Journal of Agricultural Education, 61(3), 233-260
https://doi.org/10.5032/jae.2020.0300233

Development and Validation of a Children's Agricultural Literacy Instrument for Local Food

Sara Brune[1], Kathryn T. Stevenson[2], Whitney Knollenberg[3], and Carla Barbieri[4]

Abstract

While increasing agricultural literacy (AL) has been the focus of numerous educational programs, few AL scales have been developed specifically for children. AL programming struggles to rigorously evaluate their programs, particularly when little time is available for assessments in informal contexts. The lack of evaluation tools that allow to accurately measure educational impacts compromises progress on AL. In this paper, we present the development and validation of the Agricultural Literacy Instrument for Local Foods (ALI-LF) for children between the ages of 9 and 13. The instrument measures three domains of agricultural literacy (knowledge, attitudes, and behaviors). We pilot tested the instrument with children between 9 and 13 years old at a local arboretum and further validated the instrument at six agritourism farms. To analyze the data, we used principal component factor, Cronbach's alpha, and descriptive statistics. The results support a comprehensive reliable instrument validated for informal contexts, such as farms offering recreational or educational activities to visitors (i.e., agritourism). This instrument fills the existing gap of adequate tools to evaluate AL programming which can support moving forward AL advances among children.

***Keywords*:** agricultural literacy; attitudes; children's scale; local foods

Acknowledgments: The authors disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This work was supported by USDA- NIFA grant 2017-67023-26224 (2017-2021). The authors declare no conflicts of interest. Correspondence concerning this article should be addressed to Sara Brune, 2820 Faucette Dr., Campus Box 8004, Raleigh NC 27695, USA. Email: sbrunea@ncsu.edu

Introduction

The economic, environmental, and social sustainability of food systems is an increasingly pressing concern (Rotz & Fraser, 2015). Challenges associated with unsustainable food systems include food insecurity (Tilman et al., 2011), aquatic and terrestrial habitat degradation (Tilman et al., 2002), and non-equitable access to healthy and affordable food (Myers & Sbicca, 2015). Food system localization, which aims to empower consumers and producers to adopt regionally-appropriate agricultural practices (Rotz & Fraser, 2015), is one approach to addressing these challenges while feeding an increasing population (Sage, 2014). Specifically, promoting local food systems (LFSs)

[1] Sara Brune is a Ph.D. candidate in the Department of Parks, Recreation, and Tourism Management at North Carolina State University, 2820 Faucette Dr., Raleigh, NC 27695

[2] Kathryn T. Stevenson is an Assistant Professor in the Department of Parks, Recreation, and Tourism Management at North Carolina State University, 2820 Faucette Dr., Raleigh, NC 27695

[3] Whitney Knollenberg is an Assistant Professor in the Department of Parks, Recreation, and Tourism Management at North Carolina State University, 2820 Faucette Dr., Raleigh, NC 27695

[4] Carla Barbieri is a Professor in Sustainable Tourism at the Department of Parks, Recreation, and Tourism Management North Carolina State Universit), 2820 Faucette Dr., Raleigh, NC 27695

supports sustainable agroecological practices (Rotz & Fraser, 2015), improves food security (Pearson et al., 2011), and strengthens local economies (Lyson & Welsh, 2005).

Nevertheless, conventional food production and marketing systems continue to hold an advantage regarding economies of scale and bargaining power over LFSs (Boys & Hughes, 2013; Rotz & Fraser, 2015). The perpetuation of this advantage is ultimately in the hands of the consumer, as individuals have the opportunity to create market pressures that benefit and support local farms (Adams & Salois, 2010; Boys & Hughes, 2013; Selfa & Qazi, 2005; Seyfang, 2006). However, this action requires citizens who are knowledgeable about and are motivated to support LFSs (Francis et al., 2003; O'Kane, 2016). For consumers to engage with LFSs and those systems to become a viable economic model, it is necessary to have an agriculturally literate citizenry (Blay-Palmer et al., 2016; Hess & Trexler, 2011a; Powell et al., 2008). Thus, it is vital to find ways to increase citizen's agricultural literacy with an emphasis on LFSs to support the sustainability of food systems.

Defining and Assessing Agricultural Literacy

Agricultural literacy (AL) was initially defined as the understanding of food and fiber systems within historical and socio-economic contexts (National Research Council, 1988). Over time, AL has expanded from knowledge attainment to incorporate critical thinking skills and affective constructs such as attitudes (Powell et al., 2008; Vallera & Bodzin, 2016), engagement in agricultural systems (Meischen & Trexler, 2003), and behaviors (Spielmaker et al., 2014). Hence, agriculturally literate citizens are informed decision-makers able to participate in civic, cultural, and economic affairs related to agriculture (Grady & Ball, 2009; Meischen & Trexler, 2003). Because of this emphasis on civic engagement and decision-making, the most recent AL frameworks identify knowledge, awareness, attitudes, skills, and behavior as key components (Knobloch & Martin, 2000; Powell et al., 2008; Roberts et al., 2016). These constructs also reflect behavior theories sustaining that behavior change requires more than knowledge gain (Meischen & Trexler, 2003; Spielmaker et al., 2014; Vallera & Bodzin, 2016).

Although contemporary AL definitions include constructs such as cognitive skills and affect (Spielmaker et al., 2014), instruments measuring AL have focused on content knowledge. This is the case of assessment tools for general AL, such as the Food and Fiber Systems Literacy (FFSL) framework (Dale, 2017; Kovar & Ball, 2013), as well as those applied to agricultural programs, such as the Food, Land and People Project and Agriculture in the Classroom (Herren & Oakley, 1995; Leising et al., 2003; Pense et al., 2005; Powell & Agnew, 2011). This emphasis on knowledge-driven benchmarks has resulted in assessments that largely ignore attitudes and behavior, such as the degree to which individuals care about agriculture or are motivated to support it (Hess & Trexler, 2011b).

There have been some exceptions to the emphasis on knowledge among AL assessments. For instance, studies have assessed college students beyond knowledge in terms of perceptions of agricultural issues (Birkenholz et al., 1994) and awareness and familiarity with agricultural issues (Specht et al., 2014). Knobloch and Martin (2000) also assessed teachers' perceptions about the agricultural industry and the need for agricultural awareness. However, our literature review did not reveal any evaluation tool mapping contemporary AL conceptualizations (i.e., A Logic Model for Agricultural Literacy Programs: Spielmaker & Leising, 2013), which prevents evaluating how agricultural education may promote AL and promote aspects of AL other than content knowledge.

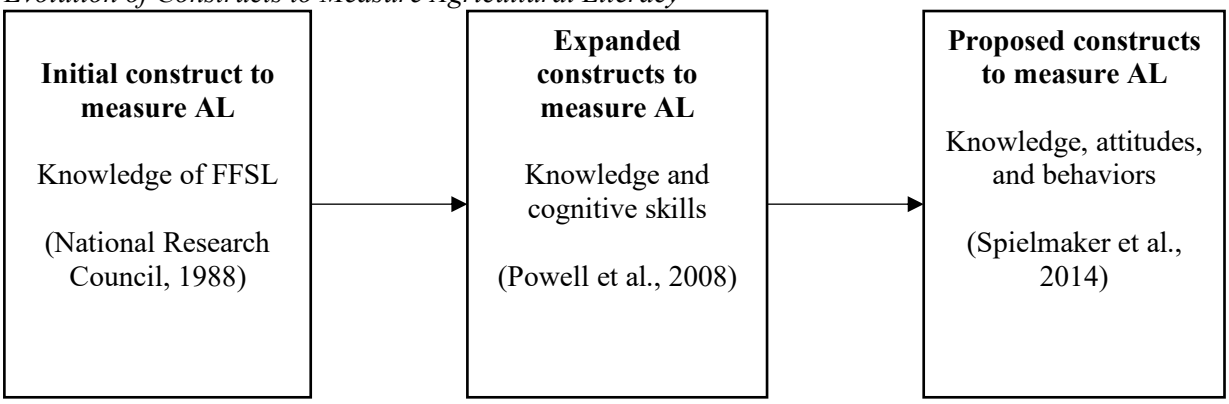
Considerations for New Agricultural Literacy Assessments

Given that few AL assessments extend beyond knowledge, evaluations in related fields may be helpful to conceive the incorporation of affective and behavioral components. For instance, food literacy evaluations incorporate knowledge, affective, and behavioral measurements of food skills, as well as connectedness with the community, which collectively determine food intake and nutrition (Sheppard, 2015; Vaitkeviciute et al., 2014). In the context of school gardens, assessments focus on

diverse affective and behavioral outcomes such as academic achievement, attitudes, health and nutrition, awareness, self-esteem, life skills, and behavior (Koch et al., 2006; Phibbs & Relf, 2005; Ratcliffe et al., 2011). Although none have linked these constructs together in a theoretical model, other "literacies" may provide useful frameworks. For example, Hollweg et al. (2011)'s environmental literacy framework parallels AL in its constructs by including knowledge, dispositions (affectual outcomes), competencies (applied knowledge, skills), and motivations (behaviors). Further, several environmental literacy instruments incorporate measures of knowledge, affect, behavior, and skills (e.g., McBeth et al., 2011; Szczytko et al., 2018) that may be useful in constructing similar instruments for AL.

