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Examination of university students' attitudes towards biotechnological studies in terms of faculty and gender variables

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Abstract

The objective of this study is to investigate university students' attitudes towards biotechnological studies in terms of faculty and gender variables. 222 students from three faculties in one university attended in this study. A questionnaire developed by Dawson and Schibeci (2003), was administrated to the undergraduate students to assess their attitudes towards biotechnological applications.

Results obtained from this study showed no statistical differences in terms of gender variable. Statistical significant differences ($p<.05$) were found between students from different faculties in terms of the results of the questionnaire and it was found that biology students were particularly supportive of biotechnological studies compared with science education and medical students.
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Keywords: Biotechnology; biotechnological applications; genetically modified organisms ; university students; attitudes.

1. Introduction

The astonishing new developments in biology and genetics have taken place over the past forty years. This technology permits us to intervene in the process of life itself and to some extent shape and reshape human nature to our own design. That is why this technology is named as "biological revolution".

There have been a number of investigations of students' attitudes towards biotechnology and genetic engineering (Lock & Miles, 1993; Chen & Raffan, 1999; Dawson & Schibeci, 2003; Gunter, Kinderlerer & Beyleveld, 1998; Kitto, Griffiths & Pesek, 2003; Massarani & Moreira, 2005; Wood-Robinson, Lewis, Driver & Leach, 1996). In these studies to determine the students' knowledge and perceptions of biotechnology, and attitudes towards the use of biotechnology they were asked to complete an Attitudes about Biotechnology questionnaire.

One study investigated GCSE students' attitudes towards biotechnology and genetic engineering and it was found that attitudes of students were context-dependent (Lock & Miles, 1993). Similar results were determined from research among Western Australian schools, aged 15-16 years, and it was found that students hold a wide range of beliefs about what is an acceptable use of biotechnology. In addition, the attitudes of students who studied

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biotechnology and have a good understanding of the processes and issues were similar in percentage and spread to those who were less informed (Dawson & Schibeci, 2003). Another study has been conducted to determine the influence of biotechnology course to the students' knowledge in relation to biotechnology and the effect of course was measured by pre and post course questionneires. Results showed that students' knowledge of biotechnology had increased (Kitto et al., 2003).

Research indicated that students exhibited net concerns about a number of biotechnology process and applications. In these studies negative perceptions of biotechnology were found among students (Gunter et.al., 1998; Masakazu ve Macer, 2004; Yunta et.al., 2005). Considering commercial application of genetically modified foods in Turkey, a survey was conducted to receive opinions of Turkish people in four different age groups (15-30, 31-45, 46-60, 61-90). Results of this study inicated that only 8% of respondents thought that GM foods were safe, 69% thought that they were little risky, 23% of them thought that they were extremely risky for human health (Mehmetoglu & Demirkol, 2007). On the other hand, in their assessment of the utility, the potential risks of modern genetics and biotechnology, Massarani and Moreira (2005) found that although young peoples were aware of the risks of these technologies, most of them believed that transgenic food could be useful and should be encouraged but they were also aware of the risks of these technology.

Citizens of all ages need a high level of scientific litearcy about the uses of the new technologies (Dawson and Schibeci, 2003) and they need to be able to evaluate critically the potential benefits and risks of scientific advances (Dawson, 2001). University students are also experience with biotechnological studies in their lessons and as they are part of the society, in some situations in their life many of them become decision makers related to these issues as today's and our future of individuals. Therefore the purpose of this study to determine university students' attitudes towards biotechnology in terms of faculty and gender variables.

2. Method

The students who comprise the sample includes; 124 preservice science teachers in a four year science teacher preparation programme which is not include biotechnology course; 34 biology students who are attending a four year science programme which include biotechnology course; 64 medical students who are attending a six year medical studies programme which is not include biotechnology course. All of the students at one university in the Marmara region of Turkey.

For this study a questionnaire developed by Dawson and Schibeci (2003) was administreted to the undergraduate students to assess their attitudes towards biotechnological applications. Adaptation of the scale was done before used which was based on Likert scale and included 15 items. The adaptation process of the scale to Turkish included translation, validity, and reliability studies.

