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EMOTIONS EXPRESSED TOWARD GENETICALLY MODIFIED ORGANISMS AMONG SECONDARY SCHOOL STUDENTS AND PRE-SERVICE TEACHERS

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Abstract. *Active student-centered instructional methods bring more emotion into science teaching, especially in the case of socioscientific issues, like research on and usage of genetically modified organisms (GMOs). We tested the strength of ten basic emotions (fear, anger, joy, disgust, sadness, shame, contempt, guilt, surprise and interest) toward different GMOs. Students expressed high levels of interest, surprise and joy towards GMOs, emotions that could be used as possible motivators to raise the level of interest in Science. Students do not express an equal level of negative emotions toward GMOs as a general category, but take a standpoint towards each item or practice separately. Knowing this, the teacher can choose list of GMOs ranked from more acceptable to the least acceptable GMOs, to avoid any obstruction of reasoning toward GMOs based on strong negative emotions.*

Key words: *emotions, genetically modified organisms, pre-service teachers,*

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Introduction

Nowadays the profession of science teacher is becoming more and more complex, profession and common awareness of declining interest in Science and Science careers works against choosing a science teaching career as a first choice (Osborne et al., 2003; Tomažič & Vidic, 2009). The quantity of knowledge in science disciplines doubles every couple of years, and to make things worse, new knowledge is not only added to the existing body of knowledge but also renders previous knowledge obsolete (Sternberg, 2001; Rebernik & irec, 2007). Owing to information overflow and its availability to students, literally in seconds any day, the old ways of teaching, with the teacher as the dominant source of information and its interpreter, and direct instructions and lectures as the prevailing methods of school work, become not just old fashioned but even inappropriate. As a consequence, the basic question in the educational field becomes "how to educate students so that they could appropriately perform in situations that were unknown in their educational period" (Illeris, 2008, p. 2), leading to the conclusion that school work must be shifted towards student-centered methods and strategies based on their active work (e.g. Dean & Kuhn, 2007; Michael, 2006). Shifting school work from teacher-centered toward student-centered methods inevitably brings more emotion into teaching.

Schools were never emotionally free institutions, and emotions are an important part of education (Čagran, Grmek Ivanuš & Štemberger, 2009), occurring at unequal intensity at different school levels. Hargreaves (2000, p. 811) recognized that *"Elementary teaching is characterized by physical and professional closeness which creates greater emotional intensity«* and that *"Secondary teaching is*

characterized by greater professional and physical distance leading teachers to treat emotions as intrusions in the classroom".

In science education emotions is a seriously neglected dimension (Alsop & Watts, 2003), even if it is well known that emotions constitute an important part in forming and expressing attitudes. Attitudes have been defined as 'feelings based on our beliefs that predispose our reactions to objects, people, and events' (Myers, 2007). Kraus (1995) argues that the basic assumption about attitudes is that they 'guide, influence, direct, shape or predict behavior'. According to the tripartite model, attitudes are based on three different sources: cognitive, affective and behavioral, which are not always consistent (Bizer, 2004). Of special interest here is the affective component of attitudes, although it is argued that in forming appropriate attitudes, both a balanced amount of information and direct participation is needed (Morgan, 1992).

Our interest lies in emotion triggered by the object of the lesson. Well known examples of such objects in biology teaching are some animals (Prokop & Tunnicliffe, 2008, 2010; Prokop et al., 2009a, b, Tomažič, 2008), animal experiments (Silberstein & Tamir, 1981), and the dissection of animals or their organs (de Villiers & Monk, 2005; Holstermann et al., 2009). For example, disgust sensitivity can negatively influence the quality of instruction, when working with various natural objects in the field (Bixler & Floyd, 1999). If students experience negative emotions such as disgust, their beliefs about their mastery of the situation decrease which consequently leads to lower achievement (Holstermann et al., 2009). Less is known about the different emotions that are triggered when learning about various ways of using genetically modified organisms (GMOs) (Prokop et al. 2007; Erdogan et al., 2009; Uşak et al., 2009).

