

High School Students' Knowledge and Attitudes Regarding Biotechnology Applications

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Abstract

The purpose of this study was to investigate high school students' knowledge and attitudes regarding biotechnology and its various applications. In addition, whether students' knowledge and attitudes differed according to age and gender were also explored. The Biotechnology Knowledge Questionnaire (BKQ) with 16 items and the Biotechnology Attitude Questionnaire (BAQ) with 37 items which were adapted into Turkish were administrated to 352 high school students. The data were analyzed by making use of both inferential and descriptive statistics. The results showed that students attained poor knowledge regarding biotechnology and its various applications. We found no statistically significant difference between male and female high school students with regard to biotechnology knowledge. On the other hand, we found significant impact of age on biotechnology knowledge. The effects of gender and age were found significant on attitudes. Furthermore, a significant difference was observed between male and female students with regard to attitudes toward biotechnology and its applications in favor of males. The older the students were the more positive attitudes they had.

Key Words

Biotechnology, Attitude, Knowledge, High School Student.

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One of the most important scientific and technological developments in twenty first century has been biotechnology and its applications in several areas (Pardo, Midden, & Miller, 2002). The discussions on biotechnology practices have been attracted by both applied sciences and social sciences (Simonneaux, Albe, Ducamp & Simonneaux, 2005). However, the acceptance of biotechnology and its applications in general public includes complex processes with societal attitudes and beliefs (Peters, Lang, Sawicka & Hallman, 2007). This can be effectively understood through developing science and technology literacy (Durant, Evans & Thomas, 1992). In this sense, Goodrum, Hackling, and Rennie (2001) and Osborne (2000) claimed that science curricula should help develop individuals' decision making in the controversial issues like biotechnology. Research studies performed in this area are more about social and moral aspects of biotechnology (Pardo et al., 2002; Saez, Niño, & Carretero, 2008), biotechnology knowledge (Gunter, Kinderlerer & Beyleveld, 1998; Priest, Bonfadelli, & Rusanen, 2003; Qin, & Brown, 2007), consumers' opinions and attitudes toward biotechnology (Arvanitoyannis, & Krystallis, 2005; Lea, 2005; Moon & Balasubramanian, 2004; Pardo et al., 2002; Saba, & Vassallo, 2002; Saher, Lindeman, & Hursti, 2006; Sturgis, Cooper, & Fife-Schaw, 2005; Zechendorf, 1994), students' and teachers' knowledge and attitudes regarding genetically modified organisms (GMO; Chen, & Raffan, 1999; Dawson, 2007; Dawson, & Schibeci, 2003a, 2003b; Dawson & Soames, 2006; Hill, Stanisstreet, O'Sullivan, & Boyes, 1999; Klop, & Severiens, 2007; Lamanauskas & Makarskaitė-Petkevicienė, 2008; Lock, & Miles, 1993; Massarani, & Moreira, 2005; Prokop et al., 2007), general tendencies on GMO(s) (Klop, & Severiens, 2007; Saez et al., 2008), and effects of biotechnology instruction on knowledge and attitude regarding biotechnology (Lock, Miles & Hugles, 1995; Olsner & Dreyful, 1999). Furthermore, the relationship between students' knowledge and attitudes were also investigated in the literature (DiEnno & Hilton, 2005; European Commission, 2001; Tikka, Kuitunen & Tynys, 2000; Weaver, 2002)

Despite its importance, the number of the research studies on biotechnology attitude and knowledge in Turkey are rather limited. Only two studies on this topic were found in Turkish literature (e.g., Darçın & Türkmen, 2006; Türkmen & Darçın, 2007)

Purpose of the Study

This study aimed at investigating Turkish high school students' knowledge and attitudes regarding biotechnology and its various applications. The following questions guided and shaped the overall study.

- (α) What are the high school students' knowledge and attitudes levels regarding biotechnology and its various applications?
- (β) Is there any correlation between high school students' knowledge and attitudes regarding biotechnology and its various applications?
- (χ) Is there any significant effect of age and gender on high school students' knowledge and attitudes regarding biotechnology and its various applications?

