Knowledge, Skills, or Attitudes/Beliefs: The Context of Agricultural Literacy in Upper-Elementary Science Curricula

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Abstract

Agricultural literacy connects knowledge, skills, and attitudes/beliefs (KSABs) about agriculture to those in science, environmental education, and education for sustainable development. To understand students' exposure to agriculture, this content analysis of 12 current upper-elementary U.S. science textbooks and curriculum programs examined the representation and contexts of agricultural concepts. Reviewed materials did not include thorough representation of agricultural concepts or a wide distribution of KSABs. Most concepts promoted knowledge acquisition of non-agricultural topics, with emphasis placed only on a few terms. These findings demonstrate the need for integrated science curriculum redesign to include agriculture to increase environmental, scientific, and agricultural literacy.

Keywords: agricultural literacy, environmental literacy, science curriculum

Americas lack sufficient agricultural literacy (National Research Council [NRC], 1988), and hold stereotypical perceptions of farmers in overalls working in barnyards full of chickens, cows, and tractors (DeWerff, 1989). Unfortunately, teachers' lack of agricultural knowledge and media-shaped stereotypes often match their students' (Balschweid, Thompson, & Cole, 1998). This is problematic, as agriculture impacts Americans' lives in relation to food and fiber production, the resources and environmental implications involved in their production, and global interconnectedness. Introducing agricultural literacy initiatives early in life can create globally competent consumers that are aware of the countless interconnection within the physical world and make better decisions regarding their health and the environment (Frick, Kahler, & Miller, 1991).

Agricultural literacy, which differs from agricultural education, includes knowledge, skills, and attitudes/beliefs (KSABs) *about* the field of agriculture that are similar to those in science, environmental education, and education for sustainable development (ESD; see Figure 1). Although agriculture has largely been removed from U.S. school curricula over the last century, recent science and environmental education reform documents – e.g., *A Framework for K-12 Science Education* (henceforth, *Framework*; NRC, 2012), *Next Generation Science Standards* (henceforth, *NGSS*; Achieve, Inc., 2013), *Excellence in Environmental Education – Guidelines for Learning* (North American Association for Environmental Education [NAAEE], 2010) – have reintroduced it in an attempt to create conscientious citizenry that apply "crosscutting concepts" as lifelong learners (NRC, 2012).

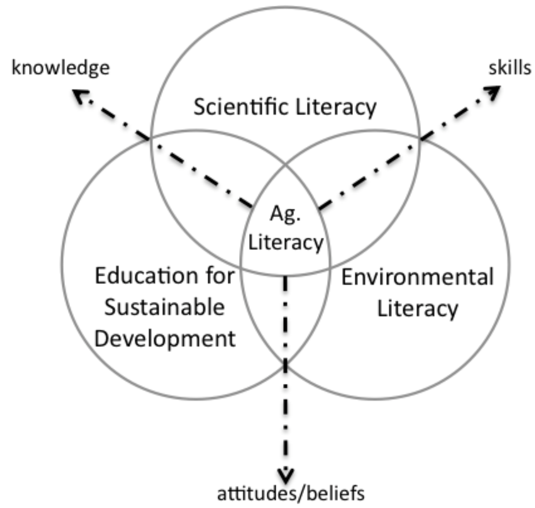

Figure 1. Agricultural (Ag.) literacy integration within scientific literacy, environmental literacy, and Education for Sustainable Development.

Organizations such as farm bureaus, 4-H, and cooperative extensions have developed myriad instructional materials in response to recommendations for agricultural reintegration. However, most resources are offered as enhancement materials to supplement existing basal curriculum but have not been designed to be integrated coherently into school-adopted curriculum, leaving agriculture's systematic presentation potentially inhibited. The issue does not stem from a dearth of agricultural materials (Bellah & Dyer, 2009) but in how agriculture is currently embedded in general education. To understand students' exposure to agriculture, this content analysis of upper-elementary U.S. science curricula examined the representation and contexts of agricultural concepts.

