RURAL ELEMENTARY STUDENTS' UNDERSTANDINGS OF SCIENCE AND AGRICULTURAL EDUCATION BENCHMARKS RELATED TO MEAT AND LIVESTOCK

Deanna L. Meischen, Graduate Assistant
Iowa State University
Cary J. Trexler, Assistant Professor
University of California, Davis

Abstract

Agricultural educators and agricultural industry leaders have called for a basic level of agricultural literacy for Americans of all ages. Benchmarks have been developed by science and agricultural educators for students at all levels regarding an understanding of meat and livestock concepts. This qualitative study sought to ascertain rural fifth grade students' cognitive structures about these concepts. Through interviews and concept mapping, student understandings were unearthed. This study found that students were aware that food products come from animals, but they were not as aware of other products that animals produce for human use. The students did not understand the size and scope of modern agriculture, but most had a very basic understanding of the process that meat travels from farm to consumer. The language these students used to describe the benchmarks was not the language experts deemed necessary. Although the students could describe the steps of the process, their discourse did not include "scientifically" acceptable terminology educators prescribed in national benchmarks for science and agricultural education.

Introduction

Literacy involves the mastery of language in both oral and written forms (Gee, 1990). Language, however, is more than simply vocabulary; it also embodies culturally based beliefs, values, and attitudes. As one becomes literate, he or she masters the ability to make judgments based on culturally based norms that reify or reshape the culture and its institutions. Agriculture is a culture unto itself.

The term "agricultural literacy" was coined by the National Research Council (NRC) in its 1988 report *Understanding Agriculture: New Directions for Education*. The report contended that an agriculturally literate person should understand many aspects of the food and fiber system, including "its history and current economic, social, and environmental significance" (National Research Council, 1988, p. 1). To further clarify the definition, Frick and Spotanski (1990), Frick, Kahler, and Miller (1991), and Russell, McCracken, and Miller (1990) also included an understanding of the production, processing, and marketing of agriculture products as components necessary for agricultural literacy.

The early definitions of agricultural literacy focused on identifying salient content but did not include an explanation of what literacy was and how agricultural literacy levels could be determined through discourse. The definition of literacy is constantly evolving as changes in society and cultures occur (Trexler, 2000a). The National Council on Agricultural Education's 1999 report *Reinventing Agricultural Education for the Year 2020* began to expand the definition of agricultural literacy by adding conversational literacy about agriculture as a goal. This was a laudable beginning; however, the new definition of literacy needs to include discourse and understanding within the culture of agriculture.

From the definition of science literacy in National Science Standards (National Research Council, 1996) and Gee's (1990) definition of literacy in relation to discourse, we offer an updated definition of agricultural literacy. This new definition merges both agriculture content and linguists' definition of literacy relative to culture. The following is suggested as an updated definition:

> Agricultural literacy entails knowledge and understanding of agriculturally related scientific and technologically-based concepts and processes required for personal decision making, participation in civic and cultural affairs, and economic productivity. At a minimum, if a person were literate about agriculture, food, fiber, and natural resource systems, he or she would be able to a) engage in social conversation, b) evaluate the validity of media, c) identify local, national, and international issues, and d) pose and evaluate arguments based on scientific evidence. Because agriculture is a unique culture, an understanding of beliefs and values inherent in agriculture should also be included in a definition of agricultural literacy so people can become engaged in the system.

In 1988, the NRC suggested that "beginning in kindergarten and continuing through twelfth grade, all students should receive some systematic instruction about agriculture" (p. 2). Producers also agreed that because "students are the consumers of tomorrow" it was important to educate them early (Messenger, 2001, p. 34). Currently most Americans, and particularly youth, have little understanding about agriculture and its significance in their lives and to the environment (Leising, 1998). Roper Starch Worldwide (2000) conducted a study commissioned by the Philip Morris Corporation and the American Farm Bureau Federation that indicated those directly involved with agriculture had miscalculated consumers' concerns about agricultural issues. Company leaders agreed that there was a lack of public education on agricultural topics and that the gaps in understanding must be identified.

