An Analysis of North Carolina Public School Superintendents' Awareness of Biotechnology and the Future of Biotechnology Education

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Abstract

The purpose of this study was to gauge the perception of North Carolina public school superintendents regarding Biotechnology and its future in the North Carolina public school curriculum. It was found that respondents overall were knowledgeable about biotechnology and saw it as beneficial in general health, nutrition, and environmental quality. With regard to the barriers of biotechnology respondents indicated that religious concerns, lack of education, ethical issues, access, labeling, and legislation were barriers. In contrast, respondents were undecided if socioeconomic factors, ecological factors, and perceptions regarding the safety of genetically engineered organisms were barriers. As for the future of biotechnology education respondents indicated that universities and industry would be important to its future, but were undecided if public support existed with respect to its implementation. Also uncertainty surrounded the need for more rigorous teacher preparation programs and the need for special programs with respect to workforce preparation. Recommendations included biotechnology stakeholders forming partnerships with school administrators and key community leaders in order to ensure the future of biotechnology education in North Carolina.

Introduction

The rapid pace of technological innovation coupled with great economic uncertainty has significantly impacted the way business is conducted within the 21st century global society. With this change comes the need for companies, particularly those within the bioscience sectors, to fill entry-level and advanced positions with individuals who possess cutting edge knowledge, dynamic skills, and excellent dispositions to successfully maneuver in a highly competitive and high-stakes industry. Given the aforementioned factors, biotechnology firms many times are in need of more highly skilled workers than are available, particularly in training programs within their local region (United States Department of Labor, 2008).

According to the Battelle Technology Partnership Practice (2009), there are many indicators that show the United States is slipping in generating the skilled educated workforce that is necessary to meet the requirements for a highly technical and trained workforce in the knowledge-based economy of today. Workers are needed in the bioscience industry to translate innovation into product development, conduct research, improve health care techniques, and produce bioscience related products. The availability of a highly skilled and educated workforce is imperative to the United States sustaining a highly competitive and vigorous bioscience industry for the long run. This is especially important from an economic security perspective as other nations are gaining ground in the Science, Technology, Engineering, and Math (STEM) disciplines, while interest among American students in the STEM areas continues to decline.

The Food and Agriculture Organization of the United Nations (2010) defined biotechnology "any technological application that uses biological systems, living organisms, or derivatives thereof, to make or modify products or processes for specific use." Given that biotechnology is not just comprised of one discipline, but the blending of many disciplines, the

ideal training for employees in biotechnology is traditional biological science, with specific emphasis upon areas such biochemistry, molecular biology, virology, genetics, and biochemical engineering. Taking into account the aforesaid factors and the ever changing biosciences industry, firms are consistently seeking workers with more formalized training in both life sciences and computers, coupled with a strong general educational background (United States Department of Labor, 2008).

With regard to the bioscience industry, over 1.42 million individuals were employed in 2008. In the area of research, testing, and medical labs, 11,670 jobs (2.1 %) were added from 2007 to 2008, medical devices and equipment added 10,140 jobs (2.4 %), and agricultural feedstock and chemicals added 5,021 (4.6 %). According to Battelle Memorial Institute (2010), the total employment by sector was as follows: Agricultural Feedstock & Chemicals (114,793), Drugs & Pharmaceuticals (311,882), Medical Devices & Equipment (435,509), and Research, Testing, and Medical Laboratories (558,140).

In order to ensure America' s continued economic growth and national security advances in science and engineering, particularly in biotechnology are essential. Over the next decade, the demand in the United States for scientists and engineers is projected to increase at four times the rate of all other occupational sectors. Despite this factor, high school students of today are not performing at sufficient levels in math and science, with even fewer pursing degrees in various technical fields (The International Society for Optical Engineering, 2008a). When analyzing this concern with respect to demographics only 4.4 % of science and engineering jobs are held by African Americans and only 3.4 % by Hispanics. With regard to gender, significant gaps exist in this area as well according to numerous studies (The International Society for Optical Engineering, 2008b).

The International Society for Optical Engineering (2008b) stated interest in STEM education has greatly declined with the majority of students in the United States not adequately prepared to succeed in college-level coursework. Moreover, students who were the most likely to pursue studies in STEM career pathways are those who develop a disposition for these respective areas early in career planning and enroll in challenging courses that provided them with the preparation for college-level science and math coursework. Public funding and support are not only critical to alleviating the aforementioned issue, but also assist in economic growth. According to many economists over the past 50 years, taxpayer investment in science and mathematics in essence has indirectly produced more than half of the nation's economic growth, an economic investment that starts within the public educational systems (The International Society for Optical Engineering, 2008b).

