TÜRK FEN EĞİTİMİ DERGİSİ
Yıl 5, Sayı 3, Aralık 2008

Journal of
TURKISH SCIENCE EDUCATION
Volume 5, Issue 3, December 2008

http://www.tused.org

Development of an Attitude Measure Oriented to Biotechnology for the Pre-Service Science Teachers

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Received: 15.04.2007 **Revised:** 22.09.2008 **Accepted:** 15.10.2008

The original language of article is English (v.5, n.3, December 2008, pp.72-81)

ABSTRACT

The aim of this study was to develop valid and reliable measures for the attitudes of pre-service sciences teachers towards biotechnology. The sample used in this study consisted of 384 science students. This study was conducted at four stages including determining the measure controls, expert opinion evaluations, pre-trials, and validity-reliability. The obtained data were analyzed by SPSS 13.00 and results were evaluated by factor analysis. The final measure developed according to these stages includes a total of 40 items where 14 of them were negative and 26 were positive. It was found that the measure fits to the sample group with 0.000 level, the KMO (Kasier-Meyer-Olkin) value was 0.827, and the Barlett test value was 4186.420. The Cronbach Alpha reliability constant of the measure was calculated as 0.75. The findings showed that the validity and reliability of the measure were acceptable.

Keywords: Attitude; Biotechnology; Factor Analysis.

INTRODUCTION

Currently, modern biotechnology is often used in our daily lives in medical sciences, medicine, food technologies, agriculture and environment. The new technologies that makes life easier, such as the development of high efficient products, the usage of gene therapy in order to cure cancer, and the production of micro-organism based medicines are, for sure, very beneficial for the humanity. The biotechnology education becomes necessary due to the increasing usage of biotechnological products that are used in industrial areas and economy, increasing number of needed technical workers, and the social and moral concerns that are reflected to the society.

It was especially mentioned in many of the studies, which are on the biotechnology education, that real and consistent information about the daily life usage of biotechnology should be added to the curriculum and the applied science teachers or candidates should have knowledge on this subject (Olsher & Dreyfus, 1999; Marchant & Marchant, 1999; Chan & Lui, 2000; France, 2000; Dunham et al., 2002; Thomas et al., 2002; Dibartolomis & Mone, 2003; Lewis et al., 2003; Rota & Izquierdo, 2003). The material development and experimental works in biotechnology education are important in terms of

understanding the complicated subjects of biotechnology and it's importance, and increasing the problem solving and applied science – mathematics abilities of the students. Most of the parts in these studies are on the awareness and attitude development works on biotechnology.

Being a very complicated concept, attitude is described as cognitive, emotional, and behavioural reaction tendency of an individual which is developed by the self or environmental social aspects, experience on an object or an event, motivation, and knowledge (İnceoğlu, 1993, p.15). In other words, attitude is a taught tendency to react, in a negative or in a positive way, to a specific object, condition, institution, concept or other people (Tezbaşaran, 1997, p. 1). As can be derived from the definitions, attitude has three components: cognitive, emotional, and behavioural and it is assumed that there is an inner consistency among these components (Tavşancıl, 2005). These three components are accepted as important factors that describes attitude (Ekici, 2002). Analyzing attitudes covers most of the research studies in all disciplines due to the relationship thought to be exist between social behaviours and attitudes (Topkaya & Yalın, 2005). That is, the identification of attitudes towards specific activities is important in order to identify the success rate at those activities (Ekici, 2002).

The attitudes of science teachers and pre-service science teachers are very important for the biotechnology education studies to be successful. The most important step in developing the biotechnology education plans for the pre-service science teachers is the attitude identification and evaluation. Because, attitude has a clear effect on the education outputs (Harms, 2002). A thorough biotechnology education model and plans can be developed by the obtained results.

In this study the aim is to develop an attitude measure oriented to biotechnology for the pre-service science teachers.

