

Informal Learning in Science: Does Agricultural Education Have a Role?

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Abstract

This study examined what science education researchers report about informal learning in science and its relationship to students' science achievement. Aspects of secondary agricultural education that may support students' informal learning in science were also described. Two components of secondary agricultural education, integral to the delivery of a comprehensive program, hold high potential for supporting students' informal learning in science: Supervised Agricultural Experience (SAE) and FFA. Agriculture teachers are encouraged to increase their commitment toward planning, designing, and delivering learning experiences that afford students substantial opportunities to acquire and apply scientific knowledge and understandings in the contexts of agriculture, food, fiber, and natural resources. Related professional development opportunities for agriculture teachers should be planned and delivered, or otherwise facilitated, that support this purpose. Moreover, in an era of scarce financial resources and "high stakes" testing, one in which student performance in core subjects is prized above all else, to merely suggest that agricultural education supports student learning in a core discipline such as science is insufficient. Empirically-based research aimed at measuring this supposition should be carried out and reported.

Introduction and Conceptual Framework

“When will we ever use that?” Or, “I’m never going to need this as an adult.” These laments are often typical of students who have not made the real world connections necessary for them to cognitively place an important principle or concept into a future practical application. Moreover, while students struggle to make real world connections, society and the workplace are placing increasing demands on citizens and employees to be scientifically and technologically literate. To this end, science education scholars (Haury, 1993/2002; Haury & Rillero, 1994; National Research Council, 1996) posit that a *hands-on/minds-on* approach to learning facilitates student achievement in science.

However, other researchers (Britton, Huntley, Jacobs, & Weinberg, 1999; Parnell, 1995) have suggested that often the science taught in schools is too “abstract,” and, it appears that for many students, it lacks the sufficient real world “connection” and relevant “context” necessary to be learned adequately and then applied. Consequently, many investigators (Balschweid, 2001; Bottoms & Sharpe, n.d.; Britton et al., 1999; Conroy, Trumbull, & Johnson, 1999; Glasgow, 1997; Hoachlander, 1999; Imel, 2000a; Imel, 2000b; Lake, 1994; Lynch, 2000, Maurer, 2000; Parnell, 1995; Shelley-Tolbert, Conroy, & Dailey, 2000) have concluded that it is very important to provide students with sufficient *context* while they learn.

Historically, agricultural education has been an appealing and robust authentic context in which students learned and then applied scientific laws, concepts, and principles (Conroy et al., 1999). To this end, Imel (2000b) argued that “contextual learning,” i.e., learning “directly related to the life experiences or functional contexts” (p. 2) of the learner, is grounded in constructivist learning theory. Ideally, this includes learning that is rich in ample opportunities for contextualization and making real world connections through a variety of hands-on, applied learning media and experience-based activities (Conroy et al., 1999; Darling-Hammond & Falk, 1997). Secondary agricultural education, through the use of relevant curriculum delivered from a student-centered perspective by skillful teachers, has high potential for engaging students in active, hands-on/minds-on learning environments rich with opportunities for learning science.

Secondary agricultural education students are provided a plethora of learning opportunities involving the use of their time spent outside of school (Etling, 1993). For example, Supervised Agricultural Experiences (SAEs) are integral extensions of the classroom that require students to use theories and applications learned in the classroom in various real-world contexts involving the agriculture, food, fiber, and natural resources system. However, do these as well as other outside of school learning activities, that are facilitated and delivered through secondary agricultural education, include significant opportunities for informal learning in science to occur?

Purpose and Research Questions

The primary purpose of this study was to describe informal learning opportunities in agricultural education that may support student achievement in science. Accordingly, the study sought to answer four questions: 1) What is informal learning? 2) What is informal learning in science? 3) What have science education scholars suggested about the association between students' informal learning opportunities in science and their subsequent achievement? 4) What are components of secondary agricultural education that either provide or hold high potential for providing students with opportunities to learn science informally?

Procedures

Sources of data included findings, conclusions, implications, and recommendations made by theorists and practitioners about informal learning, especially as it related to student achievement in science, as well as additional sources describing components of the secondary agricultural education model supporting the same. The literature reviewed included national commission reports, articles from professional journals and magazines, books, papers from research conference presentations, on-line Internet publications, and other related resources. Studies appearing in these references were found through library system searches at a Land-Grant University and through selected on-line search engines available on the Internet. All references were subjected to internal and external criticism.

