Journal of Agricultural Education,
56(4), 107-122. doi: 10.5032/jae.2015.04107

A Measure of Students' Motivation to Learn Science through Agricultural STEM Emphasis

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Abstract

There is an increased demand for motivated high school students to enter postsecondary STEM fields. Agriscience education is an innovative curriculum that can motivate students and spark interest in STEM. To recruit students to such programs, we must understand what motivates them. The purpose of this study was to determine how the secondary agriculture students conceptualized their motivation to learn agriscience. A descriptive-correlational research design was utilized with a modified version of the Science Motivation Questionnaire II (SMQ II) used as the survey instrument. Overall, students were found to have moderate levels of motivation in agriscience courses. Grade motivation and self-efficacy were found to be the motivational constructs that meant the most to students. Students were least motivated by self-determination. Getting an A and the chance to receive higher grades in their agriculture science courses were found to be the highest motivators. Researchers found that there were no significant correlations between gender or grade level and motivation to learn science. Females generally had higher motivation within self-determination and grade motivation than males. Additional research is needed in this area to determine what factors may exist that are preventing highly efficacious females from choosing STEM careers.

Keywords: agricultural science, STEM, student motivation, science education

America's ability to maintain competiveness on a global scale within science, technology, engineering and mathematics (STEM) is an issue of utmost importance (Carnevale, Smith, & Melton, 2011), while there is still need for improvement in the area of STEM education (National Research Council, 2012). STEM as a career choice still lags behind demand in the United States and recent increases (2010) trailing international growth (U.S. Department of Labor, 2007; Rothwell, 2014). The demand for motivated high school graduates to enter postsecondary STEM fields is at its highest, but student interest and readiness has been declining (ACT, 2006, Carnevale, Smith & Melton, 2011). Furthermore, motivation to learn science benefits all students by fostering scientific literacy skills including; learning science knowledge, how to identify important scientific questions, and understanding how to draw evidence-based conclusions (Bryan, Glynn & Kittleson, 2011). The need for general scientific literacy is continually increasing (National Commission on Excellence in Education, 1983; McLure & McLure, 2000; Miller, 2010). Given the pressing concerns facing STEM education, there should be academic programs and support systems that motivate and prepare students to enter these challenging and important programs are imperative.

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The National Center for Education and Economy (2007), National Academy of Science (2007), and National Research Council (2012) are among many who have acknowledged the need for new and innovative approaches to education, specifically in science education. Research has suggested that a lack of scientific literacy could be due to the science in our schools being too abstract and lacking relevant context for students to apply learned skills (Conroy, Trumbull & Johnson, 1999; Shelley-Tolbert, Conroy & Dailey, 2000). Project-based learning, which increases conceptual understanding of science and promotes positive attitudes towards learning science (Yasar, 2002), and specifically, contextualized science education (Rivet & Krajcik, 2008), presents a promising innovative approach.

Agricultural education and agriscience should be considered as one of these project-based, contextualized approaches. Courses in agriculture have historically been shown to motivate students (Campbell, 1983). As an integral part of agricultural education, the FFA student leadership organization is an integral component in motivating students to learn a variety of skills at many different levels (Phipps & Osborne, 1988; Gruis, 2006). Agriculture science programs offer opportunities to use agriculture as a context for teaching and learning scientific principles (Israel, Myers, Lamm & Galindo-Gonzalez, 2012). This leaves agricultural science programs with the opportunity to offer and positively motivate students to pursue STEM based education.

The agriculture science curriculum has shown to greatly impact students due to the holistic nature of the courses (Bailey, 1998), and agriscience education can be incorporated into the framework for science achievement (Connors & Elliot, 1995; Scales, Terry & Torres, 2009). Agriscience is a robust and appealing curriculum that employs both formal and informal learning opportunities for students (Conroy, et al., 1999; Wooten, Rayfield & Moore, 2013). Agriscience has shown to be beneficial in students' learning of STEM concepts and in helping students to transfer these skills to practical applications (Mabie & Baker, 1996; Chiasson & Burnett, 2001; Myers, Thoron & Thompson, 2009). Students in agriculture science programs demonstrated higher achievement than students who were taught by traditional approaches (Enderlin & Osborne, 1992; Ricketts, Duncan & Peake, 2006).