In order to assess the internal consistency of the inventory, Cronbach's α coefficient was computed. Reliability coefficients for the scale was found to be 0,81. After application of the scale, data were analyzed using statistical techniques.

In this study, to check the distribution of this sample, Kolmogorov-Smirnov test was done. The results of this test indicated that distribution was not different from a normal distribution (Z:1.18; p:0.12). Considering this result parametric analysis were done for the data analysis. ANOVA test was applied to find the statistically differences between the faculty groups and t test was applied to find the differences between the gender groups.

3. Results (Findings)

Table 1.The Results of ANOVA Test to Identify the Differences in terms of Faculty Variable

N, $\overline{X}$, SD				Results of ANOVA Testing					
Faculty	**N**	$\overline{X}$	**SD**	**Source of variance**	**Sum of squares**	**df**	**Mean square**	**F**	**p**
Education	124	2,1224	,3822	Between groups	3,686	2	1,84	11,218	,00
Biology	34	2,4294	,3600	Within groups	35,980	219	,164		
Medicine	64	2,0281	,4669	Total	39,666	221			
Total	222	2,1423	,4237						

As seen in Table 1 an ANOVA test was conducted to determine differences among the faculty of education, biology and medicine regarding attitudes towards biotechnological applications at the significant level .05. Results revealed that biology students' showed more positive attitudes comparing with educational and medical students and statistically significant differences were found between these groups (F: 11.218; p<.05).

Homogeneity of variances were checked to decide which post hoc test would be chosen. Since the variances were not found homogeneous (Levene: 3,837; p<.05) Tamhane testing was preferred. The results obtained are presented in Table 2.

Table 2. The Results of Tamhane Tests

Faculty (I)	Faculty (J)	(I-J) Mean Difference	Std. Error	p
Education	Biology	-,3070*	7,847E-02	,000
	Medicine	9,430E-02	6,239E-02	,421
Biology	Education	,3070*	7,847E-02	,000
	Medicine	,4013*	8,602E-02	,000
Medicine	Education	-9,4302E-02	6,239E-02	,421
	Biology	-,4013*	8,602E-02	,000

Results of the Tamhane testing revealed statistically significant differences (p<.05) between educational and biology students and between Science and Medical students as seen in Table 2.

Table 3. The Results of t-Tests to Identify the Differences in terms of Gender Variable

N, $\overline{X}$, SD				Results of t-Testing				
Faculty	N	$\overline{X}$	SD	Source of Varience	Sum of squares	df	Mean square	F	p
Female	93	2.0903	.3984	Between groups	.287	1	.287	1.620	.20
Male	89	2.1698	.4463	Within groups	32.127	180	.178		
Total	222			Total	32.414	181			

Results of t-tests showed no significant differences (F: 1.620; p>.05) between females and males regarding attitudes towards biotechnological applications.

To determine differences for each item in terms of faculty variable ANOVA testing was used. As a result of ANOVA analysis, statistically significant differences (p<.05) were found between the arithmetic means of faculties for the first, fourth, fifth, sixth, seventh, eighth, ninth, twelfth, fourteenth items in the biotechnological attitude scale (F_1:11,218, F_4:6,091, F_5:5,417, F_6:8,294, F_7:5,139, F_8:4,585, F_9:7,318, F_{12}:3,368, F_{14}:5,245; p_1:.00, p_4:.00, p_5:.00, p_6:.00, p_7:.00, p_8:.01, p_9:.00, p_{12}:.03, p_{14}:.00).

Homogeneity of variances were checked to decide which post hoc test would be chosen. Since item one, three, four, six, nine, eleven, thirteen, fourteen were not found homogeneous ($Levene_1$:39,402, $Levene_3$:4,870, $Levene_4$:8,113, $Levene_6$:17,308, $Levene_9$:10,060, $Levene_{11}$:5,686, $Levene_{13}$:6,324, $Levene_{14}$:7,025; p_1:.00, p_3:.00, p_4:.00, p_6:.00, p_9:.00, p_{11}:.00, p_{13}:.00, p_{14}:.00) Tamhane testing was preferred. In addition, since item two, give, seven, ten , twelve, fifteen were found homogeneous Scheffe testing was preffered. The results obtained are presented in Table 4 and Table 5.