Agricultural Literacy

Agricultural literacy differs from agricultural education in that its focus is on educating students *about* the field of agriculture rather than preparing students for work *within* the field of agriculture. According to the NRC's (1988) report, *Understanding Agriculture: New Directions for Education,* "Agriculture is too important a topic to be taught only to the relatively small percentage of students considering careers in agriculture" (p. 1) and should be integrated into all levels and fields. Agricultural literacy encourages understandings about food and fiber systems, global economies, nutrition, and environmental conscientiousness (NRC, 1988). Agricultural educators constructed definitions necessitating that literate students be able to "synthesize, analyze, and communicate" about agriculture (Frick et al., 1991, p. 54), as well as appreciate the values and beliefs within the system to become fully engaged (Meischen & Trexler, 2003).

(Re)Integration of Agriculture

Historically, agriculture was introduced to all students in all grade levels as a study in science education, appearing in schools in the late 1700s (Dabney, 1904). Its familiarity to students allowed for authentic contexts and experiential learning opportunities (Knobloch & Martin, 2002) and was considered an important topic in all schools (Hillison, 1998). Over time, however, agriculture became a vocational study no longer integrated into general curricula. In the 1980s, agricultural literacy efforts emerged and its integration into science and environmental education was advocated (Leising, Pense, & Portillo, 2003). Agricultural educators argued that agriculture should be integrated into existing K-12 math, science, engineering, technology, and literature curricula (Balschweid, Thompson, & Cole, 2000; Trexler, Johnson, & Heinze, 2000) because its relevance enhanced learning experiences (Knobloch, Ball, & Allen, 2007) by encouraging students to think deeply about the real world (Lockwood, 1999) and construct their own knowledge with authentic, tangible examples (Bellah & Dyer, 2009).

Science, Environmental Literacy, and ESD Initiatives

Recent educational reform initiatives within science, environmental education, and ESD discussed integrating disciplines (including agriculture) to minimize the breadth of disjointed facts and increase the depth of understanding by incorporating crosscutting concepts, practices, and core ideas shared by several fields (NAAEE, 2010; NRC, 2012). Each initiative advocates for the development of citizens that are aware of their impacts on the natural world, promotes lifelong learning, and has similar concepts that can be found in the other initiatives. Becoming "literate" in each of these fields encourages individuals to make informed decisions regarding important personal and societal issues. Unfortunately, none of the definitions has encouraged becoming literate in the other fields as well, which would help individuals grasp the fields' interconnectedness. For instance, to be considered scientifically literate (Achieve, Inc., 2013; Bybee, 1997), students should respect and understand how resources influence their environments, such as "…maintaining supplies of clean water and food, and solving the problems of global environmental change" (NRC, 2012, p. 9). However, being scientifically literate does not mean students are environmentally literate. To be environmentally literate (McBeth & Volk, 2010; Roth, 1992), students must develop scientific skills, such as observing and investigating environmental issues experienced in the natural and man-made worlds (NAAEE, 2010); yet becoming environmentally literate does not mean students are scientifically literate. To understand sustainability (Scott & Gough, 2003; Sterling, 2001), students should plan for a sustainable future, while respecting and preserving the past; but similarly, that does not mean students are scientifically and environmentally literate.

Most often these subjects are taught in isolation with minimal integration. Agriculture can link these topics by providing relevant, authentic, and familiar examples and connections students recognize by acknowledging that the resources and products people consume pass through (preferably) sustainable scientific processes with environmental impacts (Blum, 1973; Powell, Agnew, & Trexler, 2008). Rosentrater (2005) noted that integrating science into vocational agriculture improved scientific literacy "owing to the synergistic connections between the disciplines" (p. 323). Others contend the reverse to also be true: By infusing agriculture into other disciplines, agricultural literacy will likely increase (Conroy & Sipple, 2001; Vahoviak & Etling, 1994). While familiarity does not imply literacy, agricultural literacy contains crosscutting concepts, core ideas, and ties together KSABs about agriculture to those in science, environmental education, and ESD.

Purpose of Study

Studies indicate that teachers use adopted textbooks and curricula, particularly when they are unfamiliar with content knowledge (Stern & Roseman, 2004). Curricula designed well can enhance knowledge acquisition, and those designed poorly can promote misconceptions or stereotypes. If teachers use adopted materials that lack systematic development of agricultural concepts, agricultural literacy efforts will not be achieved.