Findings

Informal Learning

The changing demographics of American society have refocused the thinking of many human development theorists regarding the potential of informal and non-school settings as significant and robust contexts for learning (Galper, 1987; McLaughlin, 2000). In support, Medrich, Roizen, Rubin, and Buckley (1982) maintained that,

Children attend school seven hours a day, five days a week for thirty-six weeks a year.

From the time a student begins schooling and finishes high school, each has spent approximately 11,000 hours in the classroom and 65,000 hours, sleep excluded, outside the classroom. (as cited in Gerber, Marek, & Cavallo, 1997a, p. 2)

Accordingly, Gerber et al. (1997a) opined that, "It is reasonable to assume that children may engage in autonomous learning activities during this time spent outside the classroom" (p. 2).

It may be important to note that some agricultural education researchers, e.g., Etling (1993), distinguish between "informal education" and "nonformal education," and consider the former "even less structured" and dealing "with everyday experiences which are not planned or organized (incidental learning)" (p. 73). However, Etling also maintained that

formal and nonformal education, “along with informal education, provide powerful learning opportunities which can strengthen and support one another” (p. 75). Many science education theorists and practitioners operationalize the two types of educational experiences—nonformal and informal—simply as *informal learning*. And, they assert that “the majority of students’ science learning experiences actually take place outside of formal classroom settings and in informal learning environments” (Gerber, Cavallo, & Marek, 2001, p. 536).

Informal Learning in Science and Student Science Achievement

Researchers (Gerber et al., 1997a) have asserted “that enriched informal activities outside the classroom correspond to higher scientific reasoning abilities among students. Since reasoning ability is an important skill for science learning, these informal activities likely impact students’ achievement in the formal classroom setting” (p. 9). Gerber et al. (1997a) also maintained that, “a wide range of school and community activities that involve students in informal learning experiences” (p. 10) should be developed, implemented, and supported. In agreement, Holloway (2002) concluded that, “Students who have the opportunity to participate in experiential, science-related extracurricular activities in a nonthreatening environment feel competent, particularly when adults are available to offer suggestions, support student inquiry, and provide enrichment activities” (p. 2).

Gerber et al. (1997a) reported findings about achievement in science associated with students’ opportunities for *informal learning*, i.e., student learning in science that occurs outside of the science classroom. According to the researchers, informal learning experiences that could improve students’ scientific reasoning ability include a variety of school and community activities, such as “scouting, 4-H, volunteer groups, hobby days, intramural sports, and partnership activities between the school and community resources (e.g., businesses, industries, museums, natural areas)” (p. 10). They suggested that teachers should “encourage students to become involved in extracurricular activities associated with the school and community” (p. 11). In support, Horton and Konen (1997) stated that, “Clearly, 4-H can play a role in initiating and nurturing effective science learning environments.” What is more, Gerber et al. (1997a) contended that these informal learning experiences “stimulate cognitive conflict and promote social interaction” (p. 10) thus improving students’ scientific reasoning abilities.

Dori and Tal (2000) extended the premise of merely “spontaneous” informal learning experiences that may support classroom-based or formalized learning in science to include a “model for combined formal and informal science learning” (p. 109) by design, i.e., a continuum of planned and connected formal—informal experiences in science education. For example, they maintained that, “STS [science-technology-society] programs often lie along the continuum between formal and informal education, as the target of learning is exposure to real-world problems” (p. 109). Further, Dori and Tal posited that, “Informal education alongside a formal one is most appropriate, as it addresses the community at large. In particular, it may enable future adult citizens to act wisely in situations involving environmental quality” (109).

Similarly, Swick (1987) posited an “ecological approach” to learning and social development, i.e., schools, industry, and communities committed to supporting the common goal of citizens acquiring skills that will influence their surroundings in a productive manner.

McLure and McLure (2000) analyzed data collected by ACT, Inc. (American College Testing) from the nearly one million ACT-tested high school students who were members of the graduating class of 1998. Of the students completing the ACT Science Reasoning test, 920, 572 responded to questions about their “Out-of-Class Science Accomplishments” (p. 14); about one-third of the students reported one or more accomplishments. Out-of-class science accomplishments were operationalized as distinct activities, and included the following:

“Wrote an independent paper on a scientific topic which received the highest possible grade given in my school”;

“Performed an independent scientific experiment (not as part of a course)”;

“Participated in a National Science Foundation summer program for high school students”;

“Won a prize or award (of any kind) for scientific work or study”;

“Placed first, second, or third in a regional or state science contest”; . . .