Method

This survey study was conducted with 325 high school students (224 males, 101 females) at various levels in the spring semester of 2006-2007 academic year. The Biotechnology Knowledge Questionnaire (BKQ) and the Biotechnology Attitude Questionnaire (BAQ) were used for data collection. The BKQ includes 16 items on a Likert type scale and its Cronbach's alpha reliability coefficient was found .50. The BAQ includes 37 items on a five point Likert type scale and eight sub-dimensions and Cronbach's alpha reliability of the BAQ was found .75. Once data cleaning process was completed, data were subjected to descriptive statistics (mainly, mean, SD, percentage). The research question 2 was tested with multiple correlation analysis and the research question 3 was tested with two-way MANOVA

Results

Nine of all knowledge items were correctly answered by above 50 % of all students. The remaining seven questions were correctly answered by only 25-44% of the students. These results pointed out that students' knowledge level seemed not to be very high. Their attitudes toward each dimensions of the BQA varied; negative, neutral, and positive. While students agreed that the cloning could be used for protecting endangered species, they disagreed that the genes could be changed in order to keep the vegetable and fruits fresh. Students accepted that genetic engineering could be used for producing insulin and dealing with inhe-

riting diseases, but, they did not accept that genetically modified (GM) products could be given to children, because they believed that genetically modified food could include dangerous chemical materials and their tastes could not be better. In short, they were not willing to buy GM products. However, they accepted that genetic engineering could be used to produce medicine from animals. Even though they believed that GM plants should not be consumed, they accepted that genetic engineering should be used for providing resistance for plants against insects and salt, and for increasing the productivity of the plant genes. Students believed that consumers were not adequately informed about genetically modified products and 76% of them emphasized the importance of being informed about these products.

In order to test the effects of gender and age on students' knowledge and attitudes regarding biotechnology, a 2X3 MANOVA, where the dependent variables were knowledge and eight sub-dimensions of attitude, was performed. The main effect of age on students' biotechnology knowledge was found significant, [F (2, 319)=8.347, $p < .01$, partial $\eta^2 = .05$]. This referred that when students' age increased, their knowledge on biotechnology applications increased. However, the main effect of gender, [F (1, 319)=.515, $p = .473$], and the interaction effect of gender and age, [F (2, 319)=.987, $p = .374$] were not significant.

The main effect of gender on students' attitudes were found significant, but not for all sub-dimensions. Its effect was significant for the following dimensions in favor of males; DNMA [F (1, 319)=12.838, $p < .01$, partial $\eta^2 = .04$], GMOP [F (1, 319)=8.86, $p < .01$, partial $\eta^2 = .03$], RGE [F (1, 319)=6.106, $p < .05$, partial $\eta^2 = .02$], and PLANT [F (1, 319)=3.922, $p < .05$, partial $\eta^2 = .01$]. The main effects of age was significant for the sub-dimensions of DNMA [F (2, 319)=3.061, $p < .05$, partial $\eta^2 = .01$], ANIMALS [F (2, 319)=10.024, $p < .01$, partial $\eta^2 = .06$] and PLANT [F (2, 319)=23.374, $p < .01$, partial $\eta^2 = .13$]. When their ages increased, their attitudes increased as well. The interaction effect of gender and age was also significant for GMOP [F (2, 319)=4.199, $p < .05$, partial $\eta^2 = .03$] and RGE [F (2, 319)=6.4, $p < .01$, partial $\eta^2 = .04$].

Given in Table 1, the correlation analysis among the knowledge and eight sub-dimensions of attitudes pointed out that students' biotechnology knowledge were significantly correlated with RGE ($r = .14$, $p < .01$), ANIMAL ($r = .13$, $p < .05$), PLANT ($r = .22$, $p < .01$) and ECCGMGP ($r = -.26$, $p < .05$).

