Developing a Prospective-Teachers Oriented Attitude Scale on Genetically Modified Organisms and Psychometric Qualities of the Scale

Bülent Alagöz, PhD

Assistant Professor, Department of Elementary Education, Faculty of Education, Gaziantep University, Nizip, TURKEY.

balagoz@gantep.edu.tr

ABSTRACT

The objective of present research is to develop a tool that can measure the attitudes of prospective social sciences and classroom teachers on a globally controversial issue; namely genetically modified organisms (GMOs). The voting right of prospective social sciences and classroom teachers to take part in general elections, which indicates utmost importance in any democratic society and their role as potential decision-makers in the diet habits of not only themselves but of their potential kids, makes it an imperative to identify their attitudes towards GMOs. It is an absolute fact that GMOs bear political as well as socio-economic dimensions. Research sampling of present study consists of 1049 prospective teachers from Social Studies and Elementary Teaching Departments from 3 universities. Of the total number of participants, 499 are females and 550 are males. By employing explanatory factor analysis within the scope of validity check, the scale has been downsized to 9 factors comprising of 38 items. Via confirmatory factor analysis, this structuring with 9 factors has been tested. Thus it has been demonstrated that the model exhibits quite-good fit indices. In the analysis of parallel scale, significant relations with other scales have been demonstrated. Item analysis has been performed to detect overall reliability and reliability of subdimensions. Also Cronbach's Alpha coefficient has been measured. Validity and Reliability scores indicate that this scale exhibits employable qualities in identifying the attitudes of prospective teachers on the issue of genetically modified organisms (GMOs).

Keywords: Genetically Modified Organisms, Prospective Teachers, Controversial Issue.

INTRODUCTION

In this modern age, recent advancements on technology have reached to mind-blowing dimensions (Kaynar, 2009) on biotechnology, let aside their introduction of globally controversial issues on eco-politics level, in biotechnology and genetically modified organisms in particular (GMO is the name attributed to a new living being that is produced by duplicating genetic features of another existence and transferring such features to another existence not owning these characteristics). As a natural consequence of such effects, every new day a new biotechnological product arising serious worries and questions on its reliability for consumers and environment in particular has been introduced to the market. There have been some conflicting reactions towards genetically modified organisms (GMOs) and products which can be listed as nascent biotechnological products. Australia, New Zealand, Thailand, European Union (EU) member states, Japan and Turkey approach this issue in a more cautious manner whereas the United States of America (US), Canada, China and Argentina widely support their international use (Bredahl et al., 1998; Burton & Pearse, 2002; Chern & Rickertsen, 2002; Cook et al., 2002; Curtis et al., 2004; Fritz et al., 2003; Ganiere et al., 2006; Gaskell et al., 2000; Hefferrnan & Hillers, 2002; Huang et al., 2006; Magnusson & Hursti, 2002; McCluskey et al., 2003; Moerbeek & Casimir, 2005; Morris &

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Adley, 2000; Oguz, 2009; Özgen et al., 2007; Pardo et al., 2002; Roosen et al., 2003; Saher et al., 2006; Scott, 2001). The common attitude towards genetically modified (GM) foods is that they possess some potential to alter the global food industry. They have demonstrated top-speed growth for the last decade; nonetheless the conflicting views on this topic still remain fresh. In addition to a number of science groups, consumers also possess contradicting views on GM foods (Kahveci & Özçelik, 2008).

Researches demonstrate that although students and consumers in particular are aware of the benefits of biotechnology and GM products (Atsan & Kaya, 2008; Baker & Burnham, 2001; Ganiere et al., 2006; König et al., 2004; Özgen et al., 2007; Pandian & Macer, 1997; Schibeci, 2000) they still hold the belief that in the long-term, the negative results are likely to outweigh the positive effects. Özgen et al. (2007) have emphasized that biotechnology brings with itself not only expected benefits but a number of potential risks as well. They have also underlined that despite the indisputable social, economic and environmental benefits of modern biotechnology, it nevertheless bears in itself some damaging effects on the health of humanity and environment, socio economic structure, bio-diversity and variety of natural products, socio-economic welfare of a society or nation, tradition, ethics, moral and religious values.

Februhartanty et al. (2007) have indicated that despite the overwhelming speed of biotechnology globewide and its practices in a wide range of area from heath to agriculture and food sector, it also brings with itself a number of issues concerning the safety of human and environmental health, ethics, consumers' freedom-to-choose, socio-economical and legal aspects. Finucane & Holup argue that genetically modified foods contain in themselves a number of unidentified risks since it is a relatively new branch of science. Thus, scientists do not yet possess adequate accumulation of knowledge to make correct risk estimations. In short, they argue that the unclear description of the harmful variables on DNA structuring is not directly comprehensible. It is simply a means to delay its potential effects. They also claim that consumers have no idea about they await them when they consume these foods, since genetic engineering is a tabula-rasa for those who have no familiarity with the topic and that common users lack any kind of knowledge on which products contain which components of genetic engineering (Finucane & Holup, 2005). Cook et al. (2002) have noted that avoiding genetically modified foods is the reflection of an environmental consciousness. Ganiere et al. (2006) on the other hand point out that apparently, the greatest risk concerning genetically modified foods is their potential threat for human health.

