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A Qualitative Study of Agricultural Literacy in Urban Youth: What Do Elementary Students Understand about the Agri–food System?

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Agricultural literacy of K–12 students is a national priority for both scientific and agricultural education professional organizations. Development of curricula to address this priority has not been informed by research on what K–12 students understand about the agri–food system. While students' knowledge of food and fiber system facts have been studied, in–depth research into broader student understandings of the system have largely been ignored. This study employed semi–structured interviews to compare urban elementary students' understandings with nationally developed benchmarks for agri–food system literacy. Findings indicate that no participant had ever grown their own food, raised a plant, or cared for an animal. Participation in school fieldtrips to farms or a visit to a relative's garden were the most frequently mentioned agricultural experience. Participants could readily name common food items, but could not accurately elaborate on the origins of common foods. Post–production activities, like food processing, were not well understood. Students' agriculturally related experiences did not appear to influence their understanding about where food comes from or what happens to food as it travels from farm to plate.

Keywords: agriculture literacy, elementary, food and fiber literacy

Introduction and Theoretical Framework

The need for agricultural literacy has been established over the past two decades. Increasingly, society will be faced with issues at the social, economic and political interface of agriculture, which will require some basic literacy of the human designed agri–food system. Educators and researchers have contended that agricultural literacy requires one to possess an *understanding* of (Frick, Kahler, & Miller, 1991; Trexler & Hess, 2004) and the ability to engage in conversations about the agri–food system (National Council for Agricultural Education, 1999). The bulk of agricultural literacy research, however, has relied on survey methods primarily focused on determining what discrete pieces of knowledge people possess about the agri–food system (Knobloch & Martin, 2000; Pense, Leising, Portillo, & Igo, 2005; Reidel, Wilson, Flowers, & Moore, 2007). Although this was a reasonable place to begin agricultural literacy research, ascertaining basic knowledge may fall short in serving the profession's priorities, because both the definition and goals for agricultural literacy have evolved since the late 1980s when agricultural literacy was brought to national attention with the publication of *Understanding Agriculture: New Directions for Education* (National Research Council, 1988). As part of this evolution, agricultural education researchers have begun to focus more on helping to foster the public's ability to make informed decisions about agriculturally related issues.

In 2005, six national agricultural education organizations collaborated to develop the *National Research Agenda: Agricultural Education and Communication Research Priority Areas and Initiatives for 2007–2010* (Osborne, 2007). The report called for research to aid the public in effectively participating in decision–making related to agriculture. The report also called for participation from various societies, such as those involved in other sciences.

To address the *new goals* for agricultural literacy, the profession may profit from looking for models from other education disciplines seldom incorporated into agricultural education research. For example, science education researchers (Hewson, 1981; Posner, Strike, Hewson & Gertzog, 1982; Clough & Driver, 1986) have been focused on determining what people "understand" about foundational science concepts since the early 1980s. Much of this research was based on constructivist theory and its attendant research methods to unearth schemata of individuals necessary for science literacy.

Much of science education research is built upon the work of cognitive psychologists Piaget (1950) and Ausubel (1963) who theorized that learning is the integration of new perceptions and ideas into existing conceptual frameworks called *schemata*. Schemata represent the mental patterns (or complex mental organizers) of interconnected information individuals' hold about a topic. Schemata are constructed, deconstructed, and reconstructed in the mind of the individual. Learning (development of new knowledge and ideas) occurs when individuals reconstruct their schemata (Bereiter, 1994; Moll, 1990). As an individual engages with new information, his or her perceptions are compared to existing schemata. As result of this engagement, an individual constructs new, expanded, or reinforced schemata, which may transform existing schemata into new knowledge and understanding.

Public school curricula often focus on student development of conceptual understanding across a variety of disciplines. Because learning occurs when students' schema is transformed, educators need to know what commonly held perceptions learners have prior to teaching. Gleaning insight into commonly held conceptions of students is not new to educational research. In the 1980s, science education researchers ascertained student conceptions through interview techniques (Driver, Guesne, & Tiberghien, 1985; Posner & Gertzog, 1982) and then compared these conceptions with experts as a way to gauge understanding of concepts. By comparing the schema of small groups of students, these qualitative researchers identified commonly held naive or misconceptions that hindered the construction of new schema that more closely resembled expert conceptions (Glynn, Yeany, & Britton, 1991).