Although there have been numerous studies on adults' understandings and perceptions, few studies have measured the level of agricultural literacy in elementary students. The American Association for the Advancement of Science (AAAS, 1993) acknowledged that its agriculture concepts were based on recommendations from technology teachers, not research. Trexler (2000b) found that elementary students have little understanding of the scope of agriculture in today's society and of how new technologies affect agriculture and the environment.

Typically, agricultural literacy efforts focused on urban and suburban areas. In a study that compared rural and urban adults, urban citizens lacked the most knowledge of agriculture, however, rural non-farm citizens also lagged behind their on-farm peers (Frick, Birkenholz, & Machtmes, 1995). Children living and going to school in rural areas (characterized by the U.S. Census Bureau as locations with a population of less than 2,500) may have no more ties to agriculture than urban youth. Messenger (2001) found there were no significant differences in perceptions of the pork industry between people living close to livestock areas and those in more urban environments. In 1990, only 7% of the rural population was living on farms (Albrecht & Albrecht, 1996). In other words, "rural" can no longer be directly associated with "farm."

This study's theoretical framework is based on Piaget's research on developmental psychology, which is considered a basis of constructivism. Piaget posited that the ideas of children are based on pre-conceived thoughts about how or why things are in a certain state (Gardner, 1991). Only when these knowledge structures, or schemas, are challenged does a child's understanding of the new information begin to occur (Piaget, 1975/1985). Changes in schema occur through a process called conceptual change (Posner, Strike, Hewson, & Gertzog, 1982). This process involves dissatisfaction with an

existing idea, intelligibility, plausibility, and fruitfulness of a new understanding (Dole & Sinatra, 1998; Posner et al., 1982; Thorley & Stofflett, 1996).

Based on constructivist theory, the initial role of the researcher or teacher is to assess students' prior knowledge structures so as to link new concepts to previous ones or to cause students' dissatisfaction with their current schema and begin the conceptual change process. If constructivist learning theory percepts are to be followed in agricultural education, then uncovering students' prior knowledge structures through a process of discourse analysis is a first step in the curriculum process. Agricultural educators (Trexler, 2000b; Trexler & Heinze, 2001) have begun to investigate student understanding. This study was designed to add to that body of knowledge in terms of livestock and meat concepts.

Purpose/Objectives

The purpose of this qualitative study was to determine rural elementary students' understandings of science and agricultural education benchmarks specifically related to meat and livestock concepts. The objectives of this study were to:

1. Determine students' backgrounds and experience with meat and livestock.
2. Compare students' understandings of science and agricultural education benchmarks related to meat and livestock with expert understandings.
3. Conclude if relationships existed between students' background and experiences and their understanding of the benchmarks.

Methods

Agricultural education researchers often rely on surveys to determine what people understand. There is, however, some question as to whether these types of quantitative measurements can ferret out what people understand (Lincoln, 1998). Lincoln (1998) argued that because "knowledge cannot be separated wholly from the context in which it was generated" (p. 17) alternative methods of research are needed. Because each person has his/her own unique understanding, qualitative research and in-depth inquiry are essential in grasping insight into an individual's cognitive structure.

Population

Seven students were selected for interviews from a rural Midwestern consolidated school. Of the purposefully selected students, four were girls and three were boys. Fifth grade students were selected because they possessed vocabulary necessary to converse clearly, and fell within the grade level range of the benchmarks. Students attending the school lived in several small towns that were separated by less than 15 miles of farmland. A larger city was located approximately 35 miles from the school building. Pseudonyms were used in the reporting of data.

Data Collection

Clinical interviewing allowed the researchers to ascertain in-depth understanding and was conversational rather than scripted. The interviews were structured so as to determine the nature and extent of an individual's knowledge by identifying the relevant conceptions held and the perceived relationships among those conceptions (Posner & Gertzog, 1982).

