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Students' Perceptions of Agriscience when Taught Through Inquiry-Based Instruction

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Abstract

United States science scores have remained stable over the past 12 years, and as a result secondary school students have been deemed less proficient than international peers. Additionally, there has been increased pressure for accountability from both teachers and students. This highly competitive performance-based classroom environment has threatened student motivation. Due to this, many have moved away from an emphasis on rote memorization and lessened the threat of performance testing by using inquiry and problem solving strategies as a way to provide more autonomy in the classroom. Agricultural education has joined the movement in providing autonomy in the classroom through inquiry-based teaching methods. This study investigates the perceptions of school-based agriscience students toward agriscience and inquiry-based instruction when taught through inquiry-based instruction. The perceptions of 170 secondary agriscience students who responded to the questionnaire indicated more favorable attitudes toward agriscience. Participants also had positive responses to items regarding agriculture's importance to society, and influence in their daily lives. It is recommended that inquiry-based instruction be utilized in the agriscience classroom to promote student learning and motivation. Further investigations on the impacts of student motivation in the classroom when inquiry-based instruction is utilized in school-based agriscience education should be investigated.

Keywords: Inquiry-based instruction; students' perceptions; survey

Reports of student performance in the academic arena have called for greater student achievement, suggesting that improvements must be drastic if students are to succeed in today's world (Hanushek, Peterson, & Woessmann, 2010; United States Department of Education, 2000). The 2007 Trends in International Mathematics and Science Study (TIMSS) indicated that science scores of United States students have remained stable over the past 12 years, compared to selected countries (e.g. Hong Kong, England, Singapore) which have seen drastic increases over a 12 year period (USDE, 2009). Additionally, less than 50% of secondary students are proficient in science (Partnership for 21st Century Skills, 2008).

Literature Review

What has contributed to this level of student achievement? Research has suggested student motivation. A student's motivation to learn is reduced in highly competitive environments, or when there is an emphasis on performance goals that do not promote conceptual understanding and seem unattainable (Meece, Anderman, & Anderman, 2006; Urdan & Schoenfelder, 2006). Performance goals are often associated with surface-level cognitive

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strategies, such as rehearsing information and memorization (Meece et al., 2006). Due to the lack of conceptual understanding required by performance goals students may self-handicap, engage in cheating behavior, or obtain lower grades when expected to meet performance goals (Meece et al., 2006). Although these behaviors do not always occur when utilizing performance goals, and some students even thrive with the use of performance goals, the use of such goals does require investigation (Meece et al., 2006). Urdan and Schoenfelder (2006) suggested that student motivation can be increased by de-emphasizing performance goals in the classroom and offering students more chances for autonomy in the classroom. As a result there has been a call to move away from rote memorization and learning in the classroom and an emphasis on individual inquiry and problem solving which provides more opportunities for autonomy (Meece et al., 2006).

In addition to the effects of performance goals on student motivation, research has also suggested that student motivation to learn science is directly related to a student's attitude toward science (Sandoval & Harven, 2011). Student attitudes toward science can be affected by a number of classroom experiences including the instructional approach, the actions of the teacher, or the type of activities conducted (Wee, Fast, Shepardson, Harbor, & Boone, 2004). Less favorable attitudes toward science can have a negative impact on a student's motivation to learn science. Therefore, the use of instructional strategies that develop favorable attitudes can be a key factor in motivating students to learn science (Sandoval & Harven, 2011).

The National Research Council (1996) endorsed the use of science curricula that actively engages students in inquiry-based instruction. Inquiry is defined as "a multifaceted activity that involves making observations; posing questions; examining books and other sources of information to see what is already known; planning investigations; reviewing what is already known in light of experimental evidence; using tools to gather, analyze, and interpret data; proposing answers, explanations, and predictions; and communicating the results" (NRC, 1996, p. 23). Inquiry instruction allows students to generate authentic questions from their own experiences, apply the content to new questions, and engage in problem solving and decision making (NRC, 1996). This is a shift away from presenting information and covering scientific topics, in an effort to allow students the opportunity to learn scientific knowledge with understanding (NRC, 1996). During inquiry-based instruction students are actively engaged in utilizing scientific processes (Gibson & Chase, 2002). Haury (1993) cited that inquiry instruction has been shown to enhance student performance in the laboratory, graphing and data interpretation skills (Mattheis & Nakayama, 1988), foster scientific literacy (Lindberg, 1990), improve critical thinking skills (Narode, Heiman, Lochhead, & Solmianko, 1987), and create positive attitudes toward science (Kyle, Bonnsetetter, McCloskey, & Fults, 1985; Rakow, 1986). In regards to this, the National Research Agenda set forth by the American Association for Agricultural Education has called for meaningful, engaged learning in all environments, which includes the use of effective teaching practices to develop high student achievement and career readiness (Doerfert, 2011). This research concerning inquiry-based instruction in agricultural education will help meet the call set forth by the association.