According to the North Carolina Department of Public Education (2006), North Carolina has the third largest concentration of biotechnology companies in the United States. The biotechnology industry in North Carolina is comprised of 110 contract research and testing companies, 60 agricultural biotechnology companies, 13 publically traded companies that have a market capitalization of $11.8 billion, and employ over 57,000 individuals. Of these companies at least 75 are based upon North Carolina's universities technologies. In North Carolina about 145 bioscience patents are granted each year to companies and universities, which accounts for about 12% of all patents issued in the state. Biotechnology has an annual impact upon North Carolina's agricultural industry. In 2006, the food and fiber production was increased by 86.6

million pounds and pesticide use was reduced by 3.5 million pounds (North Carolina Biotechnology Center, 2010b).

The future viability of North Carolina's biotechnology industry greatly depends upon the development of essential knowledge, skills, and dispositions in regard to biotechnology in the public school students of today, who are the industry's future workers and consumers (United States Department of Labor, 2008). According to the North Carolina Biotechnology Center (2010a) in the state of North Carolina biotechnology is not offered as a core science option in the standard course of study, but instead is embedded across various courses within the Career and Technical Edcuation areas of Agricultural Education (Biotechnology and Agriscience Research I&II, Horticulture I&II), Family and Consumer Science (Foods II – Food Technology), Technology Education (Scientific and Technical Visualization I&II, Project Lead The Way – *Biotechnical Engineering specialty course*), and Health Occupations (Biomedical Technology, Medical Sciences I&II).

The State of North Carolina has made a commitment to biotechnology with its BioNetwork Initiative program. The program is located within agricultural education programs at community colleges and universities that are industry focused, providing hands-on training for an industry that greatly values the technical and scientific training of its employees. The BioNetwork established its center for BioAgriculture at Robeson Community College. The commitment also includes the North Carolina Department of Public Instruction and local education agencies (LEAs) throughout the state of North Carolina. The commitment to educational initiatives such as biotechnology by local education agencies is heavily influenced by superintendents, who are vital to the successful incorporation of any subject matter into the curriculum. Without their support, initiatives such as biotechnology are not feasible (North Carolina Biotechnology Center, 2009). Given the importance of the biotechnology industry to North Carolina's economic vitality, it is imperative that North Carolina's public schools chief administrators support the incorporation of biotechnology throughout the standard course of study on a broader scale.

Theoretical Framework

The theoretical framework for this study was built upon the theory of social judgment and the concept of cognitive dissonance. The theory of social judgment focuses on how people's prior attitudes distort their perceptions of the positions advocated in persuasive messages and how such perceptions mediate persuasion. Specifically, the theory assumes that a person's own attitudes serve as a judgmental standard and anchor that influences where along a continuum a persuader's advocated position is perceived to lie (Sherif & Hovland, 1961). The social judgment theory is an attempt to apply the principles of judgment to the study of attitude change (Sheirf & Hovland, 1961). According to Sherif, Sherif, and Nebergall (1965), an individual's initial attitude serves as an anchor for the judgment of related attitude communications. Opinions are evaluated against this point of reference and are placed on an attitudinal continuum. Opinions that most characterized the individual's own opinion are in the latitude of acceptance. Those opinions found most objectionable are placed in the latitude of rejection. The latitude of non-commitment consists of those opinions that are neither accepted nor rejected.

Communication that falls within the latitude of acceptance is assimilated and if judged to be fair and unbiased will result in a change in attitude within the limits of the latitude of acceptance. The greater the difference between the initial opinion and the communicated opinion, the greater the attitude change. Though some change is possible when opinions fall within the latitude of rejection, the greater the discrepancy the less the change in attitude (Himmelfarb & Eagly, 1974). In summary, social judgment theory is important because it demonstrates the importance of people's prior attitudes. Most other learning theories only deal marginally with previous attitudes. Newer theories incorporate social judgment principles as covariates and control variables in experimental designs (Wood, 1982).