While research has shown the benefits of integrated agricultural science in the learning of STEM concepts, there is a lack of research in what factors motivate students to be successful in agriscience courses. By high school, students' motivation to learn science is one of the highest predictors of science course success (Britner & Pajares, 2006). Agriscience draws a diverse population of students (Shelley-Tolbert, et al., 2000), but there has been little research into the factors of motivation in STEM coursework and entrance into STEM fields. There is, however, a record of gender disparities within STEM attitudes and program completion (Adelman, 2006). Nationally, males, people who spoke a language other than English, and people who had stronger academic preparation were more likely to engage in a career within STEM and more likely to enter STEM fields (Chen, 2009). Freeman (2004) found that females were less likely to enjoy advanced science courses in high school. Some of the reasons for this may include the curriculum offerings as well as the types of experiences and opportunities students receive (Elliot et al., 1996; Ellington, 2006; Seymour & Hewitt, 1997). Existing research reveals that the choices to pursue STEM fields are affected by math and science related interest, self-assessment (Halpern, Camilla, Geary, Gur, Hyde & Gernsbacher, 2007) and science based courses completed during high school (Ethington & Wolfe, 1988; Maple & Stage, 1991). While this information is important, we must seek to understand the perceived barriers to students choosing a career in the STEM field. To understand this better, research must be done on what motivates students to take science-influenced courses, like those found in the agriscience curriculum.

There exists several motivation and motivation-related components that have been linked to learning science: intrinsic motivation, which involves learning science for its own sake (Pintrich, 2004); extrinsic motivation, which is the learning of science as a means to an end, usually for some type of competition or reward (Mazlo, Dormedy, Neimoth-Anderson, Urlacher, Carson & Kelter, 2002); personal relevance, the relevance of learning science to an individual's goals; self-determination, the control students felt over their learning of science; and self-efficacy, or students' confidence that they can achieve science. Motivational factors also play an important role in students' learning and transfer of problem solving skills (Bereby-Meyer & Kaplan, 2005).

Theoretical Framework

The theoretical framework for this study starts with Bandura's (1986) social cognitive theory, particularly using motivation and self-efficacy as necessary for ability. Motivation is defined in social cognitive theory as an internal state that arouses, directs and sustains goal-oriented behavior. To be motivated to learn students must participate in activities and courses that are personally meaningful and worthwhile (Glynn and Koballa, 2006). Motivated students achieve academically by engaging in behavior such as asking questions, participating in labs and working in groups (Schunk, et al., 2008). Bandura described the concept of self-efficacy, as a person's beliefs about their capabilities (Bandura, 1984; 1997). With self-efficacy being closely related to ability, if a person has low efficacy or confidence in a task, then their performance in that task is expected to be low, and conversely, higher ability levels would tend to increase their motivation levels and as a result, their level of performance (Bandura, 1997).

Often linked with social cognitive theory is the theory of planned behavior (Azjen, 1985), which is an extension of the theory of reasoned action (Fishbein & Azjen, 1975; Azjen & Fishbein, 1980). Both were designed to exhibit the relationship between informational and motivational influences on behavior (Connor & Armitage, 1998). The theory of reasoned action depicts the psychological process by which attitudes cause behavior (Fishbein, 1963; Azjen, 1991). The theory of planned behavior suggests that behavioral intentions can be best viewed as consequences of an individual's attitude, which is a result of values and beliefs, in turn affected by demographic variables and knowledge. Taken together, this study examines demographic variables and knowledge as they relate to attitudes, motivation, and self-efficacy for learning science as influences on agriscience students' success in learning STEM concepts.

Purpose and Objectives

The purpose of this study was to identify how secondary agriculture students conceptualized their motivation to learn agriscience. The researchers also sought to determine whether gender or grade level correlated with these motivational factors. Specific objectives of this study were to:

1. Describe the demographic characteristics of New Mexico students enrolled in agriscience courses.
2. Measure factors that motivated New Mexico students in agriscience courses
3. Identify whether any relationships existed between students' motivation, grade level and gender.