Much of the literature base regarding inquiry-based instruction has examined student achievement in science. Research conducted by Marx et al. (2004) examined the effects of using inquiry-based instruction on student achievement in urban middle school students over the course of three years. Results suggested that inquiry-based instruction was effective at producing significant gains in student achievement as measured by a pretest and posttest based on the content taught to the students (Marx et al., 2004). Zohar and Nemet (2002) investigated the use of inquiry-based instruction among ninth-grade students. Students were taught genetics using either inquiry-based instructional methods or traditional teaching methods. Results indicated that students in the inquiry-based instructional group scored significantly higher on an achievement exam, compared to students who were taught using traditional teaching methods. Witt (2010) sought to determine the effects of inquiry instruction in sixth and seventh grade students. Students

were first taught using a traditional teaching approach and assessed using a pre-test and post-test. Students were then taught using an inquiry-based instructional approach and a pre-test and post-test were administered. Although the content taught to students was similar, but not identical, the pretest and posttest accounted for any prior knowledge students may have had. Results from the study indicated that student growth was greater when the inquiry-based teaching method was used (Witt, 2010).

Although many studies have evaluated the effects of inquiry-based instruction on student achievement, other studies have also evaluated students' perceptions of the subject matter taught when using inquiry-based instruction. For example, Selim and Shrigley (1983) sought to understand the perceptions of fifth grade students concerning the type of instructional practice that was used in the science classroom. The students in the treatment group were taught using the discovery approach (an inquiry approach) for a period of 21 days. A separate group of students was taught using a traditional lecture approach. The researchers found that students who were taught using the discovery approach had a more positive attitude toward science than students who were taught using traditional methods (Selim & Shrigley, 1983). Deters (2005) evaluated year-end chemistry portfolios assembled by high school sophomores at a private high school. Each portfolio had samples of the students' work and an explanation of why that particular piece was included in the portfolio and what they learned from the experience. Deters reviewed the comments in the portfolios and found that students had an increased interest in chemistry labs when an inquiry-based instructional approach was used. Comments from students indicated that the ability to design a lab was fun, generated more interest, and was more exciting than following specific lab procedures on a handout (Deters, 2005).

Although several studies have indicated that students enjoyed inquiry-based instruction at the end of the course, it is important to note that several studies have found that students often find inquiry-based instruction confusing and challenging when it is first utilized in the course. Harris and Rooks (2010) suggested that different expectations of inquiry-based instruction (e.g. greater participation, responsibility for learning, expectations to speak using scientific terms, increased intellectual effort) is overwhelming for students. Teachers who teach using inquiry-based instruction have suggested that traditional school kills curiosity and re-sparking that curiosity to use during inquiry instruction is difficult (Thoron, Myers, & Abrams, 2011). Furthermore, teachers also indicated the path to creating learners who were enthusiastic about inquiry-based instruction was difficult. One teacher indicated that it took two or three weeks for students to adjust to the new teaching method and focus on learning, rather than on a grade (Thoron et al., 2011).

While inquiry-based instruction has been credited with more positive attitudes and learning outcomes from students immediately following instruction, Gibson and Chase (2002) wanted to understand the long-term effects of inquiry-based instruction on students' attitudes toward science. The researchers utilized students at the Summer Science Exploration Program, which was developed to increase middle school students' interest in science. The camp's focus was to explore biological and health-related subjects using inquiry-based learning. Students were compared based on their selection to attend the camp. Those students who were selected to attend the camp held more positive attitudes toward science five years after attending the camp. Those students who applied for the camp, but were not selected started with positive attitudes toward science, but eventually had a decreased attitude toward science over the five year period.