“Participated in a scientific contest or talent search.” (McLure & McLure, 2000)

The researchers found that as the number of out-of-class science accomplishments reported increased so did students’ ACT Science Reasoning test scores (p. 14). “This pattern persisted for both male and female students . . . , for each racial/ethnic group, and for each family income group” (p. 17). McLure and McLure concluded that their findings suggest “higher science achievement scores are linked to participation in out-of-school science accomplishments” (p. 38), and that, “Out-of-class science accomplishments may be an important means of helping students achieve in science” (p. 44).

Informal Learning in Science through Secondary Agricultural Education

Researchers (Dori & Tal, 2000; Gerber et al., 1997a; Gerber, Marek, & Cavallo, 1997b; McLure & McLure, 2000; United States Department of Education, 1998) in science education have suggested that students’ informal learning experiences play a significant role in their learning science and, ultimately, in their science achievement. Gerber et al. (1997a) operationalized informal learning in science as student learning in science that occurs outside of the regular school day. Accordingly, a case can be made that selected learning opportunities in secondary agricultural education may also support student learning in science (Budke, 1991; Buriak, 1992; Conroy et al., 1999; Shelley-Tolbert et al., 2000), thus improving students’ science achievement. Two components of secondary agricultural

education, integral to the delivery of a comprehensive program, may hold high potential for supporting student learning in science: Supervised Agricultural Experience (SAE) and FFA (Dyer & Osborne, 1995; Lee, 1998; Roegge & Russell, 1990). Summer enrichment programs focusing on agricultural sciences and, in some cases, biotechnology “themes” that are offered in several states also show promise.

Supervised Agricultural Experience (SAE)

Cheek, Arrington, Carter, and Randell (1994) stated that, “Supervised agricultural experiences (SAE) in agricultural education programs incorporate experiential learning and direct application of knowledge into the students’ curriculum to enhance learning” (p. 1). Cheek et al. further asserted that, “SAE gives the student the chance to utilize the principles learned in class and apply them in real life situations” (p. 1). In addition, these researchers found that student achievement in agricultural education, as measured by teacher-developed, end-of-course examinations, was “positively related to student achievement in agriscience” (p. 4). Findings by Arrington and Cheek (1990), Dyer and Williams (1997) and Noxel and Cheek (1988) support the researchers’ positions.

Camp, Fallon, and Clarke (1999) defined supervised agricultural experience as “the planned, supervised application of agricultural principles and concepts” (p. 167). Implicit in “agricultural principles and concepts” are those opportunities for student learning that are grounded in science. In fact, one of the eight SAE categories posited by Camp et al. was “Agricultural Research” (p. 167). The researchers stated that, “Scientific research into agricultural topics would fall into this category” (p. 168). Zilbert (1999) also supported that contention. Further, Lee (1998) opined that, “Emphasis on science-based instruction has resulted in a rapid rise in research and experimentation SE [Supervised Experience]” (p. 11). Lee also maintained that, “students should follow the scientific method in designing their plans” (p. 11) for supervised agricultural experiences. The other seven SAE categories posited by Camp et al. represent additional opportunities to complement student learning and achievement in science in a problem-based, contextual fashion. Although Dyer and Osborne (1995) concluded that a national effort was needed to identify the mission of SAE and to provide assistance to teachers in integrating SAE into science-oriented and specialty areas of instruction, SAE is, undoubtedly, an informal learning venue rich with opportunities to support students’ science achievement.

FFA

The FFA Mission is as follows: “FFA makes a positive difference in the lives of students by developing their potential for premier leadership, personal growth, and career success through agricultural education” (2002-2003 *Official Manual*, p. 4).

Concomitantly, the mission of secondary agricultural education is to prepare “students for successful careers and a lifetime of informed choices in the global agriculture, food, fiber and natural resources systems” (2002-2003 *Official Manual*, p. 4). Both missions

are intentionally and irrevocably linked to one another through the common emphasis placed on future career success of students as well as by a myriad of historic, statutory, and contemporary ties and connections.