In the research conducted to evaluate teacher & student attitudes towards biotechnology and genetically modified organisms, the most pervading results have been listed as participants' lack of knowledge (Chern & Rickertsen, 2002; Darçın & Türkmen, 2006; Dawson & Schibeci, 2003; Dawson & Soames, 2006; Demirci, 2008; Ergin et al., 2008; Finucane & Holup, 2005; Huang et al., 2006; Koçak et al., 2010; Maekawa & Macer, 2004; Mohapatra & Priyadarshini, 2010; Özdemir et al., 2010; Özel et al., 2009; Özer et al., 2009; Sürmeli & Şahin, 2009; Turkmen & Darcin, 2007) or the negative views participants entertain (Demirci, 2008; Finke & Kim, 2003; Harms, 2002; Massarani & Moreira, 2005; Mohapatra & Priyadarshini, 2010; Morris & Adley, 2000; Sürmeli & Şahin, 2010; Turkmen & Darcin, 2007).

To sum up biotechnology and bioethics which particularly explores ethical dimensions of biotechnology and most particularly, the issue of genetically modified organisms is quite a globally controversial issue not only in terms of education but in social life likewise and keeps on its domination as the top issue on the agenda (Atsan & Kaya, 2008; Chen & Raffan, 1999; Curtis et al., 2004; Demirci, 2008; Ganiere et al., 2006; Grunert et al., 2001; Kaynar,

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2009; Mohapatra & Priyadarshini, 2010; Olsher & Dreyfus, 1999). Hence it is a top-priority topic concerning education and social sciences most particularly (Asada & Tsuzuki, 1996; Özel et al., 2009).

Controversial issues are unsolved social policy problems that lead to huge conflicts (Hess & Posselt, 2002) or in a different explanation, they are the issues that lack any recognized and negotiated global perspective. One key aspect of controversial issues is that the context usually divides the society into separate camps and that dominant interest groups provide conflicting explanations and solutions (Crick, 1988). Controversial issues relate to modern day; can be local or global; may relate to bullying, religious faith, politics, personal lifestyle or values. Since they provide not easy answers, they are complex. They are issues on which there are no agreements, and on which people enjoy differing experiences, and strong views reflecting their personal inclinations and values. They involve in themselves clashing, conflicting, diverting, fighting, competing matters, views and values. Hence any subject can naturally be controversial (Ersoy, 2010; Global Citizenship Guides, 2006).

RESEARCH OBJECTIVE

In relevant literature, there is a wide array of researches underlying the mighty significance of controversial issues within the discipline of social sciences (Ersoy, 2010; Hahn, 1991; Hess, 2002; Parker, 2001; Soley, 1996; Wilson et al., 1999). Driven from this motto supported by above-listed criteria, it can safely be argued that biotechnology & genetically modified organisms is also a controversial issue and can reasonably listed within the discipline of social sciences. Irrespective of this claim however, genetically modified organisms has been an issue that has long been discarded by social scientists. There is a striking domination of science teachers in the teaching of biotechnology and genetically modified organisms (Dawson & Schibeci, 2003; Dawson & Schibeci, 2004; Gunter et al., 1998; Hill et al., 1998; Lock & Miles, 1993; Pandian & Macer, 1997; Schibeci, 2000). Despite that, Frewer et al. (2004) in their research aiming to detect specific society-related issues concerning the social acceptance and dismissal of genetically modified foods and agricultural practices of gene technology argue that it is not feasible to assume that one social sciences discipline alone can effectively cover all relevant issues; hence the article encompasses expertise in social psychology, sociology, marketing and ethical disciplines. They also claim that below key headings on this issue, there has been an agreement among the perspectives from a variety of expertise areas. Likewise, the purpose of present study is, by examining the topic of teaching biotechnology and genetically modified organisms from the perspective of social sciences and positioning the topic into the field of controversial issues, to develop a measurement scale for employing in the studies directed to social sciences and prospective classroom teachers.

METHOD

Sampling

Study group of this research comprises of 1049 prospective teachers from Elementary Teaching and Social Studies Teaching departments affiliated to Department of Education in Mustafa Kemal, Fırat and Gaziantep Universities. Of all the prospective teachers constituting the sampling of present research, 499 are males and 550 are females and all are registered to 2012-2013 academic year fall- term.