This theory and line of research has direct implications for agricultural education, because researchers presently know little about the idiosyncratic schema that constitute agri–food system literacy. This study closely examines elementary students' schema for science and agricultural education benchmarks focused on (a) common foods, (b) food origins, and (c) the journey food travels from farm to consumer. Few studies in agricultural education (Meischen & Trexler; 2003; Trexler, 2000) have explored these topics with an eye on elementary student understanding and their ability to converse orally about their ideas. Because past studies were few in number and used qualitative methods that are not generalizable, similar studies, like this one, are required to flesh out what people understand about the agri–food system. Further, insights gleaned from this study will contribute to meeting the current definition of and new goals for agricultural literacy.

Purpose and Objectives

The purpose of this qualitative study was to explore elementary students' understandings of agri–food system concepts, which were written as national standards for both agricultural and science education. The study's three objectives were to: (a) determine informants' backgrounds and agriculture experiences, (b) compare informant understandings of agriculture to expert conceptions of grade–specific benchmarks and benchmark subconcepts for agriculture literacy from science and agriculture frameworks, and (c) ascertain if themes or commonalties existed among informants' backgrounds, experiences, and understandings of the food system.

Methods and Procedures

The population for this study included 18 informants from urban southern California. Upper elementary (grades 4 through 6) students were selected because they had reasonably well–developed language skills and were the same age as informants in similar studies on this topic.

Individual students were selected based on gender, ethnicity, location, and type of residence to complement previous studies and reflect demographics of this study's local urban schools. This was accomplished by working with the Boys and Girls Club of Long Beach, California. The program's director recruited ten and eleven year old volunteers from the club's summer program. Compensation of $300 was provided to the Boys and Girls Club for the benefit of all members. No participant received any direct compensation. Letters explaining the study's purpose and parental consent forms were sent home by the summer program director. All participants came to the interviews with signed parental consent forms and were read an age appropriate explanation of the interview protocol. The University of California, Davis Institutional Review Board approved this study.

Interview Protocol

Semi–structured interviews were used to elicit informant agri–food system understandings and identify states of cognitive (schema) development (Novack & Gowin, 1984). Interviews were 45 minutes in length and were digitally recorded. Audio files were transcribed, serving as the primary data source. After interviews, field notes were read back to confirm salient points, thereby insuring dependability of data. If participants did not think the field notes accurately represented their ideas, modifications were made. Field notes were analyzed as secondary data.

The interview protocol was developed based on Trexler's (2000) synthesis of AAAS's (1993) *Project 2061 Benchmarks for Science Literacy* and *A Guide to Food and Fiber Systems Literacy Framework* (Leising, 1998). First, students were asked to dissect a cheeseburger from a nationally known restaurant chain and place components into groups that were logical to them. Second, participants were asked to identify components and provide an explanation of their groupings. As participants identified components and explained the logic behind their groupings, probing questions were asked to explore understandings of K–5 grade–level benchmarks. Because agri–food system understandings require students to make connections between and across a broad number of topics, subsequent open–ended questions were formulated based on students' initial responses. In other words, interviews were framed by the benchmarks, but guided by students' responses that were based on their personal schema for the agri–food system.

Analysis of Data

To promote trustworthiness of results, researchers employed established qualitative methods. First, to bring forth potential biases, we were both high school agriculture teachers and are now currently agriculture teacher educators with particular interest in agricultural literacy. Second, credibility was enhanced through peer debriefings and independent coder review throughout the study (Guba & Lincoln, 1989). Third, to address the issues of dependability and confirmability, we relied on independent audits of research methods and interpretations by three other qualitative researchers (Creswell, 2009). Finally to promote transferability, we provided descriptive detail to allow others to decide if this study's findings are applicable to other cases.