In addition to the theory of social judgment, the concept of cognitive dissonance served as guiding framework for this study. According to Swanson (1972) a person will gradually begin to associate positive communications to an area or a subject, in this case biotechnology, as their knowledge increases, which in turn affects their attitude, and finally behavior towards biotechnology. The concept simply stated is that knowledge and experiences are precursors to attitudinal changes that must occur before behavior can change (See *Figure 1*.)

Education → Knowledge→ Attitudes→ Behavior

Figure 1. Assumed relationships among education, knowledge, attitude, and behavior – Concept of Cognitive Dissonance (Swanson, 1972).

Purpose and Objectives

The purpose of this study was to gauge the perception of North Carolina public school superintendents regarding Biotechnology and its future in the North Carolina public school curriculum. In order to accomplish the aforementioned purpose, the following research questions were developed.

1. What was the awareness level held by North Carolina Public Superintendents regarding biotechnology?
2. What was the confidence level held by North Carolina Public Superintendents regarding their awareness of selected biotechnology factors?
3. What were the benefits of biotechnology as perceived by North Carolina Public School Superintendents?
4. What were the barriers to biotechnology implementation as perceived by North Carolina Public School Superintendents?
5. What was the future of biotechnology education in North Carolina Public Schools as perceived by North Carolina Public School Superintendents?
6. What were the demographic characteristics of North Carolina Public School Superintendents who Local Education Agency possessed at least one agricultural education program?

Methodology

The population for this descriptive study consisted of North Carolina Public School Superintendents whose respective local education agency (LEA) possessed at least one secondary agricultural education program. Of the 115 local education agencies in North Carolina, 93 possessed at least one agricultural education program. Given this factor the final study population was determined to be 93. In order to accomplish the aforementioned objectives of this study a survey instrument was adopted from a previous study conducted by Totten (2007). The survey instrument consisted of five sections. The sections were entitled Section I: General Awareness of Biotechnology, Section II: Benefits of Biotechnology, Section III: Barriers to Biotechnology, Section IV: Future of Biotechnology Education in North Carolina, and Section V: Demographic Characteristics. The validity of the instrument was established by means of content validity. Brown (1983) defined content validity as "the degree to which items on a test representatively sample the underlying content domain (p. 487)." Brown recommended using expert judges as one means of establishing content validity. A panel of experts at the researchers' respective university reviewed the survey instrument for content validity, no adjustments were made as a result of the review. To establish internal consistency reliability, the instrument was analyzed using the software package SPSS according to conventions established by Nunnally (1967) and Davis (1971). The Chronbach's Alpha Coefficients for the study were as follows: Section I: .9273, Section II: .9782, Section III: .9096, and Section IV: .9500. All sections of the research survey were deemed to be reliable.

Elements of Dillman's Tailored Design Method (2009) were utilized to achieve an optimal return rate. A three-round web based questionnaire approach was utilized for this study. The first round consisted of all superintendents within the selected population receiving a letter from the researchers outlining the purpose of the research, which included a login and password for each prospective respondent. Superintendents were given one week to return the initial survey, 24 surveys were returned after the first week. The next round consisted of all non-respondents receiving a follow-up email stressing to them the importance of returning the survey for data analysis purposes and to strengthen the study, this resulting in ten more surveys. A final reminder email was sent at the end of the beginning of the third week, this resulted in nine more surveys being returned. After all collection rounds were completed the final total was 43 returned for a response rate of 46 %. In order to control for non-response error, Miller and Smith (1983) recommended comparing early to late respondents. Upon completion of the study, an evaluation of the data showed that there were no significant differences found among the early respondents (respondents during the first round) and the late respondents (respondents after the first round).

Findings

Research Question One Findings

In relation to superintendents' knowledge of biotechnology it was found that participants overall were aware of the selected biotechnology concepts addressed in the survey, with the exception of four statements. For the purposes of this research a statement was operationalized to possess a level of awareness if more than 50% of respondents answered the statement correctly. As shown in Table 1, exceptions were found with regard to perceptions of the development of human organs within livestock species, governmental required labeling of

genetically modified products, biotechnology regulation based upon use versus method of production, and lastly traditional livestock and crop production utilizing cross-breeding and cross-fertilization.

As far as confidence with regard to their responses, participants in general were sure of their answers, with exceptions being found on seven statements. For the purposes of this research a statement was operationalized to be answered affirmatively if more than 50% of respondents indicated they were sure about their response to the biotechnology statement. Exceptions were noted in relation to perceptions regarding the percentage of meat products that are from genetically-modified livestock, biotechnology being utilized to create new living organisms, cloning, the strength of genetically modified animals, labeling of genetically modified products, biotechnology regulation based upon utilization, and traditional livestock and crop production utilizing cross-breeding and cross-fertilization.