Figure 1

Evolution of Constructs to Measure Agricultural Literacy



One consideration when conceptualizing AL assessments is the length of the instruments. Existing AL assessments and standards include a wide breadth of valuable agricultural topics, and undoubtedly, each of these is important. For instance, the Pense et al. (2005)'s instrument captures knowledge on the five FFSL themes: (1) understanding agriculture, (2) history, culture, and geography, (3) science, technology, and environment, (4) business economics, and (5) food, nutrition, and health. With such breadth of content areas, it is no surprise that few have attempted to layer constructs of attitudes and behaviors for each content area beyond knowledge as this may render instruments too lengthy for practical use. One alternative may be developing parsimonious tools focusing on one topic at a time (e.g., biotechnology, local food systems) and assessing AL more holistically. This would allow for a multi-construct evaluation of specific programs as it has been done in general environmental literacy (Szczytko et al., 2018), climate literacy (Stevenson et al., 2014), and ocean literacy (Guest et al., 2015).

Most AL programs are classroom-based (e.g., high school agriculture classrooms) or follow a structured format beyond the classroom (e.g., National FFA; Project Food Land, and People). However, several informal learning opportunities also provide children and families the opportunity to engage with agricultural systems (Mars & Ball, 2016). These informal settings may include engaging in recreational or educational activities on working farms (i.e., agritourism) or visiting farmers' markets for leisure or direct purchase. The development of parsimonious and holistic instruments may facilitate the evaluation of informal learning experiences. Parsimonious tools may be more practical in these informal settings that may discourage participation in 20-30 minute assessments. The length of existing instruments may help explain why AL evaluations have occurred almost entirely in formal contexts associated with schools. Thus, shorter instruments may boost the evaluation of AL efforts in informal contexts, such as the potential of agritourism to build AL (Specht et al., 2014).

Current Study

In this paper, we outline the development and validation of the Agricultural Literacy Instrument for Local Foods (ALI-LF), which we designed to measure AL oriented towards local food of children between the ages of 9 to 13. ALI-LF will contribute to a better understanding of individuals' cognitive, affective, and behavioral orientations toward agriculture and local food. It will also provide the tools to effectively evaluate programs that seek to build AL in the context of local food. This effort aligns with the research priorities of the American Association for Agricultural Education National Research Agenda 2016-2020 to enhance the public understanding of agriculture, contribute to vibrant and resilient communities, and evaluate meaningful engaged learning (Roberts et al., 2016).

We selected working with children between 9 and 13 years old given the importance of early intervention on learning trajectories (Gorey, 2001) and to predict future engagement in a host of contexts, including in agriculture (4-H, 2017). For instance, 60% of participants in programs such as Healthy Soils CSI 4-H express greater interest in pursuing a career in agriculture after their participation (4-H, 2017). Elementary school students also have the cognitive abilities to understand complex socio-ecological systems (Gelman & Brenneman, 2004; National Academy of Science, 2007) and the capacity to develop an interest in new topics (Forbes & Zint, 2010). As they grow older, learners lose this cognitive flexibility (Gopnik et al., 2017), which stresses the need to educate the consumers of tomorrow at an early age (Meischen & Trexler, 2003). Lastly, field trips (e.g., visits to farms) are common in elementary school (Hess & Trexler, 2011b) which allow evaluating the development of AL beyond the classroom. Thus, we have prioritized parsimony in designing the ALI-LF to facilitate the evaluation of learning opportunities beyond the classroom, either those offered as school activities (e.g., field trips) or as family leisure times (e.g., visiting agritourism farms with families). Doing so will contribute to the objective of the National Center for Agricultural Literacy to assess agricultural knowledge of diverse segments of the population (NCAL, n.d).

We focused on the context of local food for two reasons. First, focusing on a single context allows for a parsimonious assessment of AL that trades breadth for depth. Thus, we designed ALI-LF to measure knowledge, attitudes, and behaviors about local food instead of attempting to measure all the content areas called for by the FFSL frameworks and standards (Pense & Leising, 2004). Secondly, we chose local foods because of its potential to support the health of agro-ecosystems and connect individuals with agricultural systems in meaningful ways (Dillon et al., 2005; Sage, 2014). Furthermore, localizing food systems may provide engaging pathways for individual involvement with them. For instance, agritourism settings focus on local foods by integrating experiential (Ives & Obenchain, 2006) and placed based educational activities (Woodhouse & Knapp, 2000), which have been linked to improved knowledge, attention, and higher-order thinking skills among children (Smeds et al., 2015). Accordingly, a focus on local foods provides the opportunity to assess AL around a topic that both supports healthy agro-ecosystems (Sheppard, 2015) and lends itself well to informal learning contexts, which represent a gap in AL evaluation (Mercier, 2015). With this focus, we will answer Trexler (2013)'s call to focus on local food production in agricultural education efforts.

Conceptual Framework

The ALI-LF includes measurements of knowledge, attitudes, and behaviors, operationalized in the context of local foods. These constructs build towards recent frameworks for AL which identifies awareness, knowledge, attitudes, skills, and behavior (Meischen & Trexler, 2003; Spielmaker et al., 2014; Vallera & Bodzin, 2016) and parallels environmental literacy frameworks and associated instruments (McBeth et al., 2011; Szczytko et al., 2018). The knowledge construct focuses on the content needed to understand what constitutes local foods such as the role of seasons in food availability (Martinez et al., 2010). The attitudes construct captures perceptions towards the

attributes of local food and its impacts on the environment and local economies (Onozaka et al., 2010). Finally, for the behavior construct, we focus on the children's willingness to ask their parents to support local food purchases.

Knowledge

In the context of developing the ALI-LF, we conceptualized knowledge as the process of learning, remembering, and relating concepts, principles, and information about the agricultural food, fiber, and natural resource system (Vallera & Bodzin, 2016). We drew on the five themes of the FFSL framework for students in fourth and fifth grades (Pense & Leising, 2004; Pense et al., 2005). There are one to two questions for each of these thematic areas for a total of 10 questions (Table 1). We used a multiple-choice format because of its acceptance and validation for measuring knowledge and comprehension (Gronlund, 1998). To address local foods specifically, we included four questions related to the knowledge needed to understand how and why foods are available in certain areas and at certain times of the year. Additionally, we addressed gaps identified from qualitative research studies, including content related to food origins and local products (Hess & Trexler, 2011b; Trexler & Heinze, 2001). Bloom's Taxonomy hierarchical framework provided guidance to frame knowledge questions from simple to complex (Krathwohl, 2002). By utilizing a gradual increase in complexity, we designed the instrument to include basic concepts in agriculture as well as an understanding of food systems (seasonality, weather, and agricultural processes).

Table 1
Agricultural Literacy Instrument for Local Foods (ALI-LF) Items in the Agricultural Knowledge Construct

Items	Source from the Literature
What is a farmer?[1]	Brandt (2016)
What do we usually call the plants that grow on farms?[1]	Leising et al. (2003)
What do juice, jelly, and raisins have in common?[3, 4]	Adapted from Leising et al. (2003)
Match the following foods with the plant or animal it came from[5, LF]	New item
Crops get their energy from[3]	Adapted from Brandt (2016)
The types of crops that can be grown in a certain region depends on[2, 5, LF]	New item
Fresh fruits and vegetables such as peaches and sweet corn are most likely less expensive during which season in North Carolina[5, LF]	New item
The soils are very dry. How could these conditions affect crops grown in North Carolina compared with last year?[5, LF]	Adapted from Brandt (2016)
Why are there more peaches available during the summer than during the winter in North Carolina?[5, LF]	New item
For each pair circle the food that is more likely to support a farmer in North Carolina. (Choose ONE item per box)[4, LF]	Adapted from Leising et al. (2003)

[1] Understanding agriculture
[2] History, culture, and geography,
[3] Science, technology, and environment
[4] Business economics
[5] Food, nutrition, and health
[LF] Emphasis on local food

Attitudes

We conceptualized attitudes as a set of a positive or negative evaluation of agriculture, farmers, or agricultural issues (Ajzen, 2001). Children develop attitudes toward environmental issues as early as kindergarten shaping their attitudes into adulthood (Leeming et al., 1995). In this

instrument, we operationalized attitudes in terms of local food attributes (e.g., taste, freshness) by adapting existing scales tested in adults (Denver & Jensen, 2014; Hempel & Hamm, 2016; Knight, 2013; Onozaka et al., 2010) as we did not find any pertinent scale for children (Table 2). Since children might not be familiar with the term local foods, we phrased the question as "foods grown by local farmers." The attitudes towards local food measured included taste and freshness, its impact on the environment, and its impact on local economies. These questions used a 5-point Likert-scale: strongly disagree, disagree, not sure, agree, and strongly agree.