Biotechnology has become one of the most dynamic Life Sciences disciplines, one which is recognized not only as something beneficial but also as a threat (Pardo et al., 2002; Christoph et al., 2008). Because debates concerning biotechnological practices such as genetic engineering, genetic healing, and reproductive cloning have escaped from scientific circles and are causing concern in society, such issues are called socioscientific issues (Sadler, 2004; Sadler & Zeidler, 2005a; Sadler & Zeidler, 2005 b). Schools and teachers, as parts of the society, cannot evade the inclusion of socioscientific issues into education, yet they are not well prepared for such work. Curricula organized by subject are not an appropriate framework for the teaching of issues that span different disciplines, and teachers cannot simply trigger the development of competences such as critical thinking, scientific reasoning or the ability to solve problems simply by the addition of new facts or by teacher-provided explanations. Chen and Raffan (1999) suggest that the absence of ethical discussion in Taiwan is responsible for less favorable attitudes to GMO. In our previous studies (Šorgo & Ambrožič, 2009; Šorgo & Ambrožič, 2010), we have shown that there is only a weak correlation between knowledge of biotechnology and acceptance of GMOs and a strong correlation between attitudes and acceptance, a finding which conforms to relations in other socioscientific issues as well (Allum et al., 2008), leading to the conclusion that meaningful debate concerning socioscientific issues in a classroom cannot neglect attitudes and the emotions what shape them.

The conceptualization of a socioscientific curriculum considers the role of emotion and character as key component in science education (Sadler & Zeidler, 2005b) and occupies a central role in the promotion of science literacy. This investigation and analysis of how students think and feel about a series of related socioscientific issues in science education showed that emotions have a facilitative effect in student engagement with controversial issues and that emotions contribute significantly to their consideration and resolution (Sadler & Zeidler, 2005b).

Only a few studies have connected emotion with opinions about, knowledge of, attitudes toward, and acceptance of GMOs and GM products, even though emotion could be an important factor in attitudes toward GMOs and their acceptability. In relation to genetic engineering and GMOs emotions can most often be described in terms of emotional involvement (Spence & Townsend, 2006) from a care perspective, in which empathy and concern for the well-being of others or relations (relatives) lead to guided decisions or courses of action (Sadler & Zeidler, 2005b). Emotions are often hidden in related concepts, such as concern (James, 2004), moral acceptability (Črne-Hladnik et al., 2009), personal or general risk and uncertainty (Finucane, 2002; Ronteltap et al., 2007; Cristoph et al., 2008). The most frequently reported emotions concerning GMOs are negative ones such as worry (anxiety) and anger

(Stewart and McLean, 2005) and even fear (Laros & Steenkamp, 2004). Reports of fear concerning genetically modified food (GMF) frequently appear in the mass media. These have played a crucial role in creating widespread fear of GMF (also known as "Frankenstein food" among the fearful) in many parts of the world (Laros & Steenkamp, 2004). Fear of GMF is positively influenced by consumers' concern for the environment and negatively affected by their faith in the technology of food production. Consumers who are more fearful of GMF have a more negative attitude towards genetically modified food and towards genetic modification of animals, and exhibit greater interest in information related to food production (Finucane, 2002; Laros & Steenkamp, 2004), and humans were found to be much more emotionally connected to animals than to plants. Because of their commercial importance, emotions are often evaluated in relation to GM food and food products (Finucane, 2002; Laros & Steenkamp, 2004). From the educational point of view interesting finding is that people expressing anxiety (worry) tend to collect more information before deciding for or against an action or decision, but those who express anger are likely to take immediate action (Stewart & McLean, 2005).

There exist different lists of and grouping criteria for the emotions important for school work (Čagran, Grmek Ivanuš & Štemberger, 2009), and there is a plethora of different theories of emotions (Strongmann, 2003). Although there is still no definite agreement on the existence or appropriateness of the term 'basic emotions' (Ekman, 1992, 1999; Barret et al., 2009; Smith & Schneider, 2009), some general characteristics of basic emotions should be taken into account (Ekman, 1999). For the present study, we have chosen the emotions that students should easily be able to define and interpret. We used the emotions defined by Izard (1977, see Izard et al., 1993), who defined 10 basic emotions: fear, anger, joy, disgust, sadness, shame, contempt, guilt, surprise and interest. The dilemma that influenced our decision was whether students should be asked to respond to GMO use in general, or if they should be offered a list of statements to each of which they would assign a level of potential emotional response. We decided to use the latter and formulated statements that were related to potential real life situations. In this way we sought to find student responses for 10 individual emotions on each statement (item).