Students were interviewed twice. During the first interview a hamburger from a nationally known fast-food chain was used to initiate conversation (Anderson & Demetrius, 1993; Trexler & Heinze, 2001). Students were asked to draw and explain a concept map of their knowledge regarding the journey meat travels from its origin to consumer. The primary researcher presented a short lesson on concept mapping to assure students understood the process of construction. Interviews were audio taped and transcribed.

After the first interview, we coded transcripts and expanded the students' concept maps by adding additional information from the interview. A second interview then served as a member check and established credibility of the research

findings (Guba & Lincoln, 1989; Taylor & Bogdan, 1998).

Interview Questions

Interview questions were based on science and agricultural education benchmarks developed by Trexler (1999) from a synthesis of the Benchmarks for Science Literacy (AAAS, 1993) and the Food and Fiber System Literacy Framework (Leising, 1998). The benchmarks were designed for students from kindergarten to fifth grade with the exception of the by-products benchmark. Although this benchmark was designed for ninth through twelfth grade, many state beef councils use this type of material in their educational programs, which is why it was also chosen for study. Table 1 contains the benchmarks and the language necessary for demonstrating understanding of these concepts.

Table 1
Concepts, Benchmarks, and Language

Concept	Benchmark	Language
What is agriculture?	1. Identify food products that come from animals. (K-1 FFSL[a] & K-2 AAAS[b])	1. Meat, milk
	2. Describe by-products that come from animals. (9-12 FFSL)	2. Clothing, sporting equipment, medicine, cosmetics, gelatin, plastic
	3. Describe farms and their products. (K-1 FFSL & K-2 AAAS)	3. Small, large
	4. Describe how animals provide for people's basic needs. (4-5 FFSL)	4. Grow, food, clothing
	5. Describe the journey a meat product travels through from farm to consumer. (2-3 FFSL)	5. Production, transportation, processing, distribution, consumption

Note. Benchmarks were derived from [a]Food and Fiber Systems Literacy Framework (Leising, 1998) and [b]American Association for the Advancement of Science 2061 Benchmarks (1993)

Analysis

Analysis began with identifying the background and experiences of the students and was reported descriptively. Next, goal conceptions and an expert concept map were developed by the researchers and were reviewed by experts in science and agricultural education, animal science, and the beef industry. To analyze student understandings of the benchmarks, Hogan and Fisherkeller's (1996) bidimensional coding system was used to judge participants' compatibility with experts and elaboration on each benchmark. Participants were coded based on the language they used. The transcribed interviews served as the data.

The students' concept maps were used as a secondary data source. To ensure confirmability of the findings, excerpts of interview transcripts that supported codings are included in the findings section of this paper (Guba & Lincoln, 1989). In addition, another researcher independently coded the data with 96% agreement with the primary researcher. Table 2 presents the coding scheme used

Table 2
Coding scheme for comparing student responses to expert conceptions.

Code	Definition
Compatible elaborate	Statements concur with the expert proposition and have sufficient detail to show the thinking behind them and/or recur throughout the transcript in the same form.
Compatible sketchy	Statements concur with expert proposition, but essential details are missing. Often represent a correct guess among choices provided, but no ability to explain why choice was made.
Compatible/ incompatible	Makes sketchy statements that concur with proposition, but which are not elaborated, and also makes sketchy statements that disagree. Contradictory statements are often found in two parts of the transcript in response to different questions or tasks on the same topic.
Incompatible sketchy	Statements disagree with proposition, but very few details or logic given, and do not recur throughout transcript. Often seem to be responses given just to say something, a guess.
Incompatible elaborate	Statements disagree with proposition and students provide details or coherent, personal logic backing them up. Same or similar statements/explanations recur throughout transcript.
Nonexistent	Used when students respond "I don't know" or do not mention the topic when asked a question calling for its use.
No evidence	Used when a topic was not directly addressed by a question and students did not mention it within the context of response to any question.