The purpose of this content analysis study of widely adopted upper-elementary U.S. basal science textbooks and curriculum programs was to determine the representation and context in which agricultural literacy concepts are presented to students in primary education. According to McReynolds (1985), "[t]he earlier in life that we present information [about agriculture] to children, the more receptive they are to accepting and applying wholesome concepts about the topic for the rest of their lives" (p. 17). This study explored the following research questions:

(1) To what degree are accepted agricultural literacy concepts embedded in upper-elementary science textbooks and curriculum programs?

(2) In what contexts do agricultural literacy concepts appear within the materials?

Methods

Since agriculture has historically been a part of science education, it was fitting to explore its current presence in science materials. This study employed content analysis of science materials to provide systematic and objective organization of data, as well as to make qualitative inferences about the embedded contexts in which agriculture appeared (Krippendorf, 2004). In this investigation, curriculum was defined as having a scope and sequence of learning activities designed around a science topic that included traditional basal textbooks and curriculum programs that are not centered on texts.

Sample

The textbooks and curriculum programs in this study were gathered by first identifying U.S. "textbook adoption states" (Education Commission of the States [ECS], 2005). Then, the most current lists of *approved* curriculum materials from the 20 adoption states were reviewed, as no lists of which materials are actually *adopted* exist. The 12 most frequently identified science textbooks and curriculum programs on the approved lists for 4th and 5th grades were collected and analyzed (see Table 1). The materials included in the study were published between 2003 and 2007; and while these seem dated and some have newer editions, states often keep materials in schools up to 10 years since curriculum review cycles, adoption cycles, publisher contracts, and budget cycles vary (ECS, 2005). The remaining states adopt materials at district, local, or school levels but may use these materials as well.

Table 1

Frequency of Most Approved Science Curricula by Adoption States

Publisher/Title/Copyright	Abbreviation	4th Grade	5th Grade
MacMillan/McGraw-Hill Science (2005)	MMH	16	17
Houghton Mifflin Science-California (2007)	HMS	13	13
Scott Foresman Science (2006)	SFS	13	13
Full Option Science System (2005) [a]	FOS	11	11
Harcourt School Publishers Science (2003)	HSP	10	10
Delta Science Modules (2004) [b]	DSM	6	8

[a]Grade four: Earth Materials, Human Body, Matter and Energy, Structures of Life, and Water. Grade five: Environments, Food and Nutrition, Landforms, Living Systems, and Water Planet.

[b]Grade four: Food Chains and Webs, Electromagnetism, Earth Movements, and Dinosaurs and Fossils. Grade five: Cells and Classification, Energy, Erosion, and Our Solar System and Beyond.

Design and Procedure

A Guide to Food and Fiber Systems Literacy (henceforth, *FFSL*; Leising, Igo, Heald, Hubert, & Yamamoto, 1998) and the *Framework* (NRC, 2012) laid the foundation for the construction of a code-sheet containing agricultural topics, themes, and concepts. The *FFSL* was developed to provide a framework for agricultural literacy in K-12 education; however, no update has been released since its inception. Therefore, additional concepts were added to align to new agricultural topics included in the *Framework*. Ten overarching agricultural categories and 385 subsequent concepts (see Table 2 for examples or http://www.lehigh.edu/~fav203/codesheet.pdf for code-sheet) were listed on the code-sheet, and the codebook provided a guide for coding the concepts. Thoughtful *a priori* research design involving coding definitions and decisions is said to improve the reliability, validity, generalizability, and intersubjectivity of the findings (Neuendorf, 2002).

Table 2

Categories with Concept Examples

Agricultural Category	Number in Category	Select Examples
General Agriculture	46	Agriculture; by-products; consumers; farmer; policy; wildlife
Food & Nutrition	48	Calories; diet; food; food chains; minerals; nutrition
Plants, Agronomy, & Horticulture	51	Bacteria; CO_2; crops; fertilizers; irrigation; plants
Livestock, Meat, & Poultry	31	Animals; birds; fish; livestock; migration; veterinarian
Dairy	23	Cheese; cows; dairy products; homogenization; pasteurization
Work Animals & Machines	19	Farm machinery; ox/oxen; plow; simple machines; tools; tractor
Fiber	22	Building structures; fiber; paper; shelter; timber/lumber; wool
Land & Natural Resources	48	Habitat; land/landforms; lakes/ponds; natural resources; erosion; water
Environment & Sustainability	47	Climate; conservation; ecosystem; energy; pollution; sustainable
Agriscience & Biotechnology	50	Agribusiness; biodiversity; biofuels; disease; pesticide; recycling
Summary	385	