Analysis of data involved four phases. In phase one, expert propositions for the agri–food system and related subconcepts were developed and were validated by experts from science and agricultural education. Expert propositions were used as goal statements for comparative analysis with informants.

In the second phase, interview responses were translated into representational propositions. Interview transcripts and investigator notes were used to write representations of informant propositions. Peer review processes were used to confirm the accuracy and trustworthiness of informant propositional statements. An expert was asked to randomly select any two propositional statements, listen to recorded interviews, and read propositional statements prepared from the interviews. Validation of propositional statements required 100% agreement of codings between the researchers and the external expert. If 100% agreement was not met, data were reviewed again, revisions made, and the process repeated until agreement was met.

The third phase focused on coding informant responses. Sophistication of informant thinking about a given goal's conception was judged for each benchmark along two dimensions: quality (compatibility) and depth (elaboration of response) in comparison to the expert proposition. Informant understandings were assigned codes based on this bimodal coding scheme (Yin, 2009). Table 1 presents the bimodal coding scheme used to determine the compatibility of informants' responses with the expert propositions.

Table 1
Coding Scheme for Comparing Informant Propositions to the Expert's

Code	Description
Compatible elaborate (CE)	Statement concurs with the expert's proposition and has sufficient detail to show the thinking behind the concepts articulated
Compatible sketchy (CS)	Statement concurs with expert proposition, but essential details are missing; bits and pieces of facts are articulated but are not synthesized into a coherent whole
Compatible/incompatible (CI)	Sketchy statements are made that concur with the proposition but are not elaborated on; at times, statements contradict proposition
Incompatible sketchy (IS)	Statements disagree with the proposition but provide few details and are not reoccurring; responses appear to be simply guesses
Incompatible elaborate (IE)	Statements disagree with proposition and informants provide details or coherent, personal logic supporting them; same or similar statements/explanations recur throughout the conversation
Nonexistent (N)	Informant responds "I don't know" or does not mention the topic when asked a question calling for its use
No evidence (Ø)	Topic was not directly addressed by a question and the informant did not mention it within the context of a response to any question

Informant responses were also coded numerically based on a comparison of responses to the underlying benchmark subconcepts. To ensure trustworthiness and credibility of coding, another researcher coded the sub–concepts independently. Intercoder reliability was set *a priori* at a correlation coefficient of (r = .90), with actual coefficients above (r = .93).

The final phase of analysis sought evidence of patterns among individuals. First, benchmarks were analyzed across individuals. Second, portraits of informant thinking were analyzed to ascertain how understandings influenced understanding of other concepts and, ultimately, the goal conception. The last step used the constant comparative method to analyze patterns developed across and between participants' responses to flesh out specific commonalities (Glaser & Strauss, 1999).

Findings

By questioning informants about their personal background and food and agriculture experiences, researchers met Research Objective One.

Research Objective One: Informants' Backgrounds and Experiences

Background. Race, gender, age, and grade–level demographic data were collected for the 18 informants. Gender and race were determined by visual observation. Ten of the informants were girls and eight were boys. One female informant was Hispanic, whereas the other nine girls were African American. One male informant was Caucasian and the other seven boys were African American. Ages ranged from 10 to 12 years. Informants were enrolled in public elementary schools with traditional academic–year calendars. Nine informants were entering the sixth grade. Eight informants were entering the fifth grade. The last informant was entering the fourth grade but was the same age as the average for informants entering fifth grade. All informants were raised in a major metropolitan area of California.

Agricultural experiences. During the interviews, informants were asked to describe where parts of a cheeseburger originated. Informants were then asked if they had ever been to a place similar to what they stated. For example, some informants said that a tomato came from a garden. As a result, conversations turned to their experiences with gardens. The information gleaned was used to determine informants' agricultural experience(s).

School field trips to farms and experiences related to visiting a relative's garden were the agricultural experiences most frequently mentioned. Of the group, eight informants went on a field trip to a farm, and seven had firsthand experiences in a relative's garden. Three informants discussed vacations to their grandparents' family farm. One informant noted a visit to an aunt's dirt farm, where the aunt kept a horse. One informant discussed a school–site presentation where a mobile dairy education facilitator conducted milking demonstrations. No informant grew plants or raised animals. Three informants had no agricultural experiences.