Table 4. Results of Tamhane Test

Items	Faculty (I)	$\overline{X}$	Faculty (J)	(I-J)	Std.Error	p
1	Education	2.6911	Biology	-,2476	,1201	,001*
			Medicine	,4435	9,546E-02	,001*
	Biology	2.9412	Education	,2476	,1201	,001*
			Medicine	,6912	,1316	,000*
	Medicine	2.2500	Education	-,4435	9,546E-02	,001*
			Biology	-,6912	,1316	,000*
3	Education	2.7317	Biology	-6.0247E-02	,1163	,920
			Medicine	,1245	9,245E-02	,528
	Biology	2.7941	Education	6,025E-02	,1163	,920
			Medicine	,1847	,1275	,388

	Medicine	2.6094	Education	-.1245	9.245E-02	.528
			Biology	-.1847	.1275	.388
4	Education	2.0569	Biology	-.5825	.1687	.000*
			Medicine	-6.0484E-02	.1341	.961
	Biology	2.6471	Education	.5825	.1687	.000*
			Medicine	.5221	.1849	.005
	Medicine	2.1250	Education	6.048E-02	.1341	.961
			Biology	-.5221	.1849	.005
6	Education	2.1301	Biology	-.6276	.1662	.000*
			Medicine	5.897E-02	.1321	.965
	Biology	2.7647	Education	.6276	.1662	.000*
			Medicine	.6866	.1822	.000*
	Medicine	2.0781	Education	-5.8972E-02	.1321	.965
			Biology	-.6866	.1822	.000*
9	Education	2.1138	Biology	-.5555	.1668	.000*
			Medicine	.1210	.1326	.768
	Biology	2.6765	Education	.5555	.1668	.000*
			Medicine	.6765	.1829	.000*
	Medicine	2.0000	Education	-.1210	.1326	.768
			Biology	-.6765	.1829	.000*
11	Education	2.4309	Biology	.1120	.1554	.892
			Medicine	.2636	.1235	.119
	Biology	2.3235	Education	-.1120	.1554	.892
			Medicine	.1517	.1703	.826
	Medicine	2.1719	Education	-.2636	.1235	.119
			Biology	-.1517	.1703	.826
13	Education	2.5447	Biology	-.1575	.1426	.515
			Medicine	.1734	.1133	.400
	Biology	2.7059	Education	.1575	.1426	.515
			Medicine	.3309	.1563	.086
	Medicine	2.3750	Education	-.1734	.1133	.400
			Biology	-.3309	.1563	.086
14	Education	2.5447	Biology	-3.9848E-02	.1495	.988
			Medicine	.3609	.1189	.018*
	Biology	2.5882	Education	3.985E-02	.1495	.988
			Medicine	.4007	.1639	.049*
	Medicine	2.1875	Education	-.3609	.1189	.018*
			Biology	-.4007	.1639	.049*

*(p<.05)

Tamhane tests revealed the following statistically significant groups' (faculty) differences on the scale; related with item one, between the education and biology students statistically significant difference was found in favor of biology students (p<.05); related with item four, between the education and biology students statistically significant difference was found in favor of biology students, and also between the biology and medicine students statistically significant difference was found in favor of biology students. Related to item six, between the education and biology students statistically significant was found in favor of biology students and also between the biology and medicine students significant difference was found in favor of biology students. Related to item nine, between the education and biology students statistically significant was found in favor of biology students and also between the biology and medicine students significant difference was found in favor of biology students. Related to iten fourteen, between the education and medicine students, statistically significant difference was found in favor of educational students and, between the biology and medicine students statistically significant difference was found in favor of biology students.

As can be seen in Table 4 no statistically significant differences were found related to item three, eleven and thirteen in terms of faculty variable (p>.05).