The codebook and code-sheets were used to determine the frequency and contexts in which agricultural literacy concepts were embedded in the curricula. Each time a concept appeared on a page in the materials, it was entered on the code-sheet. If a concept appeared more than once on a page, it was recorded only once unless it appeared in more than one context (for example, as knowledge *and* a skill), then each context was recorded individually. Tables-of-contents, glossaries, vocabulary insets, overviews/reviews, and supplemental references were not included in the analysis. Illustrations of a concept, such as dog (*animal*) or kudzu (*plant*), were coded as the concept they represented. If similar illustrations appeared on the same page, such as wolf and dog, *animal* was counted once. Concepts were then tallied to describe the frequency of each category's representation.

The materials were also reviewed to determine the context in which agricultural concepts were presented to either: 1) provide content *knowledge*, 2) teach a related *skill*, or 3) influence an *attitude* or change a *belief*. The definitions of KSABs were adapted from Bloom's taxonomy of learning domains and defined in the codebook using examples from the Association of Schools of Public Health's (2012) guiding documents for faculty and curriculum designers (see http://www.lehigh.edu/~fav203/codebook.pdf). These documents provided action verbs and examples to identify knowledge (usually as background content), skills (in labs/guided inquiries or critical thinking questions), and attitudes/beliefs (suggestions for altering opinions or behaviors) in the current study.

Upon completion, the data from the code-sheets were analyzed to address both research questions and identify the frequencies and contexts of agricultural literacy in science curricula. To ensure inter-rater reliability, a second coder examined one textbook and curriculum program from each grade level. Coding agreement occurred for the majority of items (over 90%), and when disagreements occurred, discussions took place until consensus was reached.

Findings

Table 3 contains a list of the frequencies that the agricultural categories appeared, and Table 4 showcases the distribution of the categories' contexts. None of the materials included all 385 subsequent concepts from the 10 categories. On average, the materials contained between 19% (*general agriculture*) and 60% (*plants, agronomy, and horticulture*) of the subsequent concepts in each category. Equally notable, not all of the concepts were presented as knowledge, skills, *and* attitudes/beliefs.

Table 3

Frequencies of Agricultural Literacy Concepts in Upper-Elementary Science Curricula

		4th Grade						5th Grade					
Agricultural Category	Total	MMH	HMS	SFS	FOS	HSP	DSM	MMH	HMS	SFS	FOS	HSP	DSM
General Agriculture	466	45	62	52	15	36	8	71	34	36	41	58	8
Food & Nutrition	2,113	150	136	198	125	97	19	298	214	219	461	169	27
Plants, Agronomy, & Horticulture	4,677	465	320	598	225	308	59	833	296	491	447	516	119
Livestock, Meat, & Poultry	2,081	283	194	209	112	202	56	286	75	216	193	214	41
Dairy	168	15	6	12	9	8	0	33	13	10	49	11	2
Work Animals & Machines	152	21	2	22	12	18	1	24	9	22	5	10	6
Fiber	1,028	132	117	140	49	91	9	152	71	94	69	94	10
Land & Natural Resources	5,703	627	460	592	276	485	72	823	453	615	568	622	110
Environment & Sustainability	3,521	364	265	467	96	201	42	493	325	450	313	427	78
Agriscience & Biotechnology	884	93	84	112	37	52	17	126	45	127	80	103	8
Summary	20,793	2,195	1,646	2,402	956	1,498	283	3,139	1,535	2,280	2,226	2,224	409

Agricultural Representation

The number of page occurrences for each concept was analyzed to determine the frequencies that agricultural categories appeared in the materials. *Land and natural resources* (N=5,703); *plants, agronomy, and horticulture* (N=4,677); and *environment and sustainability* (N=3,521) appeared regularly in all materials; however, some concepts appeared substantially more often than others, which increased categories' frequencies. For instance, in the *land and natural resources* category, many materials cited *water's* (N=1,746) importance as a natural resource, but did not include concepts such as *overgrazing* and *deforestation*. Similarly, in the *plants, agronomy, and horticulture* category, *plants* (N=1,025) appeared frequently as part of the food chain, ecosystem, or whose parts and processes were described and analyzed; however, concepts such as *agronomy* and *cultivation* were seldom mentioned.