Research Objective Two: Comparison of Informants' Understandings with Expert Conceptions and Grade–Specific Benchmarks

The concept "what is agriculture?" framed the study. The two agriculture benchmarks included in this concept were: (a) identify common food products and their origin and (b) describe the journey food travels from farm to consumer. To elicit conversation and probe the depth of understanding of Benchmark One, informants were asked to perform three tasks: (a) identify the cheeseburger's seven components, (b) state if each component originated from a plant or an animal, and (c) describe the agricultural crop that produced the components.

Benchmark One: Identify common food products and their origin.

Benchmark One included the following:

Identify the cheeseburger's seven components. Informants were asked to dissect the cheeseburger and name each component. Cheeseburger components were identified correctly 97% of the time. Fourteen informants (78%) correctly named all seven components, whereas four (22%) correctly named six of the seven components.

State if the component originated from a plant or an animal. Informants correctly stated which of the cheeseburger's components came from a plant or an animal 80% of the time. Five informants (28%) correctly identified all seven components' origins, while the same number correctly stated six. Four informants (22%) correctly stated the origin of five components. Four informants correctly stated the origin of four of the seven components. Informants had the most difficulty identifying the origin of the bun, with 28% correctly indicating that the bun came from a plant. Of those unable to identify the bun's origin, four said they were not sure or didn't know, while nine stated that the bun came from an animal. Table 2 shows the number and percentage correctly stating each component's origin.

Table 2
Number and Percentage of Informants Correctly Stating Cheeseburger Origin

Cheeseburger component	Component origin	Number of informants correctly stating origin (%)
Meat patty	Animal	17 (94)
Lettuce	Plant	17 (94)
Cheese	Animal	16 (90)
Pickle	Plant	16 (90)
Tomato	Plant	16 (90)
Onion	Plant	14 (78)
Bun	Plant	5 (28)

Describe the agricultural crop that produced each cheeseburger component. Informants were asked to identify the plant or animal that produced each cheeseburger component. Table 3 presents data for each cheeseburger component based on the number and percentage of informants accurately describing the item's origin. The origin of cheese was described accurately by the greatest number, while the meat patty and tomato were described accurately by roughly half of the informants. The five remaining items were accurately described by less than half of the participants. Informants described an agricultural crop origin for the bun and pickle on the fewest occasions.

Table 3
Number and Percentage of Informants Correctly Describing Common Food Origins

Cheeseburger component	Component origin	Number of informants correctly describing origin (%)
Cheese	Cow's milk	13 (72)
Meat patty	Beef animal	10 (56)
Tomato	Tomato plant	9 (50)
Lettuce	Lettuce plant	8 (44)
Onion	Bulb onion plant	7 (39)
Bun	Flour/wheat plant	5 (28)
Pickle	Cucumber bush	4 (22)

To gauge sophistication of individual understanding, informants were asked to describe the cheeseburger components' origins in greater details. Informant responses were reviewed for language that addressed the morphology, taxonomy, or cultural practice of crops that produced the cheeseburger's components. Informant language was compared to the language used in the expert proposition. Informant propositions were then coded based on a comparison to the expert proposition using the bimodal coding scheme, with a superscript number added to represent the total number of subconcepts addressed. The subconcepts for this benchmark were aligned with each cheeseburger component to assist in data collection. Table 4 presents informant coding for identification of common food items and description of crop origins.

Table 4
Coding for Identifying Common Food Items and Describing Agricultural Crop Origins

	Informant								
	Virginia Victor Parker	LeMarr	Trisha	Montie	Alicia Paul Nancy	Delaine Sandi Denise	Logan Greg Art Lilly	Lynn	Suzanne
Coding[a]	CE^7	CS^5	CI^3	IS^4	IS^3	IS^2	IS^1	IE^4	N^0

a. The superscript numeral equals the total number of subconcepts addressed by informants.