Table 5. Results of Scheffe Tests

	Faculty (I)	$\overline{X}$	**Faculty (J)**	**(I-J)**	**SD**	**p**
2	Education	2.3008	Biology	-.3112	.1421	.093
			Medicine	-.1154	.1130	.594
	Biology	2.6176	Education	.3112	.1421	.093
			Medicine	.1958	.1558	.455
	Medicine	2.4219	Education	.1154	.1130	.594
			Biology	-.1958	.1558	.455
5	Education	1.8780	Biology	-.4739	.1644	.017*
			Medicine	9.778E-02	.1307	.756

	Science	2.3529	Education Medicine	.4739 .5717	.1644 .1802	.017* .007*
	Medicine	1.7813	Education Biology	-9.7782E-02 -.5717	.1307 .1802	.756 .007*
7	Education	1.6423	Biology Medicine	-.4350 9.073E-02	.1551 .1233	.021* .763
	Science	2.0882	Education Medicine	.4350 .5257	.1551 .1700	.021* .009*
	Medicine	1.5625	Education Biology	-9.0726E-02 -.5257	.1233 .1700	.763 .009*
8	Education	1.6667	Biology Medicine	-.4696 -2.5706E-02	.1585 .1260	.013* .979
	Science	2.1471	Education Medicine	.4696 .4439	.1585 .1737	.013* .040*
	Medicine	1.7031	Education Biology	2.571E-02 -.4439	.1260 .1737	.979 .040*
10	Education	1.7561	Biology Medicine	-3.8020E-02 -5.6402E-02	.1701 .1353	.975 .917
	Science	1.7941	Education Medicine	3.802E-0 -1.8382E-0	.1701 .1863	.975 .995
	Medicine	1.8125	Education Biology	5.640E 1.838E	.1353 .1863	.917 .995
12	Education	1.7642	Biology Medicine	-.3809 5.040E-04	.1525 .1213	.046* 1.000
	Science	2.1471	Education Medicine	.3809 .3814	.1525 .1672	.046* .076
	Medicine	1.7656	Education Biology	-5.0403E-04 -.3814	.1213 .1672	1.0 .076
15	Education	1.5122	Biology Medicine	-.3449 -7.0060E-02	.1462 .1162	.064 .834
	Science	1.8529	Education Medicine	.3449 .2748	.1462 .1602	.064 .232
	Medicine	1.5781	Education Biology	7.006E-02 -.2748	.1162 .1602	.834 .232

*(p<.05)

Scheffe tests revealed the following statistically significant groups' (faculty) differences for each item on the scale. Related to item five, between the education and biology students statistically significant difference was found in favor of biology students and also between biology and medicine students statistically significant difference was found in favor of biology students. Related to item seven, between the education and biology students statistically significant difference was found in favor of biology students and also, between biology and medicine students statistically significant difference was found in favor of biology students. Related to item eight, between the education and biology students statistically significant difference was found in favor of biology students and also, between the biology and medicine students statistically significant difference was found in favor of biology students. Related to item twelve, between the education and biology students statistically significant difference was found in favor of biology students.

As can be shown in Table 5 no statistically differences were found related to item two, ten, fifteen in terms of gender variable (p>.05)

Table 6. Results of t- Testing

Items	Gender	N	SD	$\overline{x}$	t-Testing		
					t	Sd	p
1	Female Male	93 89	.5397 .7659	2.7634 2.4157	3.553	180	.00*
2	Female Male	93 89	.7589 .6910	2.3441 2.4494	-.978	180	.55
3	Female Male	93 89	.6218 .5168	2.6989 2.7753	-.899	180	.06
4	Female Male	93 89	.9086 .8942	2.0215 2.2022	-1.352	180	.94
5	Female Male	93 89	.8550 .8779	1.8280 1.9551	-.989	180	.90
6	Female Male	93 89	.8950 .9281	2.2151 2.1573	-.427	180	.30
7	Female Male	93 89	.6996 .9068	1.5484 1.7978	-2.082	180	.00*

