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Can Scientific Reasoning Scores Predict the Likelihood of SBAE Students' Intent to Pursue a STEM Career, a Career in Agriculture, or Plan to Attend College?

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Abstract

Demands placed on teachers and students continue to increase in order to develop the skills required of the 21st century workforce. There continues to be a need to utilize curriculum and instruction to inspire students to engage in STEM majors and careers. Improving instructional methods and providing opportunities for students to question and problem solve, through the use of inquiry-based instruction (IBI) can increase scientific reasoning abilities. This instructional approach may assist in improving, not only the academic achievement of students, but it may encourage students to plan to attend college and develop potential career aspirations for agriculture and STEM. This research used the scientific reasoning scores from 663 students enrolled nationwide in school-based agricultural education programs (SBAE) to predict students' likelihood to indicate plans to pursue a career in agriculture, STEM or plan to attend college. The findings reveal scientific reasoning scores predict students' likelihood to indicate intention to pursue a STEM career and plan to pursue college. Implications from this research suggest SBAE instructors should continue their efforts to incorporate IBI into instruction in order to engage students to think critically and solve real world problems, while exposing students to the skills requisite for STEM major/career access.

Keywords: scientific reasoning; inquiry-based instruction; STEM careers

Maintaining global competitiveness depends on America's ability to produce a knowledgeable labor force armed with 21st century skills and competencies and the education system is the primary source of science, technology, engineering and mathematics (STEM) labor (Gonzalez & Kuenzi, 2012). The importance of providing education in the STEM fields has been a point of emphasis over the past ten years. The secondary school setting represents a critical point to help adolescents become aware of potential STEM careers and develop a need for education to help them prepare for these careers (Hall, Dickerson, Batts, Kauffmann, & Bosse, 2011).

The goal of school-based agricultural education (SBAE) programs has been to help develop students' potential for career success (Phipps, Osborne, Dyer, & Ball, 2008). Today, this requires highlighting the STEM concepts and principles in the SBAE curriculum. Carnevale, Smith, and Melton (2011) suggested the need to conduct studies to identify STEM skills and competencies to be included in SBAE programs. The three circle model of SBAE has provided a framework to develop 21st century skills and career interest in agriculture and STEM majors/careers. The general interests of students, student needs, community workforce demands, and local area opportunities and trends are all factors for consideration during the SBAE design and development process

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(Phipps et al., 2008). As stated in the FFA motto, students are learning by doing. The SBAE curriculum focuses on providing students with opportunities to practice and apply the knowledge and skills they learn in the classroom/laboratory, through their supervised agricultural experience projects and by their participation in FFA activities. The ultimate responsibility of a SBAE program has been to assure future success for its graduates (Phipps et al., 2008).

Interest in STEM majors/careers among high school seniors has increased by over 20% since 2004 (Munce & Fraser, 2012). Each year, nearly 28% of high school freshman have declared interest in a STEM related field (Munce & Fraser, 2012). Continued efforts in SBAE programs to increase those numbers has helped to bridge the STEM employment gap. The lack of workers with basic STEM competencies has perhaps been more concerning than the shortage of workers (Carnevale et al., 2011). Emphasis within SBAE programs has been placed on secondary students with an existing interest in the STEM fields, and resources have been allocated to support that focus, thus SBAE programs can assist in preparing students for the STEM workforce. SBAE programs possess the curriculum, framework and resources required to develop those existing student interests (Conley, 2010). In addition, SBAE can inspire students in the career discovery process to develop an interest in STEM (Phipps et al., 2008).

It has been widely agreed that economic and social benefits of scientific thinking and STEM education can be broadly applied in both STEM and non-STEM occupations (Gonzalez & Kuenzi, 2012). Educational principles within agriculture and STEM disciplines have provided experiential learning opportunities for students to transfer their knowledge to real world applications in their everyday life. Critical college and career decisions are being determined as student's progress through their secondary education. This has been a crucial time to capture student interest and develop college and career readiness skills, especially in agriculture and STEM fields (Hall et al., 2011).