Virginia, Victor, and Parker, representing 17% of informants, were coded *compatible elaborate* (CE) when compared to the expert proposition because they accurately identified the food products and elaborately described the origins. LeMarr was coded as *compatible sketchy* (CS) because he was unable to describe the origin of the pickle and onion yet accurately described and elaborated on the origin for each of the other five items. Trisha was coded *compatible incompatible* (CI) because she could name the components of the cheeseburger (four of seven) but did not provide accurate descriptions that were aligned with the expert conception for the origin of the onion, cheese, and beef patty. Most informants (61%) were coded *incompatible sketchy* (IS), because, although these informants could identify most of the cheeseburger's components and plant or animal derivations, their explanations were neither compatible nor elaborate in comparison to the expert proposition. IS informants also provided inaccurate statements or what appeared to be guesses (e.g., Logan inaccurately described horses found at racetracks as the source of bread and chicken, while Montie guessed that the meat patty came from a pig).

Suzanne was coded *nonexistent* (N) because she said she was not sure or did not know when asked about the agricultural crop for each cheeseburger component. Lynn was coded *incompatible elaborate* (IE) because she gave inaccurate and elaborate descriptions about the origins of the pickle, meat patty, and bun. The following excerpt exemplifies Lynn's comments:

INTERVIEWER (I): OK, how about the pickles, [you said] they come from lions and tigers or was it lions? [Shook head affirmatively] OK, how do we get those [pickles] from lions and tigers?

LYNN (L): My granny just told me that when she was little girl, her mom used to go get lions and used to go hunt lions and tigers because they used to live by them and they used to cut them and they used to cut the pickles with [from] them.

I: Oh, OK, and how about the bread?

L: Well, my mommy told me that the bread comes from an animal. But I don't know what animal. She just said it comes from an animal.

Benchmark Two: Describe food's journey as it travels from farm to consumer.

This section focuses on the journey of food products travel on their way to consumption by humans. Holistic views of informants' benchmark understandings are presented in Table 5. Informants' descriptions, fleshed out through benchmark–related discourse, were coded with the bimodal coding and numeric subconcept superscript. The expert's proposition emphasized specific transportation concepts required to be present in benchmark descriptions for demonstrating the desired understanding of "what is agriculture?"

Table 5
Informant Coding for Understanding of the Journey Food Travels From Farm to Consumer

	Informant							
	Montie	Victor	Art	Sandi	Paul Denise Lynn Nancy Lilly LeMarr Trisha	Delaine Greg	Parker Virginia	Logan Suzanne Alicia
Codings[a]	CS^7	CS^6	CS^5	CI^5	CI^4	CI^3	IS^3	N^2

a. The superscript numeral equals the total number of subconcepts addressed by the informant.

To focus on food's journey from farm to the consumer, informants were asked how food gets to their dinner plates. Questions were structured in this way to assist in drawing on informants' direct experience with food. Informants needed to describe eating food using language that conveyed an understanding that the food they consumed originated elsewhere in a different form. All informants said they ate food. Seventeen informants (94%) traced the food they consumed to a farm or point of production (garden), but descriptions were lacking.

Three informants, Alicia, Suzanne, and Logan, provided language that, on the surface, aligned with a few subconcepts but did not convey a cogent understanding that food was produced, transported, and transformed. While surface–level language existed that related to two subconcepts, the three informants were coded N because their responses lacked a coherent connection to the benchmark as a whole. Two of eighteen informants (11%), Virginia and Parker, were coded IS because their responses disagreed with the expert proposition and also included what appeared to be guesses.

Ten informants (56%) were coded CI because their responses included both compatible and incompatible statements in comparison with the expert proposition. Denise, for example, provided both compatible and incompatible statements by saying that meat and milk come from farms, but vegetables, like the tomato, come from the store:

INTERVIEWER (I): Why do we have farms?

DENISE (D): So we so we can have lots of food and stuff to drink.

I: Lots of food and stuff to drink. And what do we get to drink that's from the farm?

