An Assessment of Agricultural Science Teachers' Knowledge of Biotechnology and Experience through Piloting New Biotechnology Curriculum

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Introduction/Need for Research

In Kentucky, only 2.6% of workers are currently engaged in STEM occupations, one of the lowest rates of STEM employment in the U.S. (Kentucky Center for Education & Workforce Statistics, n.d.). It is estimated between 2017 and 2027 STEM jobs in Kentucky will grow by 13% (Education Commission, 2018). Biotechnology is critical for the 21st century economy as it is at the forefront of innovations in medicine, agriculture, food production, and alternative fuel production. Dawson (2007) posited young people need to be highly literate in science to be prepared to research issues, think critically and question issues and claims in society today, especially in the field of biotechnology. Mansius and Hanegan (2008) found many science educators are not trained to use biotechnology equipment or have not had research experience when they graduate with their teaching certificates. Boone, Gartin, et al. (2006) and Wilson, et al. (2002) found agricultural science teachers in two states lacked knowledge in biotechnology. Only seven secondary schools in Kentucky (C. Davis, personal communication, December 4, 2017) out of 143 agricultural education programs (NAAE Kentucky, 2017) had students in the Agribiotechnology Career Pathway in the 2016-2017 school year. This pilot study was created to address the knowledge gaps in biotechnology education within the high school agricultural science curriculum by providing concrete resources to agricultural science teachers. Furthermore, the teachers' knowledge of and experience with biotechnology was documented, and the adoption and efficacy of the new curricula was quantified with a teacher follow-up survey.

Conceptual Framework

This paper leans on the integrated STEM education (Moore & Smith, 2014) paradigm and adds to research recommended by the *STEM Integration in K-12 education: Status, prospects, and an agenda for research* report by the National Academy of Engineering and National Research Council (NAE & NRC, 2014). Integrated STEM education is when one lesson, class or unit makes an effort to combine science, technology engineering and math, making connections between these subjects and problems in the real-world (Moore & Smith, 2014). The Introductory Biotechnology (IB) Unit was constructed with the idea of science, technology, engineering, and math all playing a role within the realm of agricultural careers and life. Integrating STEM into other subjects is identified as a way "that might improve student thinking, learning, engagement, motivation, or persistence," (NAE & NRC, 2014, p. 135, ¶1). Research reports the need to broaden student experiences and exposure to STEM fields and career pathways through multidisciplinary education (NAE & NRC, 2014). Teaching STEM subjects through secondary agricultural science in the form of biotechnology is one way to enhance student knowledge, understanding and experiences (Moore, 2008).

Methodology

Descriptive survey methods were utilized to achieve the objectives: 1) examine the efficacy and use of the new curriculum, the IB Unit, by agricultural science teachers', and 2) the teachers' knowledge of and experience with teaching biotechnology topics. Seven agricultural science teachers (n = 7) volunteered to pilot the IB Unit, in response to a statewide email sent to the state agricultural science teacher listserv. The survey was delivered to and completed online (Ladner, et al., 2002). The assessment tool contained selected questions from Mueller, et al.'s (2015) biotechnology education study in Indiana and Boone, et al.'s (2006) study assessing agricultural tea-

chers' knowledge and understanding of biotechnology in West Virginia. The instrument contained two sections: 1) questions about the use of the five lessons in the IB Unit, including its strengths and weaknesses, and 2) questions pertaining to demographics and experience teaching a selection of biotechnology topics.

Results/Findings

Seven teachers completed the survey after piloting the IB Unit. Teachers provided evaluative data on the usability of each of the five lessons in the IB Unit. Overall, across all five lessons, teachers (85%) reported they agreed (seven point scale with somewhat agree = 5; strongly agree = 7) the various activities within the IB Unit lessons helped students be more engaged in each lesson and 85% or more agreed (seven point scale with somewhat agree = 5; strongly agree = 7) the majority of their students met the lesson objectives. The major strengths across the five lessons were lesson activities, objectives, and content, as selected, and the overall weaknesses were the lessons were too long, followed by a couple of lessons perceived as difficult to use. Seventy-one percent (71%) of the teachers stated their students were interested in learning more about biotechnology by the end of the IB Unit. Teachers were asked what their overall impression was of the Unit. Written responses included: "It was a great unit with some really awesome activities. It was just too much to do in five 50 minute classes;" and "Students enjoy PowerPoints and having something to base some notes off of and that was not part of the lesson." Seventy-one percent (71%) stated they plan to implement the IB Unit in their class in the future. The teachers in the study were predominantly female (71%) teaching in rural public schools (57%) in the state of Kentucky (86%). A majority of the teachers had a master's degree (57%) and were in the age range of 25-29 years of age. Teachers reported a mean of 2.7 years (median = 1) of teaching experience, with a range (zero to 10 years) first year teachers to two teachers having more than five years of experience prior to the current school year. A majority (85%) of the teachers had not attended any biotechnology education workshops or trainings, and only one respondent reported having prior work experience in biotechnology prior to teaching that school year. Only 16% of the teachers reported having completed classes on or related to biotechnology prior to that school year. Fifty-seven percent (57%) stated they have not taught the topic of biotechnology ethics. Teachers were most knowledgeable about animal reproduction (M = 3.14, SD = 1.21), with 57% having taught it previously. Cumulatively, the teachers indicated being slightly knowledgeable to having no knowledge (no knowledge = 1 to expert knowledge = 5; overall mean across topics = 1.62) of the biotechnology topics in question.

Conclusions/Recommendations/Impact on Profession

The agricultural science teachers in this study were mostly inexperienced and lacked training in almost all of the areas of biotechnology posed, having no experience teaching most topics. They were favorable of the content and resources of the IB Unit and provided valuable feedback for the researchers to improve the IB Unit. The results provide feedback informing the researchers of edits to make to the IB Unit, including shortening and refining them and adding visual slides to the lessons. A recommendation of this study, although a small sample, is to provide agricultural science teachers with professional development training on biotechnology topics to empower teachers to integrate biotechnology into their classes. Agricultural science teachers educated more in the area of biotechnology may encourage more students to enter biotechnology/STEM collegiate majors and careers. Another recommendation for this type study of a small pilot would be to utilize a qualitative approach to gain further insight from the agricultural science teachers.

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