There continues to be a demand for graduates in STEM fields (Wang, 2013). Enhanced knowledge of the influences on career choice has been vital to improve intervention efforts to engage students in career access to the STEM fields (Hall et al., 2011). Extensive efforts in American K-16 education have been required, based on the demand for STEM competencies outside traditional STEM occupations (Carnevale et al., 2011). Continued efforts to produce a sufficient STEM workforce have been vital to maintain global competitiveness. The Career and Technical Education system has required a robust and rigorous curriculum at the secondary and post-secondary levels, close-fitting to the competencies requisite for STEM careers (Carnevale et al., 2011). The agriscience curriculum has integrated and highlighted STEM skills, emphasizing the importance for transfer and application of those skills to agriculture and STEM careers, thus developing student interest in those college majors and career fields. There has been a need for greater attention to be placed on factors relevant to interest and entrance into the STEM pipeline (Wang, 2013).

Review of Literature

Research on inquiry-based instruction (IBI) in science education has shown promise. Yerrick (2000) reported lower achieving students can increase their argumentation skills through the use of IBI. Huber, Smith and Shotsberger (2000) found that students who were taught using IBI felt more successful in their science classes, enjoyed learning science, and found the lessons to be useful. Gibson and Chase (2002) indicated that IBI can keep students interested in science when compared to more traditional models of instruction. Gerber, Cavallo & Marek (2001) also report, the experiential nature of IBI promotes reasoning ability. A review of empirical research in the science literature reveals documentation that inquiry teaching has promoted scientific reasoning (Adey & Shayer, 1990; Lawson, 1995; Marek & Cavallo, 1997). While IBI has shown positive results for students in science education (Anderson, 2002), relatively few studies have been conducted in SBAE.

Several studies conducted on IBI in SBAE have shown some promise. Thoron and Myers, (2011) reported student achievement on a standardized test can be increased through the use of IBI. Easterly and Myers (2011) noted SBAE programs that utilized IBI increased achievement scores for students with special needs. Thoron and Myers (2012) also reported that IBI increased scientific reasoning scores for students in SBAE. Scientific reasoning can be defined as the utilization of evidence-based reasoning to connect the process of producing scientific knowledge (Lawson, 1995). To advance scientific reasoning, students must generate expectations, control variables, generate causes, determine probabilistic reasoning, and determine proportional reasoning (Lawson, 1982). The Lawson's Classroom Test of Scientific Reasoning (LCTSR) was utilized in this research. It is important to note, development of scientific reasoning ability can aid in producing more productive, informed citizens of our society, while encouraging life-long learning (Gerber et. al, 2001).

The variables of students planning to pursue college and choosing an agricultural career were also analyzed as a point of comparison in this research. Agriculture is fundamentally important to our culture, history and economy. The content and scientific nature of agriculture technology links academic disciplines together. Interdisciplinary inquiry is necessary if SBAE programs strive to meet both industry and students' needs and career interests (Conroy, Scanlon & Kelsey, 1998). Career guidance has been embedded in the job description of an agriculture teacher. Teachers influence the career aspirations of their students more regularly than they are aware, often being more effective in career guidance than the school counselor (Kotrlik & Harrison, 1987). Adedokun and Balschweid (2008) reported a link between involvement in FFA and pursuit of an agricultural career. Their research did not distinguish the difference between agricultural careers and STEM careers.

Gerber et al. (2001) reported involving students in informal learning experiences and partnership activities between community and school resources promoted social interaction, which improves scientific reasoning. Within the three circle model of a SBAE program, the curriculum extends beyond the classroom, providing informal learning experiences. Community development projects, travel to leadership events and field trips, and interaction with local and state industry, commonly occurs. Participation in outside of school activities, including organizations such as the FFA, may excite the development of thinking and problem solving skills useful in the everyday life and future careers of students. There has been a need to explore aspects of science learning, including informal experiences and reasoning ability, to determine potential influence on future college and career decisions (Gerber et al., 2001).

Some college and career readiness indicators show a lack of alignment between high school academic content and the necessary knowledge and skills required for post-secondary success (Lombardi, Seburn, & Conley, 2011). Important factors in determining college and career readiness and adequate measures of the knowledge and skills acquired by high school graduates should be determined. Identification of assessment tools, beyond grade point average and high school achievement scores may enable schools to better prepare students to be college and career ready (Lombardi et al., 2011).

This research aimed to examine the role of scientific reasoning in students' probability to pursue post-secondary education, as well as, intent to pursue a STEM or agriculture career. Conley (2007, 2010), suggested cognitive strategies, content knowledge, contextual skills, academic behaviors and awareness are important components to develop college and career readiness skills.