METHODOLOGY

a) Sample Group of The Study

The sample group used in this study involves 384 students which had education in 2005-2006 and 2006-2007 at Gazi University, Gazi Faculty of Education, Department of Middle School Applied Sciences and Mathematics, Biology Education, Elementary School, Science Education, and Faculty of Applied Sciences and Literature, Department of Biology.

b) Studies for Developing the Measure

This study is conducted at four stages. These stages are determination of the measure controls, expert opinion evaluations, pre-trials, and validity-reliability stage.

i) Determination of the Measure Controls

In this step, 35 students from biology education and 43 students from science education were asked to answer the question of "What are your opinions on the biotechnology?" by writing down their opinions. From the 87 expressions in the essays, a draft attitude measure was prepared.

ii) Opinions of the Experts

The prepared measure was reviewed by three experts and two PhD students in the field. According to their recommendations the numbers of expressions were decreased to 55 and became ready for the pre-trial stage.

iii) Pre-Trial Stage

The measure in pre-trial stage was applied to 25 students from biology education and 36 students from science education. This application was conducted in order to evaluate the needed time for answering and the clearness of the questions. After the

application it was found that the time needed for the survey was around 30 minutes and all the items are clearly understood.

iv) Identification of Validity and Reliability

After the pre-trials that were applied by the recommendations of the experts, the measure involving 55 items was applied to the real sample group that consists of 384 students. In the measure the positive questions were graded from 5 to 1 as "Strongly Agree=5", "Agree=4", "No Idea=3", "Disagree=2", and "Strongly Disagree=1" where the negative questions were graded with the opposite options from 1 to 5.

In order to identify the working ones among 55 items in the draft measure, factor analysis is conducted to check each item differentiates. Item differentiates i.e. the item total test correlation, explains the relationship between grades obtained from the items and the total grade (Büyüköztürk, 2006). In evaluation of the item test correlation, if the item total test correlation is 0,30 or higher, then that item is distinguishing the individual in terms of the measured property (Neale & Liebert, 1980; Scherer et al., 1988).

In this study, item test correlations related to the data, and first factor weights are calculated. In the first dimension of principal component analysis where item test correlation is meaningful ($p<0,5$), items having factor weight value of 0,45 or higher added to measure. For the items related to more than one factor, if the discrepancy of the factor weights is smaller than 0,1 then that item is removed (Büyüköztürk, 2006).

In order to identify the reliability of the final measure that consists 40 items, self consistence test is conducted and Cronbach Alpha reliability constant is found as 0,75. According to this finding it can be stated that the items are consistent with each other. Also, when each item is removed one by one, it was observed that Cronbach Alpha reliability constant that was calculated as 0.75 didn't increase. Therefore in the reliability stage no item was removed from the measure (Özdamar, 1997).

RESULTS AND DISCUSSIONS

During the validity stage of the final measure, the obtained data was found to be fit to the sample group with 0.000. Also the KMO (Kasier-Meyer-Olkin) value was calculated as 0.827 and Barlett test value was found as 4186.420.

By applying the item analysis and Varimax Factor analysis to the attitude measure, which consists of 40 items, it was found that there were 11 items whose eigenvalue is higher than 1. In order to analyze further, the "Scree Test" of Cattel is applied and the graph which is related to the highest significant factor is obtained as can be seen in Figure 1.

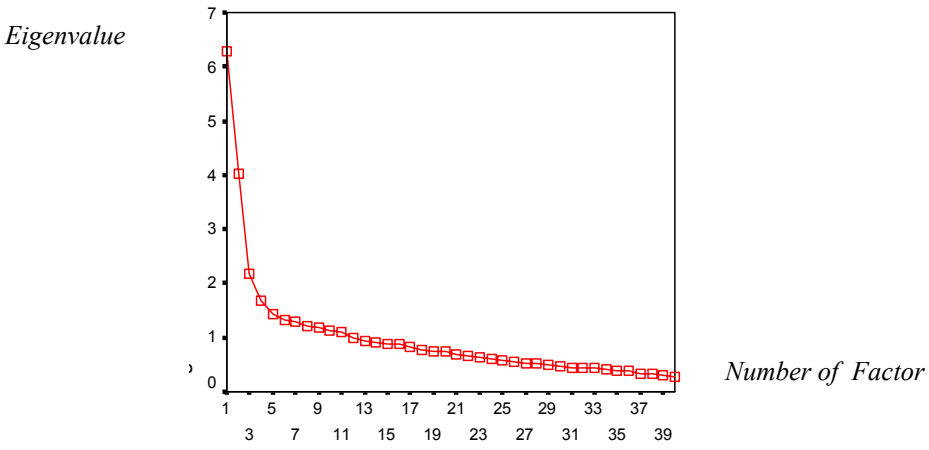

Figure 1. *Scree Plot*

In the Scree Test graph, the point where the slope decreases drastically is the 11th factor. After the 11th factor the slope remains the same. The eigenvalue, variance percentages and total variance for the 11 factors are given in Table 1.