Table 1

General Awareness of Biotechnology

Statements	*f* True	*f* False	*f* Sure	*f* Unsure
Biotechnology is defined as the use of molecules from living organisms to create new products.	33*	10	26	18
Biotechnology makes it possible for scientists to create new plants and animals by taking parts of the genes of one plant or animal and inserting them into another.	32*	11	20	24
Human, animal, plant and microbial genes can be altered with current biotechnology techniques	38*	5	28	15
Genes control visible and invisible characteristics of living organisms.	41*	2	34	10
A gene is a specific sequence of DNA that serves as a unit of inheritance.	41*	2	34	10
Most consumers in the United States have eaten food products created through biotechnology.	41*	2	34	10
A large percentage of meat products bought by consumers are obtained from genetically-modified livestock.	41	2*	33	11
Forensic biotechnology allows the analysis of DNA to help solve crimes.	23*	21	22	21
Pharmaceutical companies currently market drugs developed using biotechnology.	41*	2	34	10
Plant biotechnology can regenerate whole plants from individual plant cells.	40*	3	32	12
Cloning of a plant or animal creates an identical copy.	37*	6	19	24
Biotechnology has allowed the development of livestock that produce human organs that will	33	9*	26	16

not be rejected by transplant recipients.

Genetically-modified animals are larger and stronger than normal.	15	26*	15	27
The government requires that all genetically-modified products have clear labeling.	14*	29	13	28
The Environmental Protection Agency regulates all biotechnology products.	22*	21	23	20
Biotechnology products are regulated based on their use rather than on the method by which they were produced.	15*	28	16	26
Genetically-modified bacteria, fungi, and plants can clean up toxic waste sites in a process called bioremediation.	26*	13	10	32
Pesticide-producing genes can be directly incorporated into crop plants so the need for additional pesticide application is reduced or eliminated.	36*	5	14	29
Traditional livestock and crop production does not use cross-breeding or cross-fertilization.	34	9*	23	21

*****Correct Response

Research Question Two Findings

Respondents were asked to give their opinion on the benefits of biotechnology. Table 2 presents the means and standard deviations (SD) for the benefits of biotechnology. For the purpose of data analysis, readers should utilize the following specifications when interpreting the scale for Tables 2, 3, and 4 1-1.49=Strongly Disagree, 1.50-2.49=Disagree, 2.50-3.49=Uncertain, 3.50-4.49=Agree, and 4.50-5=Strongly Agree. In relation to the perceived benefits of biotechnology respondents agreed with all 20 statements. The highest levels of agreement was noted in relation to the perception of the development of unique products from aquatic sources, increased crop yields on less land, more accurate criminal investigations, economic savings for consumers, and improved methods to fight bioterrorism. The lowest levels of agreement were found in relation to more effective waste treatment techniques, valuable technology for the United States, and reduced environmental impact from industrial activities.

Table 2

Benefits of Biotechnology

Benefits	M	SD
Development of unique products from aquatic sources.	4.39	.655
Increased crop yields that can be realized on less land.	4.35	.613
More accurate criminal investigations.	4.35	.650
Economic savings for consumers.	4.33	.644
Improved methods to fight bioterrorism.	4.30	.734

More effective pharmaceuticals.	4.26	.658
Protection of groundwater supplies.	4.19	.588
Reduced need for chemical pesticides.	4.14	.675
Alleviation of malnutrition.	4.14	.833
Better animal health management.	4.09	.750
Improved fabrics.	4.02	.762
Improved human medical care.	3.95	.844
More nutritious and better tasting foods.	3.95	.899
New fuel sources.	3.91	.684
Improved soil conservation.	3.88	.905
Increased quality of life for people in developing countries.	3.88	.731
Greater economic profitability for farmers.	3.86	.824
Reduced environmental impact of industrial activities.	3.84	.814
Valuable technology for the citizens of the United States.	3.84	.843
More effective waste treatment techniques.	3.65	1.11

Research Question Three Findings

Respondents were asked to give their opinion on the subject of barriers and obstacles in relation to biotechnology. Table 3 presents the means, standard deviations (SD), and rank for the barriers and obstacles of biotechnology. The highest levels of agreements were found in relation to religion being a barrier to biotechnology, lack of education, and ethical issues regarding its use on a global scale. In contrast respondents were undecided regarding the socioeconomic perspective of biotechnology, biotechnology having a negative ecological impact, and the negative perception regarding the safety of genetically engineered foods.