Food and nutrition (N=2,113); *livestock, meat, and poultry* (N=2,081); *fiber* (N=1,028); and *agriscience and biotechnology* (N=884) were moderately represented in the materials; and again, some concepts were mentioned more than others. All used the term *food* (N=619) regularly; however, concepts such as *calories, hunger/starvation*, and *preservatives* rarely appeared. The *livestock, meat, and poultry* category appeared regularly simply because it contained the term *animal* (N=1,120), which seldom related to agriculture.

General agriculture (N=466); *work animals and machines* (N=152); and *dairy* (N=168) were not mentioned significantly in any of the materials. Several used *horses* to describe fossils, bones, and evolution, but offered little more about their agricultural uses, save for one that discussed *crossbreeding* and *hybrids* (both in *agriscience and biotechnology*). Other materials offered lessons on *simple machines,* demonstrating their mechanics rather than their importance in agricultural production. *Dairy* concepts appeared most often when illustrating *digestion*.

While many agricultural concepts appeared in the materials analyzed, their development was often disconnected from the agricultural literacy standards defined in *FFSL* and the *Framework*. There was minimal development of conceptual ideas pertaining to particular agricultural concepts, and topics were primarily presented as isolated facts or examples that illustrated separate, non-agricultural ideas. These findings demonstrate an overall lack of agricultural literacy concepts in reviewed upper-elementary science curricula.

Table 4

Contexts of Agricultural Literacy Concepts in Upper-Elementary Science Curricula

		4th Grade						5th Grade					
Agricultural Category	Totals	MMH	HMS	SFS	FOS	HSP	DSM	MMH	HMS	SFS	FOS	HSP	DSM
Knowledge													
General Agriculture	362	36	46	33	15	32	8	55	25	34	32	39	7
Food & Nutrition	1,717	133	112	142	119	81	19	239	165	169	380	132	26
Plants, Agronomy, & Horticulture	3,871	402	253	445	220	268	59	677	248	392	386	419	102
Livestock, Meat, & Poultry	1,731	221	155	157	107	182	56	239	57	167	181	180	29
Dairy	135	12	4	3	9	7	0	28	11	9	42	8	2
Work Animals & Machines	132	18	2	19	11	18	1	22	7	17	5	7	5
Fiber	708	90	73	97	45	76	9	101	28	65	63	51	10
Land & Natural Resources	4,579	493	347	450	257	401	72	662	339	474	508	483	93
Environment & Sustainability	2,775	285	198	350	89	164	42	391	268	332	272	326	58
Agriscience & Biotechnology	700	70	64	82	35	43	17	99	34	92	72	85	7
Summary	16,710	1,760	1,254	1,778	907	1,272	283	2,513	1,182	1,751	1,941	1,730	339
Skills													
General Agriculture	49	2	6	10	0	2	0	11	7	1	4	6	0
Food & Nutrition	358	15	24	51	6	16	0	54	45	50	62	34	1
Plants, Agronomy, & Horticulture	667	50	44	128	4	34	0	132	39	94	46	86	10
Livestock, Meat, & Poultry	282	50	36	42	5	10	0	39	12	45	7	24	12
Dairy	31	2	2	9	0	1	0	5	2	1	7	2	0
Work Animals & Machines	20	3	0	3	1	0	0	2	2	5	0	3	1
Fiber	290	36	39	42	4	12	0	44	42	26	5	40	0
Land & Natural Resources	893	107	88	113	16	67	0	133	86	123	44	106	10
Environment & Sustainability	537	55	39	86	6	20	0	88	41	105	21	59	17
Agriscience & Biotechnology	128	14	13	25	2	2	0	20	8	33	2	8	1
Summary	3,255	334	291	509	44	164	0	528	284	483	198	368	52
Attitudes/Beliefs													
General Agriculture	55	7	10	9	0	2	0	5	2	1	5	13	1
Food & Nutrition	38	2	0	5	0	0	0	5	4	0	19	3	0
Plants, Agronomy, & Horticulture	139	13	23	25	1	6	0	24	9	5	15	11	7
Livestock, Meat, & Poultry	68	12	3	10	0	10	0	8	6	4	5	10	0
Dairy	2	1	0	0	0	0	0	0	0	0	0	1	0
Work Animals & Machines	0	0	0	0	0	0	0	0	0	0	0	0	0
Fiber	30	6	5	1	0	3	0	7	1	3	1	3	0
Land & Natural Resources	231	27	25	29	3	17	0	28	28	18	16	33	7
Environment & Sustainability	209	24	28	31	1	17	0	14	16	13	20	42	3
Agriscience & Biotechnology	56	9	7	5	0	7	0	7	3	2	6	10	0
Summary	828	101	101	115	5	62	0	98	69	46	87	126	18

