each contains lessons that were developed for specific grades or grade ranges. Therefore, the database itself serves as a tool to help teachers determine which lessons are appropriate for their needs.

When I came on to the project in 2014, Caldwell and Driscoll suggested three of the four final curricula. The three were selected due to Driscoll’s familiarity with the curricula and past review using the Jury Review Checklist. I confirmed The Growing Classroom, Junior Master Gardener, and Got Veggies? selections by reevaluating each using the Jury Review Checklist, particularly considering if the material was created by reliable and reputable sources and contained a wide variety of activities to benefit a variety of ages and learning styles with measurable outcomes (see Appendix). The decision to add the Eat Think Grow curriculum was due to its comprehensive and detailed lessons and existing correlation to Common Core English language arts and mathematics standards. Additionally, a priority of the database was to provide an accessible resource for educators, and the free web availability of Eat Think Grow was important to round out the available options. Below, I listed the curricula with short notes on their reputability.

| The Growing Classroom      | Published by Life Lab, founded 1979  
|                           | Acclaimed by over 14 organizations, including US Department of Education  
|                           | Lessons for grades K-5  
|                           | 480 pages of materials including worksheets and resources  
|                           | Existing correlations to Common Core English language arts and mathematics  
|                           | Available for purchase, $39.95  |
| Junior Master Gardener     | International youth gardening program under the university Cooperative Extension network  
|                           | Lessons for grades 3-5  
|                           | 390 pages of materials including worksheets and activities  
|                           | Available for purchase, $42  |
| Got Veggies?               | Free resource developed by the Wisconsin Department of Health Services and collaborating partners  
|                           | Developed for grades 2-3, adaptable for younger and older grades  
|                           | 7 primary lessons adaptable across grade levels  |
Table 1: Chosen curricula to include in the database.

**Correlation to Standards**

**Pieces of the Correlation**

Aligning high-quality garden-based curricula to the NC Science Essential Standards is the main contribution of this project. First, I had to identifying the learning standards that are satisfied by each lesson. The Public Schools of North Carolina website (http://www.ncpublicschools.org/acre/standards/new-standards/) contains the full text of the standards arranged in downloadable PDF format.

The NC Science Essential Standards are split into two PDFs for grades K-2 and 3-5, and consist of 35 total standards. For each grade, standards are categorized by topic and scientific discipline: Physical Science (P), Earth Science (E), or Life Science (L).

<table>
<thead>
<tr>
<th>Topics</th>
<th>K</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forces and Motion (P)</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Matter: Properties and Change (P)</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Earth Systems, Structures and Processes (E)</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Structures and Functions of Living Organisms (L)</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Earth in the Universe (E)</td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ecosystems (L)</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Molecular Biology (L)</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td></td>
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<tr>
<td>Evolution and Genetics (L)</td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
<td></td>
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<tr>
<td>Energy: Conservation and Transfer (P)</td>
<td></td>
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<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Earth History (E)</td>
<td></td>
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<td></td>
<td></td>
<td>x</td>
</tr>
</tbody>
</table>

Table 2. Distribution of topics in grade levels.
Each Essential Standard consists of a shorthand numbering ID (marked A in Figure 1 below), text of the essential standard for that topic (B), and clarifying objectives. The Clarifying Objectives also have a unique shorthand ID (C) and description (D). The shorthand numbering system is an easy reference to certain qualities of the standard. Using 3.L.2.1 as an example, the first digit “3” signifies this standard is for third grade. The second digit is a letter identifying which facet of science the standard falls under; in this case, the standard is a part of the Life Science (L) category. The “2” means that this standard is in the second Life Science topic in this age group (in third grade, the first Life Science topic is Structures and Functions of Living Organisms and the second is Ecosystems). The fourth digit, in this case “1,” refers to the first Clarifying Objective of this Essential Standard.

