Technology Teachers' Beliefs About Biotechnology and Its Instruction in South Korea

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Abstract

The increased public awareness of the significance and necessity of biotechnology has encouraged educators to implement biotechnology instruction in various educational settings. One example is the great effort made by educational researchers and practitioners internationally to integrate biotechnology in technology education. Despite the gains in the popularity of biotechnology in education, the actual implementation of biotechnology instruction is not prevalent. Previous studies suggest that technology teachers' beliefs are a significant predictor of the implementation of biotechnology instruction for technology education. Thus, there is a need for further studies on this topic, however, this study investigates Korean technology teachers' beliefs related to the implementation of biotechnology instruction. It also includes several issues that are implied by the findings. A piloted self-reported online survey developed by the authors was administered to 114 Korean middle school technology teachers. This survey collected demographic information and measured these teachers' intent to implement biotechnology instruction into their classes (*intent*). The teachers' beliefs were measured in three domains: *value* (technology teachers' perceived beliefs about biotechnology teaching as valuable); *expectancy* (technology teachers' perceived beliefs about biotechnology teaching as expectancy); and *innovation* (technology teachers' perceived beliefs about biotechnology teaching as a need regarding innovation). Results indicate that Korean technology teachers' beliefs measured by value, expectancy, and innovation were significantly associated with teacher intent to teach biotechnology content in their classes. This study recommends that biotechnology content should be delivered systematically to technology teachers through professional development (i.e., in-service and pre-service training).

Introduction

Due to the pervasive impact of biotechnology, leaders in education have begun to focus on using educational settings to increase public awareness related to the benefits and impact of biotechnology (International Technology Education Association [ITEA], 2000). Within the educational community, researchers, authors, and practitioners in specific fields of education, such as technology education (ITEA, 2000), science education (Glenda & Schibeci, 2003; Steele & Aubusson, 2004), and agricultural education (Wilson, Kirby, & Flower, 2000) have realized the importance of implementing biotechnology instruction at secondary level. Technology educators have gone a step further by focusing on biotechnology as a major content organizer for technology education programs and advocating adding it to technology education programs (ITEA, 1996; ITEA, 2000; Savage & Sterry, 1991; Wells, 1994).

Despite the position taken by the technology educators, biotechnology has not been broadly implemented in technology education programs (Brown, Kemp, & Hall, 1998; Rogers, 1996; Russell, 2003; Sanders, 2001). Technology teachers' beliefs about biotechnology and its instruction have been found to be a factor in the implementation of biotechnology teaching (Daugherty, 2005; Scott, Washer, & Wright, 2006). These researchers focused on diagnosing the current conditions of biotechnology instruction in technology education and suggested that further systematic studies be undertaken to investigate technology teachers' beliefs as related to the low implementation.

There have been significant efforts to incorporate technology education into general education worldwide. Technology education was introduced in the second revision of the national curriculum in South Korea in1969. The technological revolution, especially the biotechnology revolution, resulted in the addition of significant biotechnology content in the recent South Korean national curriculum revisions (Yi, Lee, Chang, & Kwon, 2006). However, actual implementation of biotechnology instruction within the technology education curriculum has been limited (Korea Institute of Curriculum and Evaluation [KICE], 2002), compared to other content areas (e. g., manufacturing, construction, and transportation). Wells and Kwon (2008) pointed out that Korean technology teachers' low implementation of biotechnology instruction resulted from both a lack of motivation and insufficient training.

Teachers' beliefs affect their decisions regarding the content they teach and the ways in which they teach that content. In particular, technology teachers' perceived beliefs about biotechnology teaching as valuable and their perceived beliefs about biotechnology teaching as expectancy, affected the teachers' willingness to implement a curriculum in their classrooms (Abrami, Poulsen, & Chamber, 2004; Kay, 2006). In this context, Korean technology teachers' beliefs about biotechnology and its instruction can affect the implementation of this subject and the form it will take.