Agricultural Contexts

The contexts in which agricultural concepts appeared were not distributed evenly across KSABs. Assuming science curricula would present concepts primarily to provide content knowledge, also using agriculture to teach skills and address attitudes/beliefs would create comprehensive materials that support reform initiatives' hopes of producing knowledgeable, inquisitive, and conscientious students. As mentioned, none of the materials included *all* concepts represented as knowledge, skills, *and* attitudes/beliefs; however, some materials did present a few concepts in all contexts (KSABs). For instance, one text discussed *farming's* future and *hydroponics* in great detail, offering facts, questions for inquiry, and the belief that such growing may be healthier and more environmentally friendly than traditional agricultural practices. A few described *plants* and their uses, used them in labs to teach scientific skills, and discussed how protecting them would reduce *soil erosion*, *carbon dioxide*, and promote healthy *ecosystems*, all encouraging students to be more conscientious about their impacts on the environment.

Most agricultural concepts, however, were presented as content knowledge (N=16,710) to illustrate non-agricultural topics, rather than teach related skills (N=3,255) or influence attitudes/beliefs (N=828). For example, a passage highlighting a chemist who studied fuel cells mentioned ethanol (a *biofuel* made from *corn*) as *renewable energy*; however, the occupation was the focus, not the process or importance of developing biofuels for commercial use. Another mentioned *land clearing* and *plowing* as human environmental manipulations that cause *habitat* and *ecosystem destruction*, which could generate negative attitudes about agriculture, but failed to mention agriculture's importance to the survival of the global population.

When concepts were used to teach skills, most used labs, inquiries, or critical thinking questions involving *animals*, *plants*, *fruits* or *vegetables*, *soil*, *water*, *sunlight*, or *insects* to investigate *plant parts* or *growth*, *composting*, *environments*, *ecosystems*, or *pollution*. For example, onions were used in labs to teach students how to classify *plant* parts and view cells; however, not all labs were meaningfully tied back to knowledge of *growing plants* or plants' importance for survival and in *reducing carbon dioxide*. *Soil* was used in labs to encourage investigation about *erosion*, *soil composition*, and filtering *water*, but offered minimal suggestions for student action.

When concepts were presented to influence attitudes or beliefs, most materials described *pollution*, *conservation*, and *ecosystem*, *habitat*, and *environmental destruction*. Students learned through vignettes that *chemicals*, *fertilizers*, and *pesticides* caused *water*, *soil*, and *air pollution*, what individuals were doing to combat it, and what students could do to change their behaviors or help repair the *environment*. One textbook described a man who removed garbage along the Mississippi River because *pollution* and toxic *runoff* contaminate drinking *water* and encouraged students to find ways to help keep rivers clean. Another's passage offered suggestions for students to participate in Earth Day but provided little background knowledge or further inquiry. Overall, these findings demonstrate an uneven distribution of KSABs.

Discussion

This analysis revealed a lack of systematic integration of agriculture in science curricula. Reviewed materials did not include thorough representation of agricultural literacy concepts or a wide distribution of KSABs. Most concepts were presented to promote knowledge acquisition of non-agricultural topics, rather than teach transferable skills or alter attitudes/beliefs related to agricultural literacy and environmental conscientiousness. Heavy emphasis was placed on only a few terms (e.g., *water*, *plants*, *animals*), and their agricultural importance rarely emerged. Also, agricultural KSABs were found more in fifth grade materials than fourth, providing younger students with less exposure to agriculture. Regardless of agriculture's presence in national science and environmental education reform initiatives, it was not presented coherently in the science materials reviewed here.