<table>
<thead>
<tr>
<th>Essential Standard</th>
<th>Clarifying Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.L.2</td>
<td></td>
</tr>
<tr>
<td>Understand how plants survive in their environments.</td>
<td></td>
</tr>
</tbody>
</table>
| 3.L.2.1  | Remember the function of the following structures as it relates to the survival of plants in their environments:  
- Roots – absorb nutrients  
- Stems – provide support  
- Leaves – synthesize food  
- Flowers – attract pollinators and produce seeds for reproduction |
| 3.L.2.2  | Explain how environmental conditions determine how well plants survive and grow. |
| 3.L.2.3  | Summarize the distinct stages of the life cycle of seed plants. |
| 3.L.2.4  | Explain how the basic properties (texture and capacity to hold water) and components (sand, clay and humus) of soil determine the ability of soil to support the growth and survival of many plants. |

Figure 1. An example NC Science Essential Standard for third grade.

When identifying which standards are satisfied with each lesson, some lessons will match the Essential Standard but not any of the individual Clarifying Objectives within that standard. Clarifying Objectives serve to identify specific learning goals, but they do not encompass every aspect of the ES. As an example, standard 5.L.1 (see Figure 2) covers the body structures and functions of various organisms. The COs describe specific subject goals within this standard, but neither CO allows for general discussion about the body structures and functions of nonhuman organisms, such as insects. In chapter four of the Junior Master Gardener curriculum, there are four lessons specifically discussing the
structure and function of insects, which satisfies the ES requirement but not either of the COs. Therefore, lesson was entered into the database with only an ES correlation.

<table>
<thead>
<tr>
<th>Essential Standard</th>
<th>Clarifying Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.L.1</td>
<td>5.L.1.1 Explain why some organisms are capable of surviving as a single cell while others require many cells that are specialized to survive.</td>
</tr>
<tr>
<td></td>
<td>5.L.1.2 Compare the major systems of the human body (digestive, respiratory, circulatory, muscular, skeletal, and cardiovascular) in terms of their functions necessary for life.</td>
</tr>
</tbody>
</table>

Figure 2. NC Science Essential Standard 5.L.1.

Additionally, some lessons cover a wide range of standards within and between grade levels, while others will only satisfy one standard by going deeper into the subject matter of that standard or objective. Typically, each lesson plan will outline learning objectives or goals, and main themes will be clear throughout the action and main activity.

The Correlation Process

To illustrate the process of correlating individual lessons, I will use a sample lesson from *The Growing Classroom* curriculum to show the process step by step. For reference, the full text of the sample lesson can be found in the Appendix.

The lesson, titled “A Day at the Races,” introduces fifth and sixth grade students to different types of soil and how conservation techniques influence soil erosion and water flow. After reviewing the lesson, the correlator looks through each of the 35 essential standards to determine which standards match the content discussed in the lesson. As an example, we can use a third grade Ecosystems standard to illustrate this connection.
Standard 3.L.2 covers concepts surrounding plants and how they interact with their environments. More specifically, in Clarifying Objective 3.L.2.4, the focus is on soils and how they support plant growth. I correlated this CO to the lesson in two specific places:

<table>
<thead>
<tr>
<th>Essential Standard</th>
<th>Clarifying Objectives</th>
</tr>
</thead>
</table>
| 3.L.2 | Understand how plants survive in their environments. | 3.L.2.1 Remember the function of the following structures as it relates to the survival of plants in their environments:  
- Roots – absorb nutrients  
- Stems – provide support  
- Leaves – synthesize food  
- Flowers – attract pollinators and produce seeds for reproduction  
3.L.2.2 Explain how environmental conditions determine how well plants survive and grow.  
3.L.2.3 Summarize the distinct stages of the life cycle of seed plants.  
3.L.2.4 Explain how the basic properties (texture and capacity to hold water) and components (sand, clay and humus) of soil determine the ability of soil to support the growth and survival of many plants. |

Figure 3. NC Science Essential Standard 3.L.2.

Figure 4. “A Day at the Races” description and objective discuss basic properties and characteristics of soil, including its capacity to hold water.

5. Have one student from each group sprinkle a measured amount of water from about 12 inches (30 cm) above each box, pouring steadily for 5 seconds.

6. Have groups record in their journals how long water continues to flow out of the V-notch.

7. Let the water in the cups settle and have groups measure the sediment in each, recording the results in their journals.

Figure 5. “A Day at the Races” step 6 discusses soil capacity to hold water.