Previous literature indicates there is sufficient information concerning students' perceptions of inquiry in science, however there seems to be little literature regarding students' perceptions of inquiry in agriscience. Although agriscience is accepted as containing many science principles, it would be worthy to evaluate the use of inquiry-based instruction specifically in agriscience coursework. Furthermore, the American Association for Agricultural Education has called for meaningful, engaged learning in all environments. Inquiry-based instruction meets the call for meaningful and engaged learning. If inquiry-based instruction is to be utilized more in

agriscience courses, than student perceptions of inquiry-based instruction should be evaluated (Thoron, 2010).

Theoretical Framework

Constructivism was the guiding philosophical principal used in this study. Shunk (2012) suggested the increased use of constructivism in teaching in learning, which revealed a greater focus on human factors as an explanation for learning rather than environmental factors. Shunk stated that the rise in constructivism is due to theory and increasing research in human development, particularly the theories of Piaget and Vygotsky. Constructivism is cited as an epistemology that is concerned with the learner's construction of knowledge. Constructivism assumes that people are active learners, and that knowledge is constructed through interactions with people and situations (Shunk, 2012). Piaget's Theory of Cognitive Development (1972) and Vygotsky's Sociocultural Theory (1978) combined to form the theoretical basis of this study, based upon a constructivist perspective.

Piaget's Theory of Cognitive Development posits that cognitive development depends on four factors: biological maturation, experience with the physical environment, experience with the social environment and equilibration. The effects of the first three factors depend on the fourth factor, equilibration (Schunk, 2012). Equilibration is a biological drive to find a state of adaption between cognitive structures and the environment (Duncan, 1995). This is the motivating factor behind cognitive development and coordinates the actions of the first three factors (Schunk, 2012).

Through research, Piaget concluded that a child's cognitive development will pass through a fixed sequence. Thus, Piaget categorized each level of development, resulting in four stages—sensorimotor, preoperational, concrete operational and formal operational. In the sensorimotor stage, a child's actions are spontaneous as they attempt to understand the world. During the preoperational stage, children can imagine the future and reflect on the past, but remain focused on the present (Schunk, 2012). The third and fourth stages are of most interest to this study, and agricultural education. In the third stage, concrete operational, there is significant cognitive growth, individuals develop the ability to think logically, and begin to show some abstract thinking. In the final stage, formal operational, learners are able to think about hypothetical situations and abstract properties as well as develop hypotheses (Schunk, 2012).

Vygotsky's Sociocultural Theory is a constructivist theory, but there is more emphasis on the social environment as a factor in development and learning (Schunk, 2012). Vygotsky argued that interactions with people and the environment fuel developmental processes and foster cognitive growth. These interactions are used by learners in conjunction with their knowledge to reorganize their mental structures. Vygotsky's theory states that learning and development cannot be dissociated with a context. An interaction with the world transforms thinking (Schunk, 2012). This theory provides a foundation for social learning between individuals in the classroom environment, learning in a context, and the teacher as a facilitating role in this study. Piaget's theory adds knowledge of learners' experiences and learners' ability to adopt and adapt new knowledge into their schema.

Purpose of the Study

The purpose of this study was to ascertain perceptions of secondary school agriscience students toward agriscience when taught through inquiry-based instruction. The specific objectives of this study were to:

1. Describe secondary school agriscience students' perceptions toward agriscience, when taught through inquiry-based instruction.
2. Describe secondary school agriscience students' perceptions toward inquiry-based instruction in agriscience courses, when taught through inquiry-based instruction.

Methods and Procedures

Seven teachers from the National Agriscience Teacher Ambassador Academy (NATAA) were purposively selected as participants for this study; students of these teachers were the accessible population. Teachers in the NATAA program received training in utilizing inquiry-based instructional techniques. Additionally, teachers were required to audio record each lesson, which was reviewed at the conclusion of the treatment by the researcher to ensure fidelity of the treatment. Each instructor taught a prescribed unit on soil science using inquiry-based instruction. Over the course of the 12-week study, pretests and posttests were administered to students at the beginning and end of each unit, respectively, to evaluate student achievement and assess student attitudes toward inquiry-based instruction (Thoron, 2010). Since the study concluded that inquiry-based instruction was an efficient approach to teaching student attitudes were collected to further investigate the teaching method utilized.