Purpose of the Study

Because biotechnology based on modification of genetic material in organisms in good or bad will change the quality of life either for good or for ill for future generations we, as educators, must educate students about this issue. School is not a value- or emotion-free environment, and teachers and students do not necessarily share the same system of attitudes, values or emotions towards issues. As a result, latent conflict is always present in the classroom. The purpose of the study was to measure differences in emotions expressed toward genetically modified organisms between secondary school students and their potential teachers. As teacher educators, we would like to prepare pre-service teachers to be aware of the possible differences between them and their students, not only on the level of knowledge but on the emotional/attitudinal level too, to prepare appropriate teaching-learning strategies for including socioscientific issues in classroom. In the present study we set out to discover, (1) which of the selected positive or negative emotions students would rate as those that produce a moderate or high response when different ways of using of GMOs are considered, (2) which of the selected positive or negative emotions would prevail when students are specifically asked about different ways of using GMOs, (3) the degree of difference in emotions toward different kind of GMOs between secondary school students and prospective teachers.

Methodology of Research

Structure of the Sample and Sampling

The sample comprised secondary school students and pre-service teachers. The questionnaire was administered in the year 2009 to secondary school students from the schools participating in the project "Development of Science Competences", and to pre-service biology teachers and pre-service elementary teachers at the Universities of Maribor and Ljubljana. We collected 573 questionnaires. Nine

questionnaires were excluded because more than half the fields were left blank, so we ended with 564 valid cases: 341 (60.5%) from secondary schools and 223 (39.5%) from universities.

Questionnaires were delivered to the secondary students at six secondary schools in Slovenia. The questionnaires were anonymously delivered in two classes at every school. Five schools from the sample are general 4-year secondary schools, offering a general programme, and one school is 4-year technical school with a technical programme. The main purpose of the general secondary school, called "gimnazija" in Slovenia, is to prepare students for university studies and qualify them for final external "matura" examinations as a prerequisite for entering university. All students were in the first class of upper secondary school and had already completed 9-year compulsory school, which means that they were about 15 years old at the time of sampling. Our sample comprises 128 boys and 211 girls, and 2 students who chose neither gender. We collected 223 questionnaires from pre-service teachers; 166 were prospective elementary teachers and 57 prospective biology teachers in their second (N=129, third (N = 40), and fourth (N = 54) study year which means that they were between 20 and 25 years old at the time of sampling. There were 211 females and 12 males, a sample showing the feminization of the teaching profession in Slovenia.

Structure of the Questionnaire

To find out students' emotions towards GMOs, a questionnaire was assembled. It was completed anonymously.

We decided to collect only a minimal amount of personal data (name of the faculty and study programme; type of secondary school, year of study and gender). The reason was that seeking differences between subgroups in our sample was not a leading idea of our work because, as teacher educators, we cannot form study groups or prepare courses based on gender, age, religion, etc, nor will teachers form classes or prepare courses on such a basis.

To find relations between emotions and GMOs, we chose emotions that students should easily be able to define and interpret. We used emotions as defined by Izard (1977, see Izard et al., 1993), who defined 10 basic emotions. We formulated statements that were related to potential real life situations. In this way we sought to find students' responses for 10 individual emotions on each statement (item). The general introduction was as follows:

> We will propose some potential situations where you could make contact with genetically modified organisms (GMOs). We are interested in establishing the strength of your emotional response to such contact. On the list are ten basic emotions, but we have provided two blank fields where you can add additional emotions of your choice. *We ask you to indicate the strength of your response by circling the appropriate numbers in the table.* Values: 0 – 5. 0 = cannot make a decision; 1= no response; 5= maximal response.

In a table a list of basic emotions was provided as follows: Fear; Anger; Joy; Disgust; Sadness; Shame; Contempt; Guilt; Surprise; Interest, and two blank fields.

All statements are in Appendix 1.

