Interdisciplinary Activities for Agriculture and Math Educators to Promote Student-Centered Learning

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Abstract

Based on current demands placed on teachers related to the No Child Left Behind Act of 2001 (U.S. Department of Education, 2003), an interdisciplinary workshop was provided to agriculture and math educators. The workshop focused on providing educators with student-centered learning materials that would help advance the knowledge of high school students. The subject material distributed at the workshop provided educators with several teaching materials that related to infusing math, science, and English into their curriculum. High school math (n=3) and agriculture (n=17) teachers were given a pre-test questionnaire prior to the workshop and a post-test questionnaire after the workshop. Questions in the pre and post tests focused on how comfortable each teacher was in teaching reading, math, and science concepts in their classroom. Results of the pre- and post- test questionnaires indicated teachers felt more comfortable incorporating reading, math, and science concepts into their curriculum after the workshop.

Introduction

The most demanding and comprehensive legislation enacted to this date, the No Child Left Behind (NCLB) Act of 2001, was signed into law on January 8, 2002 by President George Bush (U.S. Department of Education, 2003). The NCLB Act is a national accountability system to improve student achievement and make sure that the neediest children are not being left behind. NCLB Act is unique in that it focuses on both student achievement and teacher quality. Primarily, student achievement is concentrated in the core subject areas: math, science, and English (U.S. Department of Education, 2003). The bulk of testing, every year in grades three through eight and once between grades ten and twelve, centers on reading and mathematics. However, by the school year 2007-2008, students will also be tested in science.

Beyond student achievement, core subject area teachers must be considered highly qualified. A highly qualified teacher must hold a “bachelor's degree, full state certification and licensure as defined by the state, and demonstrate competency, as defined by the state, in each core subject academic subject he or she teaches” (U.S. Department of Education, 2003, p. 12). While agricultural education is not considered a core subject, many high schools offer an Agriscience course which can be substituted for a life science course. Because of this substitution, agricultural educators must be considered highly qualified to teach Agriscience. Moreover, the state mandated curriculum requires teachers to integrate a variety of subject matter into their curriculum.

Integrating core subject areas into the agricultural education curriculum has become a priority for many high school agriculture educators. The integration of subject matter materials provides the opportunity for agricultural education to be an applied learning course. Applied learning combines essential courses (math, science, and English) into a curriculum that is student-centered (Southern Region Educational Board, 1992). In student-centered courses, students use basic skills to perform tasks and solve complex problems and the teacher utilizes more interactive discussions, group projects, meaningful

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homework assignments, laboratory experiments, and other hands-on learning activities to create the student-centered classroom (Southern Region Educational Board, 1992).

Creating a student-centered learning environment can be difficult for educators because it takes extra time to prepare innovative lessons which position students to be in control of some of their own learning. Additionally, incorporating and enforcing the core academic subject areas into the student-centered curriculum is a challenge. However, Littky and Grabelle (2004) clearly remind us that students learn best when being actively engaged in their work. It is important for teachers to receive some professional development related to innovative teaching methods which incorporate core academic subject areas into their curriculum. However, with the reduction of professional development funds in many schools, teachers are not always provided with as many opportunities to receive additional training. As university faculty members usually stay on the forefront of educational reform, they are a great resource to utilize to deliver such workshops when local schools cannot.

Purpose and Objectives

The purpose of the workshop was to form a collaborative partnership between faculty from the College of Agricultural Sciences and Natural Resources and the College of Education to deliver a comprehensive integration workshop to high school teachers in the agricultural sciences, math, and English fields. The objective was to provide them with teaching and assessment tools so they could better incorporate subject matter content (math, English, etc.) into their curriculum in order to increase student achievement.