The focus of this study was students who received inquiry-based instruction (N=170). At the end of the 12-week study conducted by Thoron (2010), the attitude survey was administered to students. This study contained 21 questions based on a summated rating scale (strongly disagree, disagree, uncertain, agree, strongly agree) that evaluated two constructs: attitudes toward agriscience and attitudes toward inquiry-based instruction. This instrument was a researcher-developed instrument. The instrument was evaluated for face and content validity by a panel of experts at the University of Florida in the Department of Agricultural Education and Communication. Experts deemed the instrument was appropriate. Internal consistency of the instrument was established using a pilot test that yielded the following Cronbach's alpha for each of the constructs: agriscience = 0.85 and inquiry-based instruction = 0.81. Post-hoc reliability analysis was also conducted for the instrument, resulting in the following Cronbach's alpha for each construct: agriscience = 0.81 and inquiry-based instruction = 0.90.

Findings

The findings of this study are limited to the participants since participants received inquiry-based instruction as a treatment by NATAA participants and the use of intact groups. Objective one sought to determine the perceptions of secondary school agriscience students toward agriscience. Results (see Table 1) indicated that 71.8% of students agreed or strongly agreed that "agriscience is useful for solving everyday problems." A majority (75.9%) of students indicated they had a "real desire to learn agriculture." Nearly all (95.9%) of students disagreed or strongly disagreed that "there is no science taught in my agriculture class."

Furthermore, 88.2% of students agreed or strongly agreed that "agriculture is of great importance to a country's development." A majority of students (51.9%) agreed or strongly agreed that "most people should study some agriculture." Nearly two-thirds (60.2%) of students agreed or strongly agreed that they "would like to have a career in agriculture."

Objective two sought to determine the perceptions of secondary school agriscience students toward inquiry-based instruction when they were taught through inquiry-based

instruction. Almost half (44.2%) of the students agreed or strongly agreed that they "preferred learning through inquiry over other ways [they] have been taught in the past." A majority (52.3%) agreed or strongly agreed they "would like to take more courses that use inquiry-based instruction." Only 28.2% of students agreed that "learning through inquiry was confusing."

Additionally, 80% of students agreed or strongly agreed that they "enjoy doing lab activities in class." Over two-thirds (72.4%) of the students indicated that "working in groups helps me learn more." Finally, 71.8% of students indicated that they "feel at ease in the agriscience classroom."

Table 1

Students' Attitudes about Inquiry-based Agriscience Instruction (N=170)

	Frequencies				
Statement	SD %	D %	U %	A %	SA %
Agriscience					
Agriscience is useful for solving everyday problems.	8.2	11.8	8.2	51.8	20.0
Agriscience is my favorite class.	8.2	0.0	24.1	47.7	20.0
When I think of agriculture, I don't think of science.	15.9	35.9	0.0	40.0	8.2
You can get along perfectly well in everyday life without agriculture.	24.1	25.9	20.0	20.0	0.0
When I hear the word agriculture, I have a feeling of dislike.	52.4	23.5	8.2	11.8	4.1
I would like to have a career in agriculture.	8.2	15.8	5.8	40	20.2
Most people should study some agriculture.	8.2	24.1	15.8	47.7	4.2
You won't be popular if you like agriculture.	72.4	8.2	7.6	11.8	0.0
I enjoy talking to other people about agriculture.	2.4	8.2	17.0	40.0	32.4
I have a real desire to learn agriculture.	8.2	8.2	7.7	35.9	40.0
Agriculture is of great importance to a country's development.	0.0	0.0	11.8	36.4	51.8
There is no science taught in my agriculture class.	71.8	24.1	2.4	1.7	0.0
Inquiry-Based Instruction					
I preferred learning through inquiry over other ways I have been taught in the past.	8.2	15.9	31.7	32.4	11.8
I would like to take more courses that use inquiry-based instruction	15.9	15.9	15.9	44.1	8.2
Learning through inquiry was confusing.	15.9	35.9	20.0	28.2	0.0
I enjoy working in groups.	8.2	3.6	0.0	48.2	40.0
I like using the computer to complete assignments.	0.0	11.8	8.2	32.3	47.7
I enjoy doing lab activities in class.	8.2	11.8	0.0	40.0	40.0
Working in groups helps me learn more.	2.4	8.2	17.0	32.4	40.0
I feel at ease in the Agriscience classroom.	0.0	20	8.2	35.9	35.9
I like learning new things.	3.5	8.2	8.2	40.1	40.0