Background to the Study

Biotechnology in Korean Technology Education

The educational system in South Korea follows a single track (ladder type), consisting of elementary school (six years), middle school (three years), high school (three years), and junior college, college and university undergraduate study (two or three, four or six years), and it is based on a strong national curriculum. Since 1948, the national curriculum has undergone seven revisions as educators have adapted to new educational needs and technological changes. As early as 1970, extensive knowledge of technology was recognized as important for all citizens, regardless of age or gender. Since then technology education has been taught as a separate subject and integral part of general education under the name of "*kisul*" (literally, "technology"). Throughout the past three decades, there have been innovations and challenges in curriculum, instruction, and teacher education in Korean technology education and Korean technology educators have faced new challenges and expectations whenever the curriculum has been revised (Yi & Kwon, 2008). Initially in 1970, Korean secondary schools started to offer technology programs that included educational goals such as career guidance and vocation, consumerism, and the study of industry and technology. Today, the technology curriculum for secondary schools follows differing content at different grade levels. In 7th – 10th grades students learn *Technology- Home Economics*, and in grades 11 and 12, students select from among *Information Society and Computers, Agricultural Science, Industrial Technology, Enterprise Management, Ocean Science, and Home Science.*

Another challenge in Korean technology education has been the lack of qualified technology teachers (Yi & Kwon, 2008). In Korea, secondary school teachers are graduates of a four-year teachers' colleges. However, in the early days of technology education, there were no qualified technology teachers in secondary schools because there were no teachers' colleges for the subject of technology. Chungnam National University graduated its first class of technology teachers in 1985, and Korea National University of Education graduated its first class of qualified technology teachers in 1995 (Kim & Land, 1994). Recently, Daebul University has graduated qualified technology teachers. The shortage of qualified technology teachers is thus being addressed resolved through the efforts of these three university programs. However, there is still a lack of talented technology teachers who have the ability to overcome systematic problems (e. g., the lack of necessary weekly class hours and the lack of needed laboratory facilities) and being capable of engaging in innovative technology teaching and learning. Considering the significance of biotechnology as a content organizer within Korean technology education, the design and development of biotechnology courses for pre-service technology education teachers should be made a priority. However, a review of the curriculum used by these institutes indicates that courses related to biotechnology are still insufficient.

Biotechnology content in the national curriculum initially stemmed from agricultural content in the elementary school (boys and girls) and middle school (girls). Because of the needs of society in the 1970s, the agricultural content had a significant place in technology education. By the sixth curriculum revision, biotechnology had become established in secondary school technology courses (KICE, 2002; Yi & Kwon, 2008). However, Korean technology educators are currently preparing for a new curriculum in a partial revision of the seventh national curriculum. The new curriculum is being developed to correct perceived weaknesses and to meet the needs of students, teachers, and society. Based on curriculum research, the new Korean technology education curriculum has been constructed using five curriculum content organizers: manufacturing, construction, communication, transportation, and biotechnology. The new technology curriculum incorporates learning content based on technological systems and students' hands-on activities. Table 1 depicts the two main features of the structure of learning contents for Grades 7 to grade 10. A basic structure of learning content and sub-content is compulsory while there is also a minimum level of knowledge and hands-on activity specified. In particular, "technology and invention," "Korean traditional technology", and "biotechnology" are new categories of learning content, introduced for the first time in the new technology curriculum.

biotechnology instruction is implemented. Biotechnology is important today because its content is essential for students' understanding of the world now and in the coming years (ITEA, 2000; Savage & Sterry, 1991; Scott et al., 2006; Wells, 1994). In other words, teaching biotechnology is valuable because it enhances the technological literacy necessary for students' lives in the future. Moreover, teaching biotechnology is important because biotechnology knowledge is significant for food, health, and environment of the world's population (Wells, 1994).

Table 1. Learning Contents of New National Technology Curriculum in Secondary School

Grade	7th Grade	8th Grade	9th Grade	10th grade
Learning Contents	Technological Development and Future Society	Information and Communication Technology	Electronics and Machine Technology	Vocation and Career Design
	Technology and Invention	Manufacturing Technology	Construction Technology	Transportation Technology
			Biotechnology	

As awareness of the importance of teaching biotechnology increases, Korean technology education has adopted and developed biotechnology instruction. Even though the Korean educational system follows a strong national curriculum, the implementation of teaching biotechnology is dependent on each technology teacher. In other words, technology teachers' beliefs about biotechnology and its instruction affect both their decisions to implement biotechnology instruction and their performance once it is introduced.