Data Analysis

The data analysis was carried out with the statistical software SPSS® 17.0. Correspondence analysis was carried out using the CANOCO package. A Detrended Correspondence Analysis (DCA) was conducted to produce a two-dimensional plot of the major variation in the dataset and to display the results in ordination space. Correspondence analysis was first introduced to ecology in the early 1970s and quickly gained popularity because of its better recovery of a one-dimensional simulated gradient, compared to principal components analysis. DCA was developed to overcome the distortions inherent in correspondence analysis ordination, in particular the tendency for one-dimensional gradients to be distorted into an arch on the second ordination axis and the tendency for samples to be unevenly

spaced along the axis (Legendre & Legendre, 1998).

Chi-square (χ^2) statistics were used to identify differences in frequencies of answers between different groups of respondents. The Mann-Whitney non-parametric test was used to identify differences in frequencies of answers concerning emotions among different groups of respondents. To make parallel comparisons of the differences in means among different groups of teachers, the F–test was performed, showing generally the same pattern as a Mann-Whitney test. We tested our data for normal distribution with the Kolmogorov-Smirnov test and found that all the variables did not follow normal distribution at the level of $p<0.01$. Owing to the distribution of data, only means and outcomes of the non-parametric test are reported in the tables. Differences between groups (gender and secondary school students: pre-service teachers) are reported only for emotions where at least one item exceeds the value of the mean = 2.5 (fear, anger, joy, disgust, surprise, interest). Thus we excluded sadness, shame, contempt, and guilt from the reports.

Results of Research

Table 1 presents the mean values for each of the statements and for each emotion. Averages greater than 2.5 were considered as indicating an important level of emotional response. Students are generally not bothered by GM but by the thought of its being used in particular contexts. They seem not to respond at least negatively to the thought of eating GM plants, living near GM animals and plants, using them for the production of chemical substances and using them for the production of biofuels.

Table 1. Means of emotions expressed toward genetically modified organisms.

No.	Item	Fear	Anger	Joy	Disgust	Sadness	Shame	Contempt	Guilt	Surprise	Interest
1	You have eaten genetically modified food from animals	2.53	2.58	1.27	2.56	2.09	1.46	1.98	1.74	2.90	2.53
2	You have eaten genetically modified food from plants	2.11	2.09	1.31	2.02	1.68	1.35	1.78	1.57	2.62	2.46
3	Living with genetically modified animals	1.85	1.96	2.35	1.68	1.87	1.34	1.56	1.53	3.56	3.49
4	Genetically modified plants growing in your immediate neighborhood	1.84	2.03	1.28	1.67	1.63	1.33	1.70	1.29	2.64	2.64
5	Transplantation of an organ from a genetically modified animal	3.87	2.28	1.97	2.65	2.41	2.00	1.86	1.86	3.44	3.17
6	Medicines from genetically modified yeast	2.66	2.21	1.35	2.15	1.72	1.45	1.72	1.46	2.82	2.65
7	Genetically modified microorganisms in the production of chemical substances	2.01	1.86	1.29	1.57	1.59	1.35	1.58	1.32	2.63	2.56
8	Genetically modified plants in the production of biofuels	1.54	1.50	2.21	1.32	1.38	1.20	1.37	1.21	2.95	3.07
9	Genetic healing	3.62	1.70	2.98	1.54	1.98	1.34	1.32	1.65	3.44	3.95
10	Contact with material produced from genetically modified plant	1.61	1.52	2.49	1.50	1.37	1.30	1.37	1.35	3.10	3.09

Ratings on the emotions of sadness, shame, contempt and guilt did not exceed values greater than 2.4 on any rated statement except for one – sadness – for the statement "transplantation of an organ from a genetically modified animal". On several statements, three "negative" emotions were rated as intense: fear, anger and disgust. Ratings of fear were the highest where usage of GMO for transplantation of organs (M=3.9) and for genetic healing (M=3.6) was considered, followed by using medicines from genetically modified yeast (M=2.7) and eating genetically modified food from animals (M=2.5). Participants expressed quite high levels of anger only to the thought of eating genetically modified food from animals (M=2.6). Ratings of disgust were quite high on statements of transplantation of organs from GM animals (M=2.7) and of eating GM food from animals (M=2.6).

For "positive" emotions such as joy, participants favor using GM for genetic healing (M=3.0). The second statement that emerged was the one about contact with GM plants (M=2.5).