Table 2
Agricultural Literacy Instrument for Local Foods (ALI-LF) Items in the Attitudes towards Local Food Scale

Items	Source from the Literature
Foods grown by local farmers are good for the environment	Denver and Jensen (2014)
Foods grown by local farmers taste good	Onozaka et al. (2010)
Foods grown by local farmers are fresh	Onozaka et al. (2010)
Foods grown by local farmers are expensive	Onozaka et al. (2010); Hempel and Hamm (2016)
Foods grown by local farmers are easy to find where my family shops	Denver and Jensen (2014)
Buying foods grown by local farmers supports my community	Onozaka et al. (2010)

Note: Survey question prompt was "How much do you agree or disagree with the following statements?"

Behavior

To develop the ALI-LF we conceptualized behavior as self-reported actions carried out to support local agriculture that included a range of advocacy (e.g., talking about agricultural issues with friends and family) and purchasing behaviors (e.g., purchasing locally sourced agricultural products). As children do not usually engage in purchasing local food on their own, we settled on behaviors where children may encourage family purchasing of local foods. Specifically, we conceptualized behavior as the degree to which children would talk to their parents about purchasing food at a farmers' market, picking their own food, or choosing foods with a local food label (Table 3). This approach is reflected in several other behavior scales that ask children the degree to which they may ask parents, elected officials, or other adults to support the environment (Duvall & Zint, 2007; Lawson et al., 2018; Szczytko et al., 2018). It is also a common practice in the food industry to influence family purchasing behavior through marketing to children (Calvert, 2008).

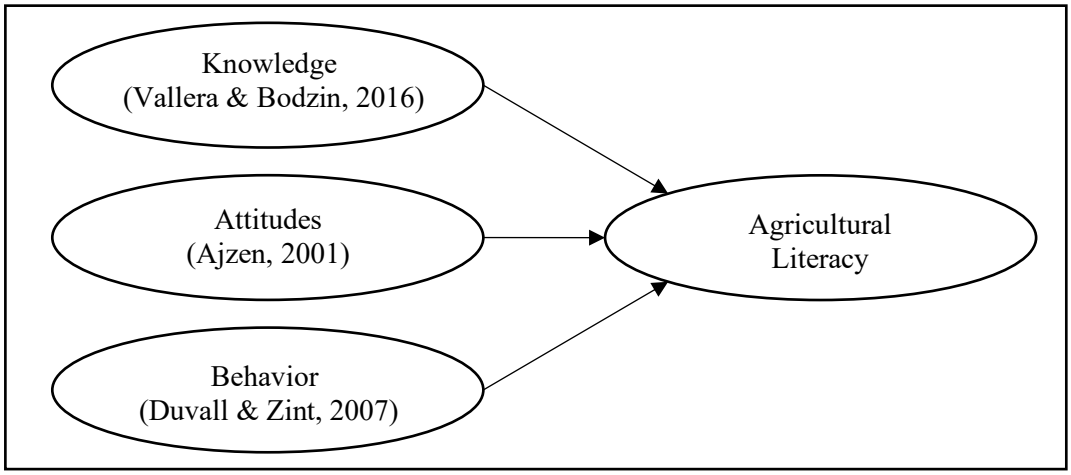
Table 3
Agricultural Literacy Instrument for Local Foods (ALI-LF) Items in the Intended Consumer Behavior towards Local Food Scale

Items Behavior Towards Local Food	Source from the Literature Reviewed
Buy foods advertised as grown in North Carolina	Denver and Jensen (2014)
Buy foods with the "GotToBeNC" label	New item
Buy foods advertised as "grown by local farmers"	Campbell et al. (2014)
Buy food at the farmers market	Chen and Scott (2014)
Take me to farms so we can pick our own produce	New item
Look at food labels to see where food comes from	Hempel and Hamm (2016)
Talk to adults other than my parent about supporting local farmers	New item

Note: Survey question prompt was "How likely or unlikely are you to do the following? Ask your parents to…"

In summary, we propose measuring agricultural literacy with an emphasis on local food including the constructs of knowledge, attitudes, and behaviors (Figure 2).

Figure 2
Conceptual Framework to Measure Agricultural Literacy



Research Methods

Grounded in the theoretical perspectives aforementioned, we developed an initial instrument (ALI-LFv1) comprising local foods knowledge, attitudes, and behavior related to local food systems. We iteratively revised this version in three phases: (1) instrument pilot testing, (2) first round of instrument testing, and (3) second round of instrument testing. Specifically, we pilot tested our initial version of the instrument (ALI-LFv1) with a small convenience sample of students (n = 20). We revised the instrument based on verbal feedback from respondents and initial reliability tests on the attitude and behavior scales, resulting in the ALI-LFv2. We then tested the instrument with a larger sample of agritourism visitors (n = 205) and analyzed the survey for reliability and validity. Based on these results, we revised the survey again (ALI-LFv3) and validated it with a similar sample of agritourism visitors (n = 165). We describe the full methods of each phase in the sub-section below while we present the full validation results from phases 2 and 3 in the results section.

Phase 1: Pilot Testing

We began piloting the draft instrument with a convenience sample of elementary school students (n = 20) attending an agricultural program at a local arboretum. We asked students to give written and oral feedback on the instrument for items that were unclear or confusing. We computed Cronbach's alphas ($\alpha < 0.60$) to test the internal reliability of the attitudes and behavior scales (Nunnally, 1978). Results indicated two -out of six- problematic items in the attitudes scale. Thus, we dropped the items "local foods are expensive" and "local foods are easy to find where my family shops" to obtain acceptable internal reliability for the attitude scale ($\alpha = 0.66$). We addressed the low reliability ($\alpha = 0.58$) of the behavior scale by improving the wording to ensure clarity and consistency of all items. For the knowledge scale, we examined the normality of responses and improved the wording clarity following students' feedback. Changes obtained in this first phase resulted in a revised instrument, ALI-LFv2.

Phase 2 and 3: Sample and Data Collection

We conducted data collection for phases 2 and 3 at agritourism farms given their suitability, yet underexplored, for informal learning (Barbieri et al., 2019; Smeds et al., 2015). The farm selection criteria aligned with the goals of a larger study seeking to assess the educational value of agritourism

for children and how this knowledge translates to family-level purchasing of local foods. As the research took place in North Carolina (NC, USA), the North Carolina Department of Agriculture and Consumer Services provided a list of 43 agritourism operations located across the state that offered educational activities (e.g., presence of signage or a guided tour), at least one type of hands-on agricultural experience (e.g., u-pick, petting animals), recreational activities for children (e.g., playground, corn maze), and an on-site store (e.g., gift shop, farm market). After on-site visits, we selected six agritourism farms across the three NC geographic regions to further test the reliability of the ALI-LF instrument. We collected data using intercept surveys during two major agritourism seasons in NC. The first data collection occurred in October 2018 during the u-pick pumpkin season. The second phase occurred in April-May 2019 when u-pick strawberries were in demand.

This paper reports on one element of a larger study examining how families engage with agritourism. Although in this paper we focus on reporting on children's agriculture literacy, the sample of this study are families composed of at least one parent accompanied by at least one child between the ages of 9 and 13 visiting any of the six selected agritourism farms. We intercepted each qualifying family upon entering the farm and invited them to participate. If the parent agreed to participate, we asked them to provide consent for their participation and their child's participation in the study. We then obtained written assent from the child before administering the survey. We gave families the option of completing a survey on iPads using the off-line Qualtrics application software or on paper. We requested a minimum of one parent and one child to participate in the survey, but multiple participants from a single family were welcome. The parents' survey focused on consumer behavior towards local food, while the children's survey measured agricultural literacy. Parents and children were asked to complete the respective surveys independently. Only children's responses are included in this paper.

Data Preparation and Analysis

For both phase 2 and 3, we recorded data in Qualtrics and downloaded the databases into an excel file. Before the analysis, we cleaned the data to identify outliers and followed listwise deletion to exclude cases that did not complete any of the three scales. We then exported each dataset to the Software for Statistics and Data Science (Stata). We recoded the knowledge scales from multiple-choice responses (with original values ranging from 1 to 4) into dichotomous responses (1= *correct*, 0 = *incorrect*). We did not recode the Likert-scale type of questions.