Technology Teachers' Beliefs

Teachers' attitudes towards value, expectancy, and innovation are the key factors affecting their choice, their performance, and their persistence in implementing the curriculum (Abrami et al., 2004; Kay, 2006; Wilson et al., 2002).

Teachers' values directly their influence performance, activity choice, and participation in such activities (Eccles, 2005). Value for teachers indicates the usefulness (Graham & Taylor, 2002) or attractiveness (Wigfield, Tonks, & Eccles, 2004) toward a specific activity. The teachers' values can be measured by the benefits or usefulness of the program to teachers and students (Abrami et al., 2004; Wozney, Venkatesh, & Abrami, 2006). Also, a specific educational activity is more likely to be implemented if teachers perceive that it has high value (Abrami et al., 2004; Kay, 2006). Technology teachers' beliefs about the value of biotechnology instruction can be a significant predictor of whether

Another possible predictor for the implementation of biotechnology instruction is teachers' expectancy. Teachers' expectancy for success directly predicts their outcomes such as their performance, persistence, and choice of activities (Eccles, 2005). These expectations for success are strongly associated with teachers' ability to perform the assigned tasks and activities (Wigfield et al., 2004). Thus, technology teachers' beliefs about their ability regarding biotechnology instruction affect the implementation of such content. In other words, technology teachers' expectations for success in teaching biotechnology promote the choice or intent to implement this instruction.

Lastly, despite a strong national curriculum, the implementation of technology education has been dependent on technology teachers' beliefs about curriculum innovation (Yi & Kwon, 2008). Therefore, the choice or decision to teach biotechnology content also may be affected by Korean technology teachers' beliefs about innovating the current technology curriculum.

Research Questions

The purpose of the study was to investigate Korean technology teachers' beliefs related to their intent to implement biotechnology teaching. More specifically, the study attempted to answer the following research questions:

1. Do Korean technology teachers perceive biotechnology to be of value within technology education?

2. What do Korean technology teachers' expect from teaching biotechnology in their classrooms?

3. Do Korean technology teachers see the need to develop the current Korean technology curriculum to accommodate biotechnology instruction?

4. What is a predictive model for the dependent variable of the Korean technology teachers' intent to teach biotechnology when the following independent variables are considered: Korean technology teachers' demographic information, their perceptions of innovation in the biotechnology curriculum, their expectancy for biotechnology teaching, and their perceived value of biotechnology teaching?

Methods

Participants

The participants of the study were 114 technology teachers who were teaching technology as a part of the *"Technology-≠Home Economics"* subject in Korean middle schools located in two major cities (Daejon Metropolitan City and Seoul Special City) and one rural area (Gyeonggi Province).

The study adopted both random sampling and convenient sampling methods. The random sampling following Cochran's (1977) guidelines was employed to select technology teachers in Daejon Metropolitan City. A total of 95 technology teachers from a possible 127 teachers teaching in middle schools during the spring semester of 2008 were selected using Cochran's formula. From these 95 teachers, 46 participated in the survey.

The study also made an effort to reduce selection bias caused by location (i.e., metropolitan/city or rural areas). Using technology teachers' directories of four local districts in Seoul Special City and Gyeonggi Province, this study chose 75 middle school technology teachers and received responses from 68.

Instruments

The instrument consisted of five sections: 1) technology teachers' intent to implement biotechnology teaching (*intent:* 6 items); 2) technology teachers' perceived beliefs about biotechnology teaching as valuable (*value:* 8 items); 3) technology teachers' perceived beliefs about biotechnology teaching as expectancy (*expectancy:* 6 items); 4) technology teachers' perceived beliefs about biotechnology teaching as needs for innovation (*innovation:* 6 items); and 5) demographic information (e.g., years of teaching technology, college major, gender, and courses taken associated with biotechnology content in the technology teachers' preparatory institute).

Constructs. The dependent variable of the study was the technology teachers' intent to implement biotechnology instruction (*intent*) measured by six items.

The three components, *teacher value, expectancy,* and *innovation*, served as the major independent variables for the study. The items of teacher value and expectancy were developed based on definitions by motivation theorists (Eccles, 2005; Graham & Taylor, 2002; Wigfield, et al. 2004), whereas teacher innovation was created by following the suggestions for innovating the Korean technology curriculum (KICE, 2002; Yi et al., 2006). More specifically, value is defined as "intrinsic interest," "importance," and "usefulness," while expectancy is defined as "beliefs about ability" (Eccles, 2005; Graham & Taylor, 2002).