Furthermore, this study addresses Research Priority Three of the American Association for Agricultural Education (AAAE) National Research Agenda – Sufficient Scientific and Professional Workforce That Addresses the Challenges of the 21st Century (Doerfert, 2011).

Methods and Procedures

This non-experimental, descriptive study focused on secondary students enrolled in an agriculture science course in New Mexico. A list of all teachers who were offering an agriculture science course was obtained from the New Mexico Department of Education. Participants were selected based upon the criteria that they were enrolled in at least one agriculture science course where they were receiving core science credit. Dillman's method of tailored design (2007) guided data collection. After IRB approval, the first author contacted all of the 55 teachers identified as teaching an agriscience course and offering science credit to their students. Following an agreement for student participation protocol and parent permission, teachers received a packet via mail with the number of surveys for each student enrolled in their agriscience course. These packets also included a postage-paid envelope to return the completed surveys. All surveys sent to teachers were returned. A total of 539 students participated in this study. As New Mexico is a very rural state, small numbers of students in courses like this is representative of the population. Collected data was entered and analyzed using SPSS version 19 on measures of central tendency and correlations where appropriate. Magnitudes of the correlations were reported using Davis's convention (1971). Caution should be used when making inferences beyond the census population.

This study used a descriptive-correlational research design (Gall, Gall, and Borg, 2007), "to discover the direction and magnitude of the relationship among variables through the use of correlational statistics" (Gall, Gall, and Borg, 2007, p. 636). Specifically, a point-biserial correlational statistical method, a special case of the pearson product-moment correlation, was utilized (Creswell, 2008), a point-biserial correlational method is used ". . . when one variable is measured as an interval or ratio scale and the other has two different values [a dichotomous scale]" (p. 644) to correlate interval scale data with a dichotomous variable. Additionally, this study is descriptive, as it also employs a methodology that allowed secondary agriscience students to describe factors that motivate them and correlated these findings with student demographic characteristics. Due to the nature of this study, caution should be taken when generalizing the findings or when making inferences beyond the sample population.

The instrument used for this study was a modified version of the Science Motivation Questionnaire II (SMQ II) (Glynn, Brickman, Armstrong & Taasoobshirazi, 2011). Glynn and Koballa (2006), following guidelines by DeVellis (2003) and Bradburn et al. (2004), developed the Science Motivation Questionnaire to assess the motivation to learn science. The 25-question instrument included the following five-item scales: *intrinsic motivation, self-determination, self-efficacy, career motivation,* and *grade motivation.* Students respond to each item on a Likert-type rating scale: never (1), rarely (2), sometimes (3), often (4), or always (5). The raw scores should be interpreted carefully, as the scales are ordinal. According to Boone and Boone (2012), analysis of Likert-type and Likert-scale data are different and must be reported as such. Likert-type data that do not contribute to a composite scale are treated as individual questions, and reported using descriptive statistics (i.e., median, mode, and frequencies), where Likert-type data that contributes to a composite score (i.e., Likert-scale) is reported using means and standard deviations for variability (Boone & Boone, 2012).

An advantage of this questionnaire is that it does not distinguish among different science subjects, but focuses on a general motivation to learn science. The items of the revised questionnaire were designed so that the word "science" in each item can be replaced with the word biology, chemistry, or agriscience, creating a Biology Motivation Questionnaire, Chemistry Motivation Questionnaire, or Agriscience Motivation Questionnaire, respectively (Taasoobshirazi & Glynn, 2009). It has been emphasized by Glynn and Koballa (2006) that the instrument can easily be used in all of science. For this study, the version used replaced the term "science" with "agriculture science."

In earlier studies (Glynn, Taasoobshirazi, & Brickman, 2009; Glynn, Brickman, Armstrong, & Taasoobshirazi, 2011), the Science Motivation Questionnaire II was found to have good content validity and criterion-related validity. Face and content validity was confirmed for this study through the use of a panel of experts comprised of agriscience teachers and university faculty. The panel felt the statements "my career will involve agriculture science" and "I will incorporate agriculture science in my career" were too similar. The latter was removed, leaving the researchers with 24 motivation statements in the instrument. The possible score range on each of the five 5-item sub-scales was 5–25. Overall a participant's summated score could range from 24-120. The survey began with the prompt, "In order to better understand what you think and how you feel about agriscience, please respond to each of the following statements from the perspective of "When I am in an agriculture science course . . ."