As we designed the scales following the theoretical model, we tested the construct validity of the attitudes and behavior scales separately using principal component factor (PCF) analysis assuming a one-factor structure using an orthogonal varimax rotation (Harman, 1976). We used this technique to assess the degree to which each item aligns with the latent construct using 0.4 as a cut off value for item loadings (Everitt & Hothorn, 2011). Next, we tested the internal reliability of the scales using Cronbach's alpha ($\alpha > 0.6$, Nunally, 1978). We did not conduct PCF analysis for the knowledge section as we designed the knowledge questions specifically to provide a range of difficulty, and we would not expect items to correlate as they would in a typical additive scale (van Schuur, 2003). Instead, we used descriptive statistics to evaluate the difficulty of the knowledge section and we looked for the distribution of the scores of the knowledge scale.

Results

Phase 2: First Round of Testing the Instrument (Fall Data Collection)

A total of 205 children participated in the test during the fall season (2018) at agritourism farms. Among these, 89.2% were between 9 and 13 years old with the largest percentage made of 11 years old (50%), and only 11.4% of the respondents had less than 9 or more than 13 years (Table 4). Slightly over half of the respondents were female (55.8%); most were white (77.3%), followed by Latin/Hispanic (6.1%), and Asian (4.4%).

Table 4
Demographic Characteristics of Respondents (Phase 2)

Demographic characteristic		Frequency	Percent
Age			
Younger than 9		10	5.7
9		32	18.1
10		29	16.4
11		50	28.1
12		29	16.4
13		17	9.6
Older than 13		10	5.7
	Total	177	100
Gender			
Female		101	56.1
Male		79	43.9
	Total	180	100
Race that best described the respondent			
White		140	77.3
Latin/Hispanic		11	6.1
Asian		8	4.4
African American		5	2.8
Native American		5	2.8
Other		12	6.6
	Total	181	100

Note: The single factor PCF analysis confirmed the construct validity of the attitudes ($\chi^2 = 147.02$, $p < 0.001$, $n = 181$) and behavior ($\chi^2 = 368.46$, $p < 0.001$, $n = 171$) scales with items presenting adequate loading values (> 0.645, Table 5). Cronbach's alpha indicated high internal reliability of the attitudes ($\alpha = 0.72$) and behavior ($\alpha = 0.83$) scales. Therefore, we used the same scales for the phase 3 data collection in spring 2019.

Table 5
Item Reliability (Alpha) and Principal Component Factor Analysis of the Attitude and Behavior Scales (Phase 2)

Variable	Factor	Uniqueness	Eigenvalue	Alpha
Attitudes[1] (α = 0.72)			2.21	
Foods grown by local farmers are good for the environment	0.736	0.458		0.67
Foods grown by local farmers taste good	0.779	0.393		0.63
Foods grown by local farmers are fresh	0.721	0.480		0.67
Buying foods grown by local farmers supports my community	0.734	0.461		0.67
Behavior[2] (α = 0.83)			3.44	
Buy foods advertised as grown in North Carolina	0.745	0.446		0.80
Buy foods with the "GotToBeNC" label	0.736	0.459		0.80
Buy foods advertised as "grown by local farmers"	0.711	0.495		0.80
Buy food at the farmers market	0.664	0.560		0.81
Take me to farms so we can pick our produce	0.645	0.584		0.81
Look at food labels to see where food comes from	0.676	0.543		0.81
Talk to adults other than my parents about supporting local farmers	0.728	0.469		0.80

[1] Measured on a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree).
Note: Survey question prompt read "How much do you agree or disagree with the following statements?"
[2] Measured on a 5-point Likert scale (1 = very unlikely, 5 = very likely).
Note: Survey question prompt read "How likely or unlikely are you to do the following? Ask your parents to…"

Regarding the knowledge section, a histogram graph indicated a normal distribution of the responses (Figure 3). Descriptive statistics revealed that four out of 10 knowledge questions were problematic because most respondents answered then correctly, indicating the questions were not sufficiently challenging for different ranges of knowledge (Table 6). As our goal was to create a parsimonious, yet sensitive, instrument, we edited items in which 90% or more of the respondents answered correctly. Specifically, we replaced the following questions: (1) "What is a farmer?", (2) "What do we usually call the plants that grow on farms?", (3) "Match the following foods with the plant or animal it came from on the farm?" [For the options bread, cheese, and hamburger patties] and, (4) "For each pair circle the food that is more likely to support a farmer in North Carolina" for the options "Apples or pineapples" and "peaches or mangos? (highlighted in grey in Table 6).

Figure 3
Distribution of Phase 2 Responses for the Knowledge Scale

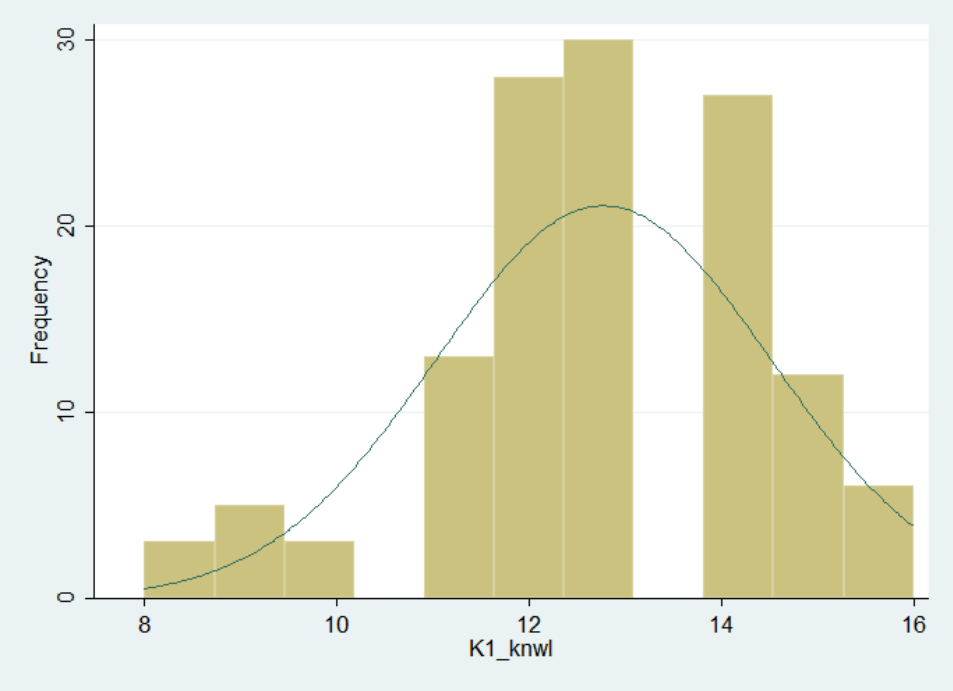


Table 6
Percentage of Correct Answers Obtained for Items Used in Phase 2

	Items	Correct Answers	Percent of Correct Answers
1	What is a farmer?[1]	200	98.04
2	What do we usually call the plants that grow on farms?[1]	202	99.02
3	What do juice, jelly, and raisins have in common?	138	68.32
4	Match the following foods with the plant or animal it came from on the farm:[5]		
	Tortilla chips	46	23.12
	Bread	200	99.50
	Cheese	197	98.01
	Hamburger patties	197	97.52
5	Crops get their energy from[3]	163	81.09
6	The types of crops that can be grown in a certain region depends on[2]	157	78.11
7	Fresh fruits and vegetables such as peaches and sweet corn are most likely less expensive during which season in North Carolina?[4, LF]	58	29.44
8	How do weather conditions affect crops?[2, 3]	138	71.88
9	Why there are more peaches available during summer than during winter?[5, LF]	58	29.44
10	Below is a list of paired food items. For each pair circle the food that is more likely to support a farmer in North Carolina. (Choose ONE item per box)[5, LF]		
	Apples or pineapples	185	97.88
	Turkey sandwich or pulled pork sandwich	95	67.38
	Peanuts or almonds	85	58.22
	Peaches or mangos	165	90.91

[1] Understanding agriculture
[2] History, culture, and geography,
[3] Science, technology, and environment
[4] Business economics
[5] Food, nutrition, and health
[LF] Emphasis on local food
Note: highlighted cells are the items replaced in Phase 3

Additionally, during data collection, volunteers administering the surveys identified that three items "What do juice, jelly, and raisins have in common," "Fresh produce is most likely less expensive during which season in North Carolina," and one option in the question "For each pair circle the food that is more likely to support a farmer in North Carolina" [option "Turkey sandwich or pulled pork sandwich"] were problematic as answers were not as straightforward as required, thus we also replaced those items. We revisited the literature to substitute the new items with ones already validated while covering the same targeted areas identified through the FFSL framework (Pense et al., 2005): (1) understanding agriculture, (2) history, culture, and geography, (3) science, technology, and environment, (4) business economics, and (5) food, nutrition, and health formulating (Table 7).