Finally, to determine relationships between students' backgrounds and experiences and compatibility and depth of responses, we inductively and intuitively searched for patterns that developed from the data (Taylor & Bogdan, 1998).

Findings

By questioning students about their personal experience with livestock, the researchers were able to achieve research objective one. All students were Caucasian. Three students lived on farms while the other four lived in small towns. Two students' families raised steers and one student raised lambs for 4-H projects. One student had an uncle who raised cattle. None of the other three students, however, had direct experience with livestock. Most students' parents worked in a near by city. When asked what their parents did for a living, many of the students replied only with the company name and not the actual occupation. Table 3 lists the students along with their background and experiences.

Table 3
Student Background and Experience

Name	Gender	Home Location	Parent(s) occupation	Livestock Experience
Greg	Male	Farm	Father: Food production company Mother: In city (unknown)	Family raises steers
David	Male	In Town	Father: Label company Mother: Cook	None
Heidi	Female	In Town	Father: Train driver Mother: College student	None
Jim	Male	In Town	Father: Miner Mother: Department store salesperson	Uncle raises cattle
Jessica	Female	Farm	Father: Firefighter/ Carpenter/ Farmer Mother: Nursing home employee	Family raises steers
Lynn	Female	In Town	Father: Filter company Mother: Stays at home	None
Melissa	Female	Farm	Father: Department of Transportation Mother: College student	Shows lambs in 4-H

Research objective two was met by directly asking students to describe their understanding of an agriculture and science concept about the nature of agriculture. The first benchmark identified food products that came from animals. Codings assigned to students based on an interpretation of the language are found in Table 4. Black dots indicate students' understandings of the subconcepts that were necessary to understand the benchmark. A superscript to the coding further quantifies the student's depth of understanding.

Table 4
Student Understanding of Identification of Food Products from Animals

Benchmark	Greg	David	Heidi	Jim	Jessica	Lynn	Melissa
1. Identify food products from animals							
a. meat	•	•	•	•	•	•	•
b. milk	•	•	•	•	•	•	•
Coding	CE^2	CE^2	CE^2	CE^2	CE^2	CE^2	CE^2

ø--No evidence; N--Nonexistent; IE--Incompatible Elaborate; IS--Incompatible Sketchy; CI--Compatible/Incompatible; CS--Compatible Sketchy; CE--Compatible Elaborate
Superscript indicates depth of understanding of the benchmark and was determined based on how many subconcepts the student identified.

All students effectively articulated an understanding that cattle produce meat and milk for human consumption. Some students said that different types of cattle were used for different types of production. Greg, Jessica, and Melissa all noted that dairy cows were used mainly for the production of milk and dairy products and that these cows were different than cattle primarily used for meat production. Heidi

felt that only the "boys" were used for meat production and the "girls" give the milk. Although her understanding was partially correct, she did not seem to understand that different types of cattle produce different products. Lynn's understanding of different types of cows was linked with what she recognized in the grocery store. She thought some cows produced 2% milk and some whole.

The second benchmark required that students describe cattle by-products. Table 5 lists the codings assigned to each student.

Table 5
Student Understanding of By-Products from Animals

Benchmark	**Greg**	**David**	**Heidi**	**Jim**	**Jessica**	**Lynn**	**Melissa**
2. Describe by-products that come from animals							
a. leather -clothing -sporting equipment		•	• •	• •			•
b. medicine							
c. cosmetics							
d. other		•					
Coding	N	CS[2]	CS[2]	CS[2]	N	N	CS[1]

ø--No evidence; N--Nonexistent; IE--Incompatible Elaborate; IS--Incompatible Sketchy; CI--Compatible/Incompatible; CS--Compatible Sketchy; CE--Compatible Elaborate
Superscript indicates depth of understanding of the benchmark and was determined based on how many subconcepts the student identified.