Developing an Attitude Scale towards Genetically Modified Organisms

In this study conducted on the basis of scanning method (Cohen et al., 2011) which is an ideal research method to implement studies on attitude that require a sampling with broad

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level of participation, the process of developing items of the scale that shall be employed to detect the attitudes of Classroom and Social Sciences prospective teachers towards genetically modified organisms (GMO) involves five steps (Balcı, 1995; Demir & Akengin, 2010; Karasar, 1995; Tavşancıl, 2005):

Generating An Item Pool

Biotechnology and genetically modified organisms are topic titles that have been discussed over quite an extensive area (academic books and articles; social, written & visual media; news, literature, art, intellectual and scientific journals). Concordantly, researches also include a wide range of samplings extending from children to adults. Hence, in generating an item pool, an extensive scope of articles published in scientific & academic resources have been scrutinized. At this point particular attention has been paid to prepare scale items answerable by college students studying in social sciences. In the end, after a thorough review of national and international literature and supplementary printed, visual & written studies and resources (Chen & Raffan, 1999; Cook et al., 2002; Darcin & Turmen, 2006; Dawson, 2007; Ganiere et al., 2006; Februhartanty et al., 2007; Frewer et al., 2004; Harms, 2002; Lock & Miles, 1993; Schibeci, 1999; Turkmen & Darcin, 2007; Usak et al., 2009) a pre-test form with 96 items has been prepared. To balance "approval" tendency of form respondents (Tavşancıl, 2005) there existed 96 items 30 of which are negative and 66 are positive. All the attitude items prepared have been prepared in a way to reflect not factual conditions but desired or undesired situations.

Receiving Expert Views

In order to assure that this 96-itemed pre-test form includes adequate number of questions and applicable to represent the case aimed to be measured, a context-validity test has been made on the basis of expert views. To achieve that, the test has been examined by 7 experts (3 academicians from the field of Teaching Social Studies, 2 experts from Measurement and Evaluation field and 2 experts from Department of Teaching Turkish). Experts have examined if scale items measured students' attitudes towards teaching of biotechnology and genetically modified organisms and grammatical clarity of the questions. In line with their views, problematic items have been corrected meaningfully. 10 items have been excluded from the scale.

Pre-Test Application

Attitude Scale towards Teaching of Genetically Modified Organisms initially comprised of 96 items but upon receiving relevant experts' views and suggestions, 6 items that had been unfit in terms of both content validity and way of expression have been excluded from the test. Items have been randomly listed. Pre-test application of prepared scale draft has been implemented on 44 prospective teachers studying at Gaziantep University Nizip Faculty of Education Department of Teaching of Social Studies. Students who were included in the pre-test application of scale were excluded from the study group. Prior to conducting the draft scale on study group via pre-test practice, it has been checked if items were understood by the students and applicable to their level. At the end of pre-test application, in line with feedbacks received from 44 students, 10 items that might trigger misinterpretation or misunderstanding were excluded. Thus draft scale was finalized in a manner to be applicable to study group.

Application of Pre-Test Form On Study Group Factor, Step Of Factor Analysis And Reliability Calculation

Upon receiving expert views and pre-test application, draft scale consisting of 80 items has been conducted on 1049 students studying at Elementary and Social Studies Teaching

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Departments in the educational faculties of Mustafa Kemal, Fırat and Gaziantep Universities. Based on the findings of this application, factor analysis has been performed and in line with the analysis result, construct validity has been attempted to secure validity.

Data Collection Tools

Biotechnological Applications Scale (BAS)

BAS has been developed by Erdogan et al. (2009) in order to measure prospective teachers' attitudes towards biotechnological applications. The scale has 28 scales categorized under 7 subdimensions. Items are graded according to 5-Likert scale as (1) I completely agree, (2) I agree, (3) I do not know, (4) I disagree (5) I completely disagree. At the end of pilot study conducted among 192 students, feedbacks have been received from initial form consisting of 53 items and 16 items have been excluded. Remaining 37 items have been conducted on 326 students and validity-reliability analyses of the scale have been performed. Bartlett test has been found to have <0.001 level of significance (2,512.702). KMO value has been identified as .86. At the end of factor analysis, 9 items have been excluded from the scale and the final form of the scale has been set as 28 items with 7 factors.

Biotechnological Attitude Scale

BATS has been adapted into Turkish on the basis of Sürmeli's (2008) work reflecting Dawson and Schibeci's research of year 2003. At the end of Pearson analysis conducted to analyze the correlation between the scores received from BATS's Turkish and English versions, a positive correlation was detected (r: 075; $p<0.05$). At the end of Pearson analysis conducted to analyze the relations between the scores received from Biotechnological attitude scale's pilot 1 and pilot 2 studies, a positive relation was identified (r: 0.89; $p<0.05$). Biotechnological attitude- scale utilized in the research comprised of 15 statements and below each item, there is a three-grading scale named as "acceptable, unacceptable and undecided".