Table 7
New Items Introduced in Phase 3 for the Knowledge Scales

Items	Source from the Literature Reviewed
How do plants use soil?	Brandt (2016)
What do farmers manage?	Leising et al. (2003)
What has reduced manual labor requirements for agriculture?	Adapted from Leising et al. (2003)
Match the following foods with the plant or animal it came from Ketchup Yogurt Cake	New item
Match the agricultural products with the season in which they are harvested in Sweet corn Pears Strawberries Pecans	New item
For each pair circle the food that is more likely to support a farmer in North Carolina. (Choose ONE item per box) Apples or oranges Bison hamburger or pulled pork sandwich Peaches or cherries	Adapted from Leising et al. (2003)

Phase 3. Final Testing of the Instrument (Spring Data Collection)

The sample for the spring 2019 season consisted of 165 children. Children who participated in the survey were mainly between 9 and 13 years old with the largest percentage made of 11 years old (25.5%); only 10.9% of the respondents had less than 9 or more than 13 years (Table 8). Most respondents were female (64.2%) and white (58.9%). However, this sample represented a more ethnically diverse population than the previous one (Phase 2), with a relatively large proportion of African American (9.8%), Latin/Hispanic (9.8%), and Asian (9.2%) participants.

Table 8
Demographic Characteristics of Respondents of Phase 3

Demographic Characteristics		Frequency	Percent
Age			
Younger than 9		4	2.6
9		22	19.1
10		30	12.7
11		20	25.5
12		40	17.8
13		28	19.1
Older than 13		13	8.3
	Total	157	100.0
Gender			
Female		104	64.2
Male		58	35.8
	Total	162	100.0
Race that best described the respondent			
White		96	58.9
African American		16	9.8
Latin		16	9.8
Asian		15	9.2
Native American		8	4.9
Other		12	7.4
	Total	163	100.0

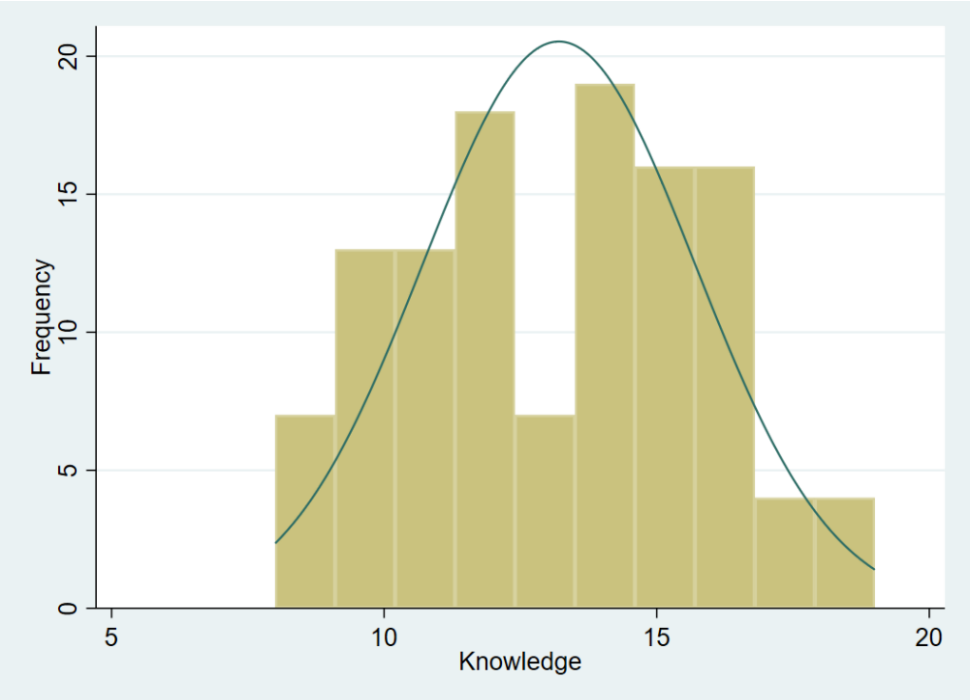
The descriptive information of the ALI-LFv3 shows that the modifications of the knowledge items produced a more challenging scale with a range of difficulty that can capture different levels of knowledge (Table 9). Additionally, Figure 4 illustrates the distribution of the scores obtained on the knowledge scale, showing that the distribution of the respondents' final scores is close to normality.

Table 9
Percentage of Correct Answers Obtained for Phase 3

	Items	Correct Answers	Percent of Correct Answers
1	How do plants use soil?[1]	143	84.1
2	What do farmers manage?[1]	131	77.98
3	What has reduced the manual labor in farms?[1]	87	53.37
4	Match the following foods with the plant or animal it came from on the farm:[5]		
	Tortilla chips	111	67.27
	Ketchup	164	98.8
	Yogurt	157	95.15
	Cake	124	75.61
5	Crops get their energy from[3]	143	84.12
6	The types of crops that can be grown in a certain region depends on[2]	130	77.38
7	Match the following foods with the season in which they are harvested on?[4, LF]	58	29.44
	Sweet corn	41	25.31
	Pears	36	22.22
	Strawberries	110	67.07
	Pecan	68	42.50
8	How do weather conditions affect crops?[2, 3]	112	68.29
9	Why there are more peaches available during summer than during winter?[5, LF]	104	63.03
10	Below is a list of paired food items. For each pair circle the food that is more likely to support a farmer in North Carolina. (Choose ONE item per box)[5, LF]		
	Apples or oranges	123	77.84
	Bison hamburger or pulled pork sandwich	101	71.63
	Peanuts or almonds	82	56.55
	Peaches or cherries	93	62.00

[1] Understanding agriculture
[2] History, culture, and geography,
[3] Science, technology, and environment
[4] Business economics
[5] Food, nutrition, and health
[LF] Emphasis on local food

Figure 4
Distribution of Responses for the Knowledge Scale in Phase 3



Since the attitudes and behavior scales did not change across data collection seasons, we combined both data sets (phases 2 and 3) to increase power. PCF analysis confirmed construct validity on the attitudes ($\chi^2 = 271.67$, $p < 0.001$, $n = 340$) and behavior ($\chi^2 = 753.44$, $p < 0.001$, $n = 322$) scales (Table 10). The Cronbach's alphas indicated adequate internal reliability for the attitudes scale ($\alpha = 0.72$) and strong internal reliability for the behavior scale ($\alpha = 0.84$) of the final instrument (ALI-LFv3).

Table 10
Internal Reliability (Alpha) and Principal Component Factor Analysis for the Attitudes and Behaviors Scale (Phase 2 and 3 Combined)

Variable	Factor	Uniqueness	Eigenvalue	Alpha
Attitudes[1] (α = 0.72)			2.22	
Foods grown by local farmers are good for the environment	0.755	0.431		0.66
Foods grown by local farmers taste good	0.767	0.412		0.65
Foods grown by local farmers are fresh	0.747	0.441		0.66
Buying foods grown by local farmers supports my community	0.710	0.497		0.69
Behavior[2] (α = 0.84)			3.59	
Buy foods advertised as grown in North Carolina	0.751	0.436		0.81
Buy foods with the "GotToBeNC" label	0.768	0.411		0.81
Buy foods advertised as "grown by local farmers"	0.761	0.421		0.81
Buy food at the farmers market	0.687	0.528		0.82
Take me to farms so we can pick our produce	0.632	0.601		0.83
Look at food labels to see where food comes from	0.633	0.600		0.83
Talk to adults other than my parents about supporting local farmers	0.767	0.412		0.80

[1] Measured on a 5-point Likert scale (1 = *strongly disagree*, 5 = *strongly agree*).
Note: Survey question prompt read "How much do you agree or disagree with the following statements?"
[2] Measured on a 5-point Likert scale (1 = *very unlikely*, 5 = *very likely*).
Note: Survey question prompt read "How likely or unlikely are you to do the following?"

Discussion

In this paper, we introduce the ALI-LF as a validated instrument designed to measure AL oriented towards local food for children between the ages of 9 to 13. This instrument is composed of three scales: knowledge, attitudes, and behavior. We adapted the language from scales designed to measure adults' local foods attitudes and behaviors for children in our study's age range. As children rarely engage in direct food purchasing, we modified the behavior to include a measure of what children would ask their parents to do, stemming from environmental literacy approaches (Szczytko et al., 2018). Our results show that each scale (knowledge, attitudes, and behavior) of the resulting ALI-LF is reliable and valid to use in informal contexts. To our knowledge, this is the first instrument to measure simultaneously children's knowledge, attitudes, and behavior towards local food. This is relevant because many local food initiatives are geared towards children and it is important to measure their impact with valid instruments (Joshi et al., 2008).

Our ALI-LF builds towards AL by providing a tool for practitioners and researchers to measure the impact of programs, projects, and interventions promoting AL and local foods (Dillon et al., 2003; Dillon et al., 2005; Doerfert, 2011; Roberts et al., 2016). By operationalizing existing proposed AL frameworks (Dillon et al., 2005; Spielmaker et al., 2014), we facilitate measuring their effectiveness and impacts. Given the instrument focus on local foods, we suggest that future applications tailor it to local contexts, particularly in the knowledge section, because local agricultural products differ across regions. Additionally, researchers may use our approach as a template for developing parallel instruments exploring other content areas of AL, such as genetically modified foods and nutrition. Ideally, differing versions would be compiled and shared, for example through

the National Center for Agricultural Literacy, which gathers relevant AL questions facilitating access to agricultural education practitioners (https://www.agliteracy.org/).