Methods

Faculty from the College of Agricultural Sciences and Natural Resources and the College of Education, Health, and Human Sciences at a Southern university teamed up to provide an interdisciplinary workshop-- “Just because it is a standard doesn't mean it has to be a boar”-- for agriculture, math, science, and English high school educators. Materials at the workshop were presented by university faculty members who represented the agricultural education, English education, and math education programs. The science educator could not be present; therefore, the agriculture educator developed an innovative Agriscience lesson for participants. The workshop was offered on three separate occasions to accommodate the schedules of the high school educators. Agricultural educators were instructed to bring a math, science, or English teacher with them to the integration workshop so the educational materials provided would enhance each discipline being represented. However, only three agriculture educators were able to secure a math educator to attend and the remaining 14 agriculture educators were not able to secure a math or English educator to attend.

To obtain feedback from the workshop, a questionnaire consisting of four questions was given to each teacher prior to the workshop. The questionnaire was developed and validated by the presenters of the workshop and contained a code number. The purpose of the code number was to secure the identity of participants involved in the workshop. The purpose of the questionnaire was to determine how comfortable each teacher felt about teaching reading, math, and science concepts in their daily lessons. The questions asked were: 1) How comfortable are you in teaching reading strategies (as indicated by your state standards) to your students? 2) How comfortable are you in teaching math strategies (as required by your standards) to your students? 3) How comfortable are you in teaching science strategies (as required by your standards) to your students? 4) What do you need to know to better incorporate math, science and/or English skills in your classroom? The questionnaire utilized a four-point Likert-type scale with 1=very uncomfortable, 2=uncomfortable, 3=comfortable, and 4=very comfortable. Additionally, teachers were asked to explain their ranking to each question.

Workshop Components

The workshop outlined here was an attempt to provide agriscience and math educators with ways to address issues related to agriscience and other core academic subject matter. Components of the workshop were divided between reading comprehension, math integration, and innovative science concepts. Subject matter curriculum materials and accompanying rubrics were presented by university faculty in each of those fields. English, Math, and Agriscience subject areas focused on practical lesson ideas to assist teachers in the integration of these topics into their high school curriculum.

A. Reading comprehension

When anyone reads, three componentsthe reader, the climate, and text featureswork interactively to help them make meaning. Each reader brings with him or her certain knowledge and experience. The more a reader “brings” and can associate with a text, the easier it is to make connections and understand new material. Then, the climate in which students read (the physical aspects of the classroom, their level of safety and comfort, how accepted they feel, etc.) influences their learning. Finally, the type of text read affects comprehension. Are there pictures and/or charts to provide information? How large or small is the print? What type of vocabulary is used? Many students have problems with reading comprehension because one, or all three of these conditions, is lacking (Billmeyer and Barton, 1998). For example, students often have difficulty reading science textbooks (such as chemistry or physics) because they have had no prior experience with these new concepts and terms. Moreover, quite often students' science textbooks are written above their grade level causing added difficulty (Braselton and Decker, 1994; Miller, 1997). Because of the nature of Agriscience classes and the materials students read in them, stressing these features at the beginning of the workshop was vital. The reality is that if students are having difficulty with reading comprehension in English class, they probably have problems with reading in all classes.

In attempting to continue the workshop's theme, the English educator began the reading comprehension session by using an introduction to and plot summary of Animal Farm by George Orwell (1946), a novel whose main characters are farm animals. This piece of literature was selected to reinforce the notion that "reading" is not just for when students are in English class, but that reading and teaching reading skills can be practiced in all classes. This idea was reinforced through the notion of curricular integration. After participants read the material they were asked to determine ways that activities and/or lessons from science, mathematics, history/social studies, and English could be incorporated with the novel. Using a grid (see Figure 1), participants worked together to identify potential ideas.

From there, the reading session focused on the use of graphic organizers that might work well with Agriscience classes. Participants were asked to come up with examples and lessons for each of the blank templates provided. Three, in particular, were identified as most useful by workshop participants: the anticipation guide, chronological sequence, and a KWL chart.