Attitude Scale towards the Effects of Genetically Modified Organisms (ASTEGMO)

ASTEGMO has been developed by Oğuz (2009) according to the data compiled through face-to-face interviews among 250 people. 16 items of which factor value was below 0.3 were excluded from the scale. In the end, a 5-Likert type scale comprising of 14 items and 4 sub-dimensions (GMOs' Effect on Human and Environmental Health-6 items, Socio-Economic Structure-4 items and Control-4 items) has been received. Items have been categorized and scored as "I do not agree at all-5", "I disagree-4", "I am undecided-3", "I agree-2" and "I totally agree-1". Cronbach alpha value of sub-factors has been measured as .64. Factor scores on the other hand have been determined via frequency analysis. In order to test the fitness of total scores of sub-factors on normal distribution, Shapiro-Wilk test which enables to see if there is a normal distribution has been employed. To do that, analyses have been performed on median values. Total scores have been compared among gender groups via Mann-Whitney U and via Kruskal-Wallis test among age, education and income level groups. Relation among sub-factors has been examined via Spearman Correlation Coefficient test.

FINDINGS

Data Analysis

In the evaluation of findings obtained from current study, statistical package program (SPSS 20) has been utilized for statistical analyses; in the evaluation of research data descriptive statistics methods (Means, Standard deviation) have been employed. To unravel construct validity, Explanatory Factor Analysis has been used. Dimensions obtained from Explanatory

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Factor Analysis have been reassessed via Confirmatory Factor Analysis. To detect overall reliability and reliability of subdimensions, Cronbach's Alpha has been exploited. If Alpha coefficient value is >0.90, the scale is recognized as a highly reliable scale; if between 0.80–0.90 it is quite a reliable scale; if between 0.70–0.79 it is a scale with low reliability; if between 0.60–0.69 it is not a reliable scale (Cohen et al. 2007, 506).

For Factor analysis, KMO and Bartlett tests which reveal the adequacy of sampling have been used. If at the end of tests KMO value is detected to be close to 1, then significance level of Bartlet test is expected to be p<0,05 (Scott & Morrison 2005, 203). Following this step, in order to designate subdimensions of scale, factor analysis is performed and reliability tests of obtained factors are held individually. In addition, variance description ratio of the factors is also evaluated. To analyze the similarity of measurements with Parallel 3, Pearson Correlation Analysis has been employed. Obtained results have been evaluated between 95% confidence interval, p<0,05 significance level and p<0,01 p<0,001 advanced significance level.

Item Analysis: The scores received from test-retest application have been, on the basis of item, individually exposed to statistical analysis and among test-retest participation ratios of 1, 3, 4, 18, 22, 23, 24, 25, 31, 32, 33, 38, 40, 61, 65, 71, 72, 76, 77. items, a significant difference has been identified. (p<0,05). To gain a better understanding of questions, these 19 items have been excluded from the study after a comprehensive examination. Reliability level of the test exposed during test step has been found as 0,730 and reliability level of scale employed in retest step has been found as 0,739.

Factor Analysis *Explanatory Factor Analysis*

In order to measure the reliability level of 61 items in GMO scale, "Cronbach Alpha" which is an internal consistency coefficient, has been computed. Overall reliability of scale has been found as alpha=0.874, which is high. To manifest construct- validity of scale, explanatory (exploratory) factor analysis method has been preferred. At the end of conducted Bartlett test (p=0.000<0.05), a relation has been detected among the variables included in factor analysis. Conducted test (KMO=0.905>0,60) revealed that sampling size is comprehensive enough to conduct factor analysis. In the application of factor analysis, varimax method has been selected to ensure that the structure of the correlation among factors stayed the same. At the end of factor analysis, variables have been collected under 9 factors and total explained variance was 49.439%. According to alpha value indicating reliability level and explained variance value, it has been verified that GMO scale is a valid and reliable tool. Factor structure of the scale is as shown in the table 1 below.

In the evaluation of GMO Attitude Scale's explanatory factor analysis, particular care has been paid to analyze factors of which eigenvalue is greater than one, to select high factor loads which indicate the weight of variables among factors, and for the same variable not to select factor loads which are very close to one another. The highness of the reliability coefficient constituting the scale factors and explained variance ratios indicates that scale demonstrates a strong factor structure. In the measurement of the scores of scale factors, upon summing the values of factor items, the total number has been divided into item number (arithmetic means) so that factor scores have been obtained. The highness of the reliability coefficients of the factors constituting the scale and explained variance ratios demonstrates that the scale has a strong factor structure. Items stated under first factor have been analyzed as Approving Genetic Engineering Applications. Reliability of eight items constituting the first factor has been detected as alpha= 0.775 and explained variance ratio as 8.891%. Items attributed to second factor have been examined as the Effects of Genetically Modified Organisms on Humans and Environmental Health. Reliability of five items constituting this

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factor has been detected as alpha= 0.673 and explained variance ratio as 6.043%. Items listed in third factor have been named as Consuming Genetically Modified Products.