Table 1.
Multiple Correlations among Students' Knowledge and Attitudes Regarding Biotechnology Applications

	KNOWLEDGE	DNAM	GMOP	RGE	SGMP	ANIMALS	PLANT	ECCGMP
DNAM	.08							
GMOP	-.02	.18 (**)						
RGE	.14 (**)	.13 (*)	.11					
SGMP	.08	-.02	.24 (**)	.32 (**)				
ANIMALS	.13 (*)	.25 (**)	.25 (**)	.15 (**)	.27 (**)			
PLANT	.22 (**)	.27 (**)	.14 (*)	.16 (**)	.25 (**)	.21 (**)		
ECCGMP	-.26 (**)	.03	.17 (**)	-.06	.11 (*)	.03	.25 (**)	
PAGEF	.07	.06	.12 (*)	.32 (**)	.15 (**)	.22 (**)	.15 (**)	.04

(*) A correlation was significant at .05 significance level

(**) A correlation was significant at .01 significance level

Conclusion

It is observed that the findings of the present study are complementary to professional literature and the findings of other research studies conducted in other countries such as Australia, Brazil, England and Taiwan. This study was limited with the data gathered from 352 high school students. For that reason, in order to provide wider perspectives on the biotechnology practices, students from various grades (i.e. primary and tertiary level) and adults should be targeted groups of the further research studies. This will be a significant source for further curriculum development and revision and also for the policy making regarding biotechnology and its various applications. Comparative studies should also be undertaken so as to see people's understanding and acceptance of biotechnology in different cultures and contexts.

References / Kaynakça

- Arvanitoyannis, I. S., & Krystallis, A. (2005). Consumers' beliefs, attitudes and intentions towards genetically modified foods, based on the 'perceived safety vs. benefits' perspective. *International Journal of Food Science and Technology*, *40*, 343-360.
- Chen, S. Y., & Raffan, J. (1999). Biotechnology: Student's knowledge and attitudes in the UK and Taiwan. *Journal of Biological Education*, *34* (1), 17-23.
- Darçın, E. S., & Türkmen, L. (2006). A study prospective Turkish science teachers' knowledge at the popular biotechnological issues. *Asia Pacific Forum on Science Learning and Teaching*, *7* (2), Article 9,
- Dawson, V. (2007). An exploration of high school (12-17 year old) students' understandings of, and attitudes towards biotechnology processes. *Research in Science Education*, *39*, 59-73.
- Dawson, V., & Schibeci, R. (2003a). Western australian school students' understanding of biotechnology. *International Journal of Science Education*, *25* (1), 57-69.
- Dawson, V., & Schibeci, R. (2003b). Western australian high school students' attitudes towards biotechnology processes. *Journal of Biological Education*, *38* (1), 7-12.
- Dawson, V., & Soames, C. (2006). The effect of biotechnology education on australian high school students' understandings and attitudes about biotechnology processes. *Research in Science & Technological Education*, *24* (2), 183-198.
- DiEnno, C. M., & Hilton, S. C. (2005). High school students' knowledge, attitudes, and levels of enjoyment of an environmental education unit on nonnative plants. *Journal of Environmental Education*, *37*, 13-25.
- Durant, J., Evans, G., & Thomas, G. (1992). Public understanding of science in britain: the role of medicine in the popular representation of science. *Public Understanding of Science*, *1* (2), 161-82.
- European Commission (2001). *Eurobarometer 55.2-Europeans, science and technology*. Retrieved January 15, 2007 from, http://ec.europa.eu/public_opinion/archives/eb/ebs_154_en.pdf.
- Goodrum, D., Hackling, M., & Rennie, L. (2001). *The status and quality of teaching and learning of science in australian schools*. A research report prepared for the Department of Education, Training and Youth Affairs. Retrieved on June 14, 2005, from www.detya.gov.au/schools/publications/2001/science
- Gunter, B., Kinderlerer, J., & Beyleveld, D. (1998). Teenagers and biotechnology: A survey of understanding and opinion in Britain. *Studies in Science Education*, *32*, 81-112.
- Hill, R., Stannistreet, M., O'Sullivan, H., & Boyes, E. (1999). Genetic engineering of animals for medical research: Students' views. *School Science Review*, *80*, 23-30.
- Klop, T., & Severiens, S. (2007). An exploration of attitudes towards modern biotechnology: A study among dutch secondary school students. *International Journal of Science Education*, *29* (5), 663-679.
- Lamanauskas, V., & Makarskaitė-Petkevičienė, R. (2008) Lithuanian University students' knowledge of biotechnology and their attitudes to the taught subject. *Eurasia Journal of Mathematics, Science & Technology Education*, *4* (3), 269-277.
- Lea, E. (2005). Beliefs about genetically modified foods: A qualitative and quantitative exploration. *Ecology of Food and Nutrition*, *44*, 437-454.
- Lock, R., & Miles, C. (1993). Biotechnology and genetic engineering: Students' knowledge and attitudes. *Journal of Biological Education*, *27* (4), 267-272.

