

**Incorporating Biotechnology into a High School Curriculum**

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## **Introduction**

For many years agriculturalist have been improving wild plants and animals through the selection and breeding of desirable characteristics. From these breeding techniques the results have developed domesticated plants and animals that are commonly used in crop and livestock agriculture. Scientists have discovered, traits are passed from one generation to the next through genes and genes are made of DNA (USDA, n.d.). Today, biotechnology is biology's fastest-growing discipline prompted by the ever-increasing demand for food and fuel in a cleaner and greener environment (Shrestha, 2019). A safe and sufficient food supply, that is grown in an environmentally responsible fashion, has become an essential drive for society. Like any other technology advancements, agricultural biotechnology will have its economic and social impacts on the world. The integration of biotechnology into school based agricultural education (SBAE) has the potential to increase student learning in all related areas and create a growing need in the career field.

Modern biotechnological techniques were accelerating in the 70's and 80's, SBAE was at a major intersection as to which direction to go. With a challenge from the Academy of Sciences, the profession broadened the relevance and scope to better prepare students for the study of agriculture in post-secondary schools for current and future career opportunities in agricultural sciences (National Research Council, 1988).

## **Conceptual Framework**

Integrating science and agriculture has shown to have several positive effects on SBAE and students. It has been found that students were better prepared in science after completing a course in SBAE that integrated more science into the program (Mowen, et al., 2007). Research has shown that without knowledge of biotechnological concepts, teachers cannot incorporate the concepts into their curricula needs (Boone, et al., 2006). Agricultural educators were most likely to teach biotechnology if they have less years of teaching experiences, have attended some biotechnology training, and perceived that the curriculum will fulfill their program needs (Boone, et al., 2006). However, according to the finding of Wilson, et al. (2002), nearly half of the SBAE teachers in their study were unable to pass the knowledge exam created for high school students in an agricultural biotechnology course.

## **Purpose and Objectives**

The purpose of this study was to explore the agricultural education teachers' competency levels and importance toward incorporating biotechnology into high school curriculum. The following research statements were developed to guide the study:

1. Determine the biotechnology instructional needs of Kansas teachers using Mean Weighted Discrepancy Scores.
2. Determine the if a difference in MWDS is present between all teachers and early career teachers in biotechnology instructional needs.

## **Methods and Procedures**

The population of study was all SBAE teachers in Kansas consisting of 277 teachers. The data collection was undertaken through an online questionnaire survey sent out through an email. This questionnaire was validated by professors of agricultural education and plant science. Cronbach's Alpha was calculated for reliability, estimates ranged from .84-.97. Teachers were asked to rate 77 biotechnology competencies on competence and importance. Out of the 277 teachers 72 responded with a usable survey, resulting in a 26% response rate. Of the 72 responses received, 20.9% of them were between the age of 20 and 25. While the other 79.1% of

the respondents fell between the age range of 26 and 65. There was a close split between males and females but males were 53.5% of the total. The highest percent of respondents were first to five-year teachers (42.6%). A comparison of early to late responders was conducted to address non-response error (Lindner, Murphy, & Briers, 2001). No significant differences were found, therefore it can be deemed that the responding sample statistically represents the population.

A discrepancy score for each individual competency was calculated by subtracting competence from importance. Then a weighted discrepancy score was calculated by multiplying by the mean importance rating. A mean weighted discrepancy score (MWDS) was calculated by taking the sum of the weighted discrepancy scores and dividing by the number of observations. A higher MWDS is an indication of higher need due to a larger difference between the importance and competence.

### Results

An analysis of the MWDS for all teachers indicated 23 of the 77 biotechnology competencies had a score greater than 4.0. The five highest scores were ethical, legal, social, and cultural (5.02), biotechnology globalization (5.05), major regulatory issues (5.10), industrial biotechnology (5.15), and health, safety, and environment (5.37). Seven of the competencies, received a MWDS less than 2.0, indicating competence and importance that are very similar among agricultural teachers, two were below 1.00 (genotype influences phenotype: 0.76 and personal protective equipment and use: 0.89).

An analysis of the MWDS for first through fifth year teachers indicated 14 of the 77 competencies had a score greater than 4.0. The five highest scores were biotreatment of biological wastes (5.38), microorganisms in biological waste management (5.88), major regulatory issues (5.93), health, safety, and environment (6.09), and biotechnology globalization (6.36). Two of the competencies had negative scores, indicating that the competence was higher than the importance: DNA versus RNA (-0.54) and genotype influences phenotype (-0.19). Two additional competencies received zeros (personal protective equipment and use & extract and purify DNA/RNA).

### Conclusion/Implications/Recommendations

SBAE teachers had the highest need for development in *ethical, legal, social and cultural, biotechnology globalization, major regulatory issues, industrial biotechnology and health, safety, and environment*. As biotechnology is still ever evolving these competencies might be topics many have not heard of before. Integrating these competencies into a curriculum might prove to be a little harder feat as these topics are constantly changing with biotechnology.

SBAE teachers with 5 or less years of teaching had higher MWDS in *biotechnology health, safety, and environment, biotechnology globalization, major regulatory issues, microorganisms in biological waste management, and biotreatment of biological wastes*. Compared to all Kansas agricultural teachers there was a visible difference in ability and importance of these topics.

State officials in SBAE should provide training for all teachers on content to meet the competencies of the biotechnology pathway. This material should focus more on competencies that are strictly related to biotechnology instead of competencies that can be found in other agriculture classes. Additionally, in-service training and curriculum materials should be available possibly through scholarships for CASE training in the APB curriculum. Changes to the teacher preparation programs can help teachers start out on the right foot by requiring a biotechnology course to be taken as part of the degree requirements.

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