Theoretical and Conceptual Framework

Constructivism was the guiding framework for this research. Constructivism is the belief that students "construct" truth based on the world around them (Doolittle & Camp, 1999). At its foundational level, the effectiveness of constructivism stems from having learners construct their own beliefs and thoughts about what they experience. According to Schunk (2012), in constructivism no real truths exist; learners discover and verify truth as they see it. Doolittle and Camp (1999) identify cognitive constructivism as a branch of constructivism that is particularly applicable in career and technical education. According to Doolittle and Camp (1999):

> . . . Cognitive constructivists also emphasize the ability of individuals to construct similar, if not identical, mental models based on similar or identical experiences. This ability to construct similar mental models supports the career and technical education requirement of students learning a core set of historically reliable knowledge and skills.

Constructivism is considered an epistemology. Since the tenants of constructivism span across different philosophers it is difficult to test as a true theory (Schunk, 2012). Bearing in mind the epistemological nature of constructivism, this research used IBI as the content delivery method and an operational definition for constructivism. IBI was developed from the tenants of constructivism (Parr & Edwards, 2004; Thomas, 2008). IBI guides students to question and discover the answers to questions by using the scientific method. The National Science Education Standards (National Research Council, 1996) defined IBI 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 results. Inquiry requires identification of assumptions, use of critical and logical thinking and consideration of alternative explanation (p. 23).

The National Science Education Standards (NRC, 1996) have been framed by IBI and have required students to combine scientific knowledge and processes while using critical thinking and scientific reasoning to develop an understanding of science.

The Thoron and Myers (2012) conceptual model for the effects of IBI was used for this research. The model explained the interactions that occurred in an inquiry-based classroom between the student and teacher and highlighted the outcome variables. Scientific reasoning was the outcome variable explored in this research. Scientific reasoning measures students' ability to use and understand the scientific method (Lawson, 1982). Evidence-based reasoning is used to make predictions about outcomes and organize meaningful scientific experiments and draw meaning from them (Thoron & Myers, 2012).

To operationally define IBI as the constant for this research, the instructors, selected to participate in this research, all recently completed the same high quality professional development program. The training explicitly modeled and offered opportunities for collective participation to provide strategies to implement IBI into agriscience classroom instruction. The student outcome variable of scientific reasoning was the independent variable of interest explored in this research. Students' intent to pursue a STEM career, agriculture career, and plan to attend college were the dependent variables.