Four students had some understanding of how by-products from cattle are used in products they encounter daily. Heidi and Jim were the only students who mentioned leather as a product from cattle. David and Melissa both knew that clothing came from animals, but Melissa's conception was linked to her background with sheep. She thought that cattle were shaved and their fur was used to make coats rather than the hide used for leather. David also noted that fertilizer for farmers came from cattle bones. Jim knew about the exportation of niche products to other countries, specifically Asian markets, evidenced by this comment, "I mean like some things they might ship it over to the people in Japan because they eat some of the weird things that we don't eat, like the brain and stuff like that." Also noteworthy about Jim's conversation was his conceptualization of meat.

Interviewer: What are some part that we don't eat?
Jim: The muscle.
I: Tell me about that.
J: It's an organism in your body that helps you move your bones and it pulls on 'em and makes 'em move.
I: What part is the meat?
J: The stuff underneath the muscle.

Although Jim understood the function of muscle, he did not realize that muscle is what he eats as meat.

Students coded as nonexistent repeatedly noted that the cattle parts humans do not consume are thrown away. Greg's interview was similar to others with a nonexistent understanding.

I: What does the butcher do with

the things that we don't eat?
G: Um, he probably just throws them away.
I: What kinds of things don't we eat that he might throw away?
G: I know they throw away the bones, unless it's like a T-bone steak or something like that. I can't think of anything else.
I: What about the fur or the skin, what do they do with that?
G: They probably throw that away, too.

Greg, Lynn, and Jessica all said that what was not eaten was thrown away. No students knew that by-products from cattle were used in pharmaceuticals or cosmetics.

Benchmark two asked students to describe the size and scope of the farms where cattle were produced. Included in Table 6 are the student codings for this benchmark.

Table 6
Student Understanding of Farms and Their Products

Benchmark	**Greg**	**David**	**Heidi**	**Jim**	**Jessica**	**Lynn**	**Melissa**
3. Describe farms and their products.							
a. large farm size							
b. one main type of animal							
Coding	IE	IE	IE	IE	IE	IE	IE

ø--No evidence; N--Nonexistent; IE--Incompatible Elaborate; IS--Incompatible Sketchy; CI--Compatible/Incompatible; CS--Compatible Sketchy; CE--Compatible Elaborate
Superscript indicates depth of understanding of the benchmark and was determined based on how many subconcepts the student identified.

All students knew that cattle were raised on farms; however, they were coded incompatible elaborate because their conceptions of what these farms looked like were not in line with modern agriculture. No student understood that most cattle are produced on large farms, encompassing hundreds or thousands of acres. Because a football field was a visual image students could easily comprehend and is comparable to an acre, students were asked to use this measure to indicate the size of the farms where the cattle were raised. Student responses varied from one 12 acres.

The fourth benchmark required an understanding of the process that meat products go through on their way from the farm to consumer. The students' codings for these benchmarks are included in Table 7.

Table 7
Student Understanding of the Journey of Meat Products

Benchmark	Greg	David	Heidi	Jim	Jessica	Lynn	Melissa
1. Describe the journey meat products travel.							
a. production	•	•	•	•	•	•	•
b. transportation	•	•	•	•	•	•	•
-trailer	•		•	•	•		•
-refrigerated truck		•		•	•		•
c. processing	•	•	•	•	•	•	•
d. distribution					•		
e. consumption	•	•	•	•	•	•	•
Coding	CS^5	C/I^5	CS^5	CS^6	CS^7	CS^4	CS^6

ø--No evidence; N--Nonexistent; IE--Incompatible Elaborate; IS--Incompatible Sketchy; CI--Compatible/Incompatible; CS--Compatible Sketchy; CE--Compatible Elaborate
Superscript indicates depth of understanding of the benchmark and was determined based on how many subconcepts the student identified.