Figure 1. Workshop participants' examples ofcurricular integration utilizing the novel Animal Farm

Ways to Integrate the Curricula
Science o Darwin; survival of the fittest o Evolution o Crop rotation
Math o Figuring out total acreage o Buying and selling o Windmill production
History/Social Studies o Stalinist Russia o World War II
English o Fables o Study the author o Allegory

1. Identify the major concepts that students should learn from reading.
2. Determine ways these concepts might support or challenge the students' beliefs.
3. Create four to six statements that support or challenge the students' beliefs and experiences about the topic under study. The statements can address important points, major concepts, controversial ideas, or misconceptions. Easy, literal statements should not be used.
4. Share the guide with students. Ask the students to react to each statement, formulate a response to it, and be prepared to defend their opinions.
5. Discuss each statement with the class. Ask how many students agreed or disagreed with each statement. Ask one student from each side of the issue to explain his response.
6. Have students read the selection with the purpose of finding evidence that supports or disconfirms their responses on the guide.
7. After students finish reading the selection, have them confirm their original responses, revise them, or decide what additional information is needed. Students may be encouraged to rewrite any statement that was not true in a way that makes it true.
8. Lead a discussion on what students learned from their reading.

1. anticipation guide

Anticipation (prediction) guides are sets of generalizations related to the theme of a selection. Teachers use anticipation guides to activate and measure students' prior knowledge, to focus reading, to identify any misperceptions, and to encourage unenthusiastic readers by stimulating their interest in the topic (Beers, 2003; Billmeyer and Barton, 1998). Teachers need to follow several steps (Billmeyer and Barton, 1998, p. 104) in creating anticipation guides. Following the steps, outlined in the box below, is an anticipation guide created by workshop participants (see Figure 2).

2. chronological sequence

As the name implies, a chronological sequence graphic organizer is a way for students to understand a process (a key concept in agriscience). The organizers are relatively easy to make with any word processing software, or they can be hand drawn. Sequencing charts can be used during and/or after reading to help students comprehend what they are reading. Figure 3 is an example created by workshop participants dealing with plant breeding of corn.

3. KWL

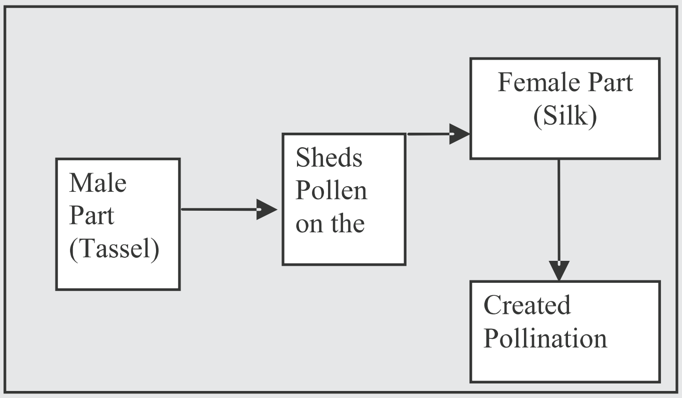
What I know, want to learn, and learned chart (KWL) is a strategy that helps students predict and connect new information with prior knowledge. Especially effective with expository texts (like textbooks), KWLs can be used for brainstorming, previewing new vocabulary and concepts, and recalling what was read (Beers, 2003; Billmeyer and Barton, 1998; Ogle, 1986). The format of a KWL is very simple. On the board or chart paper (or as a pre-made handout), the teacher makes three columns. To activate prior knowledge, students are asked to brainstorm all they know about a particular topic and list those items/concepts under the K column. This can be done as a class or individually; however, answers are shared and the teacher organizes them into categories.

Figure 2. Directions for and an example of an anticipation guide for biotechnology and genetically modified foods

Directions: *Before reading the text,* in the column labeled ME, place a check next to any statement with which you agree. *After* reading the text, compare your opinions with information contained in the text by placing a check next to statements (in the TEXT column) which the text states are true.