As recommended by DeVellis (2003), the items were randomly ordered, strongly worded, unambiguous declarative statements in the form of short, simple sentences without jargon. The statements were easy to read. The Flesch-Kincaid formula indicates readability at the sixth-grade level (Taasoobshirazi & Glynn, 2009). The items were focused on the motivation to learn science in courses rather than a multitude of contexts, such as hobbies. Because of this focus, the scales were not long, and the entire questionnaire could be completed efficiently in about 15 minutes. Reliability of the Science Motivation Questionnaire II resulted in Cronbach's Alpha Coefficient of 0.92 (Glynn, et al., 2011). The reliability of the individual scales assessed by Cronbach's alphas for the modified instrument was: career motivation (0.92), intrinsic motivation (0.89), self-determination (0.88), self-efficacy (0.83), and grade motivation (0.81).

Findings

The first objective of this study was to describe the demographic characteristics of [STATE] students enrolled in agriscience courses. This included information about participants' genders and grade levels. The population was predominantly male (62.2%), and largely freshman (29.6%) and sophomore students (29.8%). Table 1 describes these findings.

Table 1

Demographic Characteristics

	F	*%*
Gender*		
Male	322	62.2
Female	196	37.8
Grade Level**		
9	153	29.6
10	154	29.8
11	125	24.2
12	85	16.4

Note * n = 518, ** n = 517

The second objective of this study sought to determine how the secondary New Mexico agriculture students conceptualized their motivation to learn agriscience. Tables 2 and 3 describe these findings.

Table 2

Conceptual Factors Motivating Students to Learn Agriscience (n = 539)

Components/Statements	*M*	*SD*
Intrinsic Motivation		
Learning agriculture science is interesting	3.96	0.95
I enjoy learning agriculture science	3.92	1.00
The agriculture science I learn is relevant to my life	3.80	0.93
I am curious about discoveries in agriculture science	3.63	1.07
Learning agriculture science makes my life more meaningful	3.39	1.10
Self-Efficacy		
I believe I can earn a grade of "A" in agriculture science courses	4.15	1.02
I am sure I can understand agriculture science	4.07	0.95
I am confident I will do well on agriculture science labs	3.81	1.01
I believe I can master agriculture science knowledge and skills	3.80	1.06
I am confident I will do well on agriculture science tests	3.74	1.01
Self-Determination		
I put enough effort into learning agriculture science	3.93	0.96
I use strategies to learn agriculture science well	3.64	1.04
I spend a lot of time learning agriculture science	3.46	1.10
I study hard to learn agriculture science	3.41	1.14
I prepare well for agriculture science tests and labs	3.38	1.10
Grade Motivation		
It is important that I get an "A" in agriculture science courses	4.16	1.06
Getting a good agriculture science grade is important to me	4.07	1.08
Scoring high on agriculture science tests and labs matters to me	3.99	1.07
I like to do better than other students on agriculture science tests	3.87	1.13
I think about the grade I will get in agriculture science courses	3.82	1.13
Career Motivation		
Learning agriculture science will help me get a good job	3.93	1.11
Knowing agriculture science will give me a career advantage	3.94	1.16
Understanding agriculture science will benefit me in my career	3.76	1.26
My career will involve agriculture science	3.33	1.39
Summated Scores	90.96	25.83

Students were found to have a moderate level of motivation in agricultural science with a summated average of 90.96 out of a possible 120 score. It was found the largest motivators for students were grade motivation, specifically, the importance of getting an A in their agriculture science class (*M* = 4.16), and self-efficacy, believing they could get an A in the course (*M* = 4.15) and that they can understand agricultural science (*M* = 4.07). The least common motivators were career, students' belief that their career would involve agriculture science (*M* = 3.33), self-determination, spending time to prepare for class (*M* = 3.38), and intrinsic, that learning agriculture science makes their life more meaningful (*M* = 3.39). The highest motivational constructs were found in the areas of grade motivation with an average mean for the five items of 3.98. Following in importance were self-efficacy (*M* = 3.91), intrinsic motivation (*M* = 3.74), career motivation (*M* = 3.73) and self-determination (*M* = 3.56).