D: What do we get? We get milk.

I: What kind of food do we get from the farm?

D: We get meat and chicken wings and pig feet.

I: Where do you think they grow tomatoes?

D: In the backyard.

I: So you think Jack in the Box got their tomato from someone's backyard?

D: No.

I: Where do you think they got it?

D: The store.

I: From the store, OK. Where do you think the store got it?

D: I'm not sure.

The remaining three informants (17%), Victor, Montie, and Art, were coded CS because their statements concurred with the expert proposition, but essential elements or subconcepts were missing. Victor's, Montie's, and Art's responses lacked sufficient detail to support a coherent picture of the entire journey.

Research Objective Three: Ascertain Themes or Commonalties Among Informants With Regard to Their Backgrounds, Experiences, and Understandings of the Agri–food System

The third research objective was met by analyzing data across and between the informant group and the benchmarks. Commonalities among the informants were (a) their African American origins (only one informant was Caucasian and one was Latino), (b) their ages, at approximately 10–12 years, and (c) their non–agricultural background and limited experiences. The patterns and commonalities found are presented by benchmark in the following paragraphs.

Benchmark One: Identify common food products and their origin. Benchmark One required informants to (a) identify, by name, common food items that comprised a cheeseburger; (b) state whether each cheeseburger component came from a plant or animal; and (c) describe, with a discernable level of detail, the crops from which the cheeseburger's components were derived. All informants demonstrated enough knowledge to identify common food items. With the exception of the bun, most informants accurately identified foods as coming from plants or animals. On a deeper and more complex level, most informants (72%) held misconceptions or lacked conceptions about the origin of some common foods. Informants with misconceptions inaccurately identified the animal from which specific meat products were derived (e.g., hamburgers came from pigs) or believed that some plant–based food products came from animals. In other cases, particularly those informants coded as either IS or CS, essential knowledge and understanding were missing. Informants lacked detailed knowledge and understanding of specific agricultural crops (e.g., taxonomy, morphology, or cultural practices) that prevented them from discussing connections with food items in more than a superficial way.

Benchmark Two: Describe the journey food travels from farm to consumer. Thirteen informants (72%) were compatible with some aspect of the expert proposition regarding food's journey. Ten were coded CI and made sketchy statements that concurred with the proposition but were not elaborated upon. Generally, this group did not discuss the journey food takes between the point of production and the point of consumption with depth and/or complexity.

All informants understood that people *consume* food at restaurants or at home and 94% knew that food was *produced* on a farm or in a garden. Most informants (89%) used language that conveyed an understanding of the concept of distribution but did not use terms like *distribution, commerce, wholesale*, or *retail*. The majority talked about food being *transported* from one point to the next by cars or trucks, but other modes of transportation were neglected. Most informants (83%) failed to discuss factories and locations where food was *manufactured*. No informant addressed the subconcepts *processing* and *marketing*.

Conclusions

This study found the following: (a) agricultural experiences of the urban youths did not appear to influence schema development related to where food originates or what happens to food as it travels from farm to plate; and (b) informants held inaccurate schemata and lacked the schemata necessary for entering into discourse about agricultural crops and postproduction activities leading to consumption. A more detailed account is provided below.

The informant group was urban, with no traditional agricultural background. No informant grew plants or raised an animal. A unique feature was the large number of informants having agricultural experiences related to a school–based farm field trip or a home–based interaction in a relative's garden. These particular informants were able to speak vividly about their personal experiences, but data did not suggest that the experiences altered their discourse on benchmarks in comparison to the expert propositions. Informants, with or without unique agricultural experiences, shared the same levels of compatibility to the expert propositions for Benchmark One, *to identify common food products and their origins*, and Benchmark Two, *to describe the journey food has as it travels from farm to consumer*.