ME	TEXT	
		1. We identify genes through gene mapping.
		2. Genetically modified is a special set of technologies that alter the genetic make-up of such living organisms (animals, plants, or bacteria).
		3. Labeling of GM foods is not mandatory in the United States.
		4. GM crops are grown commercially or in field trials in over 40 countries and on 6 continents.

Figure 3. Chronological sequence for corn breeding



Next, in the W column, students list what they want to know about the topic; these can be phrases and/or questions. Then, they read the assigned text looking specifically for answers to what they wanted to learn. What they learned goes in the last column of the KWL. A sample from the workshop regarding genetically modified foods is included (see Figure 4).

B. Math integration

From the perspective of the mathematics teacher, integrating with science, reading, and agriculture is natural. In the Principles and Standards for School Mathematics, the National Council of Teachers of Mathematics (2000) listed connections, problem solving, and communication skills as three of the ten standards for mathematics, ranking them as being equally important as measurement, algebra, statistics, and geometry. One example of how these mathematics standards might play out would be in a windmill project. If the students are assigned the task of constructing a model of a windmill, there are several connections to agriculture such as the applications/uses of a windmill and connections to science, including issues related to wind and the mechanical advantage via gear ratio, can be taught in those courses and reinforced in the mathematics course.

A major project in a mathematics course could be the actual construction of a scale model of the windmill (see Figure 5). The concept of ratio and proportion plays a major role in algebra, as well as in geometry, meaning that this project might fit naturally into either course. It fits especially well into a technical mathematics course. The content involved includes measurement, ratios, proportions, and algebra. There are plenty of problems to pose and solve throughout the assignment. A sample rubric (see Figure 6) is provided below but the rubric should be adjusted to fit the goals of the course and unit in which the project is embedded.

Afterwards, students would describe the process they went through justifying why they used the pieces they did and explaining how the project is or is not a good scale model of the original. The project would then be evaluated by the educator utilizing the grading rubric (see Figure 6).

C. Innovative science integration

Science integration has continuously been implemented into the agricultural curriculum. However, biotechnology and genetic modification are not always included in the curriculum; therefore, these two components were focused on in the workshop. Teachers were given a detailed lesson plan over genetically modified foods. The lesson plan included a list of all the genetically modified foods that we eat, a communication activity that focused on interviewing the public about genetically modified foods, a reading activity that was related to the global ethics of genetically modified foods, and a newscast role playing activity.

Figure 4. KWL chart for genetically modified foods

K What I know	W What I want to find out	L What I learned
GM Foods contain genetic material from another organism. GM foods are in several products that we eat.	Are genetically modified foods bad for you? Is labeling required for GM foods?	Scientists have not found harm to humans from genetically modified foods. No, labeling is not required in the United States for GM foods.

Figure 5. Students would build a scale model of a windmill like the one pictured in the advertisement

Figure 6. Grading rubric for the scale windmill mathematics problem

	Inadequate (0 points)	Acceptable (1 Point)	Excellent (2 Points)
Ratio/Proportion	The ratio is not documented. – or- there is little attempt at keeping the ratio consistent throughout the project.	The ratio between the original and the model is established and documented. The process is not as well documented as it should be – or – It is well-documented but there are errors along in some parts.	The ratio between the original and the model is established, documented, and used throughout. The process of preserving the ratio is visible to the teacher/observer.
Measurement Skills	The measurements are consistently inaccurate – or the measurements are not documented.	The measurements that are documented are accurate but documentation is incomplete – or – the documentation is complete but some measurements are off.	The measurements of the original and the model are accurate and well-documented.
Error Discussion	The explanation is incomplete and poorly written.	The explanation is well-written but does not reflect a solid understanding of the effects of errors in measurement and related issues – or – There seems to be a solid understanding but it is not well written and/or is incomplete.	The explanation of error is well-written in terms of grammar and accurately describes the issues involved.