After looking through each of the essential standards, I found that “A Day at the Races” was correlated to a total of four standards, including 3.L.2.4 above. I entered the
The majority of lessons aligned well with the Clarifying Objectives. However, occasionally a lesson addressed an aspect of the Essential Standard that was outside the scope of the supplied Clarifying Objectives. In such cases, I matched the lesson to the applicable Essential Standard, with the Clarifying Objective cell left blank. When searching for lessons based on the education standards, this distinction means that the user should filter using both the NCES (NC Essential Standard) and NCESCO (NC Essential Standard Clarifying Objective) filter checkboxes.

In general, the focus was on matching lessons with standards that match the grade level for that activity. However, in a number of instances, lessons for a certain development level were matched to standards that were for higher or lower grades. For example, a lesson geared toward fifth graders that also addressed standards in first grade was entered into the database correlated with applicable standards from all grade levels. While in this case, they would not help a fifth grade teacher address new concepts, the standards would help to recall and review old concepts from previous grades. Additionally, in most cases, educators would be able to adjust certain aspects of the lesson to fit with an older or younger age group. Aligning each lesson with all K-5 standards allows instructors to have that flexibility when developing a plan for their classroom needs.

Within the curricula, certain chapters that were not relevant to the NC Science Essential Standards were not included in the database. The Growing Classroom (chapter 1) and Junior Master Gardener (chapter 8) contain chapters that focus on garden rules, cooperation, life skills, and career expectations. While these chapters are important for the holistic development of students, they do not align with any science standards and are outside the scope of this project, and therefore I excluded them from the final database. Within relevant chapters, some lessons did not match with any standards but provided additional content or activities related to the overall topic of the chapter. In these cases, the un-correlated lessons, including the descriptive criteria, were included in the database.

Data Preparation & Database Software

The decision to use software to create the database was to ensure the database was both usable and updateable. In some instances, like with the existing correlations of Junior
Master Gardener and state standards, the results are shown in a table and the user must look through individual rows and columns to find the lessons they are searching for. Especially for large amounts of data, using a database structure creates an easier way for educators to locate lessons based on one or more criteria.

Alongside robust usability, choosing to present the correlation results in a database allows for easier management of the behind the scenes records. In the future, if my client decides to add or delete certain individual lessons or entire curricula, she will be able to do so without having to update and redistribute new files or influencing the ability for teachers around the state to use the tool remotely.

In order to be useful for teachers, the database needs to be searchable by the criteria of each lesson, including grade level(s), season, curriculum, whether the activity is indoors or outdoors, and the NC Science Essential Standards and Clarifying Objectives. Additionally, being able to search by keywords will allow them to find lessons with specific objectives or topics mentioned in the description. A database can provide this functionality in a user-friendly interface.

Microsoft Access

We originally chose Microsoft Access, the database program included in the Microsoft Office 2013 package, because it seemed to be the most accessible database creator to use for this project. However, a number of issues arose with the usability of Access. First, when creating a new file, the user must decide from the beginning whether they want a desktop database or a web application database, and if you choose a web application database, you must know the exact server location from the start. Conversely, a number of features in desktop databases are not available in web application databases, making the desktop database a more comprehensive option. Desktop databases cannot be hosted online without an external hosting service, which range from expensive monthly subscriptions to very limited free services. Even the web application databases require a Share Point or Structured Query Language (SQL) server, which are online hosting locations that require a monthly subscription for hosting services. These options were not ideal for my client’s budget constraints or our preferred usability of the database.

Additionally, Access has a complicated and limited search interface. While the ‘query’ function in Access allows the user to make specific one-time searches, it is wholly
unusable by someone with no Access experience. With accessibility as one of our main goals for this project, limiting functions to only users who have existing Access knowledge would create another barrier to utilizing this tool. The ideal methodology for making a more usable search feature is through the ‘form’ function, but the main functionality of Access forms are to enter data into an existing database rather than searching the database to extract data by multiple search criteria. After reaching out for help from employees at the Duke Library Data and Visualization Department and the Duke Social Science Research Institute (SSRI), data experts suggested that we switch software rather than invest time coding in SQL mode to achieve the desired functionality.