As ALI-LF is pioneering a subject-specific multi-construct approach to measuring AL, we acknowledge several areas for future instrument development. First, our final knowledge section had several items with a low-level of difficulty. However, one of our goals for this instrument was for use in informal settings, and research suggests that students may be less likely to answer difficult questions correctly in these settings (Fisher-Maltese & Zimmerman, 2015), thus, a lower difficulty level may be appropriate for informal contexts. Therefore, the suitability of ALI-LF for evaluations in formal settings (i.e., classroom) and structured programs (e.g., FFA) that need to account for the balance between parsimony and consistent reliability, particularly among children, needs further scrutiny.

Secondly, our attitudes scale displayed acceptable reliability, but it could be improved. The brevity of the scale likely helps explain this reliability level (Gliem & Gliem, 2003) as does our young audience who may find it hard to comprehend Likert-type questions (Mellor & Moore, 2014). The internal reliability of the attitudes scale might be improved by increasing the number of items while sacrificing parsimony. The behavior scale did show higher reliability, but as with all self-reported behavior, future researchers should be cautioned around the possibility of acquiescence bias (Mellor & Moore, 2014). Thus, future studies focused on children's behavior could consider pairing survey methods with observation, parent reporting, or other methods of triangulation (Heimlich & Ardoin, 2017). Finally, we suggest testing the ALI-LF instrument among older and/or higher-achieving students for further validation.

Conclusion

The ALI-LF instrument contributes to enhancing the analysis of children's cognitive, affective, and behavioral orientations towards agriculture and local food. This effort aligns with the research objective to measure the public understanding of agriculture and evaluate meaningful engaged learning by using an agritourism operation as a setting to test this instrument (Dillon et al., 2003, 2005; Doerfert, 2011; National Council for Agricultural Education, 2000). Future studies could expand this instrument by answering the call for several authors to include cognitive skills (Dillon et al., 2005; Powell et al., 2008). Research on the development of cognitive skills focuses on areas of processing speed, working memory capacity, and fluid reasoning (Finn et al., 2014). Constructs associated with cognitive skills in an environmental context include issue identification, issue analysis, and action planning (McBeth et al., 2011; Szczytko et al., 2018). These approaches might be a good starting point to incorporate cognitive skills in this instrument. Overall, the ALI-LF development and initial validation contribute to the research priorities of the American Association for Agricultural Education National Research Agenda 2016-2020 to evaluate meaningful engaged learning (Roberts et al., 2016) and the call for a greater emphasis on local foods in agricultural education (Trexler, 2013). Yet, the pressing need to enhance engaged learning experiences, call to continue its validation among different contexts (e.g., formal settings) and samples (e.g., older students).

References

4-H. (2017). *4-H grows: National 4-H council 2017 annual report*. https://4-h.org/wp-content/uploads/2018/06/AnnualReport-2017.pdf

Adams, D. C., & Salois, M. J. (2010). Local versus organic: A turn in consumer preferences and willingness-to-pay. *Renewable Agriculture and Food Systems*, *25*(4), 331–341. https://doi.org/10.1017/S1742170510000219

Ajzen, I. (2001). Nature and operation of attitudes. *Annual Review of Psychology*, *52*(1), 27–58. https://doi.org/10.1146/annurev.psych.52.1.27

Barbieri, C., Stevenson, K. T., & Knollenberg, W. (2019). Broadening the utilitarian epistemology of agritourism research through children and families. *Current Issues in Tourism*, *22*(19), 1–4. https://doi.org/10.1080/13683500.2018.1497011

Birkenholz, R. J., Harris, C. R., & Pry, H. W. (1994). A pilot study: Assessment of agricultural literacy among college students. *NACTA Journal*, (March), 63–66.

Blay-Palmer, A., Sonnino, R., & Custot, J. (2016). A food politics of the possible? Growing sustainable food systems through networks of knowledge. *Agriculture and Human Values*, *33*(1), 27–43. https://doi.org/10.1007/s10460-015-9592-0

Boys, K. A., & Hughes, D. W. (2013). A regional economics – based research agenda for local food systems. *Journal of Agriculture, Food Systems, and Community Development*, *3*(4), 145–150.

Brandt, M. R., & Brandt, M. R. (2016). *Exploring elementary students ' agricultural and scientific knowledge using evidence centered design*. University of Nebraska.

Calvert, S. L. (2008). Children as consumers: Advertising and marketing. *The Future of Children*, *18*(1), 205–234. https://doi.org/10.1353/foc.0.0001

Campbell, J., DiPietro, R. B., & Remar, D. (2014). Local foods in a university setting: Price consciousness, product involvement, price/quality inference and consumer's willingness-to-pay. *International Journal of Hospitality Management*, *42*, 39–49. https://doi.org/10.1016/j.ijhm.2014.05.014

Chen, W., & Scott, S. (2014). Shoppers' perceived embeddedness and its impact on purchasing behavior at an organic farmers' market. *Appetite*, *83*, 57–62. https://doi.org/10.1016/j.appet.2014.08.010

Dale, C. (2017). An assessment of the agricultural literacy of incoming freshmen at a land-grant university. *NACTA Journal*, *61*(1), 7–14.

Denver, S., & Jensen, J. D. (2014). Consumer preferences for organically and locally produced apples. *Food Quality and Preference*, *31*(1), 129–134. https://doi.org/10.1016/j.foodqual.2013.08.014

Dillon, J., Rickinson, M., Sanders, D., Teamey, K., & Benefield, P. (2003). *Improving the understanding of food, farming and land management amongst school-age children: A literature review*. https://www.researchgate.net/publication/237206801_Improving_the_Understanding_of_Food_Farming_and_Land_Management_Amongst_School-Age_Children_A_Literature_Review

Dillon, J., Rickinson, M., Sanders, D., Teamey, K., Dillon, J., Rickinson, M., … Sanders, D. (2005). On food, farming and land management: Towards a research agenda to reconnect urban and rural lives. *International Journal of Science Education*, *27*(11), 1359–1374. https://doi.org/10.1080/09500690500153865

Doerfert, D. L. (2011). *National research agenda: American Association for Agricultural Education's research priority areas for 2011-2015*. Lubbock, TX.

Duvall, J., & Zint, M. (2007). A review of research on the effectiveness of environmental education in promoting intergenerational learning. *Journal of Environmental Education*, *38*(4), 14–24. https://doi.org/10.3200/JOEE.38.4.14-24

Everitt, B., & Hothorn, T. (2011). *An introduction to applied multivariate analysis with R*. Springer.

Fisher-Maltese, C., & Zimmerman, T. D. (2015). A garden-based approach to teaching life science produces shifts in students' attitudes toward the environment. *International Journal of Environmental & Science Education*, *10*(1), 51–66. https://doi.org/10.12973/ijese.2015.230a

Forbes, C., & Zint, M. (2010). Elementary teachers' beliefs about, perceived competencies for, and reported use of scientific inquiry to promote student learning about and for the environment. *Journal of Environmental Education*, *42*(1), 30–42. https://doi.org/10.1080/00958961003674673

Francis, C., Lieblein, G., Gliessman, S., Breland, T. A., Creamer, N., Salomonsson, L., … Wiedenhoeft, M. (2003). Agroecology: The ecology of food systems. *Journal of Sustainable Agriculture*, *22*(3), 99–118. https://doi.org/10.1300/J064v22n03

Gelman, R., & Brenneman, K. (2004). Science learning pathways for young children. *Early Childhood Research Quarterly*, *19*(1), 150–158. https://doi.org/10.1016/j.ecresq.2004.01.009

Gliem, J. A., & Gliem, R. R. (2003). Calculating, interpreting, and reporting Cronbach's alpha reliability coefficient for Likert-type scales. *Midwest Research to Practice Conference in Adult, Continuing, and Community Education*, 82–82. https://doi.org/10.1016/B978-0-444-88933-1.50023-4

Gopnik, A., O'Grady, S., Lucas, C. G., Griffiths, T. L., Wente, A., Bridgers, S., … Dahl, R. E. (2017). Changes in cognitive flexibility and hypothesis search across human life history from childhood to adolescence to adulthood. *Proceedings of the National Academy of Sciences*, *114*(30), 7892–7899. https://doi.org/10.1073/pnas.1700811114

Gorey, K. M. (2001). Early childhood education: A meta-analytic affirmation of the short- and long-term benefits of educational opportunity. *School Psychology Quarterly*, *16*(1), 9–30. https://doi.org/10.1521/scpq.16.1.9.19163

Grady, R., & Ball, A. (2009). Secondary agricultural science as content and context for teaching. *Journal of Agricultural Education*, *50*(1), 81–91. https://doi.org/10.5032/jae.2009.01081

Gronlund, N. E. (1998). *Assessment of student achievement* (6th ed.). Allyn & Bacon Publishing.