Although students had a general idea of the agri-food system process, six of the seven students were assigned compatible sketchy codings because they missed important details. The language students used to describe the process was not compatiblet with experts' conceptions. The codings were assigned based on their understanding rather than just on language alone. Many of the students, for example, used the term "butcher" instead of processor. Their understanding as to what occurred during that phase of the process (killing the animal and fabricating the meat), however, was clear based on their explanation. The following narrative is Jim's brief explanation of his concept map.

I: Tell me about what you did.
J: A cow ate the grass, which gave it fat or meat to the cow. Which then got butchered for the meat. Which then got shipped to McDonalds™ and then McDonalds™ sold it to you.
I: Where did the cow come from?
J: A farm.
I: The cows then come from the farm. How do they get to this butcher place?
J: In a wagon, or a trailer or yeah, trailer.
I: So what all happens at this place?
J: They bring the cow in and then they butcher it. They usually butcher it outside though. And then once they do that, he brings the meat in that he got out from [the animal] and then he might season it or dry it for jerky or something and then he'll put it in the freezer and then you'll come pick it up or he'll have it shipped to you.
I: After they butcher the meat you said it gets shipped to McDonalds™, how does it get there?
J: They get it in a big semi and they pack [the meat] in big crates and boxes in slices. And all the people at McDonalds™ have to do is they take it and they put it in little box things and then opens it

up and then it warms them really warm and then they put it in the bun and then they serve it.
I: Is it cooked when it gets to McDonalds™ then?
J: No.

His description of what the butcher does allowed the researchers to equate that phase in the journey with processing even though his language was not the same as the prescribed vocabulary.

Most students had a basic understanding of meat's journey from farm to plate. David was unique because he thought the cow was killed and cut into large pieces by the farmer and then was taken to a butcher where it was further processed and packaged. The other fifth graders knew that the cattle were shipped from the farm to a place where the cattle were killed and processed. The language that the students used, however, varied from student to student as well as the depth of description about the stops the meat made. Jessica was the only informant who included a distribution step in her description. Although she did not call the step "distribution," she said that there was a "second place" where the meat was further packaged and sold to stores.

Greg and Jessica, whose families raised steers, described cattle production in more detail than their classmates. These students, however, were not able to more elaborately explain the process after the cattle left their farms. This was evident in Greg's description of meat processing before it got to the fast food restaurant.

I: Who sent the meat to [McDonalds™]?
G: I don't know.
I: OK, so where did you say that the meat came from before it got to McDonalds™?
G: I don't know.
I: How do you think it got ground like that? Who did that?
G: Probably the butcher.
I: So it comes from a butcher then?
G: Maybe.

Greg thought the meat came to the fast-food restaurant as ground meat and then the restaurant employees made the patties before cooking them. Lynn, Jessica, and David's schema also concurred with Greg's. All informants knew some type of processing took place before the meat arrived at the restaurant, but the students' answers varied as to how much.

The students' answers also varied with regard to the type of transportation used to move cattle and meat. Neither David nor Lynn mentioned the use of a trailer to transport the cattle. In David's conception, there was no need to transport live animals, because he believed that they were killed on farms. David, Jim, Jessica, and Melissa all understood that once the animal was killed, the meat had to be transferred in a truck with some type of cooling system. Greg, Heidi and Lynn never mentioned refrigerated trucks to transport meat. Heidi compared a mail truck with the type of vehicle used to transport meat; and Greg compared it to a "truck [from which] you sell Doritos or chips." Heidi, Greg, and Lynn knew meat had to be kept cold in their homes, but said nothing about meat needing to be refrigerated during transport.

Conclusions/Implications

Objective One: Background and Experiences

None of the students' parents were primarily farmers. Therefore, even though these students grew up in a rural community, they, like other rural youth, cannot be generally labeled as farmers. These students lacked understanding of agricultural concepts even though they were raised in rural areas. This, then, raises questions about agricultural education's primary focus of agriculture literacy for only urban and suburban students.