The degree of agreement for each item of the independent and dependent variables was measured by selecting one of the following responses for each item: strongly disagree: 1; disagree: 2; neutral: 3; agree: 4; Strongly agree: 5. The study included the "neutral" category to encourage respondents to make a response, instead of not responding (Bognar, 1997), although several researchers have found that respondents are more likely to choose the "neutral" category, and this can make a difference in responses.

Content validity. The instruments were reviewed for content/face validity by a panel of experts made up of two technology education scholars who hold doctoral degrees in the field of technology education. To overcome potential problems caused by translation, three Korean language teachers and two English language teachers from South Korean high schools reviewed the survey items.

Reliability of constructs. The researchers first conducted a pilot study using 21 participants from 10 technology middle schools who were not randomly selected and who had taught biotechnology for at least three years. The participants of the pilot study were asked to complete and comment on the web-based survey. In the pilot study, the reliability statistics measured by the Cronbach's alpha for expectancy, value, innovation, and intent ranged from 0.85 and 0.87. Corrections as suggested by pilot study participants were made to the total survey.

In the main data collection, the reliabilities (Cronbach's alpha) of teachers' belief of *expectancy, value, innovation*, and *intent* were measured at 0.889, 0.876, 0.843, and 0.888 respectively. For further statistical analysis, we conducted factor analysis for the three components.

Demographics. The study also collected demographic data (e.g., teaching experience measured by years of teaching, gender, major, and courses taken in the technology teachers' preparatory institutes). The years of teaching technology were divided into 8 categories (1 = less than 1 year; 2 = 1-3 years; 3 = 4-6 years; 4 = 7-10 years; 5 = 11-15 years; 6 = 16-20 years; 7 = 21-25; 8 = over 26 years).The courses related to biotechnology content at the teachers' preparatory institute were measured according to six categories: agricultural technology, environmental science/engineering, genetic engineering, food science/engineering, biology, and general science.

Data Collection

Both randomly selected and conveniently selected teachers were sent a web link to access a web-based survey, *"Korean Technology Teachers' Perception toward Biotechnology Teaching",* which was developed by the researchers, and included corrections based on the pilot study. Technology teachers (95) from the teachers' directory of Daejon Metropolitan City were used to select teachers randomly; 75 technology teachers from Seoul Special City and Gyeonggi Province were used to select teachers conveniently. An e-mail (including a link to the online survey and a cover letter) was sent to each selected teacher asking the teacher to complete the survey. This study was approved by the Virginia Tech School Institutional Review Board (IRB).

Results

Demographic Information

A total of 114 respondents (58.8% male and 41.2% female technology teachers) completed the survey instrument, with a total response rate of 67.5%. The missing data were replaced by the total means of each variable to capture all possible information without affecting the analysis results. The majority of respondents (n = 101, 88.6%) were technology teachers who had majored in technology education. About 11.4 percent of respondents (n = 13) had majored in "Home Economics," "Industrial Subjects," or "Agricultural Science."

Approximately 32 percent of the respondents had taught content relating to biotechnology for 7 to 10 years. Most of the respondents (73.7%, n = 84) took agricultural technology courses in the technology teachers' preparatory institutes as well. However, there were other courses required for technology teachers' preparatory work, such as environmental science/engineering (18.4%, n = 21), genetic engineering (23.7%, n = 27), food engineering (18.4%, n = 21), biology (38.6%, n = 44), and science (23.7%, n = 27).

Factor Analysis

The study performed a series of factor analyses to confirm interrelationships among items of each of the four components (*expectancy, value, innovation, and intent*). As presented in Table 2, most of the items of each component displayed high factor loadings. Through this process, one item, *"Q6: I am interested in reading newspapers and books and watching TV programs related to biotechnology"* indicated a cross-loading for value and expectancy (.301 for value .343 for expectancy), and thus it was removed from the survey.

Descriptive Statistics and Correlations among Variables

Table 3. presents the means, standard deviations, and correlation coefficients for the variables of *intent, value, expectancy, innovation,* years of teaching, number of courses in biotechnology content, and gender.