Guest, H., Lotze, H. K., & Wallace, D. (2015). Youth and the sea: Ocean literacy in Nova Scotia, Canada. *Marine Policy*, *58*, 98–107. https://doi.org/10.1016/j.marpol.2015.04.007

Harman, H. H. (1976). *Modern Factor Analysis* (3rd Ed.). University of Chicago Press.

Heimlich, J. E., & Ardoin, N. M. (2017). Understanding behavior to understand behavior change: a literature review. *Environmental Education Research*, *14*(3), 215–237. https://doi.org/10.1080/13504620802148881

Hempel, C., & Hamm, U. (2016). How important is local food to organic-minded consumers? *Appetite*, *96*, 309–318. https://doi.org/10.1016/j.appet.2015.09.036

Herren, R. V., & Oakley, P. (1995). An evaluation of Georgia's Agriculture In The Classroom program. *Journal of Agricultural Education*, *36*(4), 26–31. https://doi.org/10.5032/jae.1995.04026

Hess, A., & Trexler, C. (2011a). A qualitative study of agricultural literacy in urban youth: Understanding for democratic participation in renewing the agri–food system. *Journal of Agricultural Education*, *52*(2), 151–162. https://doi.org/10.5032/jae.2011.02151

Hess, A., & Trexler, C. (2011b). A qualitative study of agricultural literacy in urban youth: What do elementary students understand about the agri–food system? *Journal of Agricultural Education*, *52*(4), 1–12. https://doi.org/10.5032/jae.2011.04001

Hollweg, K. S., Taylor, J. R., Bybee, R. W., Marcinkowski, T. J., McBeth, W. C., & Zoido, P. (2011). Developing a framework for assessing environmental literacy. *North American Association for Environmental Education*. papers3://publication/uuid/94978D29-345A-45B3-80CA-F04DCBC9373B

Joshi, A., Azuma, A. M., & Feenstra, G. (2008). Do farm-to-school programs make a difference? Findings and future research needs. *Journal of Hunger and Environmental Nutrition*, *3*(2–3), 229–246. https://doi.org/10.1080/19320240802244025

Knight, A. J. (2013). Evaluating local food programs: The case of Select Nova Scotia. *Evaluation and Program Planning*, *36*(1), 29–39. https://doi.org/10.1016/j.evalprogplan.2012.05.003

Knobloch, N. A., & Martin, R. A. (2000). Agricultural awareness activities and their integration into the curriculum as perceived by elementary teachers. *Journal of Agricultural Education*, *41*(4), 15–26. https://doi.org/10.5032/jae.2000.04015

Koch, S., Waliczek, T. M., & Zajicek, J. M. (2006). The effect of a summer garden program on the nutritional knowledge, attitudes, and behaviors of children. *HortTechnology*, *16*(4), 620–625.

Kovar, K., & Ball, A. (2013). Two decades of agricultural literacy research: A synthesis of the literature. *Journal of Agricultural Education*, *54*(1), 167–178. https://doi.org/10.5032/jae.2013.01167

Krathwohl, D. R. (2002). A revision of Bloom's Taxonomy: An overview. *Theory Into Practice*, *41*(4), 212–218. https://doi.org/10.1207/s15430421tip4104

Lawson, D. F., Stevenson, K. T., Peterson, M. N., Carrier, S. J., Strnad, R., & Seekamp, E. (2018). Intergenerational learning: Are children key in spurring climate action? *Global Environmental Change*, *53*(October), 204–208. https://doi.org/10.1016/j.gloenvcha.2018.10.002

Leising, J. G., Pense, S. L., & Portillo, M. T. (2003). *The Impact of selected Agriculture in the Classroom teachers on student agricultural literacy*. https://www.agliteracy.org/research/doc/evaluation/impact2003.pdf

Lyson, T. A., & Welsh, R. (2005). Agricultural industrialization, anticorporate farming laws, and rural community welfare. *Environment and Planning A*, *37*(8), 1479–1491. https://doi.org/10.1068/a37142

Mars, M., & Ball, A. (2016). Ways of knowing, sharing, and translating agricultural knowledge and perspectives: alternative epistemologies across non-formal and informal settings. *Journal of Agricultural Education*, *57*(1), 56–72.

Martinez, S. W., Hand, M., Da Pra, M., Pollack, S., Ralston, K., Smith, T., Vogel, S., Clark, S., Lohr, L., Low, S., Newman, C. (2010). *Concepts, impacts, and issues*. (Economic Research Report Number 97). USDA https://www.ers.usda.gov/webdocs/publications/46393/7054_err97_1_.pdf?v=42265

McBeth, W., Hungerford, H., Marcinkowski, T., Volk, T., & Cifranick, K. (2011). *National environmental literacy assessment, phase two: Measuring the effectiveness of North American environmental education programs with respect to the parameters of environmental literacy. Final Report.* https://www.noaa.gov/sites/default/files/atoms/files/NELA_Phase_Two_Report_020711.pdf

Meischen, D. L., & Trexler, C. J. (2003). Rural elementary students' understanding of science and agricultural education benchmarks related to meat and livestock. *Journal of Agricultural Education*, *44*(1), 43–55. https://doi.org/10.5032/jae.2003.01043

Mellor, D., & Moore, K. A. (2014). The use of likert scales with children. *Journal of Pediatric Psychology*, *39*(3), 369–379. https://doi.org/10.1093/jpepsy/jst079

Mercier, S. (2015). *Food and agricultural education in the United States*. http://www.foodandagpolicy.org/sites/default/files/AGree_Food and Ag Ed in the US.pdf

Myers, J. S., & Sbicca, J. (2015). Bridging good food and good jobs: From secession to confrontation

within alternative food movement politics. *Geoforum*, *61*, 17–26. https://doi.org/10.1016/j.geoforum.2015.02.003

National Academy of Science. (2007). Taking science to school: Learning and teaching science in grades K-8. https://www.nap.edu/catalog/11625/taking-science-to-school-learning-and-teaching-science-in-grades

National Council for Agricultural Education. (2000). *The national strategic plan and action for agricultural education: Reinventing agricultural education for the year 2020*. https://eric.ed.gov/?id=ED463416

National Research Council. (1988). *Understanding agriculture: New directions for education.* National Academy Press.

Nunnally, J. (1978). *Psychometric Methods*. Mc-Graw Hill.

O'Kane, G. (2016). A moveable feast: Exploring barriers and enablers to food citizenship. *Appetite*, *105*, 674–687. https://doi.org/10.1016/j.appet.2016.07.002

Onozaka, Y., Nurse, G., & McFadden, D. T. (2010). Local food consumers: how motivations and perceptions translate to buying behavior. *Choices*, *25*(1), 7–12.

Pearson, D., Henryks, J., Trott, A., Jones, P., Parker, G., Dumaresq, D., & Dyball, R. (2011). Local food: understanding consumer motivations in innovative retail formats. *British Food Journal*, *113*(7), 886–899. https://doi.org/10.1108/00070701111148414

Pense, S. L., & Leising, J. G. (2004). An assessment of food and fiber systems knowledge in selected Oklahoma high schools. *Journal of Agricultural Education*, *45*(3), 86–96. https://doi.org/10.5032/jae.2004.03086

Pense, S. L., Leising, J. G., Portillo, M. T., & Igo, C. G. (2005). Comparative assessment of student agricultural literacy in selected agriculture in the classroom programs. *Journal of Agricultural Education*, *46*(3), 107–118. https://doi.org/10.5032/jae.2005.03107

Phibbs, E. J., & Relf, D. (2005). Improving research on youth gardening. *HortTechnology*, *15*(3), 425–428. https://doi.org/10.21273/HORTTECH.15.3.0425

Powell, R. B., & Agnew, D. (2011). Assessing agricultural literacy elements of project Food Land and People in K-5 using the Food and Fiber Systems Literacy Standards. *Journal of Agricultural Education*, *52*(1), 155–170. https://doi.org/10.5032/jae.2011.01155

Powell, R. B., Agnew, D., & Trexler, C. (2008). Agricultural literacy: clarifying a vision for practical application. *Journal of Agricultural Education*, *49*(1), 85–98. https://doi.org/10.5032/jae.2008.01085

Ratcliffe, M. M., Merrigan, K. A., Rogers, B. L., & Goldberg, J. P. (2011). The effects of school garden experiences on middle school-aged students' knowledge, attitudes, and behaviors associated with vegetable consumption. *Health Promotion Practice*, *12*(1), 36–43. https://doi.org/10.1177/1524839909349182