Interest and surprise were emotions which students rated for each statement very near or above the value of 2.5. For surprise, it is difficult to discern whether students were rating an individual statement in a positive or negative sense (negative or positive surprise). The ratings for both emotions were similar for every statement except the first (eating GM food from animals), where participants expressed a greater degree of surprise (M=2.9) than interest (M=2.5) and the ninth (genetic healing), where students expressed greater interest (M=4.0) than surprise (M=3.4).

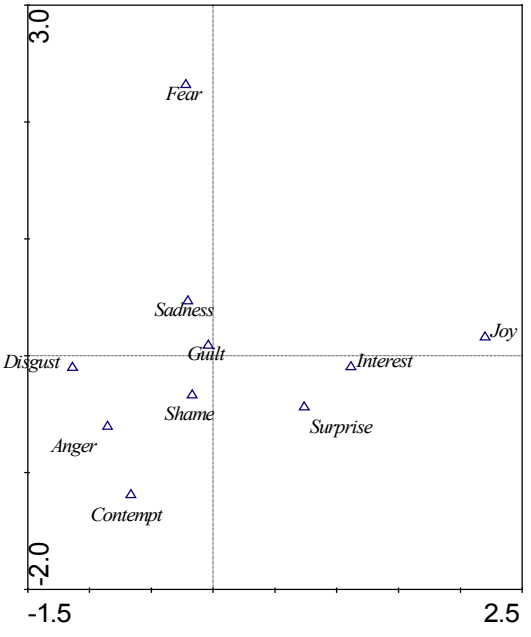

Figure 1: Detrended correspondence diagram displaying relationship between emotions according to GMOs. Axes I (69.0%, horizontal) and II (19.1%, vertical) 88.1% of variance explained together.

In the detrended correspondence analysis included the means data of emotions expressed (Table 1.) The eigenvalue of the first axis was 0.018, and of the second axis only 0.005. Among others, Disgust and Anger are at the other end of the first axis. All these emotions are clearly "negative". At the opposite end of the axis are the positive emotions Joy and Interest. The first axis corresponds to a gradient from "negative to positive emotion".

Differences in Expressed Emotions by Gender and School Level

We analyzed only emotions where the expressed mean of the sample was above 2.5.

Interest: We did not find statistically significant differences in expressed Interest between male and female students. Pre-service teachers are statistically significantly ($p< 0.05$) more interested than high school students in four items (You have eaten genetically modified food from animals; Genetically modified plants in the production of biofuels; Genetic healing; Contact with material produced from genetically modified plants), a finding which can be at least partially explained by the study field (Biology or Biology in combination with other subjects) of about one third of the prospective teachers.

Surprise: We did not find statistically significant differences in expressed Surprise between male and female students, and pre-service teachers and secondary school students.

Joy: Males find more Joy in genetically modified plants in the production of biofuels than females do ($p<0.001$), a result which can most probably be explained by the higher level of interest on the part of males toward technology. Pre-service teachers find more Joy in the possibility that a life could be saved by transplantation ($p< 0.01$).

Fear: Female students expressed much higher levels of Fear than male students on 6 items (Items 1, 2, 5,6,8,9, Table 1). On the other hand, they do not fear GMO's more extensively in general. The differences are statistically insignificant ($p < 0.05$) or near significance ($p < 0.06$) when expressed fear is very low. Such items include living with genetically modified animals and plants, contact with GM cotton, and the use of genetically modified microorganisms in the production of chemical substances. Statistically significant differences ($p < 0.05$) between secondary school students and pre-service teachers were found only on two items, both connected with health (Transplantation of an organ from a genetically modified animal, and Genetic healing), and the means are in both cases higher for pre-service teachers.

Anger: A statistically significant difference appeared ($p < 0.01$) between genders on two items. Females expressed higher levels of Anger for both statements about the consumption of GM food. In all other cases we found no differences. The difference between secondary school students and pre-service teachers in the level of anger expressed is greater by youngsters ($p < 0.05$) in the case of transplantation of an organ from a genetically modified animal.

Disgust: we found statistically significant differences ($p < 0.001$) only on eating food from a GM animal, and these values were higher for males. Secondary school students expressed higher levels of disgust ($p<0.05$) on four items (see appendix, variables 4, 5, 6, 10).