Switch to Tableau

The Duke Library Data and Visualization Department first ascertained that rather than continuing with Microsoft Access, a better plan was to transfer the data to a different, more user-friendly software. Tableau is a data analysis and visualization software that has both a desktop and web-based platform. Tableau addressed the two main complications with Access: high cost of online hosting, and limited search performance. While Duke subscribes to a fee-based version of Tableau for affiliated users, Tableau’s free public version is available to my client and contains all the functionality necessary to maintain and update the database moving forward.

Tableau is capable of uploading datasets from a number of file types. We downloaded the existing Access data and transferred it to a Microsoft Excel spreadsheet in order to reorganize the structure and maintain the integrity of the references. Creating bridges between different columns and sheets of data was important to maintain organization and usability of the table. Once the user creates a database on the desktop version of Tableau, the user is then able to push the final product to the web. Authors then can either link directly to the data on Tableau’s public site or embed their creation on their own website.
RESULTS & DISCUSSION

Navigating the Tableau Database Structure

The first sheet in the Excel workbook, titled Lesson Plans, contains the main content of the database. The given ID numbers link the lessons to other criteria throughout the workbook.

Figure 6. Each lesson is assigned a unique Lesson ID number in the first sheet.

Figure 7. The Lesson ID's are used to relate the individual lesson to other criteria, including NC Science Essential Standards and Clarifying Objectives, seasons, and grade levels, each located in a separate sheet. Here, we can see that lesson 1 is associated with three NC Science Essential Standards (in red):

- K.P.1: “Understand the positions and motions of objects and organisms observed in the environment.”
- K.P.2: “Understand how objects are described based on their physical properties and how they are used.”
- K.L.1: “Compare characteristics of animals that make them alike and different from other animals and nonliving things.”

Likewise, each of these descriptive NCES names are related to a unique ID (in orange) located in another sheet (see Figure 8).

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>NCESName</td>
<td>NCES_ID</td>
<td>StandardDescription</td>
</tr>
<tr>
<td>K.L.1</td>
<td>1</td>
<td>Understand the positions and motions of objects and organisms observed in the environment.</td>
</tr>
<tr>
<td>K.L.2</td>
<td>2</td>
<td>Understand how objects are described based on their physical properties and how they are used.</td>
</tr>
<tr>
<td>K.E.1</td>
<td>3</td>
<td>Understand change and observable patterns of weather that occur from day to day and throughout the year.</td>
</tr>
<tr>
<td>K.L.1</td>
<td>4</td>
<td>Compare characteristics of animals that make them alike and different from other animals and nonliving things.</td>
</tr>
<tr>
<td>L.1.1</td>
<td>5</td>
<td>Understand how forces (pushes or pulls) affect the motion of an object.</td>
</tr>
<tr>
<td>L.1.2</td>
<td>6</td>
<td>Recognize the features and patterns of the earth/moon/sun system as observed from Earth.</td>
</tr>
<tr>
<td>L.1.2</td>
<td>7</td>
<td>Understand the physical properties of Earth materials that make them useful in different ways.</td>
</tr>
<tr>
<td>L.1.2</td>
<td>8</td>
<td>Understand characteristics of various environments and behaviors of humans that enable plants and animals to survive.</td>
</tr>
<tr>
<td>L.1.2</td>
<td>9</td>
<td>Summarize the needs of living organisms for energy and growth.</td>
</tr>
</tbody>
</table>

Figures 8 & 9. Each individual Science Essential Standard is given a unique ID number, shown in orange. In a separate sheet, the NCES Clarifying Objectives are also given unique ID's, shown in green. The Clarifying Objectives are each associated with their parent Essential Standard.

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>NCESCOName</td>
<td>NCESCO_ID</td>
<td>NCESCO_redulted</td>
</tr>
<tr>
<td>K.P.1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>K.P.1.2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>K.P.2.1</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>K.P.2.2</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>K.E.1.1</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>K.E.1.2</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>K.E.1.3</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>K.L.1.1</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td>K.L.1.2</td>
<td>9</td>
<td>2</td>
</tr>
</tbody>
</table>

Figure 10. Seven sheets within the workbook maintain the relationships between the data.