Table 1. Factor Analysis

Dimension	*Item*	*Factor load*	*Variance*	*Cronbach's Alpha*
Factor 1 (Approving Genetic Engineering Applications)	59. I support the modification of genes to ensure that fruits and vegetables remain fresh for a long time.	0,676	8,891	0,775
	73. To be able to produce more effective vegetables, genetic structures of plants can be modified.	0,605		
	68. Genetically modified foods are safe.	0,563		
	42. I support the modification of sheep genes to ensure that their meat is more nutritional.	0,554		
	69. In order to feed all the people in the world, we are forced to produce genetic engineering plants.	0,543		
	53. Genetically modified plants do not endanger normal plants.	0,525		
	58. Modifying genetics of fowls increases the yield to procure from them.	0,490		
	46. Modifying the genetic structure of animals gives them no pain.	0,438		
Factor 2 (Effects of Genetically Modified Organisms on Humans and Environmental Health)	34. We have no right to attack nature for more food and produce genetic engineering plants.	0,644	6,043	0,673
	47. It is not ethical to interfere with DNA.	0,581		
	35. I cannot accept modification of genes to improve the taste of fruits and vegetables.	0,564		
	75. Since it is against the law of nature, man has no right to interfere with DNA.	0,466		
	80. Genetically modified foods may cause the formation of new allergic agents in the foods.	0,343		
Factor 3 (Consuming Genetically Modified Products)	6. Genetically modified foods do not affect human health negatively.	0,769	5,453	0,663
	9. Consuming genetically modified foods does not harm human genes.	0,684		
	2. I believe genetically modified products have no adverse effects on natural environment.	0,672		
	13. If genetically modified foods were sold at the same price with other foods, I would then buy.	0,423		
Factor 4 (Risks of Biotechnology and Genetically Modified Products)	70. Genetically modified agricultural products are harmful for human health.	0,628	5,347	0,616
	74. Nutritional and vitamin values of foods cannot be increased through genetic engineering.	0,542		
	79. I believe genetically modified plants leave global side effects on biodiversity.	0,490		
	67. Due to its potential risks on environment,	0,487		

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	biotechnology should be avoided.			
	63. I am against the administration of genetically modified foods to children.	0,381		
Factor 5 (Attitude towards Genetically Modified Products)	49. I would never buy genetically modified products.	0,642	5,174	0,561
	66. I never consume processed foods since I do not know their ingredients.	0,576		
	57. If I consume genetic engineering foods, I feel guilty.	0,565		
	48. I consume what I like to eat. I do not bother myself to think if these foods are healthy or not.	0,550		
Factor 6 (Opinion towards Genetic Engineering and Biotechnology)	64. Biotechnology shall be, in the next 5 years, beneficial for the personal benefits of mankind.	0,723	4,793	0,516
	62. Genetic engineering practices should be supported.	0,701		
	52.I accept the duplication of near-extinct species to let them survive.	0,371		
Factor 7 (Ethical and Legal Aspects of Genetic Engineering)	54. Genetic interventions damage ecological relations.	0,745	4,710	0,725
	56. Modification of animals' genes through genetic engineering must decidedly be legally set.	0,710		
Factor 8 (Production-Consumption and Health Dimension of Genetically Modified Foods)	12. To let them grow better in salty soils, genetic structures of plants should not be modified.	0,581	4,584	0,478
	15. Genetically modified foods contain hazardous chemicals.	0,575		
	11. I support biotechnological applications that allow the plants to be more resistant against pesticides by modifying plants' genetics.	0,428		
	44. I prefer not to buy genetic engineering foods.	0,425		
Factor 9 (Control)	28. If I am convinced that it is reliable then I can buy genetically modified food.	0,791	4,444	0,580
	41. If the producers guarantee no health risk, I can willingly buy genetically modified foods.	0,744		
	29. Between plants and animals, a transfer of genetic materials can be performed.	0,409		
	Total Variance 49,44%			

Reliability of four items constituting this factor has been designated as alpha= 0.663 and explained variance ratio as 5.453%. Items listed in fourth factor have been named as Risks of Biotechnology and Genetically Modified Products. Reliability of five items constituting this factor has been detected as alpha= 0.561 explained variance ratio as 5.347%. Items listed in fifth factor have been named as Attitude towards Genetically Modified Products. Reliability of five items constituting this factor has been detected as alpha=0.561 and explained variance ratio as 5.174%. Items listed in sixth factor have been named as Opinion towards Genetic

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Engineering and Biotechnology. Reliability of three items constituting this factor has been detected as alpha=0.516 and explained variance ratio as 4.793%. Items listed in seventh factor have been named as Ethical and Legal Aspect of Genetic Engineering. Reliability of two items constituting this factor has been detected alpha= 0.725 and explained variance ratio as 4.710%. Items listed in eight factor have been named as Production-Consumption and Health Dimension of Genetically Modified Foods. Reliability of four items constituting this factor has been detected as alpha=0.478 and explained variance ratio as 4.584%. Lastly, items listed in ninth factor have been named as Control. Reliability of three items constituting Control factor has been detected as alpha= 0.580 and explained variance ratio as 4.444%. In the measurement of the scores of scale factors, upon summing the values of factor items, the total number has been divided into item number (arithmetic means) so that factor scores have been obtained.