Total Grade: 6 = A 5 = B 4 = C 3 = D 0-2 = F

Additionally, each activity corresponded with biology standards that are currently emphasized in biology classrooms. After thorough discussion of the lesson plan and activities, teachers were given a grading rubric (see Figure 7) for scoring activities listed in the lesson plan.

Results and Discussion

Listed in Table 1 are scores obtained on the pre- and post- questionnaires. Overall, the mean scores slightly increased in all subject matter areas. However, the greatest increase was in the area of teaching science strategies. The professional development workshops provided agriculture and math educators with various materials to incorporate into their daily lessons. For example, the workshop did equip them with more materials to incorporate into their lessons, as stated by one of the participants, "A lot of the handouts I believe will be very useful in assisting in teaching reading strategies." Most of the participants felt more comfortable integrating math, science, and English strategies into their curriculum after the workshop. By providing high school educators with teaching and assessment tools, they can better incorporate various subject matter content into their curriculum. Even though the workshop provided teaching and assessment documents, participants indicated wanting more workshops like this one obtain more teaching materials.

The workshop described here has implications for others who want to incorporate subject matter across the curriculum. Collaboration among university faculty members sets a positive example for high school teachers and might prompt them to work together. The university faculty spent numerous hours collaborating to develop the integration workshop and they provided a workshop where different academic disciplines could attend, which makes for interesting dialogue among participants. In addition, it generates creative ideas for teaching and learning that may not have been presented otherwise. Overall, creating a collaborative partnership with other faculty members often times leads to future working relationships that are both positive and productive for university and high school educators.

Based on the positive feedback received from the workshop, more integration workshops are being developed. In addition, regional workshops are being considered so several high school teachers can attend and learn how to better integrate subject matter into their curriculum. Future research is still needed to answer questions that surfaced from this study. Research should strive to answer the following:

• 1. Do the high school educators, who attended the workshop, utilize the workshop materials when they teach?

• 2. What would be the impact of delivering an integration workshop to several high school teachers across the southern region?

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Figure 7. Genetically modified foods and organisms grading rubric

Poor	Good	Excellent
Brought one GMO product. (10)	Brought two GMO products but didn't bring information to back up the product. (15)	Brought three or more GMO products and information to back up the product. (18)
Identified two steps a biotechnologist would need to conduct to create a GMO. (10)	Identified three steps a biotechnologist would need to conduct to create a GMO. (15)	Identified four or more steps a biotechnologist would need to conduct to create a GMO. (18)
Described two potential risks of GMO's to farmers, consumers and the environment. (10)	Described four potential risks of GMO's to farmers, consumers and the environment. (15)	Described five or more potential risks of GMO's to farmers, consumers and the environment. (18)
Described two potential benefits of GMO's to farmers, consumers and the environment. (10)	Described four potential benefits of GMO's to farmers, consumers and the environment. (15)	Described five or more potential benefits of GMO's to farmers, consumers and the environment. (18)
Polled less than two people regarding GMO products. (6)	Polled three people regarding GMO products. (11)	Polled four or more people regarding GMO products. (14)
Brought one article related to GMO products. (6)	Brought two articles related to GMO products. (11)	Brought three or more articles related to GMO products. (14)

Table 1. Mean scores of agriculture and math educators on pre and post questionnaires (N=16)

	Pre		Post	
Question	M	SD	M	SD
How comfortable are you in teaching reading strategies (as indicated by your state standards) to your students?	2.68	.84	3.00	.73
How comfortable are you in teaching math strategies (as required by your state standards) to your students?	2.93	.82	3.33	.78
How comfortable are you in teaching science strategies (as required by your state standards) to your students?	2.96	.94	3.46	.80

Note. Ratings were based on a four-point scale (1=very uncomfortable, 2=uncomfortable, 3=comfortable, 4=very comfortable)