Maintaining consistency of the criteria column labels and relationships within the Excel document ensures that the proper referencing will be maintained when importing the data for the search feature, which is called “filtering” in Tableau. The sheets from Excel are transferred individually when uploading the data from an Excel workbook into Tableau. The consistency within the data is important in order for Tableau to recognize the relationships between the master sheet and secondary sheets when joined. The following steps are shown using the desktop version of Tableau.
Figures 11 & 12. A new file (also called a Book) in Tableau. To import existing data from another source, click “Connect to Data.” For the purpose of this project, the data was imported from one Excel workbook containing multiple sheets, as shown above in Figure 10.
Figure 13. Link the master sheet of individual lesson plans with each secondary sheet of the varying criteria. To link the sheets, click and drag the desired sheet from the list on the left (in orange) into the workspace across the top (in red). If the data source is formatted properly with consistent column headers in Excel, Tableau will often recognize and create the connection between data automatically.

Figure 14. The database on the Tableau Public site. In Tableau, there is a built-in feature called “filtering” to allow users to search data by specific criteria. The example above shows the results that match the criteria on the right side. The list of resulting lessons that are aligned to NC Science Essential Standard 3.L.2 and contain
“soil” in the description is on the left, for any grade level and in any curriculum. There is an option to download the results as a PDF for future reference.

The resulting database consists of over 350 lesson plans specifically geared toward garden education. As would be expected based on the nature of gardens, the most common correlations between the lessons and science standards are in the Ecosystems; Earth Systems, Structures and Processes; and Structures and Functions of Living Organisms categories.

In light of the existing research on garden education that shows that hands-on learning in garden settings improves measures from student comprehension to consumption of produce, the process of creating this database filled a gap in the existing resources for North Carolina. Across the country, states and organizations have varying responses to the increased popularity of environmental education and school garden programs. Some states have curricula that have been aligned specifically with their specific state standards, such as the Eat Think Grow curriculum, which was designed with Oregon state education standards in mind. Other curricula such as The Growing Classroom, in light of the current push for states to adopt the Next Generation Science Standards in place of individually created science standards, are focused on correlating to the NGSS rather than individual state standards. Furthermore, some choose to rely on volunteers to correlate their lessons to the individual state standards. Junior Master Gardener is one such curricula, but has existing correlations for only 11 states (Junior Master Gardener 2015). None of these solutions was previously implemented for science educators in North Carolina.

The final database will be hosted by my client Liz Driscoll on the North Carolina 4-H “Grow For It” (www.growforit.org) page as a freely available resource for educators.

RECOMMENDATIONS

This project created a framework that houses lessons correlated to the NC Science Essential Standards. In the future, my client could choose to expand the scope and scale of the database in a number of different ways.
Of the included curricula, *The Growing Classroom* and *Eat Think Grow* were the only ones with existing correlations to English language arts and mathematics Common Core standards. Providing Common Core alignment for the remaining curricula, as well as correlating to other subjects within the NC Essential standards (including Social Studies, Arts Education, and Healthful Living) would make for a more robust resource that would allow educators to expand the subject matter they teach in the garden.

Furthermore, it would be valuable to identify additional resources that would assist educators with presenting topics and lessons to the class and engaging students. Resources could include interactive websites, relevant books and readings, or local (North Carolina) museums, parks, or education centers. Specifying the individual garden design elements relevant to each lesson would also be helpful to educators who have limited outdoor features. The potential for this database to continue to grow and expand is huge, and building upon this platform could expand to a multi-dimensional resource base for North Carolina-based educators.
WORKS CITED


http://doi.org/10.3200/JOEE.40.2.15-38


http://doi.org/10.1177/0013916510385082


## NC 4-H Curriculum Jury Review Checklist

All curriculum used with 4-H learners should adhere to the standards and principles of the 4-H Curriculum Philosophical Framework. Curriculum that has been vetted and approved by National and State 4-H curriculum experts adheres to the guidelines and is ready for use with your learners. However, sometimes you may consider using curriculum from an outside source.

When you are deciding whether or not to use outside curriculum that you have found, you should be able to answer “Yes” to three questions:

- Should I do this?
- Can I do this?
- Will my learners benefit from this?

Use the checklist items to help you decide whether to use the curriculum. You must be able to check off all boxes for each question before you answer “Yes” to the corresponding question.