In general, students who raised animals for meat could more elaborately describe the production of animals; however, they had no greater understanding about the processing of the meat products than their non-livestock raising contemporaries. Few cattle were raised in the area and row crops (corn and soybeans) dominated local agriculture. If the study was conducted in an area where livestock production was a primary

agricultural entity, the results of the study may have been different with regards to student language use and their conceptual frameworks.

Objective Two: Understanding of Benchmarks

Benchmark one asked students to describe food products that came from animals. Students understood very well that meat and dairy products originate from animals. This supports Trexler's (2000b) finding that elementary students know that food comes from plants and animals. Many people continue to focus agricultural literacy efforts toward informing students about the origin of food. It seems, however, that resources could be reallocated to other areas where students actually lack knowledge, such as this study's second benchmark.

The second benchmark concerned student understanding of cattle by-products. Most students did not understand that cattle produce many products besides meat and milk. Those in the agriculture industry would benefit from consumers realizing that agriculture producers and processors profit from reducing waste. If students understand that many of the products they use everyday rely on by-products from animals, then they may better understand the impact of agriculture on their lives. This is important because it may generate support for the industry as policy issues surface. To foster schema development concerning by-products, educators could design activities that require students to discover the sources of ingredients in many everyday products, such as cosmetics and medicines, through research and discovery.

The third benchmark dealt with student understanding of farms and their products. Students possessed alternative mental frameworks from the expert conception about farm size and scope and elaborated on their understandings. These rural students did not have an accurate schema for the large scale of modern production agricultural operations. This finding parallels Trexler's (2000b) study of urban and suburban students. Both urban and suburban students in Trexler's study and the rural students in this study did not understand the large scale of farming today. These rural students were also similar to those in Trexler's study in that they believed that farms are diversified. This study's students believed that most farms raise many different species of livestock, which was akin to Trexler's urban and suburban student's ideas about crop production.

Agricultural literacy efforts may benefit from helping students re-conceptualize their notions of a farm. Rather than teaching students that meat comes from cattle, it may be more productive to devise curricula and programs that help students change their conceptions toward a more accurate picture of modern agriculture. To better understand the environmental trade-offs manifest in large-scale livestock production, students' conceptions of farms need to be challenged so they have the opportunity to change their inaccurate schema. Educators (whether formal or informal) of elementary students can challenge student conceptions by taking students to modern, large-scale production facilities and allowing them to experience first-hand the structure of agriculture today. If this is not an option, media can be created by curriculum developers that present an accurate picture of livestock production.

Benchmark four described the journey that meat took from the farm to the consumer. Most of these rural students seemed to understand that meat is processed, and that this processing is completed by different companies. All but one understood that the farmer's primary responsibility is raising the animal for slaughter, and that the farmer then passes the animal to others who perform the next step of processing. In a time of ready-to-eat food products, it is not surprising that most students were able to identify that fast-food restaurants receive meat that has been processed in some manner.

Although the students seemed to have a basic understanding of meat's journey from farm gate to plate, the results of this study indicate that the language that the AAAS (1993) suggested this age group of children should have is either too advanced or had never been introduced to these students. No students used words such as "processed" or "distributed" when describing the processes meat undergoes. The language they used instead was "butchered," "cut up" or

"shipped." Further studies may indicate a need to change the expected benchmark vocabulary to one more appropriate for fifth grade students.

Further studies using a similar research protocol but different informants may lead to a more complete understanding of what students understand about livestock. 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). The current agricultural benchmarks developed by both agriculture and science educators have not been thoroughly tested for suitability to the age groups for which they were designed. Once educators have a clearer picture of children's schema, they can more effectively develop agricultural literacy curriculum that causes dissatisfaction with pre-existing knowledge structures and pulls students into the conceptual change process.

References

Albrecht, D.E., & Albrecht, S.L. (1996). Family structure among urban, rural, and farm populations: Classic sociological theory revisited. *Rural Sociology, 61*(3), 446-463.

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

Anderson, O.R. (1992). Some interrelationships between constructivist models of learning and current neurobiological theory with implications for science education. *Journal of Research in Science Teaching, 29*, 1037-1058.