Confirmatory Factor Analysis

Findings concerning validity works of GMO scale, upon creating a 9-factor structure of 38 items formed on theoretical base, by establishing on the results of Explanatory Factor Analysis scale's model reflecting 9 dimensional model has been tested via Confirmatory Factor Analysis. In the DFA executed on the basis of 38 items, a positive factor load has been created in all items (Table 2).

Table 2. Factor loads and explained variances obtained via DFA

Dimension	*Item*	*Factor load*	R^2
F1 Approving Genetic Engineering Applications	59. I support the modification of genes to ensure that fruits and vegetables remain fresh for a long time.	0,18	0,38
	73. To be able to produce more effective vegetable genetic structures of plants can be modified.	0,21	0,46
	68. Genetically modified foods are safe.	0,26	0,48
	42. I support the modification of sheep genes to ensure that their meat is more nutritional.	0,14	0,45
	69. In order to feed all the people in the world we are forced to produce Genetic engineering plants.	0,18	0,48
	53. Genetically modified plants do not endanger normal plants.	0,28	0,50
	58. Modifying genetics of fowls increases the yield to procure from them.	0,14	0,42
	46. Modifying the genetic structure of animals gives them no pain.	0,09	0,36
F2 Effects of Genetically Modified Organisms on Humans and Environmental Health	34. We have no right to attack nature for more food and produce Genetic engineering plants.	0,12	0,36
	47. It is not ethical to interfere with DNA.	0,27	0,58
	35. I cannot accept modification of genes to improve the taste of fruits and vegetables.	0,31	0,61
	75. Since it is against the law of nature man has no right to interfere with DNA.	0,09	0,34
	80. Genetically modified foods may cause the formation of new allergic agents in the foods.	0,33	0,64
F3 Consuming	6. Genetically modified foods do not affect human health negatively.	0,19	0,46

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Genetically Modified Products	9. Consuming Genetically modified foods does not harm human genes.	0,17	0,46
	2. I believe Genetically modified products have no adverse effects on natural environment.	0,19	0,52
	13. If Genetically modified foods were sold at the same price with other foods I would then buy.	0,15	0,49
F4 Risks of Biotechnology and Genetically Modified Products	70. Genetically modified agricultural products are harmful for human health.	0,13	0,39
	74. Nutritional and vitamin values of foods cannot be increased through Genetic engineering.	0,10	0,41
	79. I believe Genetically modified plants leave global side effects on biodiversity.	0,24	0,53
	67. Due to its potential risks on environment Biotechnology should be avoided.	0,21	0,45
	63. I am against the administration of Genetically modified foods to children.	0,26	0,50
F5 Attitude towards Genetically Modified Products	49. I would never buy Genetically modified products.	0,15	0,41
	66. I never consume processed foods since I do not know their ingredients.	0,18	0,49
	57. If I consume Genetic engineering foods I feel guilty.	0,29	0,62
	48. I consume what I like to eat. I do not bother myself to think if these foods are healthy or not.	0,12	0,39
F6 Opinion towards Genetic Engineering and Biotechnology	64. Biotechnology shall be in the next 5 years beneficial for the personal benefits of mankind.	0,20	0,51
	62. Genetic engineering practices should be supported.	0,08	0,31
	52.I accept the duplication of near-extinct species to let them survive.	0,09	0,30
F7 Ethical and Legal Aspect of Genetic Engineering	54. Genetic interventions damage ecological relations.	0,14	0,38
	56. Modification of animals' genes through Genetic engineering must decidedly be legally set.	0,30	0,55
F8 Production-Consumption and Health Dimension of Genetically Modified Foods	12. To let them grow better in salty soils Genetic structures of plants should not be modified.	0,24	0,53
	15. Genetically modified foods contain hazardous chemicals.	0,23	0,53
	11. I support biotechnological applications that allow the plants to be more resistant against pesticides by modifying plants' genetics.	0,33	0,69
	44. I prefer not to buy Genetic engineering foods.	0,17	0,48
F9 Control	28. If I am convinced that it is reliable then I can buy a Genetically modified food.	0,36	0,69
	41. If the producers guarantee no health risk I willingly buy genetically modified foods.	0,26	0,53
	29. Between plants and animals a transfer of Genetic materials can be performed.	0,30	0,51

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Table 3. Correlation Analysis