In similar research, Trexler (2000) explored fifth–grade students' thinking about three pest–related science benchmarks and concluded that agricultural experiences were the strongest determinant in promoting discourse most compatible with agri–food system experts and that urban, non–gardening students appeared to lack a schema for pest–related benchmarks. The informants in this study appeared to align with the non–gardening urban students from Trexler's study because they generally lacked schemata. They did not appear to align with those having deeper and more personally meaningful agricultural experiences (gardening). The nature of the agriculture–related experiences appears to be a plausible reason for the difference between this and Trexler's study. Informants in this study were tourists in their experience (they had not grown a plant or raised an animal), whereas students in Trexler's study were full participants in their experiences (they grew plants). Some experiences, then, are more fruitful in promoting schema formation and, in this study, informants' experiences were not robust enough to develop schema needed to articulate an understanding of agri–food system benchmarks.

Benchmark One focused on informants' understanding of common food items and their origins. Informants easily identified common food items and identified common agricultural crops. They also knew that food came from plants and animals. This supports Trexler's (2000) findings that elementary students know that food comes from plants and animals. This also supports Meischen and Trexler's (2003) findings that students know that meat products come from animals, but not necessarily what animal. A familiar thread gleaned from these past studies, and supported by this study, is that fifth grade children appear to hold basic schemata about the names of common foods, know food comes from plants or animals, and grows on farms or in gardens.

Informants in this study lacked accurate schemata to engage in benchmark–compatible discourse that described agricultural crop origins (geographic locations). In addition, most informants held misconceptions that were in stark contrast to the expert conception. This was especially true when describing the origins of the cheeseburger's bun (wheat) and pickle (cucumber). These processed food items presented the greatest area of difficulty for the group. Informants lacked a basic understanding of food processing, manufacturing, and marketing.

Implications

Although the results of this study are not generalizable in the quantitative sense, they are transferable in the qualitative paradigm if the contexts of the comparison are similar (Guba & Lincoln, 1989). All informants recalled the names of common foods in raw form and most knew foods were grown on farms or in gardens. They did not, however, possess schema necessary to articulate an understanding of post–production activities nor the agricultural crop origin of common foods. In other words, basic knowledge was present, but gaps in schema were evident that inhibited discourse about more complex, and to these students, foreign, agri–food system concepts. As clearly articulated in the introduction of this paper, because understanding and the ability to engage in discourse are the ultimate goals for agricultural literacy (Frick, Kahler, & Miller, 1991; Trexler & Hess, 2004), the profession would be well advised to use schema theory and its attendant research methods to unearth what elementary students understand about the complex system called agriculture.

Though a connection to learning theory is apparent, some may question the importance of determining what students know about the names of common foods and their origins, or even if it's important for them to understand agriculture as part of their daily lives. However, both science and agriculture educators believe this knowledge and understanding is important and developed national education benchmarks for K–12 students to achieve. While this study primarily seeks to gauge elementary student understandings of benchmarks, the underlying implications for society clearly become evident.

Knowledge of the system, even at foundational level in the elementary grades, is needed to build a sophisticated understanding that enables an individual to make informed decisions about resource allocation and the sustainability of the food system. For example, the *local* and *slow food* movements are gaining acceptability. Those who seek to eat more locally often do so based on a sophisticated understanding of the trade–offs inherent in choices made related to seasonal availability, varietal shelf–life, burning fossil fuel to transport, air and water pollution related to production and manufacturing processes, promoting local economies, etc. Without exploring the foundations of agri–food system knowledge at the elementary grade level, educators cannot understand what basic knowledge and understandings held by youth need to be addressed (schema theory) to develop the sophisticated understanding needed by adults to make informed and well–reasoned choices.

In terms of future research, both AAAS Benchmarks (AAAS, 2009) and the Guide to FFSL (Leising, 1998) call for K–3 students to understand: (a) foods often travel long distances once they are produced on farms and (b) human designed technologies that transform foods prior to consumption (e.g., processing and manufacturing). This study points to the fact that students do not possess the requisite language, nor schema for these concepts. Next steps are to more systematically focus research on these two concepts to determine where gaps exist between students' accurate schema about food production and their underdeveloped schema for post–production transformations. With this research in hand, it would be possible to design curricula and plan intentional learning experiences that would help learners develop and modify schema that is aligned with desired science and agricultural education learning benchmarks.