Table 3

Measurement of Individual Factors Motivating Student Learning

Statements	*Median*	*Mode*
It is important that I get an "A" in agriculture science courses	5.0	5.0
The agriculture science I learn is relevant to my life	4.0	4.0
Learning agriculture science is interesting	4.0	4.0
I am curious about discoveries in agriculture science	4.0	4.0
I enjoy learning agriculture science	4.0	4.0
I am confident I will do well on agriculture science tests	4.0	4.0
I am confident I will do well on agriculture science labs	4.0	4.0
I believe I can master agriculture science knowledge and skills	4.0	4.0
I believe I can earn a grade of "A" in agriculture science courses	4.0	5.0
I am sure I can understand agriculture science	4.0	4.0
I put enough effort into learning agriculture science	4.0	4.0
I use strategies to learn agriculture science well	4.0	4.0
I like to do better than other students on agriculture science tests	4.0	5.0
Getting a good agriculture science grade is important to me	4.0	5.0
I think about the grade I will get in agriculture science courses	4.0	5.0
Scoring high on agriculture science tests and labs matters to me	4.0	5.0
Learning agriculture science will help me get a good job	4.0	5.0
Knowing agriculture science will give me a career advantage	4.0	5.0
Understanding agriculture science will benefit me in my career	4.0	5.0
I spend a lot of time learning agriculture science	3.0	3.0
I prepare well for agriculture science tests and labs	3.0	3.0
I study hard to learn agriculture science	3.0	3.0
Learning agriculture science makes my life more meaningful	3.0	3.0
My career will involve agriculture science	3.0	5.0

When looked at individually, we find that the lowest median scores (3.0) were related to how meaningful agriculture science classes were to students' overall life and how much preparation/studying they had to go through when preparing for class. The highest median score (5.0) was found within students' motivation to get the highest grade in their agriculture science courses. Table 4 displays the differences among the five motivational constructs' mean scores.

Table 4

Motivational Construct Means

Construct	*M*	*SD*
Grade Motivation	3.98	1.09
Self-Efficacy	3.91	1.01
Career Motivation	3.74	1.23
Intrinsic Motivation	3.74	1.01
Self-Determination	3.56	1.07

Grade motivation and self-efficacy were the highest motivational factors for student success in agriscience courses, consistent with the individual item scores. This is also consistent with previous research into science motivation which found that self-efficacy was a strong prediction of science motivation and performance (Britner & Pajares, 2006). Self-determination was the lowest motivator for students to succeed in agriscience courses.

The third objective was to identify relationships between student motivation and demographic characteristics. Means scores between each of the motivational constructs and participants' gender is presented in Table 5, while mean and summated mean scores by grade level are presented in Table 6.

Table 5

Comparing Motivation Factors by Gender

Component Scale	Measure	Male (n = 322)	Female (n = 196)
Intrinsic Motivation	*M*	3.69	3.84
	SD	1.06	0.92
Self-Efficacy	*M*	3.89	3.95
	SD	1.07	0.90
Self-Determination	*M*	3.53	3.84
	SD	1.15	0.99
Grade Motivation	*M*	3.86	4.19
	SD	1.15	0.96
Career Motivation	*M*	3.70	3.79
	SD	1.24	1.22