Table 1. *The Structure of The Factors of The Measure*

Factors	Eigen Values	% of Variance	Cumulative %
1	3,000	7,499	7,499
2	2,874	7,185	14,684
3	2,262	5,654	20,338
4	2,205	5,511	25,849
5	2,196	5,490	31,340
6	2,153	5,382	36,721
7	2,147	5,368	42,090
8	2,015	5,038	47,127
9	1,530	3,826	50,953
10	1,528	3,819	54,772
11	1,196	2,991	57,763

As can be observed from Table 1, the eigenvalues of the 11 factors in the measure are changing between 3,000 and 1,196. These factors corresponds 57,763% of the total variance. As the variance is higher then 41%, which is the acceptable value (Kline, 1994), the measure can be evaluated by 11 factors measure. As a result of the factor analysis, the factor distributions and factor weights of the items, that are decided to be included in the measure, can be found in Table 2.

Table 2. *Weights of The Factors of The Measure*

Items	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11
29	,681										
32	,672										
34	,620										
28	,601										
30	,594										
38	,472										
14		,611									
13		,598									
15		,587									
40		,568									
18		,564									
17		,553									
26		,405									
12			,825								
37			,814								
20			,640								
22				,664							
11				,634							
36				,610							
21				,439							
09					,809						
10					,804						
04					,571						
24						,704					
16						,636					
25						,508					

Table 2. *Continued..*

Items	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11
23						,475					
08							,655				
06							,607				
02							,454				
03								,660			
01								589			
05								,572			
39									,736		
33									,496		
27									,456		
31										,650	
35										,554	
07											,566
19											,486

The values obtained form the analysis showed that, only two items that are in the measure have a factor weight smaller than 0.45. As can be observed from Table 2, the factor weights of the 40 items at the measure are changing between 0.425 and 0.825. With respect to this analysis, it can be stated that all the 40 items are qualified to be in the measure.

CONCLUSIONS

In this study, a measure that identifies the attributes of applied science teacher candidates to the biotechnology is developed. The data that is used in developing the measure is obtained from 384 students having education at Gazi University, Gazi Faculty of Education, Department of Middle School Applied Sciences and Mathematics, Biology Education, Department of Elementary School, Science Education, and Faculty of Applied Sciences and Literature, Department of Biology. The initial measure, which consists of 87 items, was reduced to 40 items at the draft measure. It is found that the measure which includes 40 items fit to the sample group with 0.000 level, the KMO (Kasier-Meyer-Olkin) value is 0.827, and the Barlett test value is 4186.420. By applying the item analysis and Varimax Factor analysis to the measure, it was found that there were 11 items whose eigenvalue is higher than 1. These factors corresponds to 57,763% of the total variance. The factor weights of the 40 items at the final measure are changing between 0.425 and 0.825. The reliability constant of the measure is found as 0.75.

To summarise, the validity of the scope of the measure is analyzed. After that by applying factor analysis, item total correlation and item differentiates property methods, structural validity is analyzed. In order to define the reliability, self consistency test is applied (Çakır, 2004; Gür & Bütüner, 2006). All the findings from the analysis showed that the validity and reliability of the measure are acceptable.

There are total of 40 items in the measure where 14 of them are negative and 26 of them are positive. The grade interval is between 40 and 200. The grade of an individual defines the applied science teacher candidates' attitude towards biotechnology. It can be stated that, if the grade is higher then the attitude is positively high.

SUGGESTIONS

In the scope of the findings in the study, following can be recommended:

• By accepting this study as an initial step, the proposed measure can be further developed in terms of validity and reliability by using different and larger sample groups.

• Biotechnology education is important in terms of evaluation of social and moral reflections of the biotechnology to the society and for the positive behaviour of the individuals.

• Individuals should be taught not only the practical applications of the science, but also the evaluation ability of the social and moral results (Dawson & Taylor, 2000). In order to do that attitudes should be identified.