Note. SD = strongly disagree, D = disagree, U = uncertain, A = agree, SA = strongly agree

Conclusions

These results suggested that students responded positively to both agriscience and inquiry based instruction. Responses to items regarding agriculture indicated an overall positive opinion of agriculture, agriculture's importance to society, and agriculture's influence in the students' lives. This result led to the conclusion that inquiry-based instruction has a positive influence toward for shaping students' attitudes toward agriscience.

In terms of inquiry-based instruction, students preferred learning through this method and were interested in taking more courses that utilized this method. Although slightly less than half of the students were uncertain or agreed that learning through inquiry was confusing, an overwhelming majority indicated that they liked learning through inquiry techniques such as group work and using computers. Overall, these results indicated favorable attitudes for both using inquiry-based instruction and using this methodology to teach agriscience.

Discussion and Implications

The findings of this study support the work of Gibson and Chase (2002) that suggested when students are taught through inquiry, more favorable attitudes are formed toward science. Research (Sandoval & Harven, 2011) has shown that favorable attitudes toward a subject matter increase a student's motivation to learn that subject matter. Since results indicated there was increased motivation from students who were taught through inquiry-based instruction, students may have been more engaged in the subject matter being taught. Research has shown correlations between student engagement and student motivation (Meece et al., 2006).

Furthermore, Sandoval and Harven (2012) recommended the use of instructional strategies that promote the development of a favorable attitude. Through this population, inquiry has proved to be successful in promoting favorable attitudes toward agricultural education. Gibson and Chase (2002) also found the development of favorable attitudes in the area of science when inquiry instruction was used with middle school students. Both these studies indicated that inquiry instruction could be used with other subjects that utilize laboratory settings in order to promote the development of favorable attitudes for the subject matter.

However, both Thoron et al. (2011) and Harris and Rooks (2010) indicated that inquiry-based instruction is often confusing and challenging for students when the teaching method is first used. Results from this study indicate that some students did find this teaching method challenging and had difficulty adapting to inquiry based instruction. Although students thought this method of instruction was confusing, teachers in the Thoron et al. study indicated that it took time for students to grasp this method and focus on learning. Since this instrument was administered at the end of the study, there is no way of knowing if students were reflecting on the whole time inquiry-based instruction was used, or just remembering when they began using this method. Regardless, research has shown that students need time to adjust to a new teaching method before they feel comfortable and successful (Thoron et al., 2011).

Gibson and Chase (2002) indicated that middle school students taught science using inquiry-based instructional practices were more aware of careers within the field of science. However, these researchers also found that the students' interests in science careers decreased between middle school and high school (Gibson & Chase, 2002). Results from this study indicate an increased interest and awareness of careers in agriculture with high schools students. Therefore, this method of instruction for use in increasing interest in careers has proved to be congruent with previous research.

The use of the inquiry method has been endorsed by the National Research Council (1996) as appropriate for promoting active engagement in the development of scientific knowledge. Due to the overall positive opinion of agriculture and inquiry instruction from the use of inquiry-based instruction in this study, it may be important to prepare pre-service teachers for

the use of inquiry-based instruction in their classroom. Due to the consistency of the results when using inquiry in science settings, and inquiry in agriculture settings, it is plausible to suggest that the use of inquiry in other agriculture classrooms be used to promote the development of favorable attitudes, scientific knowledge, and promote the career opportunities in agriculture. Therefore, teacher preparation programs should be prepared to provide instruction to pre-service teachers in the area of inquiry-based instruction. Additionally, professional development should be provided for teachers in both inquiry-based instruction teaching methodology and encouraging learners when IBI is difficult. Providing teachers with the tools to help students be successful in adapting to IBI will help make the transition to this teaching style easier. Finally, the implications developed through this study have contributed to the National Research Agenda set forth by the American Association for Agricultural Education (Doerfert, 2011) by providing insight into effective teaching practices that can be utilized in the agriculture classroom to promote student engagement and achievement.

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