Table 3

Barriers to Biotechnology

Barriers and Obstacles	M	SD
Religious concerns are a major barrier to biotechnology acceptance.	4.48	.590
Lack of education leads to resistance toward biotechnology products.	3.98	.628
Ethical issues regarding biotechnology are a major barrier to its extensive use on a global scale.	3.95	.776
Equal access to the benefits of biotechnology will not be realized by all sectors of society.	3.82	.947
Issues concerning the labeling of genetically modified foods can have a major impact upon the agricultural industry.	3.73	.924
Legislation is a major barrier to broad biotechnology implementation throughout society.	3.59	.787
The economic cost of biotechnology research is a barrier to its widespread practical daily implementation.	3.50	.792

From a socio-economic perspective biotechnology can affect the relationship between and relative power of different groups in society.	3.45	1.044
Biotechnology can have negative ecological impacts which reduce its acceptance.	3.34	.888
The negative perception regarding the safety of genetically engineered food is a major barrier to biotechnology.	3.18	.870

Research Question Four Findings

Respondents were asked to give their opinion on the subject of the perceived future of biotechnology education. Table 4 presents the means, standard deviations (SD), and rank for the future of biotechnology education. The highest level of agreements were found in relation to offering biotechnology as a general science core option, utilizing industry and university biotechnology specialist to teach special topics within the public schools, and infusing industry grants into public schools in order to encourage biotechnology incorporation. In contrast respondents were undecided if special programs concerning biotechnology should be implemented for students with an interest in the industry. Additionally, indecision was noted with regard to whether teacher education programs should revise their respective baccalaureate degree programs with respect to biotechnology and whether there would be great public support for biotechnology education at the secondary level.

Table 4

Future of Biotechnology Education

Statements	M	SD
Biotechnology should be offered as a general science option for the core curriculum.	4.34	.645
Industry and university biotechnology specialists should be utilized to teach special biotechnology topics in the public school systems.	4.26	.621
Industry grants should be provided to public school systems to infuse biotechnology education into their respective curricula.	4.25	.811
North Carolina students will be interested in enrolling in biotechnology courses and programs.	4.05	.806
Industry leaders should aid in biotechnology curriculum development in North Carolina's public schools.	4.05	1.05
Special programs concerning biotechnology should be implemented for "college/university" prep students.	4.02	.731
Internships should be provided in biotechnology-related organizations as an option for "College Tech Prep" work-based experience requirements.	4.00	1.01
North Carolina's universities should have a major impact on the infusion of biotechnology at the secondary level of education.	4.00	.610
Universities should offer advanced placement courses concerning biotechnology at the secondary level.	3.91	.830

Public school administration overall should be supportive of biotechnology education.	3.84	1.03
Biotechnology education can help alleviate negative public perception regarding the industry.	3.82	.843
The supply of qualified teachers to teach biotechnology will be very low.	3.75	.967
Programs should be developed to link secondary level education in biotechnology with current community college biotechnology programs.	3.68	1.07
Industry and university biotechnology specialists should be utilized to teach special biotechnology topics in the public school systems.	3.66	.834
The North Carolina General Assembly should provide funding to develop and infuse biotechnology curriculum into the public school system.	3.59	.923
Special programs concerning biotechnology should be implemented for students hoping to enter the bio-manufacturing workforce after high school graduation.	3.41	1.14
The infusion of biotechnology into North Carolina's standard course of study will require teacher education programs to revise and plan more rigorous baccalaureate degree programs.	3.30	.823
There will be great public support for biotechnology education at the secondary level in North Carolina.	3.20	.878

Research Question Five Findings

Table 5 displays the demographic characteristics of the North Carolina public school superintendents who participated in this respective study. The average age of respondents was 53 years of age, with the majority being Caucasian males who held a doctorate degree. In relation to years of public education experience, the average experience level was 22 years, with seven being the average years of experience as a superintendent.