Anderson, O.R., & Demetrius, O.J. (1993). A flow-map method of representing cognitive structure based on respondents' narrative using science content. *Journal of Research in Science Teaching, 30* (8), 953-969.

Dole, J.A., & Sinatra, G.M. (1998). Reconceptualizing change in the cognitive construction of knowledge. *Educational Psychologist, 33* (2/3), 109-128.

Frick, M., Birkenholz, R. & Machtmes, K. (1995). Rural and urban adult knowledge and perceptions of agriculture. *Journal of Agricultural Education, 36*(2), 44-53.

Frick, M., Kahler, A., & Miller, W. W. (1991). A definition and the concepts of agricultural literacy. *Journal of Agricultural Education, 32*(2), 49-57.

Frick, M., & Spotanski, D. (1990). Coming to grips with agricultural literacy. *The Agricultural Education Magazine, 62,* 6,13.

Gardner, H. (1991). *The unschooled mind: How children think and how schools should teach*. New York, NY: Basic Books.

Gee, J. (1990). *Social linguistics and literacy: Ideology in discourses*. Bristol, PA: The Falmer Press.

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

Hogan, K., & Fisherkeller, J. (1996). Representing students' thinking about nutrient cycling in ecosystems: Bidimensional coding of a complex topic. *Journal of Research in Science Teaching, 3*(9), 941-970.

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

Lincoln, Y.S. (1998). From understanding to action: New imperatives, new criteria, new methods for interpretive researchers. *Theory and Research in Social Education, 26* (1), 12-29.

Messenger, J. (2001, September). Manure management: Consumers' perceptions count. *Pork*, 32-34.

National Research Council. (1988). *Understanding agriculture: New directions*

for education. Washington, DC: National Academy Press.

National Research Council. (1996). *National science education standards*. Washington, DC: National Academy Press.

National Council on Agricultural Education. (1999). *A new era for agricultural education: Reinventing agricultural education for the year 2020*. Alexandria, VA: Author.

Piaget, J. (1985). *The equilibration of cognitive structures* (Brown, T., & K. J. Thampy, Trans.). Chicago, IL: The University of Chicago Press. (Original work published 1975)

Posner, G. J., & Gertzog, W. A. (1982). The clinical interview and the measurement of conceptual change. *Science Education, 66* (2), 195-209.

Posner, G., Strike, K., Hewson, P., & Gertzog, W. (1982). Accommodation of a scientific conception: Toward a theory of conceptual change. *Science Education, 66* (2), 211-227.

Roper Starch Worldwide. (2000). *Sharing knowledge: An analysis of the Philip Morris/Farm Bureau gap research results*. New York, NY: Philip Morris/Farm Bureau.

Russell, E., McCracken, D., & Miller, W. W. (1990, March). Position statement on agricultural literacy. *The Agricultural Education Magazine, 62,* 13-14,23.

Taylor, S.J., & Bogdon, R. (1998). *Introduction to qualitative research methods*. New York, NY: John Wiley & Sons, Inc.

Thorley, N.R., & Stofflett, R.T. (1996). Representation of the conceptual change model in science teacher education. *Science Education, 80* (3), 317-339.

Trexler, C.J. (1999). *Elementary student and prospective teachers' agri-food system literacy: Understandings of agricultural and science education's goals for learning*, Unpublished doctoral dissertation. Michigan State University, East Lansing.

Trexler, C.J. (2000a, July-August). Conversational literacy: A moving target that has yet to be defined. *The Agricultural Education Magazine, 73* (1), 2,4-5.

Trexler, C.J. (2000b). Suburban and urban elementary student understandings of pest-related science and agricultural education benchmarks. *Journal of Agricultural Education, 41* (3), 22-34.

Trexler, C.J., & Heinze, K. (2001). Prospective elementary teacher understandings of pest-related science and agricultural education benchmarks. *Journal of Agricultural Education, 42* (1), 82-97.