		Approving Genetic Engineering Applications	*Genetically Modified (Effects of Genetically Modified Organisms on Humans and Environmental Health Etkisi*	*Consuming Genetically Modified Products*	*Risks of Biotechnology and Genetically Modified Products*	*Attitude towards Genetically Modified Products*	*Opinion towards Genetic Engineering and Biotechnology*	*Ethical and Legal Aspect of Genetic Engineering*	*Production-Consumption and Health Dimension of Genetically Modified Foods*	*Control*	*GMO Attitude towards Prospective Teachers Scale total score*
Ethical Aspect of Genetic Engineering	r	0,046	0,034	-0,100	0,056	-0,031	0,067	0,066	0,009	0,063	0,079
	p	0,633	0,725	0,302	0,566	0,747	0,491	0,494	0,929	0,512	0,416
	N	109	109	109	109	109	109	109	109	109	109
Consumption of Genetically Modified Foods	r	-0,011	0,125	-0,098	0,145	0,049	0,018	-0,022	0,097	-0,056	0,064
	p	0,910	0,194	0,310	0,133	0,614	0,856	0,819	0,317	0,565	0,506
	N	109	109	109	109	109	109	109	109	109	109
Application of Genetic Engineering in Health Sector	r	-0,145	0,053	0,010	-0,028	-0,006	0,030	0,158	0,202	-0,197	0,022
	p	0,131	0,586	0,921	0,772	0,950	0,760	0,101	0,035	0,040	0,824
	N	109	109	109	109	109	109	109	109	109	109
Buying Genetically Modified Products	r	0,063	-0,144	-0,036	-0,071	-0,160	-0,019	0,026	-0,012	-0,098	-0,142
	p	0,512	0,136	0,712	0,465	0,097	0,842	0,790	0,902	0,311	0,140
	N	109	109	109	109	109	109	109	109	109	109
Genetic Engineering in Agricultural production	r	-0,006	-0,081	0,051	0,026	0,012	0,100	-0,129	-0,135	0,185	0,013
	p	0,951	0,400	0,602	0,789	0,905	0,300	0,182	0,161	0,055	0,896
	N	109	109	109	109	109	109	109	109	109	109
Ecological Effects of	r	0,009	0,052	-0,106	-0,035	0,082	-0,003	0,006	0,185	0,020	0,053

Genetic Engineering	p	0,926	0,592	0,273	0,721	0,398	0,974	0,953	0,054	0,835	0,585
	N	109	109	109	109	109	109	109	109	109	109
Public Awareness on Genetically modified organisms	r	0,190	-0,125	0,155	-0,000	0,076	0,093	-0,001	-0,241	0,209	0,136
	p	0,048	0,196	0,107	0,999	0,432	0,338	0,989	0,011	0,029	0,157
	N	109	109	109	109	109	109	109	109	109	109
Scale total score of Biotechnological Applications	r	0,058	-0,025	-0,050	0,025	-0,002	0,084	0,062	0,054	0,010	0,072
	p	0,552	0,798	0,606	0,793	0,982	0,387	0,524	0,579	0,917	0,455
	N	109	109	109	109	109	109	109	109	109	109
Biotechnological Attitude Scale total score	r	0,021	0,019	-0,071	-0,115	-0,058	0,008	-0,029	0,082	0,078	-0,021
	p	0,828	0,841	0,463	0,234	0,552	0,938	0,763	0,397	0,417	0,828
	N	109	109	109	109	109	109	109	109	109	109
Effects of Genetically Modified Organisms on Humans and Environmental Health	r	0,118	-0,149	0,140	-0,201	0,119	0,120	-0,116	0,081	0,002	0,012
	p	0,223	0,121	0,147	0,036	0,217	0,213	0,228	0,403	0,984	0,898
	N	109	109	109	109	109	109	109	109	109	109
Socio-economic effect of Genetically Modified Organisms	r	-0,056	-0,042	-0,053	-0,034	-0,009	-0,080	-0,013	-0,082	0,043	-0,099
	p	0,563	0,661	0,588	0,729	0,922	0,410	0,894	0,395	0,654	0,303
	N	109	109	109	109	109	109	109	109	109	109
Control	r	-0,071	-0,014	-0,083	-0,052	-0,026	-0,138	-0,110	-0,145	-0,158	-0,271
	p	0,462	0,887	0,391	0,595	0,792	0,154	0,257	0,134	0,100	0,004
	N	109	109	109	109	109	109	109	109	109	109
Prospective Teachers Oriented Genetically Modified Organisms Attitude Scale total score	r	-0,001	-0,094	0,006	-0,130	0,040	-0,039	-0,107	-0,061	-0,047	-0,154
	p	0,993	0,329	0,951	0,176	0,678	0,690	0,270	0,529	0,626	0,109
	N	109	109	109	109	109	109	109	109	109	109

The relation among error variance of 5 item pairs has been included in the model. Then in order to test the 35-item model with four potential variables fit indices(GFI, AGFI, CFI, NFI, NNFI, RMSEA, S-RMR) retrieved after DFA application have been examined and it has been detected that Chi-square value is (χ2=2731,83, N=1049, sd=625, χ2/df=4,37, p=0,000) significant. Fit index values have been set as RMSEA=.057, GFI=0,95, CFI=0,96, AGFI=0,96, NFI=0,95, NNFI=0,98, SRMR=0,052. Highness of fit index values indicates that it is a good model (Dickey, 1996; Stapleton, 1997; Byrne, 1998).