The respondents' composite mean of perceived value for teaching biotechnology was 3.92 on a five-point Likert scale, indicating that they perceived that biotechnology and its instruction was useful. The composite mean of expectancy for teaching biotechnology was 3.26

Table 2. Independent/Dependent Variables and Factor Loadings

Factors	Predictor Variables	Loading
Value (_=.889)	I believe that human life will improve through biotechnology	.781
	Biotechnology is one important content that should be taught in TE classes	.781
	Considering students' future life, learning biotechnology is essential	.778
	I like to teach biotechnology content	.756
	I believe that teaching biotechnology is valuable, considering the developmental trends of contemporary technological society	.748
	I am interested in learning new terminologies and concepts of biotechnology	.742
	Considering students' actual life, learning biotechnology is useful	.731
	I believe that all literate people should know biotechnology content	.690
Expectancy (_=.876)	I can implement problem-based learning in biotechnology instruction	.821
	I can develop hands-on activities related to biotechnology for TE classes	.813
	I can employ the content or strategies of other subjects (e.g. biology, mathematics, etc) for teaching biotechnology in TE classes	.789
	I can manage materials, tools, equipment, and the laboratory for biotechnology hands-on activities	.778
	I can evaluate/assess hands-on activities in biotechnology instruction	.774
	I can teach biotechnology in a unique method different from that of biology and agriculture teachers	.752
Innovation (_=.843)	We should employ biotechnology topics in motivating students	.858
	We should emphasize hands-on activities and practice, providing students with practical experiences	.820
	We should add the topics dealing with social/environmental impact as major content in biotechnology curriculum	.806
	We should eliminate simple cultivation technology and cover a variety of biotechnology topics	.766
	Developing more practical problem solving ability should be one of major goals teaching biotechnology **for** TE classes	.724
	We should emphasize the affective domain students (developing the attitude toward biotechnology)	.542
Intent (_=.888)	I will develop hands-on activity for my biotechnology teaching	.874
	I will acquire materials, tools, and equipment for biotechnology teaching	.837
	I will recognize the content of the textbook to teach biotechnology	.813
	I will build up knowledge and competency related to the biotechnology content	.802
	I will apply student based hands-on activities for biotechnology teaching	.801
	I sincerely teach biotechnology content in my class	.674

Table 3. Descriptive Statistics and Correlations of Variables

Variables	M	SD	1	2	3	4	5	6
1. Intent	3.938	0.654	-					
2. Value	3.921	0.574	.676**	-				
3. Expectancy	3.261	0.680	.681**	.536**	-			
4. Innovation	4.149	0.570	.541**	.426**	.336**	-		
5. Teaching yr	4.030	1.436	-.331**	-.290**	-.155	-.264**	-	
6. Courses	1.960	1.088	-.032	-.042	.088	-.122	.187*	-
7. Gender	1.410	0.493	-.076	.076	-.238*	.118	-.182	-.288**

*p<.05, **p<.01.

on the same scale, indicating a comparatively lower worth than *value*. In terms of changes to Korean technology education, teachers perceived that several aspects of the current biotechnology curriculum were in need of development: (1) Biotechnology content in technology education must be changed into more interesting topics to motivate students; (2) the current Korean technology curriculum must be reorganized into problem-based learning or hands-on activities; and (3) the biotechnology curriculum should avoid the topics of simple cultivation technology and should employ a variety of biotechnology topics.

The intercorrelations revealed that Korean technology teachers' intent to teach biotechnology was significantly associated with *value, expectancy,* and *innovation* (676, .681, and .541, respectively). A significant negative correlation was noted between the intent and teaching years (-.331). In other words, technology teachers who had taught for a longer time were less likely to want to teach biotechnology.

Teacher Intent to Implement Technology Education

Overall, Korean teachers indicated a willingness to teach biotechnology, having a mean of intent of 3.938 on a five-point Likert scale. An ANOVA was conducted to compare the degree of teachers' intent to teach technology education among the three locations of Seoul, Daejon, and Gyeonggi, and there was no significant difference ($F = 2.877$, $p > 0.05$), as shown on Table 4. This finding was further verified when data were analyzed using Levene's test (0.614, $p > 0.05$).

developed by the authors was administered, to 114 Korean middle school technology teachers who had been selected using random and convenient sampling methods from three different districts. An ANOVA was used to check the difference of teacher intent, which could be caused by different sampling methods and locations; however, no significant difference was noted ($F = 2.877$, $p > 0.05$).