Discussion

The inclusion of ten basic emotions (Izard, 1977, see Izard et al., 1993) to find the emotional response to potential use of or contact with different kinds of GMOs, followed by "classical" and correspondence analysis, gave us better insight into the premises to be used in planning teaching activities about GMOs.

First of all we identified emotions connected with GMOs that were not included in other studies. Such emotions are high-rated Interest, Surprise and sometimes Joy (Table1). Most studies reported negative emotions such as worry (anxiety), anger (Stewart & McLean, 2005), and fear (Laros & Steenkamp, 2004) usually connected with risk and its perception (Spence & Townsend, 2006). Interest, Surprise and Joy were never mentioned. Positive emotions are usually associated with potential needs and benefits and are connected with trust (Spence & Townsend, 2006), with empathy, caring and sympathy (Sadler & Zeidler, 2005b), with morality and ethics (Sadler & Zeidler, 2004). To increase our understanding of the role of these positive emotions, future studies are necessary. To understand the needs, benefits, trust, empathy, sympathy, morality and ethics, it is necessary to gain insight into these positive emotions, as well. More research is needed to clarify the direction of these relations.

The statements used in our questionnaire were connected to various possibilities for GMO use. These differences would probably guide student approval of individual use of GMOs and consequently

their willingness to learn about the use of GMOs. As is known, if negative emotions are experienced, they may cause reactions such as withdrawal (fear), attack (anger) or rejection (disgust). Before including an organism in class debate special attention should be given to the finding (Table 1) that on several items students expressed quite high levels of fear and disgust. We speculate that the main reason for this was not GMOs as such but terms such as "transplantation" and "genetic healing". Education concerning GMOs should therefore at the same time engage students in discovering the benefits of genetic healing, organ donation and transplantation in order to lessen disgust sensitivity. Statements that did not mention any direct harming of the body envelope or potential contamination or illness (use of medicines) did not produce higher ratings on negative emotions (e.g., living with a GM animal, growing GM plants near home, GM microorganisms for the production of chemicals, GM plants for biofuels and materials from GM plants). Interestingly, participants rated eating GM plants lower – less afraid, angry and disgusted – then they did for eating GM animals, although both were defined as the intake of food (possible contamination). Differences between gender also exists with possible explanation that females invest more to reproduction, thus risk less than males and consequently have greater fear of risky products (Ozden et al, 2007).Eating GM animals was also the statement that elicited the most anger from participants. That discovery led to the conclusion that acceptability of a particular GMO is not a one-dimensional issue (presence of genes) but is a complex issue that could be connected, for example, with exploitation on abuse of animals or related issues. No other statement produced average ratings of anger higher than 2.5.

Positive emotions, on the other hand, include a component of positive affect and function as internal signals to approach and continue. As Fredrickson (2001) points out, these are often neglected. The main reasons may be that there are fewer positive emotions and that they are harder to study, while psychology is oriented towards solving problems, a category usually exclusive of positive emotions (Seligman & Csikszentmihalyi, 2000; Fredrickson, 2001); finally, theories of emotion tend to describe emotions in general.

What was particularly surprising to us was that students rated the emotions of Surprise and Interest above the level determined as important on all the statements. Since we know that surprise can be researched as both positive and negative (Talarico et al., 2009), we can only speculate on whether the surprise, where Fear, Anger or Disgust ratings were elevated, was positive or negative.

The term Interest, as reviewed by Abrahams (2009), can be viewed as personal and situational. That is of great importance in education. Teachers can effectively influence situational interest but can be quite ineffective in changing students' personal interest. The latter is more resistant to external influence, while the first depends on a given situation.

Also interesting was the statement about the use of GM for genetic healing, where participants rated Joy extremely high in comparison with other ratings on the same emotion. That is probably due to the beneficial effects of this type of healing on human - personal health. This statement at the same time produces the fear of getting ill or simply fears of something still untested.