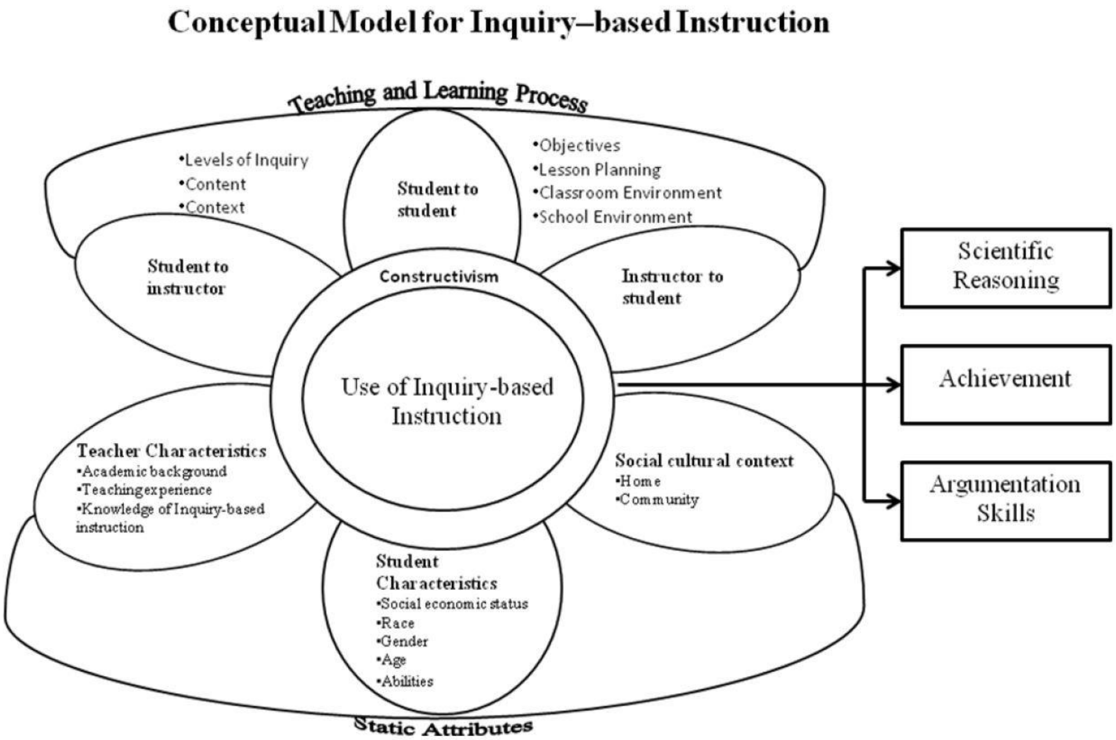

Figure 1. A conceptual model for inquiry-based instruction (Thoron & Myers, 2012)

Purpose and Research Questions

The development of effective and efficient educational programs is one of six key priorities in the *Agricultural Education National Research Agenda* (Doerfert, 2011). The key outcome of this priority suggests highly effective educational programs will meet the academic, career, and developmental needs of diverse learners in all settings and at all levels (Doerfert, 2011). The purpose of this research was to provide findings to expand the literature base and indicate attributes of exemplary SBAE programs, specifically operationalizing IBI in relation to scientific reasoning scores as the exemplar. This research used the scientific reasoning scores from 663 students enrolled nationwide in SBAE programs, taught by teachers using IBI, to predict the likelihood of their plan to pursue a career in agriculture, a STEM career or plan to attend college.

Several factors represent the necessary components of curriculum that improves the skills required for students to be successful in the STEM fields. Based on Thoron and Myers' (2012) research, an assumption was made that IBI increases scientific reasoning scores. The purpose of this research was to determine if scientific reasoning scores can predict students' likelihood to indicate they plan to pursue a career in STEM. The variables of students' intention to enter an agriculture career and students' plan to attend college were also measured.

The following research questions provided the framework for this research:

1. Can scientific reasoning scores predict students' likelihood to indicate they plan to pursue a career in STEM?
2. Can scientific reasoning scores predict students' likelihood to indicate they plan to pursue a career in agriculture?
3. Can scientific reasoning scores predict students' likelihood to indicate they plan to attend college?

Methods

A causal-comparative design was used for this research. The target population of this research was students in SBAE classes where the agriscience teacher used IBI. To verify the treatment of IBI, the instructors were all selected from the same professional development program where IBI was operationally defined. As teachers incorporate IBI into their daily lesson plans, students are inspired to think critically, problem solve and pose questions. A purposive sample of 48 agriscience teachers who completed the National Agriscience Teacher Ambassador Academy (NATAA) training, in the summer of 2012, were contacted via phone and follow-up email, inviting them to participate in this research. Eleven teachers agreed to participate in the research and collectively reported total program enrollment of 1068 students. Data from a total of 663 students was provided for a 62% response rate.

Survey Instrument

The 2000 revised edition of the Lawson's Classroom Test of Scientific Reasoning (LCTSR) (Lawson, 2000) with the addition of 13 demographic questions was used to collect the data for this research. The LCTSR consisted of 24 multiple-choice questions that tested the scientific reasoning of the students using 'what' and 'why' questions. The instrument included questions testing identification and control of variables, proportional and probabilistic reasoning and hypothetical-deductive reasoning. The instrument focused on student ability to apply aspects of scientific and mathematical reasoning in order to analyze a situation, to make a prediction or solve a problem (Lawson, 2000). Established by six experts in the area of Piagetian research, the LCTSR is known to be a valid instrument (Thoron & Myers, 2012). The author of the instrument reported a Kuder-Richardson 20 reliability estimate for grade levels 8, 9, and 10 as .78 (Lawson, 1978). A researcher-developed packet consisting of detailed instructions, student consent forms, parental consent forms, student scan sheets, student questionnaires/examinations, and paid postage return envelopes was mailed to the instructors at the beginning of October during the 2012-2013 school year. In addition, instructors were provided an electronic copy of all documents including a detailed instructional presentation that outlined the guidelines for the administration of the instrument packet. Definitions of STEM careers and agriculture careers were not operationalized for the teachers and students in this study. Instructors were given a recommended three-week timeframe to have students complete and return the instruments. One additional week was provided for collection of student and parental consent forms.