### Jury Review Checklist

<table>
<thead>
<tr>
<th>Should I do this?</th>
<th>Can I do this?</th>
<th>Will my learners benefit from this?</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Copyright</strong></td>
<td><strong>Activity Logistics</strong></td>
<td><strong>Audience</strong></td>
</tr>
<tr>
<td>□ I have researched and understand the material’s copyright protections.</td>
<td>□ I have enough time to do the activity effectively with my learners.</td>
<td>□ The material is appropriate for my learners based on 4-H Ages and Stages guidelines.</td>
</tr>
<tr>
<td>□ The way I intend to use the material will NOT violate the material’s copyright protections.</td>
<td>□ The material is appropriate to use in the location/space I have available.</td>
<td>□ This activity will create a learning experience that is inclusive and diverse.</td>
</tr>
<tr>
<td><strong>Appropriate Source</strong></td>
<td>□ I have resources available that I will need to do the activity.</td>
<td>□ I can use the material in a way that incorporates all learning styles.</td>
</tr>
<tr>
<td>□ The material has been created and vetted by a reliable source. (E.g., Nationally respected youth development program, university, credible education professional)</td>
<td>□ The activity will work well with the number of participants who will be engaged.</td>
<td></td>
</tr>
<tr>
<td>□ The material has been developed using a research-based approach.</td>
<td>□ I, or my co-facilitators, have the skills and experiences necessary to facilitate this activity effectively.</td>
<td></td>
</tr>
</tbody>
</table>

*Purpose*

□ This material aligns with the 4-H Mission Mandates and Essential Elements.

□ The activity will have measurable learning outcomes.

□ The activity can be facilitated using the experiential learning, scientific inquiry, and/or inquiry-based learning method.
A Day at the Races

DESCRIPTION
Students prepare soil flats using five different soil conservation techniques and then compare water flow and soil loss.

OBJECTIVE
To demonstrate soil erosion and ways to conserve soil.

TEACHER BACKGROUND
Throughout history, different means of soil conservation have been used. Terracing has been used to keep soil on hillsides by creating level platforms for farming that step down the hill. Terraces take a long time to build. Contour farming is a simpler practice, in which the planting takes place in rows across the hill rather than up and down the slope. However, the key to soil conservation is to mimic nature and keep the soil rooted in with plants.

MATERIALS
- Five shoe boxes trimmed to 5 cm deep, V-notched on one end, and lined with plastic
- Five watering cans
- Five measuring cups
- Soil (enough to fill one shoe box)
- Soil
- Water
- Five blocks
- Three rulers
- Clock or watch
- Science journals

CLASS DISCUSSION
Why is soil important to plants? Have you ever seen soil washed away by rain or rivers? What do you think will happen to soil if it gets washed away year after year? Do you have ideas for saving soil and keeping it where it is? (List responses on the board.) Let’s design a soil race and see who the real winners are.

ACTION
1. Divide the class into five groups.
2. Distribute the materials.
3. Have each group fill a box with soil prepared in the following ways:
   - **Group 1:** Fill the box with moist soil and pack it down tightly.
   - **Group 2:** Fill the box with soil.
   - **Group 3:** Fill box with moist soil and, using fingers, make packed furrows across the slope. (Furrows run the width of the box.)
Group 4: Fill the box with moist soil and, using fingers, make furrows up and down the slope. (Furrows run the length of the box.)

Group 5: Fill the box with soil and, using a ruler, make steps (terraces) across the slope. If other ideas were suggested during discussion, another group can be added to test the ideas.

4. Have each group use the blocks to line up their boxes on an incline and place measuring cups beneath the V-notches to catch the water that drains off.

5. Have one student from each group sprinkle a measured amount of water from about 12 inches (30 cm) above each box, pouring steadily for 5 seconds.

6. Have groups record in their journals how long water continues to flow out of the V-notch.

7. Let the water in the cups settle and have groups measure the sediment in each, recording the results in their journals.

**WRAP UP**
Discuss which box lost the most soil. Which lost the most water? Which methods were most effective in controlling erosion in the experiment? What other methods might help conserve the soil?

**DIGGING DEEPER**
Have students walk around school grounds and identify evidence of soil erosion. How can it be prevented?