Table 6

Comparing Motivational Factors by Grade Level

Component Scale	Measure	9th a	10th b	11th c	12th d
Intrinsic Motivation	*M*	3.60	3.73	3.86	3.86
	SD	1.08	1.05	0.95	0.88
	Summated Total	17.99	18.63	19.30	19.32
Self-Efficacy	*M*	3.71	3.91	4.06	4.09
	SD	1.08	1.03	0.94	0.89
	Summated Total	18.55	19.55	20.28	20.47
Self-Determination	*M*	3.41	3.55	3.70	3.69
	SD	1.09	1.03	1.05	0.99
	Summated Total	17.06	17.73	18.31	18.47
Grade Motivation	*M*	3.85	3.95	4.11	4.09
	SD	1.21	1.12	0.98	0.99
	Summated Total	19.27	19.73	20.51	20.43
Career Motivation	*M*	3.64	3.72	3.75	3.94
	SD	1.26	1.12	0.98	1.07
	Summated Total	14.54	14.89	14.98	15.77

Note: a (*n = 153*); b (*n = 154*); c (*n = 125*); d (*n = 85*); e - Intrinsic motivation, self-efficacy, self-determination and grade motivation summated scores could range from 5 - 25. Career motivation scores could range from 4 - 20.

Motivation to learn agricultural science was found to go up as students advanced in grade level. There was found to be little differences between junior and seniors motivation to learn agricultural science. Summated scores increased with each grade level except for grade motivation, which dropped by 0.08 points between the 11th and 12th grade. Variance was found to go down between scores as students grade level advanced from 9th - 12th grade. Construct mean scores for self-efficacy and grade motivation for males was (M = 3.89; 3.86) respectively with female mean scores being (M = 3.95; 4.19). All of the motivational statements were found to have weak correlations with gender and grade level. Thus, there was not found to be any significant correlations between students' gender or grade level and their specific motivational factors in agriscience courses (Table 7).

Table 7

Correlations Between Gender and Grade Level

Motivational Statement	Gender r_s	Grade Level r_s
The agriculture science I learn is relevant to my life	.10	.11
Learning agriculture science is interesting	-.01	.13
Learning agriculture science makes my life more meaningful	.11	.12
I am curious about discoveries in agriculture science	.10	.09
I enjoy learning agriculture science	.07	.061
I am confident I will do well on agriculture science tests	-.04	.16
I am confident I will do well on agriculture science labs and projects	-.01	.16
I believe I can master agriculture science knowledge and skills	-.01	.14
I believe I can earn a grade of "A" in agriculture science courses	.12	.10
I am sure I can understand agriculture science	.08	.16
I put enough effort into learning agriculture science	.08	.09
I use strategies to learn agriculture science well	.01	.12
I spend a lot of time learning agriculture science	.04	.14
I prepare well for agriculture science tests and labs	.01	.12
I study hard to learn agriculture science	.10	.06
I like to do better than other students on agriculture science tests	.09	.10
Getting a good agriculture science grade is important to me	.20	.06
It is important that I get an "A" in agriculture science courses	.19	.12
I think about the grade I will get in agriculture science courses	.13	.09
Scoring high on agriculture science tests and labs matters to me	.14	.08
Learning agriculture science will help me get a good job	.08	.08
Knowing agriculture science will give me a career advantage	.07	.11
Understanding agriculture science will benefit me in my career	.02	.05
My career will involve agriculture science	-.01	.06

The researchers next sought to determine any perceived relationships between each motivational statement and the participant's gender or grade level. The point-biserial coefficient correlation revealed that the top two ranking motivational statements correlations for gender were: Getting a good agriculture science grade is important to me (r_s = .200); and It is important that I get an "A" in agriculture science courses (r_s = .192), with the bottom two ranking motivational statements correlations for gender being: I am confident I will do well on agriculture science labs and projects (r_s = -.002); and I believe I can master agriculture science knowledge and skills (r_s = -.005); which was tied with the statement: I prepare well for agriculture science tests and labs (r_s = .005). Regarding the top two ranking motivational statements correlations for grade level: I am confident I will do well on agriculture science labs and projects (r_s = .162); and I am confident I will do well on agriculture science tests (r_s = .159), with the bottom two ranking motivational statements correlations for grade level being: Understanding agriculture science will benefit me in my career (r_s = .052), and I study hard to learn agriculture science (r_s = .056).