Data Analysis

The student answer sheets were scanned and coded into Microsoft Excel 2010. The data were then imported into SPSS 20.0 for data analysis. Descriptive statistics such as frequencies, percentage scores, standard deviations, and crosstabs were initially analyzed. Agresti (1996) identified the logistic regression model used for this research as:

$$logit[\pi(x)] = log\left(\frac{\pi(x)}{1-\pi(x)}\right) = \alpha + \beta x$$

In order to determine the effect of each variable stated in the research questions, the following logistic regression models were used.

Research question 1: $X_{STEM} = a + b_{SR\ score}$

Research question 2: $X_{AG\ Career} = a + b_{SR\ score}$

Research question 3: $X_{College} = a + b_{SR\ score}$

Logistic regression was used because it is appropriate when attempting to predict a categorical dependent variable by using a linear independent variable. According to Metler and Vannatta (2010), logistic regression tests a model's ability to predict a person's likelihood of belonging to a categorical dependent variable. A further requirement of logistic regression is that the dependent variable is categorized as a binary, pass/fail variable. For the purpose of using this statistic, indication of students' plan to pursue a STEM career, plan to pursue a career in agriculture, and plan to attend college, were selected as the "pass" variables. Odds ratios, which indicate logarithmic odds at a particular score, were analyzed for comparison (Field, 2009). The variable used as the prediction variable was scientific reasoning score and the outcome was intent to attend college, pursue a career in STEM, and pursue a career in agriculture. An alpha level of $p < .05$ was used for all analysis.

Findings

Data were reported from 663 students enrolled in SBAE from eleven programs in the United States. The scientific reasoning score was recorded as the percentage of correct responses on the LCTSR exam. The mean scientific reasoning score for the sample was M = 33% (SD = .16). Of the respondents, 32.7% (n = 216) reported they plan to pursue a STEM career and 40.2% (n = 265) of respondents reported they plan to pursue an agriculture career. Of the respondents surveyed, 92.3% (n = 612) reported they plan to attend college. Of the respondents, 60% (n = 398) were male and 40% (n = 265) were female. The respondents were asked if they had an individual education plan (IEP), 52.4% (n = 345) had no IEP, 11.2% (n = 74) had an IEP, 33.9% (n = 225) did not know, and 3% (n = 19) did not respond. Of the respondents, 70% (n = 464) reported they were white, 13% (n = 86) black, 3.9% (n = 26) American Indian, 3.6% (n = 24) Asian, 2.4% (n = 16) Pacific Islander, and 7.1% (n = 47) did not respond. On a separate item, 12.4% (n = 82) of the respondents indicated they were Hispanic/Latino.

Research question 1- Can scientific reasoning scores predict students' likelihood to indicate they plan to pursue a career in STEM?

The logistic regression model for scientific reasoning scores predict students' plan to pursue a STEM career. The model was found to be statistically significant at the $\alpha < .05$ level (Table 1). The adjusted $R^2 = 0.07$.

Table 1

Regression Coefficients for Choosing a STEM Career

	B	*p*
Constant	-1.74	-
Scientific Reasoning Score	0.03	<.00*

Note. *$p < .05$ level, adjusted $R^2 = 0.07$

Sample calculations were explored to illustrate the effect of scientific reasoning scores on the variable of choosing a STEM career. The model indicated, at two standard deviations below the mean, scientific reasoning scores predict students have a 17.3% likelihood of selecting a STEM career, those at the mean have a 31.4% probability of selecting a STEM career, and those two standard deviations above the mean have a 54.3% probability of selecting a STEM career (Table 2). The greatest increase in predictive probability occurs at the score of 58.0%. The odds ratio was calculated to predict the overall probability at a specific score. At the mean score of 33% the calculated odds ratio was .46. Because the odds ratio was less than 1 at a mean score of 33%, a student with that score is less likely to indicate they plan to pursue a career in STEM. At a score of 60% the odds ratio is 1.00, which indicates that students at that score have a 50% probability of indicating they plan to pursue a career in STEM.

Table 2

Predicted Probability of the STEM/Scientific Reasoning Scores Model

	Score	Calculated Odds Ratio	Predicted Probability
2 SD below mean	06	0.21	17.3
1 SD below mean	17	0.29	22.1
Mean	33	0.46	31.4
1 SD above mean	49	0.73	42.1
2 SD above mean	66	1.19	54.3

Note. Score = % correct responses on the Lawson's Classroom Test of Scientific Reasoning (LCTSR); Predicted Probability = % predicted to choose they would select a STEM career.

