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Development of 'Bioethical Values Inventory' for Pupils in Secondary Education within the Scope of Bioethical Education

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This study has led to the development of the 'Bioethical Values Inventory' that can be used to reveal secondary school students' ethical values in decisions that they make during ethical debates regarding the application of biological sciences. An original inventory development model was used, consisting of four steps and involving qualitative as well as quantitative data collection processes in line with the objectives of the study. In the first step of this model an analysis of ethical debates on biological sciences was followed by the statement of the inventory topics. In the second step, scenarios were created on the ethical dilemmas related to each chosen topic. In the third step, these scenarios were applied to ninth graders (n = 493) in 18 secondary schools in eight districts of Ankara, Turkey. The students' responses to the scenarios were revealed through content analysis strategies and the inventory was converted into a multiple-choice questionnaire through thematic coding. In the fourth step, the inventory was finalized by gathering experts' and students' views on the multiple-choice items. The final version of the inventory and its importance for science/bioethics education is discussed in the light of the relevant literature.

Keywords: bioethics education, ethical dilemmas, scale/inventory development, socioscientific issues

INTRODUCTION

We acquire all our attitudes and values that we use in the decision-making process from our social environment. This means that, while passing ethical judgements, we are influenced by our personal experiences, families, religious beliefs, ethnic culture, and the society that we live in. From this viewpoint, each individual makes evaluations within the framework of their knowledge and social environment. Through studying ethics, the individual learns to be guided by the existing universal ethical theories and principles, as well as by his or her own personal experiences, in the evaluation and decision-making process (Taylor, 1975).

In this context, bioethics education makes it possible for individuals to grasp the value conflicts caused by biological sciences and to develop decision-making skills based on ethical theories and principles (Macer, Asada, Tsuzuki, Akiyama, & Macer, 1996; Reich, 1995). Rather than enabling students to make the 'right' decision in a given situation, bioethics education concerns itself with allowing them to have the scientific background necessary for ethical discussions and to improve their reasoning and decision-making skills. Only with sufficient scientific background, debates with peers, and their reasoning skills can educated individuals use their scientific knowledge in the assessment of personal and social issues and express opinions about them (Sadler & Donnelly, 2006).

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State of the literature

- Today educational curricula must involve science and technology teaching together with social, cultural, environmental, political, and ethical elements.
- It is important for an individual to become aware of his/her own values and to explain them in a conscious way. So, today science education curricula focus on the elements conducive to society-wide science literacy rather than imparting 'pure scientific knowledge' to students.
- A close inspection of bioethics education shows that almost all of the scales used in the literature so far have overlooked individuals' values in decision-making process.

Contribution of this paper to the literature

- In this study, the 'Bioethical Values Inventory' (BVI), was developed to reveal individuals' values while making decisions about value issues in biological sciences in general and 'genetic technologies' in particular was developed.
- The BVI has experimentally derived multiple-choice items based on ethical dilemmas. With its structure, the inventory can be used in large-scale studies.
- This inventory can be considered educational material in argumentation-based tackling of socio-scientific issues. Bioethics education can be done through the scenarios involving the topics of the scale while the students understand the relevant scientific facts and notice the ethical dilemmas in the scenarios.

It is important for an individual to become aware of their own values and to explain them in a conscious way. This process overlaps with value clarification, value analysis, and ethical-moral dilemma of the value teaching approaches (Kormondy, 1990; Macer, 2008).

Developed by Raths, Harmin, and Simon upon John Dewey's philosophy of education, the value-clarification approach mainly aims to allow individuals to discover their priorities and values. For this, the individual examines their choices and their potential consequences, discovers and explains their own values in the mean time, and shares them with others so that they too can understand (Doğanay, 2006, pp: 268-269). This process is vital for forming arguments from a critical viewpoint and effectively developing ethical decision-making skills. In reaching ethical maturity, it is crucial for the individual to discover their own values and analyze them rationally, logically, and systematically comparing them to others rather than simply accepting a set of values presented by others (Güngör, 1993, p. 8; Akbaş, 2004, pp. 77-78). This brings us to the value analysis approach which requires students to have scientific research and rational thinking skills when making decisions about value issues. For this reason, this is in fact a problem-solving process with an organizational structure of eight steps (Doğanay, 2006, pp. 272-274):

determining the value issue,
clarifying the value issue encountered,
collecting information and evidence about the issue,
verifying the information and evidence,
determining possible modes of solution,
assessing the consequences of each solution,
opting for one choice,
behaving accordingly.

Another approach suggested for reaching ethical maturity is the use of ethical dilemmas. This approach makes use of ethical dilemmas so that the individual, in the ethical analysis process, can identify their value issues and come up with solutions. Ethical dilemmas are open-ended real life problems with conflicting value principles and various right answers instead of a single one (Doğanay, 2006, p. 275). A close inspection of ethical decision-making and reasoning processes along the guidelines of bioethics education shows that almost all of the scales used in the literature so far have overlooked individuals' values in decision-making and basic ethical principles (Chen & Raffan, 1999; Dawson & Soames, 2006; Cavanagh, Hood & Wilkinson, 2005; Dawson, 2007). It is crucial to know 'how' and 'with what values' students tackle socioscientific issues. For values are the criteria by which humans determine their preferences and evaluate others. Values are also important as motivation for individuals' behaviour and attitudes (Özgüven, 1999, p. 350).