New frameworks and standards (NRC, 2012; Achieve, Inc., 2013) are guiding decision makers and educational policy toward curriculum redesign; and this study reaffirms the critical need for redesign with the systematic integration of agriculture. Agricultural literacy can help students connect KSABs in science, environmental education, and ESD; and returning to agriculture's historic scientific foundation through integrated curriculum can increase science, environmental, and agricultural literacy. The next generation of basal science textbooks and curriculum programs needs to include agriculture.

The following recommendations can guide developers to redesign science curriculum to promote agricultural literacy. First, comprehensive agricultural literacy curriculum should be developed that align to the *FFSL, Framework*, *NGSS*, and *Common Core Standards*. However, simply following the documents as though they were curriculum will not provide students a systematically integrated curriculum (Shepardson, Niyogi, Choi, & Charusombat, 2009). Appropriate design should allow agricultural literacy topics to fit into adopted science curricula. Analysis of existing materials' tables-of-contents will determine appropriate places for inclusion.

These findings suggest upper-elementary curriculum should include a sequence of the following agricultural literacy topics:

General Agriculture

- Production, processing, regulation, and distribution of food and fiber products.
- Global interconnections, trade, and weather/climate.

Food, Nutrition, and Agriculture

- Plant, livestock, and dairy systems.
- Healthy eating and diets.

Agricultural and Environmental Conscientiousness

- Humane treatment of animals, sustainable practices, and responsible stewardship of resources.
- Advancements in agriscience and biotechnology.

Students can learn about the processes foods and fibers pass through before reaching consumers that can be connected to science lessons on ecosystems, living things, weather, and the human body, providing a basis for understanding the need for global trade, producing certain products in certain places, and how to make healthy lifestyle choices. By studying agricultural systems in more detail, students can distinguish between sustainable practices and the environmental impacts of irresponsible practices, and eventually come to appreciate their responsibilities as informed citizens by participating in discussions and decisions regarding public policy.

Secondly, agricultural literacy assessments should align to frameworks and standards and measure science and environmental literacy through multiple approaches and instruments (NRC, 2014). Providing several methods of summative and formative assessment, checks-for-understanding, and authentic performance tasks incorporating agricultural literacy KSABs will help students gain scientific knowledge and skills, learn to question and investigate environmental issues, and plan for a sustainable future.

Finally, in order to implement new curricula, teacher professional development should be released to provide agricultural KSABs. Hands-on agricultural experiences would also address stereotypes and misconceptions and improve educators' agricultural literacy as well.

There were some limitations within this study involving material selection. While the sampling procedure included materials approved by adoption states, it did not include all basal textbooks or curriculum programs available to teachers and districts. While it is safe to assume that many non-adoption states use these materials, those not selected may have higher frequencies nationwide. Additional, materials that did not appear on approval lists may be widely used by non-adoption states. There is also no guarantee that teachers adopt or use the materials included herein or implement all volumes even when adopted. Furthermore, some materials were outdated, and it is unclear if and when states adopt newer editions.

Summary

Identifying the need for revised curricula that align to *NGSS* and *Common Core Standards* to promote agricultural literacy is timely. Even though studies have found that teachers had favorable impressions of agriculture, that they recognized it would enhance their curriculum, and that it could be integrated into any subject (Knobloch & Martin, 2002), it is still not present in classrooms (Leising et al., 2003) and materials. Resources are available; however, teachers' lack of knowledge or interest, their stereotypes, or their lack of time due to full curricula and high-stakes testing may drive their decisions to not include agriculture in their classes (McReynolds, 1985).

In the development of the next generation of U.S. science curriculum, it is important that curriculum developers design programs to incorporate agriculture in a coherent, systematic fashion. We encourage science curriculum developers to address deficiencies found in this study and work with agricultural and environmental experts to build more integrated curriculum. Future research might include investigation into other fields to support these findings regarding agriculture's absence in elementary curricula; however, science seems the likely place to begin agriculture's reintegration into general education.

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