Research question 2- Can scientific reasoning scores predict students' likelihood to indicate they plan to pursue a career in agriculture?

The logistic regression model for scientific reasoning scores predicts students' plan to pursue a career in agriculture. This model was not statistically significant at the $\alpha < .05$ level (Table 3). The predicted outcomes were not calculated for this variable given the lack of statistical significance.

Table 3

Regression Coefficients for Choosing an Agriculture Career

	B	*p*
Constant	-0.70	-
Scientific Reasoning Score	0.01	.07

Note. adjusted R^2 = 0.01

Research question 3- Can scientific reasoning scores predict students' likelihood to indicate they plan to attend college?

The logistic regression model for scientific reasoning scores predicts students' plan to attend college. This model was found to be statistically significant at the $\alpha < .05$ level (Table 4). The adjusted R^2 =0.02.

Table 4

Regression Coefficients for Planning to Attend College

	B	*p*
Constant	1.81	-
Scientific Reasoning Score	0.02	.03*

Note. $*p < .05$ level, adjusted $R^2 = 0.02$

Sample calculations were explored to illustrate the effect of scientific reasoning scores on the variable of planning to attend college. The model indicated that at two standard deviations below the mean scientific reasoning scores, students have an 87.3% likelihood of indicating they plan to attend college, those at the mean have a 92.2% likelihood of indicating they plan to attend college, and those two standard deviations above the mean have a 95.8% likelihood of indicating they plan to attend college (table 5). The greatest increase in predictive probability occurs at the score of 90.5%. The odds ratio was calculated to predict the overall probability at a specific score. At the mean score of 33% the calculated odds ratio was 11.82. A student with a score of 33%, which is at the mean, is 11.82 times more likely to indicate they plan to attend college than not.

Table 5

Predicted Probability of the College/Scientific Reasoning Scores Model

	Score	Calculated Odds Ratio	Predicted Probability
2 SD below mean	06	6.89	87.3
1 SD below mean	17	8.59	89.6
Mean	33	11.82	92.2
1 SD above mean	49	16.28	94.2
2 SD above mean	66	22.87	95.8

Note. Score = % correct responses on the Lawson's Classroom Test of Scientific Reasoning (LCTSR); Predicted Probability =% predicted to choose they plan to attend college.

Conclusions and Implications

More than 92% of the students who participated in this research indicated plans to attend college. Further, 40.2% of students plan to pursue a career in agriculture and 32.7% plan to pursue a career in STEM. Logistic regression calculations indicated the likelihood of students' intention to pursue a STEM career increased as scientific reasoning scores increased. This same phenomenon was observed regarding students' intention to attend college. Given the $R^2 = .02$, and the high percentage of students who indicated they plan to attend college (92.2%), caution should be used when interpreting the results of scientific reasoning scores as related to students' plan to attend college. There was not a significant predictive association between scientific reasoning score and intention to pursue a career in agriculture. For this sample, scientific reasoning score has the highest predictability of students' likelihood to indicate they plan to pursue a STEM career. Given these findings, it is important for agriscience teachers to be aware of this relationship between increased scientific reasoning scores and a students' plan to pursue a STEM career. Efforts to provide teacher professional development programs to improve instruction using IBI in SBAE programs should continue and should be expanded to reach a greater population of agriscience teachers throughout the United States.

As SBAE instructors continue their efforts to incorporate IBI into their instruction, students will have additional meaningful opportunities to critically think and problem solve, while constructing new knowledge from those enriched experiences, provided in their agriscience classroom. Based on the findings of this research, knowledge construction following this format of IBI has the potential to increase scientific reasoning scores and thus increase students' probability to enter a STEM career. This finding is supported by the conceptual model for IBI (Thoron, & Myers, 2012) which suggests use of IBI in the teaching and learning process can be directly related to scientific reasoning, the focus of this research. Figure 2 proposes a model that explains the variables of interest for this research in relation to the conceptual model of IBI presented by Thoron & Myers (2012). Determining instructional methods to improve student interest in college and careers is vital to meet the workforce demands of the 21st century (Carnevale et al., 2011).