Parallel Scale Analysis

By examining the correlation between Parallel 3 scales and GMO, it has been examined if GMO scale measured similar attitudes. Parallel scales have been examined as Biotechnological Applications Scale (BAS), Biotechnological Attitude Scale (BATS) and Attitude Scale towards Genetically Modified Organisms (ASTEGMO). Applied statistical process manifested that between Genetically Modified Organism Scale (GMOS) and BAS a statistically significant and positive relation has been determined (r=.072 and p<0.01); between GMOS and BATS (r=0 and p<0.01) and between GMOS and ASTEGMO (r=0 and p<0.01) no statistically significant relation has been determined (Table 3).

At the end of correlation analysis conducted to identify the relation between Genetically Modified Organisms' Effect on Human and Environmental Health sub-dimension and Approving Genetic Engineering Applications sub-dimension, there has been a significant negative relation amounting to 56,1% (r=-0,561; p=0,000<0,05). According to this relation, as Genetically Modified Organisms' Effect on Human and Environmental Health sub-dimension score increases, Approving Genetic Engineering Applications sub-dimension's score decreases.

At the end of correlation analysis conducted to identify the relation between Consuming Genetically Modified Products sub-dimension and Approving Genetic Engineering Applications sub-dimension, there has been a significant positive relation amounting to 35,2% (r=0,352; p=0,000<0,05). According to this relation, as Consuming Genetically Modified Products sub-dimension score increases Approving Genetic Engineering Applications sub-dimension's score also increases.

At the end of correlation analysis conducted to identify the relation between Attitude towards Genetically Modified Products and Approving Genetic Engineering Applications sub-dimension, there has been a statistically significant relation between scores (r=-0,042; p=0,666>0,05).

CONCLUSION

In current study, the researcher has aimed to analyze psychometric features of (GMOTS) developed to measure the attitudes of social sciences and classroom teachers towards genetically modified organisms. Scores received from test-retest practice conducted to determine the reliability of scale have been statistically analyzed on the basis of each item and upon this assessment, 19 items have been excluded from the study. During the test step, reliability level of scale has been identified as 0,730 and during retest step, reliability level of scale has been found as 0,739. GMOTS's general reliability has been detected as alpha=0.874, which is quite a high figure. To identify construct validity of scale, explanatory (exploratory) factor analysis method has been employed. Bartlett test results revealed that (p=0.000<0.05) there is a relation between variables tested via factor analysis. Test result (KMO=0.905>0,60) demonstrated that sample size is sufficient enough to conduct factor analysis. In the implementation of factor analysis, varymax method has been selected to assure that the structure of the relation between factors remained the same. At the end of

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factor analysis, variables have been categorized under 9 factors of which total explained variance was 49.439%. Factor loads of scale items have varied between 0,08 and 0,36 values. In order to provide criterion-related validity of scale its correlation with "Biotechnological Applications Scale-BAS", "Biotechnological Attitude Scale-BATS" and "Attitude Scale towards the Effects of GMOs -ASTEGMO" has been scrutinized. At the end of statistical process, it has been detected that a positive direction statistically-significant relation exists between Genetically Modified Organisms Scale (GMOS) and BAS amounting to r=.072 and p<0.01; however no statistically significant relation could be identified between GMOÖ and BATS (r=0 and p<0.01) and between GMOS and ASTEGMO (r=0 and p<0.01). Based on the results of Explanatory Factor Analysis, 9–dimensional model structure of scale has been tested via Confirmatory Factor Analysis. In this DFA conducted over 38 items, a positive factor load was obtained in all items. The relation between error variances of 5 item pairs has been included in the model. Hence at the end of DFA conducted to test the 35-item containing four latent variable model, it has been detected that Chi-square value is (χ2=2731,83, N=1049, sd=625, χ2/df=4,37, p=0,000) significant. Fit index values however were identified as RMSEA=.063, GFI=0,88, CFI=0,81, AGFI=0,86, NFI=0,75, NNFI=0,78, SRMR=0,052. These fit index values reveal that model is fit. According to the data obtained from statistical processes, GMOTS is a valid and reliable tool.

DISCUSSION

Genetically Modified Organisms Attitude Scale (GMOTS) can be easily applied and interpreted by social scientists that only have even the most basic knowledge on biotechnology and GMO and indeed this scale should be employed frequently. Since this is still quite a new, modern and controversial issue it is imperative that social scientists endowed with as much experience and knowledge accumulation as ever should conduct further researches on this matter. Current study has been designed on the basis of researcher's point of view and philosophical attitude. Because GMO is an issue related to all segments of society, via studies that will be conducted by social scientists from different social classes it shall be possible to reach more generalizable and verifiable results with more precise conclusions. A further varied assortment of researches shall introduce new and different dimensions to the discussion, so that more number of prospective teachers and eventually greater numbers of citizens shall be able to find more about GMOs. If social science is a discipline with tight connections to daily life, conducted researches should likewise possess a quality that shall make it possible to attain inferences with the same connections in all daily aspects.

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