Roberts, T. G., Harder, A., & Brashears, M. T. (2016). *American Association for Agricultural Education National Research Agenda 2016-2020*. http://www.foodandagpolicy.org/sites/default/files/AGree_Food and Ag Ed in the US.pdf

Rotz, S., & Fraser, E. D. G. (2015). Resilience and the industrial food system: analyzing the impacts of agricultural industrialization on food system vulnerability. *Journal of Environmental Studies and Sciences*, *5*(3), 459–473. https://doi.org/10.1007/s13412-015-0277-1

Sage, C. (2014). The transition movement and food sovereignty: From local resilience to global

engagement in food system transformation. *Journal of Consumer Culture*, *14*(2), 254–275. https://doi.org/10.1177/1469540514526281

Selfa, T., & Qazi, J. (2005). Place, taste, or face-to-face? Understanding producer-consumer networks in "local" food systems in Washington State. *Agriculture and Human Values*, *22*(4), 451–464. https://doi.org/10.1007/s10460-005-3401-0

Seyfang, G. (2006). Ecological citizenship and sustainable consumption: Examining local organic food networks. *Journal of Rural Studies*, *22*(4), 383–395. https://doi.org/10.1016/j.jrurstud.2006.01.003

Sheppard, R. (2015). Food literacy: Definition and framework for action. *Canadian Journal of Dietary Practice and Research*, *76*(3), 140–146. https://doi.org/10.3148/cjdpr-2015-010

Smeds, P., Jeronen, E., & Kurppa, S. (2015). Farm education and the value of learning in an authentic learning environment. *International Journal of Environmental and Science Education*, *10*(3), 381–404. https://doi.org/10.12973/ijese.2015.251a

Specht, A. R., Mckim, B. R., & Rutherford, T. (2014). A little learning is dangerous: The influence of agricultural literacy and experience on young people's perceptions of agricultural imagery. *Journal of Applied Communications*, *98*(3), 63–73. https://doi.org/10.4148/1051-0834.1086

Spielmaker, D. M., & Leising, J. G. (2013). *National agricultural literacy outcomes*. http://agclassroom.org/teacher/matrix

Spielmaker, D. M., Pastor, M., & Stewardson, D. M. (2014). A logic model for agricultural literacy programming. *41st Annual Meeting of the American Association for Agricultural Education*, 1–2. http://www.aaaeonline.org/uploads/allconferences/5-8-2014_148_2014_AAAE_Poster_Proceedings.pdf

Stevenson, K. T., Peterson, M. N., Bondell, H. D., Moore, S. E., & Carrier, S. J. (2014). Overcoming skepticism with education: interacting influences of worldview and climate change knowledge on perceived climate change risk among adolescents. *Climatic Change*, *126*(3–4), 293–304. https://doi.org/10.1007/s10584-014-1228-7

Szczytko, R., Stevenson, K., Peterson, M. N., Nietfeld, J., & Strnad, R. L. (2018). Development and validation of the environmental literacy instrument for adolescents. *Environmental Education Research*, *4622*, 1–18. https://doi.org/10.1080/13504622.2018.1487035

Tilman, D., Balzer, C., Hill, J., & Befort, B. L. (2011). Global food demand and the sustainable intensification of agriculture. *Proc. Natl Acad. Sci. (PNAS) USA*, *108*(50), 20260–20264. https://doi.org/10.1073/pnas.1116437108

Tilman, D., Cassman, K. G., Matson, P. A., Naylor, R., & Polasky, S. (2002). Agricultural sustainability and intensive production practices. *Nature*, *418*, 671–677. https://doi.org/10.1038/nature01014

Trexler, C. J. (2013). What the cheeseburger studies help us understand about teaching for agricultural literacy. *The Agricultural Education Magazine*, *85*(6), 6.

Trexler, C. J., & Heinze, K. L. (2001). Prospective elementary teacher understandings of pest-related science and agricultural education benchmarks. *Journal of Agricultural Education*, *42*(1), 82–95. https://doi.org/10.5032/jae.2001.01082

Vaitkeviciute, R., Ball, L. E., & Harris, N. (2014). The relationship between food literacy and dietary intake in adolescents: A systematic review. *Public Health Nutrition*, *18*(4), 649–658. https://doi.org/10.1017/S1368980014000962

Vallera, F. L., & Bodzin, A. M. (2016). Knowledge, skills, or attitudes/beliefs: The contexts of

agricultural literacy in upper-elementary science curricula. *Journal of Agricultural Education*, *57*(4), 101–117.

van Schuur, W. H. (2003). Mokken scale analysis: Between the Guttman scale and parametric Item Response Theory. *Political Analysis*, *11*, 139–163. https://doi.org/10.1093/pan/mpg002

Appendix A. ALI-LF

Farming Literacy Survey
Student's Pre-visit

INSTRUCTIONS:	*For each question, choose the **single best answer**.*
	Read each question and answer carefully before making your choice.

Please write your initials: _____and Your birth date (mm/dd): _____ /_____

WHAT DO YOU KNOW ABOUT FARMING?

1. How do plants use soil?

A. To store food
B. To provide nutrients
C. To conduct photosynthesis
D. To attract sunlight

2. Which of the following do farmers manage?

A. Rainfall B. Temperature C. Soil
D. Uranium

3. What has reduced the manual labor requirements for agriculture?

A. More workers
B. Smaller farms
C. Tractors
D. Politics

4. Match the following foods with the plant or animal it came from on the farm:

___ Tortilla chips
A. Tomatoes

___ Ketchup
B. Wheat

___ Yogurt
C. Corn

___ Cake
D. Cows

5. Crops get their energy from the:

A. Soil B. Earth C. Sun D. Air

6. The types of crops that can be grown in a certain region depends on:

A. Rainfall B. Soil type C. Temperature D. All of these

7. Match the following agricultural products with the season in which they are harvested on

___ Sweet corn
___ Pears
___ Strawberries
___ Pecans

A. Spring
B. Summer
C. Winter
D. Fall

8. Imagine North Carolina had a very hot summer with very little rainfall. The soils are very dry.

How could these conditions affect crops grown in North Carolina compared with last year?

A. More crops would survive because they had more sunlight.
B. Fewer crops would survive because they had less water.
C. More crops would survive because they had less water.
D. Fewer crops would survive because they had more sunlight.

9. Why are there more peaches available during the summer than during the winter in North Carolina?

A. Because peaches are planted in the summer.
B. Because peaches are harvested in the summer.
C. Because peaches are imported from North Dakota in the summer.
D. Because peaches are good to eat in the summer.

10. Below is a list of paired food items. For each pair circle the food that is *more likely* to support a farmer in North Carolina. (Choose ONE item per box)

Apples OR Oranges	Peanuts OR Almonds
Bison hamburger OR Pulled pork sandwich	Peaches OR Cherries

HOW DO YOU FEEL ABOUT FARMING?

11. How much do you agree or disagree with each statement?	**Strongly Disagree** 👎👎	**Disagree** 👎	**Not Sure** ?	**Agree** 👍	**Strongly Agree** 👍👍
Foods grown by local farmers are good for the environment.	❒	❒	❒	❒	❒
Foods grown by local farmers taste good.	❒	❒	❒	❒	❒
Foods grown by local farmers are fresh.	❒	❒	❒	❒	❒
Buying foods grown by local farmers supports my community.	❒	❒	❒	❒	❒

WHAT DO YOU DO?

NOTE: We know families come in lots of forms. When we talk about your 'parent' below we mean your biological, foster, or adoptive parent or parents, or guardians of any form.

12. How likely are you to do the following?	**Very Unlikely** 👎👎	**Unlikely** 👎	**Not Sure** ?	**Likely** 👍	**Very Likely** 👍👍

Ask my parent to buy foods advertised as grown in North Carolina.	❒	❒	❒	❒	❒
Ask my parent to buy foods with the "GotToBeNC" label.	❒	❒	❒	❒	❒
Ask my parent to buy foods advertised as "grown by local farmers."	❒	❒	❒	❒	❒
Ask my parent to buy food at the farmers market.	❒	❒	❒	❒	❒
Ask my parent to take me to farms so we can pick our own produce.	❒	❒	❒	❒	❒
Look at food labels to see where food comes from.	❒	❒	❒	❒	❒
Talk to adults other than my parent about supporting local farmers.	❒	❒	❒	❒	❒

ABOUT YOU

13. How old are you? _____ years.

14. Which of the following best describes your gender?

❒ Male ❒ Female ❒ Other

15. Which of the following best describes your race/ethnicity? *(Check all that apply).*

❒ Native American *(ex: Cherokee, Lumbee)*
❒ Latin *(ex: Hispanic, Mexican, Salvadoran)*
❒ Asian *(ex: Indian, Vietnamese, Chinese)*
❒ White *(ex: German, Irish)*
❒ African American *(ex: Haitian, Black, Kenyan)*
❒ Other. Specify: _____

Thank You Very Much!