Conclusions

The purpose of this study was to determine who secondary agriculture students are and how they conceptualized their motivation to learn agriscience, particularly whether gender correlated with motivational factors, given traditional gender imbalance in STEM programs. Due to the nature of this study, caution should be taken when generalizing the findings beyond the population. However, generalization with caution may contribute to the knowledge base of what motivates students within the context of agriculture science courses. Almost two-thirds of the population of the study was male. The results of this study supported previous findings concerning gender disparity regarding, as posited by Adelman (2006). Participants existed across all grade levels, with a majority representing the freshman and sophomore class.

When analyzing the conceptual factors that motivate students to learn agriscience, the highest motivational construct existed in grade motivation, with the largest student motivator reflecting the importance of getting an "A" in their agricultural science class. This finding supports the research of Mazlo, et al. (2002), who identified those extrinsic motivations such as learning science as a "means to an end" (i.e., competition, rewards, good grades, etc.) can serve as a motivator to learn science. It is important to note that there was only a .07 difference between grade motivation and the next highest motivational construct, self-efficacy, corroborating with previous research into science motivation, which found that self-efficacy, student's perceived capability to achieve specific results, was a strong prediction of science motivation and performance (Britner, 2008; Kupermintz, 2002; Lodewyk & Winne, 2005).

However, differences existed between males and females in their motivation to learn agricultural science. Both the constructs regarding grade motivation and self-determination had the highest difference in mean score between genders. However, these two constructs also had the highest mean scores for both genders. Construct mean scores for self-efficacy and grade motivation for males was (M = 3.89; 3.86) respectively with female mean scores being (M = 3.95; 4.19). The increased mean of self-efficacy in females over males corroborates with research on other physical and life science courses (Britner, 2008; Britner and Pajares, 2006).

Recommendations for Research

This study did not uncover a statistically significant correlation between motivational statements and student gender, but did show gender differences in motivational constructs, specifically grade motivation and self-efficacy. The higher self-efficacy of females in their motivation to learn agricultural "science" should be an indicator of future success in STEM related fields, more specifically, science. However, male STEM graduates still outnumber female STEM graduates, despite a higher number of women overall enrolling in undergraduate study in the United States (Adelman, 2006). Additional research is needed in this area to determine what factors may exist that are preventing highly efficacious females from choosing STEM careers, including school science textbooks that rarely represent females equally, lack of time in school for women to use tools and equipment, or less real-world connection of content for females than males (Burke & Mattis, 2007). Moreover, what additional courses and activities have the potential to provide personal meaning and relevance to further motivate females to enter these career areas?

The high scores for external motivation factors, particularly motivation to earn good grade, should also be further examined. Grades are not necessarily indicative of long-term learning, or the ability to generalize and transfer knowledge and skills. Intrinsic motivation is also more strongly linked to long-term persistence than extrinsic motivators.

As a census study, generalization is limited, and caution should be taken when applying the findings beyond this population. Further studies replicating this research should be conducted in other states as well as nationally to further support the conclusions from this body of work. Additionally, the inclusion of additional measures of self-efficacy and motivation should be employed to reinforce those findings.

Recommendations for Practice

Democracy demands a scientifically-literate public (Feinstein, 2011; Miller, 2010), and competitive economics demands a STEM-prepared workforce (Carnevale et al., 2011). Agricultural science can provide a contextualized, problem-based curriculum for students. With self-efficacy being highly correlated with academic success, it stands to reason that teachers must find new and innovative ways to support the increase of self-efficacy in their students, and take advantage of the research that has indicated that agriculture courses have been found to provide that motivation in students (Campbell, 1983). Agricultural educators should design their curricula and supporting curricular activities around experiences that provide meaningful sustained learning and motivational opportunities. Teachers should focus on exercises and labs that require real-world application of science skills in the agriculture classroom.

Further, STEM teacher educators are encouraged to try to motivate and enhance student learning through contextualized agricultural science education. Agricultural education and science teacher educators in university preparatory programs can support the emphasis of these connections by themselves, by connecting with what have recently been separate, certification and preparation processes. Development of agriscience standards at the state and national level can also support these connections. In schools, shared planning and even shared teaching when possible between agricultural and STEM teachers can lead to lessons that mutually reinforce each other, providing context to the STEM content and providing STEM skills to the agricultural courses (Chiasson & Burnett, 2001).

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