The involvement of secondary agricultural education students in FFA-sponsored activities clearly fits what science education researchers (Gerber et al., 1997a; Gerber et al., 1997b) maintain about informal learning experiences, i.e., the potential for stimulating “cognitive conflict” and promoting “social interaction,” thus improving students’ scientific reasoning abilities (Gerber et al., 1997a, p. 10-11). In addition, these and other researchers (Dori & Tal, 2000; Etling, 1993; Galper, 1987; McLaughlin, 2000; Swick, 1987) encouraged the involvement of students in “a wide range of school and community activities” (Gerber et al., 1997a, p. 10), including partnerships between the school and local community. In fact, the Public Education Network (McLaughlin, 2000) studied youth who participated in 120 different after-school community organizations in 34 cities (urban, suburban, and rural) across the United States, and reported that, “higher levels of participation in community-based organizations are associated with greater likelihood of academic success” (p. 4) for participating students when compared to American youth in general. Moreover, McLaughlin concluded that the more successful programs shared three common traits; they were youth-centered, knowledge-centered, and assessment-centered. The FFA component of a secondary agricultural education program is a rich vehicle for accomplishing these and similar aims. One of many possible examples is the participation of students in FFA Career Development Events (CDEs).

Career Development Events provide students an opportunity to explore a variety of agriculture-, food-, and environmentally-related “careers, ranging from agricultural communications to environmental and natural resources to livestock selection” (2002-2003 *Official Manual*, p. 49; National FFA Organization *Career Development Event Handbook 2001-2005*). In preparation for the events, students learn technical and academic content that integrates and relies on their understandings and application of numerous scientific terms, principles, concepts, and operations in areas such as agricultural mechanization, including dimensions of bio-systems engineering, agronomy, environmental science, food science, horticultural science, plant science, and poultry science. Connors and Mundt (2001) stated, “Career Development Events are an excellent bridge between what the students learn in the classroom or laboratory, the skills they have learned as part of the SAE program, and the competition and recognition available through the FFA. This bridge builds the transition into career success.” (p. 7)

Many of the CDEs involve team activities that are cooperative learning exercises in which students work collaboratively to interpret and resolve problem-based scenarios, thus addressing science educators’ calls for informal learning opportunities in science that “stimulate cognitive conflict and promote social interaction” (Gerber et al., 1997, p. 11). Moreover, as students prepare to participate in CDEs, frequently, an array of community resources (human and non-human) are called forth to assist in the effort. These student-adult (e.g., novice-expert) and student-resource/realia interactions are consistent with the position of science educators (Dori & Tal, 2000; Gerber et al., 1997a; Gerber et al., 1997b; Gerber et

al., 2001) regarding the positive impact of informal learning activities on student achievement in science. They also reflect long-standing, community-based instructional practices employed by many secondary agricultural education teachers.

McLure and McLure (2000) suggested “that higher science achievement scores[, as measured by the ACT Science Reasoning test,] are linked to participation in out-of-school science accomplishments” (p. 38), and, moreover, “Out-of-class science accomplishments may be an important means of helping students achieve in science” (p. 44). The National FFA Organization sponsors several activities that provide opportunities for student learning in science similar to those described by McLure and McLure, e.g., the National FFA Agriscience Fair (2002-2003 *Official Manual*, p. 43). This learning activity involves “students [grades 7-12] who are studying the application of scientific principles and emerging technologies in agricultural enterprises. . . . Areas of participation closely mirror those of the international science fair, but reflect an agricultural theme [or context]” (p. 43). Categories in the National FFA Agriscience Fair include “Biochemistry/Microbiology/Food Science; Environmental Sciences; Zoology (Animal Science); Botany (Plant/Soil Science); and Engineering Mechanical/Agricultural Engineering Science)” (p. 43).

The National FFA Organization also supports the “Agriscience Student Recognition and Scholarship Program” (2002-2003 *Official Manual*, p. 44), an effort that “recognizes high school students who are studying the application of scientific principles and emerging technologies in an agricultural enterprise” (p. 44). In addition, several National FFA Proficiency Awards require that students demonstrate science-related competencies and thus provide another venue for stimulating students’ out-of-class science accomplishments (p. 45).