- Lock, R., Miles, C., & Hughes, S. (1995). The influence of teaching on knowledge and attitudes in biotechnology and genetic engineering contexts: Implications for teaching controversial issues and the public understanding of science. *School Science Review*, 76, 47-59.
- Massarani, L., & Moreira, I. C. (2005). Attitudes towards genetics: a case study among Brazilian high school students. *Public Understanding of Science*, 14, 201-212.
- Moon, W., & Balasubramanian, S. K. (2004). Public attitudes agrobiotechnology. *Review of Agricultural Economics*, 26 (2), 186-208.
- Moerbeek, H.H.S.; Casimir, G.J. (2005) Gender differences in consumers' acceptance of genetically modified foods, *International Journal of Consumer Studies*, 29(4), 308 - 318
- Osborne, J. (2000). Science for citizenship. In M. Monk & J. Osborne (Eds.), *Good practice in science teaching: What research has to say* (pp. 225-240). Philadelphia, PA: Open University Press.
- Olsher, G., & Dreyfus, A. (1999). The fostension-teaching approach as a means to develop junior high student attitudes towards biotechnologies. *Journal of Biological Education*, 34 (1), 24-30.
- Priest, S. H., Bonfadelli, H., & Rusanen, M. (2003). The "trust gap" hypothesis: predicting support for biotechnology across national cultures as a function of trust in actors. *Risk Analysis*, 23 (4), 751-766.
- Pardo, R., Midden, C., & Miller, J. D. (2002). Attitudes toward biotechnology in the European Union. *Journal of Biotechnology*, 98 (1), 9-24.
- Peters, H. P., Lang, J. T., Sawicka, M., & Hallman, W. K. (2007). Culture and technological innovation: Impact of institutional trust and appreciation of nature on attitudes towards food biotechnology in the USA and Germany. *International Journal of Public Opinion Research*, 19 (2), 191-220.
- Prokop, P., Lešková, A., Kubiak, M., & Diran, C. (2007). Slovakian students' knowledge of and attitudes toward biotechnology. *International Journal of Science Education*, 29 (7), 895-907.
- Qin, W., & Brown, J. L. (2007). Public reactions to information about genetically engineered foods: Effects of information formats and male/female differences. *Public Understanding of Science*, 16, 471-488.
- Saba, A., & Vassallo, M. (2002). Consumer attitudes towards the use of gene technology in tomato production. *Food Quality and Preference*, 13 (1), 13-21.
- Saez, M.J., Niño, A.G. & Carretero, A. (2008) Matching society values: Students' view of biotechnology. *International Journal of Science Education* 30(2), 167-183.
- Saher, M., Lindeman, M., & Hursti, U. K. (2006). Attitudes towards genetically modified and organic foods. *Appetite*, 46, 324-331.
- Simonneaux, L., Albe, V., Ducamp, C., & Simonneaux, J. (2005). Do high-school students' perceptions of science change when addressed directly by researchers? *Eurasia Journal of Mathematics, Science and Technology Education*, 1 (1), 21-40.
- Sturgis, P., Cooper, H., & Fife-Schaw, C. (2005). Attitudes to biotechnology: Estimating the opinions of a better informed public. *New Genetics and Society*, 24 (1), 34-58.
- Tikka, P. M., Kuitunen, M. T., & Tynys, S. M. (2000). Effects of educational background on students' attitudes, activity levels, and knowledge concerning the environment. *Journal of Environmental Education*, 31 (3), 12-19.

Türkmen, L., & Darçın, E. S. (2007). A comparative study of Turkish elementary and science education major students' knowledge levels at the popular biotechnological issues. *International Journal of Environmental & Science Education*, 2 (4), 125-131.

Weaver, A. A. (2002). Determinants of environmental attitudes. *International Journal of Sociology*, 32 (1), 77-108.

Zechendorf, B. (1994). What the public thinks about biotechnology. *Bio/Technology*, 12, 869-885.

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