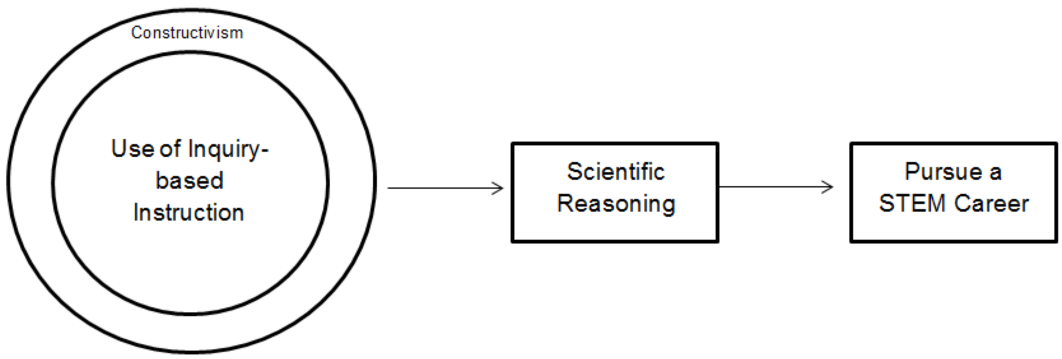

Figure 2. A conceptual model for students' likelihood to indicate a plan to pursue a STEM career

Caution should be used when interpreting these results. This study did not use an experimental design, which limits the conclusions that can be made about the effectiveness of IBI compared to other methods when measuring career outcome variables. Additionally there was no control for the amount of career instruction provided to students during this study, which could be a variable that impacts a students' career decision making process. When interpreting the results, the relatively low mean score (33%) on the LCTSR instrument should be considered. Although student response rate was relatively high, the 23% participation rate of teachers is a limitation for this research.

Recommendations

Three major questions arise from this research. First, since this research found a model that holds some predictive power for the relationship between scientific reasoning score and student intention to plan to attend college and intention to pursue a STEM career, but a large part of the variability remains unexplained, other factors influencing these decisions should be the focus of further inquiry. Further investigation using logistic regression models should be conducted to determine other factors that have predictive power over students' college and career decisions.

Second, if scientific reasoning is an outcome of IBI, as documented by Thoron & Myers (2012), then the benefits of scientific reasoning for students should be further explored. It was noted that IBI can be defined in various ways. This research operationally defined IBI as the method taught as part of a high quality professional development program. Since the instructors recently completed the program during the implementation of this research, further investigation should be done with instructors who have more experience with IBI. Given the mean scientific reasoning scores were relatively low (M = 33%), further logistic regression models should be used to determine if the model holds true and explains more of the variation for samples with higher scores. Further investigation is needed to determine if other operational definitions of IBI experience similar results, or if there is something unique in the manifestation of this teaching method. In either case, it is recommended that work be completed to seek to determine what factors of IBI lead to the increase in science reasoning score. Therefore, it may be possible to apply those factors in other teaching methods common in SBAE, in addition to IBI.

Finally, since educating students about STEM careers was not an overt focus for the teachers in this study, further studies should be conducted to determine what SBAE teachers can do to encourage students to consider STEM careers, specifically STEM careers related to agriculture. Preparing students throughout the nation to enter STEM related careers will be critical to maintain competiveness in the global marketplace. There is a documented need to investigate what factors affect students' decisions to pursue a STEM career (Wang, 2013). With formal education being found as an important means to make students aware of STEM careers (Hall et. al., 2011), it is critical that teachers be equipped with the most effective methods to teach content, as well as, capture the interest of students in STEM. Moreover, the fact that scientific reasoning scores predicted students' likelihood to indicate plans to pursue a career in STEM, but not agriculture, suggests a need to crystalize the relationship between the two types of careers in the minds of teachers and students. Further research should be conducted to determine what SBAE students know about STEM careers as they relate to agriculture.

SBAE has an important place in the discussion of student career choice. It is critical that teachers be given the tools to assist students in making informed decisions regarding college enrollment and career choice. The findings of this research should be shared with classroom teachers, school administrators, and state staff in order to leverage the outcomes for student benefit. Teacher professional development on the implementation of effective teaching strategies, such as IBI, that increase student scientific reasoning score needs to be widely available. Further, teacher educators are encouraged to include instruction on IBI in teaching methods courses taught in teacher preparation programs.

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