References

American Association for the Advancment of Science. (1993). *Benchmarks for science literacy*. New York, NY: Oxfod University Press.

American Association for the Advancment of Science. (2009). *Benchmarks for science literacy*. New York, NY: Oxfod University Press. Retrieved from http://www.project2061.org/publications/bsl/online/index.php?chapter=8#A2

Ausubel, D. P. (1963). *The psychology of meaningful verbal learning*. New York, NY: Grune and Stratton.

Bereiter, C. (1994). Constructivism, socioculturalism, and Popper's world 3. *Educational Researcher, 23*(7), 21–23. doi:10.2307/1176935

Clough, E. E., & Driver, R. (1986). A study of consistency in the use of students' conceptual frameworks across different task contexts. *Science Education 70*(4), 473–496. doi:10.1002/sce.3730700412

Creswell, J. (2009). *Research design: qualitative, quantitative, and mixed methods approaches*. Thousand Oaks, CA: Sage.

Driver, R., Guesne, E., & Tiberghien, A. (1985). *Children's ideas in science*. Buckingham, England: Open University Press.

Frick, M., Kahler, A., & Miller, W. (1991). A definition and the concepts of agricultural literacy. *Journal of Agricultural Education, 32*(2), 49–57. doi: 10.5032/jae.1991.02049

Glaser, B. G., & Strauss, A. L. (1999). *The discovery of grounded theory: Strategies for qualitative research.* Hawthorne, NY: Aldine de Gruyter.

Glynn, S. M., Yeany, R. H., & B. K. Britton (Eds.). (1991). *Psychology of learning science*. Hillsdale, NJ: Lawrence Erlbaum.

Guba, E., & Lincoln, Y. (1989). *Fourth generation evaluation.* Newbury Park, CA: Sage.

Hewson, P. (1981). A conceptual change approach to learning science. *International Journal of Science Education 3*(4), 383–396. doi:10.1080/0140528810304004

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

Leising, J. (1998). *A guide to food and fiber systems literacy*. Stillwater, OK: Oklahoma State University.

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

Moll, L. (1990). *Vygotsky and education: Instructional implications and applications of socio–historical psychology*. New York, NY: Cambridge University Press.

National Council for Agricultural Education. (1999). *Reinventing agricultural education for the year 2020: Creating the preferred future for agricultural education*. Alexandria, VA: W.K. Kellogg Foundation.

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

Novack, J., & Gowin, D. (1984). *Learning how to learn*. New York, NY: Cambridge University Press.

Osborne, E. W. (Ed.) (2007). *National research agenda: Agricultural education and communication, 2007–2010.* Gainesville, FL: University of Florida, Department of Agricultural Education and Communication.

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

Piaget, J. (1950). *Psychology of intelligence*. London, England: Routledge and Kegan Paul.

Posner, G. J., & Gertzog, W. A. (1982). The clinical interview and the measurement of conceptual change. *Science Education*, *66*(2), 195–209. doi:10.1002/sce.3730660206

Posner, G., Strike, K., Hewson, P., & Gertzog, W. (1982). Accommodation of a scientific conception: Toward a theory of conceptual change. *Science Education*, *66*(2), 221–227. doi:10.1002/sce.3730660207

Reidel, J., Wilson, E., Flowers, J., & Moore, G. (2007). A definition and the concepts of agricultural literacy. *Journal of Southern Agricultural Education Research*, *57*, 1–13.

Trexler, C. J. (2000). A qualitative study of urban and suburban elementary student understandings of pest–related science and agricultural education benchmarks. *Journal of Agricultural Education*, *41*(3), 89–102. doi: 10.5032/jae.2000.03089

Trexler, C. J., & Hess, A. J. (2004). 15 years of agricultural literacy research: Has the profession only focused on a particular picture of what it means to be literate? *Proceedings of the 23rd Annual Western Region Agricultural Education Research Conference*, 12–22.

Yin, R. K. (2009). *Case study research: Design and methods* (4th ed.). Thousand Oaks, CA: Sage.

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