The good news from the teaching standpoint is our study's' discovery that students at the secondary school and university levels are interested in topics concerning GMOs. Their general interest, combined with Surprise and Joy (Figure 1) could form a basis for teaching about GMOs. Additionally, our finding could provide the impetus toward inclusion of such topics in teaching, in order to raise student interest in Science and Science careers, which is declining globally. The finding can be even more important locally in countries like Slovenia, where Science is unpopular among students as early as in upper primary school, and attitudes concerning Science subjects are even more negative than in other parts of the world. Recognizing this problem, many educators worldwide are trying to find a way to make Natural Sciences more attractive, while not losing quality but even raising it. Based on findings from many studies (Michael, 2006), it is possible to conclude that raising the quality of teaching and learning can only be achieved with fully engaged students, who expect the teaching of science to involve a mixture of interesting, multimedia-supported lectures with frequent laboratory and field work. Additionally choosing balanced kinds of GMOs as a topic in teaching can be used to raise interest in science in both genders (Jones et al., 2000).

At the other end of the scale are the emotions of fear, disgust and anger, which can work against

intended teaching outcomes, which is to educate a person who will make his/her decisions concerning socio-scientific issues on the basis of scientific facts, understanding and critical thinking. Because not all applications or GMOs triggered an equal response and are not equally acceptable (orgo & Ambrožič, 2009; Šorgo & Ambrožič, 2010), we should plan teaching activities carefully to prevent any strengthening of negative emotions, with special attention given to Fear. Additionally, we can recognize from Figure 1 that fear and disgust are not connected. Our findings contradict finding that disgust and fear toward parasites correlate (Prokop et al., 2010 a; Prokop et al, 2010 b) showed that fear and disgust of GM products are different from evolved mechanisms protecting humans against harmful animals. In-depth research in this field is necessary.

So, in dealing with fear, one could start with a GMO that does not produce disgust as a response. The reason is that disgust would be understood as emotion that protect individuals against potentially harmful objects or subjects and males showed higher mean disgust score in the case of GM products. Further research in the protective role of disgust and gender differences is required, because recent research show inconsistent results in this field (Prokop & Fančičova, 2010).

When thinking internationally we have to take into account that there should be differences in strategies between countries or states where GMOs are openly used in food production and countries where students do not have first hand experience with GMOs, or are unaware of them, even if they are available the on market (e. g. drugs from GMOs).

All the above clearly shows the need to further investigate the role of emotion, especially positive emotions, not only in the case of GMOs, but in other socioscientific topics to raise not only interest and knowledge about important science topics but also willingness to participate in public debate from the standpoint of the scientifically literate citizen.

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Appendix 1

V1: You have unknowingly eaten a meal containing food produced from g**enetically modified animals** (e. g., Salmon with an additional gene for fast growth, or a pig with a genes to change the relation between the content of saturated and unsaturated fats). Shortened: **You have eaten genetically modified food from animals.**

V2: Unknowingly you have eaten a meal containing food produced from g**enetically modified plants** (e. g., Potato resistant to viral diseases, tomatoes with genes that delay softening). Shortened: **You have eaten genetically modified food from plants.**

V3: In the apartment where you live your roommate has brought home a genetically **modified animal** (e. g., A cat with non-allergenic fur, or a fish that glows in the dark). Shortened: **Living with genetically modified animals.**

V4 You have recognized that in your immediate neighborhood **genetically modified plants** are being cultivated (e. g., Maize MON 810). Shortened: **Genetically modified plants growing in your immediate neighborhood.**

V5: One of your internal organs is losing its function, and you have been offered replacement of the damaged organ by an organ from a **genetically modified animal**. Shortened: **Transplantation of an organ from a genetically modified animal.**

V6: You have learned that an active substance in your prescription drugs is produced from **genetically modified yeast**. Shortened: **Medicines from genetically modified yeast.**

V7: You have learned that a biotechnical plant in your immediate neighborhood is producing **chemical substances for use in the paper industry by using genetically modified microorganisms**. Shortened: **Genetically modified microorganisms in the production of chemical substances.**

V8: You have been informed that a nearby biotechnological plant is using **genetically modified plants (e.g., corn) for the production of biofuels.** Shortened: **Genetically modified plants in the production of biofuels.**

V9: Your child or relative has diabetes and will be dependent on insulin throughout his life. You have learned that there is a possibility for **genetic healing**, where new intact genes will be transferred into the cells of the pancreas of the ill person. Shortened: **Genetic healing.**

V10: You have learned that the cotton shirt you are wearing was produced from **genetically modified cotton resistant to insects.** Shortened: **Contact with material produced from genetically modified plant.**

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