Korean technology teachers saw the benefits of biotechnology in their students' lives and the need to teach biotechnology content in technology education class. However, their belief in their ability to teach biotechnology content

Table 4. Analysis of Variance Summary Regarding Teachers' Intent

	Sum of Squares	df	Mean Square	F
Between Groups	2.389	2	1.194	2.877
Within Groups	46.070	111	.415	
Total	48.459	113		

Factors for the Intent to Teach Biotechnology Content

The major tool of the study was the hierarchical multiple regression with which the effects of independent variables can be examined step by step after controlling for the effects of demographic variables. The analysis model first controlled for the effect of teacher gender, years of teaching, and number of courses; then v*alue, expectancy, and innovation* were added to the model, one by one, as presented in Table 5.

The results show that three independent variables (teachers' ***value, expectancy, and innovation***) successfully predict the dependent variable (the intent to implement biotechnology teaching), which is indicated by F-value of 34.929 ($p < 0.01$) and R-square of 0.664. When the contribution of each independent variable was added, Korean technology teachers' value was found to be a significant predictor in this model. The coefficients of teachers' value (•, = .726, p < 0.01), expectancy (•, = 0.411, $p < 0.01$), innovation (•, = .278, $p < 0.01$) were significant, and this was also verified by the significant Pearson's correlation coefficients ($r = 0.681$ $p < 0.01$; $r = 0.676$, $p < 0.01$; $r = 0.541$, $p < 0.01$, respectively).

Summary and Conclusion

This study used an online survey to investigate Korean technology teachers' beliefs (value, expectancy, and innovation) associated with their intent to teach biotechnology content in technology education classes. The piloted survey

successfully was not consistent with their level of perceived value of the subject. The survey results suggested that the teachers believed that the current biotechnology curriculum within Korean technology education should be developed in terms of learning topics, instructional strategies, and a variety of hands-on activities. In particular, they wished to teach a variety of biotechnology topics through problem-based learning or hands-on activities.

The major finding of the study was that Korean technology teachers' beliefs as measured by value, expectancy, and innovation were significantly correlated with teacher intent to implement biotechnology in their classrooms. Hierarchical multiple regression model successfully predicted their intention to teach biotechnology content after controlling for demographic information (years of teaching, courses, and gender).

In addition, the study discovered that those technology teachers who had taught longer were less likely to teach biotechnology content in their classes.

Implication

There are several implications for future practice and for studies that should be conducted. As stated previously, the results of this study suggest that technology teachers face a lower expectancy level than the value they place on technology education. This finding may

Table 5. Hierarchical Multiple Regression Analysis Summary (N=114)

Variable	B	SEB	_	R2	_R2
Step 1				.124**	
Years of Teaching	-.159	.042	-.348		
Courses	-.004	.057	-.007		
Gender	-.188	.125	-.141		
Step 2				.497***	.374***
Value	.726	.081	.637		
Step 3				.619***	.122***
Expectancy	.421	.072	.438		
Step 4				.664***	.045***
Innovation	.278	.074	.243		

Predictor Variable: Teacher intent to teach biotechnology
***p<0.001

highlight the need to improve their expectancy level toward biotechnology and its instruction. In particular, these teachers show strong motivation to innovate current biotechnology curriculum for technology education classes. Professional development programs emphasizing biotechnology and its instruction can help technology teachers to improve their competency level (Daugherty, 2005; Scott et al., 2006). This study recommends that biotechnology content should be delivered systematically during technology teachers' professional development.

In addition, this study concentrated on investigating technology teachers' attitudes and motivation toward biotechnology and its instruction. However, there may be other variables affecting biotechnology instruction for technology education programs. External factors such as school support, facilities, and equipment can affect biotechnology instruction (Brown et al., 1998; Daugherty, 2005). Also, the sample of this study was middle school technology teachers in South Korea. In this country, technology education is a compulsory subject under the national curriculum, and biotechnology content is part of technology education presented at the middle school level. Therefore, future studies should investigate the beliefs of technology teachers in other countries including related external factors.

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