Table 5

Demographic Characteristics of North Carolina Public School Superintendents

Demographics	n	M or %	SD
Age		53	5.34
Gender			
Male	35	80	
Female	9	21	
Race			
Caucasian	37	84	
Black	7	16	
Years of Public Education Experience		20	7.04
Administrative Experience as Superintendent		7	5.30

Education		
Masters	8	18
Specialist	10	23
Doctorate	26	59

Table 6 provides the demographic data for the local education agencies (LEAs) for which the respondents administrate. With regard to the average number of schools within the LEAs, 20 were found to be the mean level, with an average enrollment level of 12,945 students. The majority of the school districts were labeled as rural with 29% indicated a combination status.

Table 6

Local Education Agency Demographics (LEA)

Demographics	n	M or %
Total number of schools in L.E.A.		20
Total number of students in L.E.A.		12,945
Type of L.E.A.		
Urban	2	5
Rural	29	66
Combination	13	30

Conclusions

In relation to the knowledge level possessed by North Carolina's public school superintendents in relation to biotechnology, overall respondents were knowledgeable regarding the selected concepts and possessed a level of confidence in their respective answers. According to Swan (1972), the knowledge that a person possesses regarding a particular topic in turn influences their attitude and behavior regarding that subject matter. When considering perceptions about the benefits of biotechnology, respondents in general agreed with all statements provided. As stated by Sherif and Hovland (1961), an individual's initial attitude towards a subject serves as an anchor with regard to any future communication regarding the subject. Given that the superintendents within this study were positive about the benefits of biotechnology, the effort to infuse biotechnology broadly throughout the public schools could perhaps be easier, if the support of the superintendents is solicited for specific initiatives.

With regard to the barriers of biotechnology, respondents indicated that religious concerns, lack of education, ethical issues, access, labeling, and legislation were barriers. In contrast respondents were undecided if socioeconomic factors, ecological factors, and perceptions regarding the safety of genetically engineered were barriers. According to Eagly and Chaiken (1993), positions falling within the latitude of rejection will be contrasted away from a person's initial attitude regarding a particular subject, thus causing them to develop a negative perception regarding the specific variable.

With respect to views regarding the future of biotechnology education in North Carolina respondents agreed that industry and university experts should be involved with the development of biotechnology in the public schools, and that public school administration and the General

Assembly should support biotechnology education. It was also agreed upon that students would be interested in biotechnology programs if created and that special programs should be implemented for college prep and tech prep students in relation to biotechnology. In contrast respondents were undecided if special programs regarding biotechnology should be developed for individuals desiring to enter the bio-manufacturing industry after high school. Additionally, superintendents were undecided if the future of biotechnology education would require the development of more rigorous teacher education programs or if there would be adequate public support for biotechnology education. It appears that superintendents are supportive of biotechnology education, and recognize the need for multiple stakeholder involvement in its development, but appear to be somewhat undecided about its future in some key areas. This could be due to the variety of information that they are given about the subject that fall within their latitude of rejection, thus contrasting with their initial anchor position (Eagly & Chaiken, 1993).

Recommendations

When considering the recognized economic importance of biotechnology to North Carolina and the push for better preparation of students in relation to the STEM disciplines, it is recommended that North Carolina's public school superintendents collaborate with various stakeholder groups to ensure infusion of biotechnology throughout the North Carolina Standard Course of Study. This would aid in implementing the recent recommendations that States should incorporate biotechnology as they revise their science standards and should involve research scientists with expertise in the biosciences in their development (Battelle, 2009). As a result of President Obama's "Education to Innovate" campaign, initiatives such as the Biotechnology Institute's "Scientist in the Classroom" which is designed to train and deploy scientists from 40 companies with secondary teachers and students in high-impact laboratory, collaborations will better prepare students in the STEM disciplines (Biotechnology Institute, 2010). Collaboration such as these is the future of biotechnology education.

Implications

According to the Labor Day Report (2005) America's ability to compete in the 21st century will not be determined by just performance, but its workforce ability to invent and innovate. Regrettably, signs show that America's workforce is not prepared to meet innovation's challenge, and its position as the global economic leader is threatened. According to Paul A. Hanle (2010):

> The United States is the global leader in biotechnology innovation. Our industry creates high-wage jobs while developing breakthrough technologies that help heal the sick, feed the hungry, and restore the environment … The ability of the United States to continue to lead in the global biotechnology marketplace depends on developing new talent.

Superintendents and school administrators will be at the fore front of collaborative opportunities with the biotechnology industry as the biotechnology industry is investing in bioscience education by contributing to class room instruction through innovative programs to address needs in STEM education.

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