Summer Enrichment Programs in Agricultural Education

Further, McLure and McLure (2000) cited “participated in a National Science Foundation summer program for high school students” and/or “participated in a scientific contest or talent search” as examples of students’ out-of-class science accomplishments that were positively related to their science reasoning achievement. In fact, several states (e.g., Georgia, Pennsylvania, and Virginia) sponsor enriched summer programs for high school students who aspire to be agricultural scientists and researchers. In the case of Virginia Governor’s School for Agriculture, its “mission is to provide hands-on, cutting-edge scientific and academic instruction to future leaders and scientists to develop their understanding of the scope, opportunities, challenges, and both academic and scientific rigor of the broad fields of agriculture and natural resources” (Broyles & Camp, 2002, p. 1). The program in Georgia focuses on student learning in agriscience as well as biotechnology (Navarro, Marable, Byrd, & Edwards, 2002). The Georgia and Virginia programs demand that participants be academically-talented, and both states require program applicants to undergo a rigorous admission process.

Conclusions

Science education researchers (Dori & Tal, 2000; Gerber et al., 1997a; Gerber et al., 1997b; Gerber et al., 2001; McLure & McLure, 2000) have described informal learning in science as learning experiences supporting student achievement in science that occur outside of the science classroom, including a variety of activities occurring outside the regular school day in students' homes, workplaces, and communities. Researchers (Gerber et al., 1997a; Gerber et al., 1997b; Gerber et al., 2001) further contend that informal learning experiences involving scientific vocabulary, principles, concepts, laws, and understandings, and creating “cognitive conflict” for learners while also stimulating “social interaction” between them, held high potential for helping students learn science better.

Investigators in agricultural education (Budke, 1991; Buriak, 1992; Conroy et al., 1999; Shelley-Tolbert et al., 2000) have asserted that selected student learning experiences in secondary agricultural education support student achievement in science. Moreover, this study described two fundamental components of secondary agricultural education—SAE (Arrington & Cheek, 1990; Camp et al., 1999; Cheek et al., 1994; Dyer & Osborne, 1995; Dyer & Williams, 1997; Lee, 1998; Noxel & Cheek, 1988; Roegge & Russell, 1990; Zilbert, 1999) and FFA (*2002-2003 Official Manual*; National FFA Organization *Career Development Event Handbook 2001-2005*; Roegge & Russell, 1990)—and a less prominent one—summer enrichment programs (Broyles & Camp, 2002; Navarro et al., 2002)—that appear to offer students significant opportunities for informal learning experiences in science. These experiences may be useful in addressing the calls of science educators' for students to experience cognitive conflict and social interaction in informal contexts involving science thus increasing their science achievement.

Discussion and Implications

Findings of this study suggest that components of secondary agricultural education, such as SAE, FFA, and summer enrichment programs, may be valuable informal learning venues in which students improve their understandings of science while experiencing the agriculture, food, fiber, and natural resources system. Optimistically, secondary agricultural education may indeed *support student learning across the curriculum*, and, perhaps, most acutely in the sciences. Intuitively, many agricultural educators hold that conviction.

In an era of scarce financial resources and “high stakes” testing, one in which student performance in core subjects is prized above all else, to merely “suggest” that agricultural education supports student learning in a core discipline such as science is insufficient (G. Shinn, personal communication, August 19, 2002; L. Case, personal communication, November 15, 2002). However, if significant associations exist that could be demonstrated with substantial empirical rigor, then it is more likely that stakeholders, including decision-makers who set priorities and allocate resources, would be inclined to learn more about secondary agricultural education and its potential for positively enhancing student achievement in select core subjects.

Recommendations for Research and Practice

Additional research should be conducted to demonstrate whether selected informal learning opportunities in secondary agricultural education, such as SAE (Dyer & Osborne, 1995), various FFA activities (Roegge & Russell, 1990), etc., are significantly related to student achievement in science. Investigators should focus on identifying student characteristics, teacher characteristics and behaviors, the nature of science-rich experiences set in the context of agriculture, food, fiber, and the environment, learning resources, and other variables that may influence relationships between students' informal learning in secondary agricultural education and their subsequent science achievement.

Science educators have demonstrated that students benefit from their participation in informal science learning activities. Accordingly, agriculture teachers should increase their commitment toward planning, designing, and delivering learning experiences that afford students substantial opportunities to acquire and apply scientific knowledge and understandings in the contexts of agriculture, food, fiber, and natural resources. To this end, related professional development opportunities for both pre-service and in-service agriculture teachers should be planned and delivered, or otherwise facilitated, by teacher educators and state staff personnel. Further, National FFA Organization staff should review existing activities and programs to determine whether sufficient opportunities exist for students to experience informal learning in science, as well as consider other activities that could be developed to achieve that purpose.

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