8	Female	93	.7431	1.5699	-2.685	180	.00*
	Male	89	.9051	1.8989			
9	Female	93	.8545	2.1398	-.047	180	.01*
	Male	89	.9360	2.1461			
10	Female	93	.7585	1.5591	-3.135	179	.00*
	Male	89	.9335	1.9545			
11	Female	93	.7962	2.3226	-1.025	180	.15
	Male	89	.7223	2.4382			
12	Female	93	.7842	1.8387	.256	180	.88
	Male	89	.7816	1.8090			
13	Female	93	.6953	2.5914	.701	180	.27
	Male	89	.7403	2.5169			
14	Female	93	.7608	2.5054	1.053	180	.15
	Male	89	.8196	2.3820			
15	Female	93	.6633	1.4086	-2.130	180	.00*
	Male	89	.8012	1.6404			

To determine which groups caused differences for each item found in the biotechnology attitude scale, t-test analysis was applied. t-Tests were revealed that statistically significant differences were found between the arithmetic means of first, seventh, eighth, ninth, tenth and fifteenth items in the scale regarding gender variables (F_1:31.172, F_7:21.669, F_8:10.734, F_9:5.895, F_{10}:15.061, F_{15}:8.371; p_1:.00, p_7:.00, p_8:.00, p_9:.01, p_{10}:.00, p_{15}:.00). In relation to item seven, eight, nine, ten and fifteen statistically significant differences were found in favor of males. However, regarding item one, the statistically significant difference was found in favor of females (t_1:3.553, t_7:-2.082, t_8:-2.685, t_9:-.047, t_{10}:-3.135, t_{15}:-2.130; p_1:.00, p_7:.00, p_8:.00, p_9:.01, p_{10}:.00, p_{15}:.00).

As seen in the table (6) no statistically significant differences were found related to item two, three, four, five, six, eleven, twelve, thirteen and fourteen ($p>.05$).

4. Discussion

Assessment of the questionnaire indicated that university students' attitudes towards biotechnological studies showed discrepancy and context dependence: while there was a broad acceptance of modifying microorganisms in decomposing waste, and making wine and beer, this approval was low in making human and animal foods. In addition, there was also a broad approval of modifying human genes for the treatment of diseases. Besides this, acceptance of the inserting genes into fertilised eggs was found very low acceptance. Surveys by Chen and Raffan (1999) also examined the teenagers' attitudes about biotechnology and found that teenagers considered genetic engineering of plants more acceptable than genetic engineering of food crops and animals. In our study, modification of animals and plants were found lees acceptable compared with the study of Chen and Raffan (1999).

In regard to faculty variable, statistical significant differences were found between students from different faculties in terms of the results of the questionnaire and it was found that biology students were particularly supportive of biotechnological studies compared with science education and medical students. This was an expected result due to biology students have attended courses related with biotechnological studies. However in a study of Dawson and Schibeci (2003) no obvious difference was found in the attitudes of students regardless of whether or not they have studied biotechnology.

Although it was found that biology students had more positive attitudes compared to other faculty students, they had less acceptable attitudes towards the genetic modification of animals to increase the quality of food and inserting genes from humans into the fertilised eggs of mamals

The results of this study indicated that biology students were more accepting of the genetic modification of microorganisms and genetic modification of plants to improve the quality and altering the genes in an embryo to treat the genetic disease comparing to education and medicine students. On the other hand, medicine students were less accepting of genetic modification in microorganisms, plants and animals for producing human foods comparing with other applications of biotechnology. This result considered that human health was taken into consideration by medicine students more than other students.

In regard to gender variable, results showed that, in general, no statistically significant was found between males' and females' attitudes towards biotechnological applications. However analysis of each item determined that males were more accepting of altering genes in fruits to improve taste, altering genes in tomatoes to make them ripen more slowly and have longer shelf life, and to provide pesticide resistance interting genes from microorganisms into

crops. In contrast, it was found that females were more accepting of genetic modification of microorganisms. Studies also indicated average scores for acceptibility of genetic manipulation and it was found that males had higher scores for accepting genetic manipulation of animals in a laboratory than females (Kitto et al., 2003).

In conclusion, considering the results of this study, it can be suggested that, students' interests in biotechnology should be supported with courses including biotechnological applications but the aim of these courses is not to change students' attitudes. As mentioned Dawson and Schibeci (2003) it is important for students to develop an increases awareness, tolerance and respect for a diversity of views, in aiming for science for citizenship, therefore the aim of these courses should be to educate scientifically literate students.

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