• One of the difficulties in biotechnology education is the problems in the education of applied science teacher candidates (Darçın & Türkmen, 2006). In order to get rid of these problems, candidates' attitudes should be identified and education should be developed accordingly.

Acknowledgments: This study is conducted in the scope of "Experimental Planning of Biotechnology Education for Applied Science-Technology and Biology Teacher Candidates" project which is supported by Gazi University Scientific Research Project Department. This study is conducted in the permission of Gazi University President and related Faculty Deans.

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APPENDIX Attitude Measure Oriented to Biotechnology for Pre-Service Science Teachers

Name – Surname:
ID:
Class/Department:

Dear Students,

In this study our aim is to identify your attitude towards biotechnology. We believe in your sincere answers as they are very important for healthy data. We would like to thank you for your contributions.

SA= Strongly Agree
A= Agree
NI= No Idea
DA= Disagree
SD= Strongly Disagree

EXPRESSIONS	**SA**	**A**	**NI**	**DA**	**SD**
1. A lot of health problems will be solved by the help of stem cells.					
2. Biotechnology brings economical benefits in our life.					
3. It is not possible to use stem cells instead of organ transplantation.					
4. It is wrong to use biological weapons, that are produced using biotechnology, as a power demonstration.					
5. The usage of biotechnology in gene illnesses is a very important development.					
6. The starvation problem, which is increasing as the world population increases, could be solved by biotechnology.					
7. Transfer of the gene, which increases strength against drought, to the plants by biotechnology, contributes to agricultural production.					
8. One of the ways in order to increase wealth is to benefit from biotechnology.					
9. It is humanity's shame that biotechnological developments results in biological weapons.					
10. Individuals, who abuse biotechnology, should be punished with the possible highest punishment.					
11. For the cure of the illnesses due to genes such as Mediterranean anemia which is mostly due to the intermarriages and cancer, only cordon blood should be used.					
12. Foods which are genetically modified would bring harm to the health of the humans.					
13. Identification of the genes and replacement of ill genes with the healthy ones would makes life better.					
14. Biotechnology is a science which uses biology and technology in order to make things easier in several other areas.					
15. Although biotechnology is cost benefit in terms of human power, it makes economy worse since it is an expensive system.					
16. Biotechnology, by using micro organisms, has several effects to protect the environment.					
17. By genetic engineering studies, transferring insulin gene to diabetics is useful in both terms of cost and moral.					
18. The biotechnological method known as DNA finger print shouldn't be used to identify guilty people since it's an expensive procedure.					
19. Agricultural biotechnology studies should only focus on developing resistance for the agricultural insects.					
20. The biotechnological products can be safely used since they don't have any harm on humans, animals and plants.					
21. The stem cell transplant is not a positive development in terms curing gene illnesses.					
22. In the future when the gene map of humans is fully discovered, cures for the diabetics and cancer will be possible.					

EXPRESSIONS	**SA**	**A**	**NI**	**DA**	**SD**
23. Biotechnology is useful for saving endemic plants whose population is decreasing.					
24.Biotechnological studies contribute to the economy by protecting the environment.					
25. One of the disadvantages of biotechnology is the micro organisms that are used in the wars, which effect the ecosystem.					
26. Biotechnology is the most practical application of biology knowledge.					
27. All of the environmental biotechnology studies are moral in terms of living and environment.					
28. Food, produced by biotechnology, harm human health due to its low nutritive value.					
29. The unconscious usage of biotechnology would bring new illnesses.					
30. Biotechnological developments become more effective in our lives.					
31. The usage of biotechnology for evil, should be avoided.					
32. Genetically manipulated organisms, produced by recombinant DNA technology, never gives harm to flora, fauna, and ecosystem.					
33. Due to the sperm banks, children, who doesn't have a family concept and love, are coming into the world.					
34. Genetically manipulated plants have negative effects on the living.					
35. Bio safety studies should be developed parallel with the biotechnological studies.					
36. The cure for all gene illnesses will be found in the future by biotechnology.					
37.Manipulating plant genes is one of the side effect of biotechnology.					
38.It is not true for humans to manipulate other livings' nature for their own advantages.					
39.It is not moral to define the unborn babies' gender, hair and eye color.					
40.The applications such as stem cell transplant and gene cloning are revolutionary for humans.					