In this context, the need is felt for focusing on an individual's 'values' rather than attitudes and the skills they will need in the decision-making process. For this reason, this study looks at the existing scales and inventories developed in the literature. The literature review showed that researches aiming to find out student attitudes in this field has not used 'scenarios based on ethical dilemmas' except the studies of Saez, Nino & Carretero (2008), Dawson (1999) and Rest, Narvaez, Thoma & Bebeau (1999). These dilemmas are, however, of crucial importance in values education for improving students' thinking, values-statement, debate, and reasoning skills (Doğanay, 2006, p. 275). Ethical dilemmas are of further use as tools in clarifying the 'vague' nature of ethical problems, enabling students to do analyses 'relating to the real world', and allowing them to grasp the difference between facts, opinions, and values (Velasquez *et al.*, 2009).

Viewed in light of values education, the limited use of ethical dilemmas is noteworthy in studies tackling bioethical issues and assessment of attitudes. Unlike the common practice in this field, Saez, Nino, & Carretero

(2008) and Dawson (1999) used 'ethical dilemmas' in revealing students' attitudes and values in their decision-making processes. These scenario-based dilemmas concluded with open-ended questions in both studies. With content analysis, the students' values in their decision-making processes were sought out of their answers to each scenario. This is a good method for small groups of students. With larger groups or large-scale studies, however, it may be quite dificult to administer. The structure of Rest's (1979) Defining Isues Test (DIT) is a good example to overcome this difficulty. DIT-2 (the revised version of DIT) inculdes five hypothetical moral dilemmas. Each moral dilemma is followed by 12 issues that could be involved in making a decision about the dilemma. Participants are asked what decisions they would make in each dilemma and which issues they would consider most important in making decisions. These responses are scored to find which moral schema students follow in making a moral decision; personal interest schema, maintaining norms schema, postcponventional schema (Rest, Narvaez, Thoma & Bebeau, 1999).

In light of all this, the present study aims to develop an inventory designed to reveal individuals' values when making decisions about value issues in biological sciences in general and 'genetic technologies' in particular. To this end, the 'ethical dilemma' and 'value analysis' approach was taken as the basis and the construction of an inventory with scenarios on biological sciences and mostly 'genetic technologies' was attempted.

METHOD

This study primarily aims to develop a valid and reliable inventory that could be used in large scale surveys. For this reason, the teaching strategies and research techniques used in bioethics education were reviewed in the literature. This literature review highlighted the scenarios of ethical dilemmas in bioethics education both for teaching and for finding out students' attitudes, values, and opinions. At the same time, various attitude scale development models were also looked at for the purposes of methodology and research techniques. In line with the objectives and the theoretical basis of the study, an original inventory development model was produced based on the scale development models used by Saez, Nino, & Carretero (2008) and Aikenhead & Ryan (1992) (see Figure 1). The whole development process of this model and the features of the resulting inventory are explained in the section below.

The Development Process of the Bioethical Values Inventory (BVI)

Step 1

Within the framework of the above model, Step 1 mainly involved literature review in biological sciences and particularly 'genetic technology' as well as an analysis of the ethical debates in science journals and the printed and visual media. The list of topics yielded by the analysis was studied in light of the researchers' and teachers' opinions and the inventory topics were narrowed down. However, considering the ethical debates in the literature, a single scenario for some of the topics was thought insufficient for revealing the relevant attitudes. Therefore, more than one scenario were written up for the topics of 'genetically modified foods' and 'genetic screening tests'. Table 1 shows the topics and sub-topics of the 10 scenarios used in the inventory.

Step 2

After the topics were determined, a draft scenario was written for each topic in Step 2. The scenarios were carefully drafted to include dilemmas leading to the ethical debates in the literature as well as further debates. The scenarios ended with open-ended questions to allow students to reveal their value judgements, attitudes, and opinions on the issue.

The content validity is ensured by a medical doctor specializing in bioethics and two biology teachers. The medical doctor reviewed the scenarios by identifying domains relevant to medical ethics. As a result, the scenarios were evaluated and modified by the researchers. Subsequently, two biology teachers examined the scenarios regarding their scientific content. A pilot study was conducted with 20 students in ninth grade, at a school in Ankara. In this study semi-structured interviews were also conducted. The scenarios were first handed out to the students to read through and then their opinions were asked on any confusing or ambiguous points or areas that needed clarification. In the light of teachers' and students' suggestions, the draft scenarios were improved and the pre-administeration inventory (version 1) was obtained.

According to Aikenhead and Ryan (1992), one of the common sense behavior in scale/inventory development studies is to assume that students will perceive the statements used in the scale/inventory in the same way as the researchers and give their answers accordingly. In these scale/inventory development studies, while forming an items pool, most researchers write down the expressions themselves using their own experiences and background. However, students and researchers may have different uses of language and this

Table 1. Topics and sub-topics of the scenarios used in the BVI

Number	Scenario Topic	Scenario Sub-topic
1	Use of Animals in Experiments	
2	Prenatal Genetic Diagnosis and Abortion	
3	Determining the Gender or Physical Appearance of Unborn Babies (Designer Babies)	
4	Genetically Modified Organisms	Agricultural biotechnology and economy
5		Agricultural biotechnology and companies
6		Labelling and the right of information
7		Agricultural biotechnology and local use
8	Genetic Screening Tests	Advantages and disadvantages of genetic screening tests
9		Limitations of genetic screening tests and the use of genetic information
10	Therapeutic Cloning	

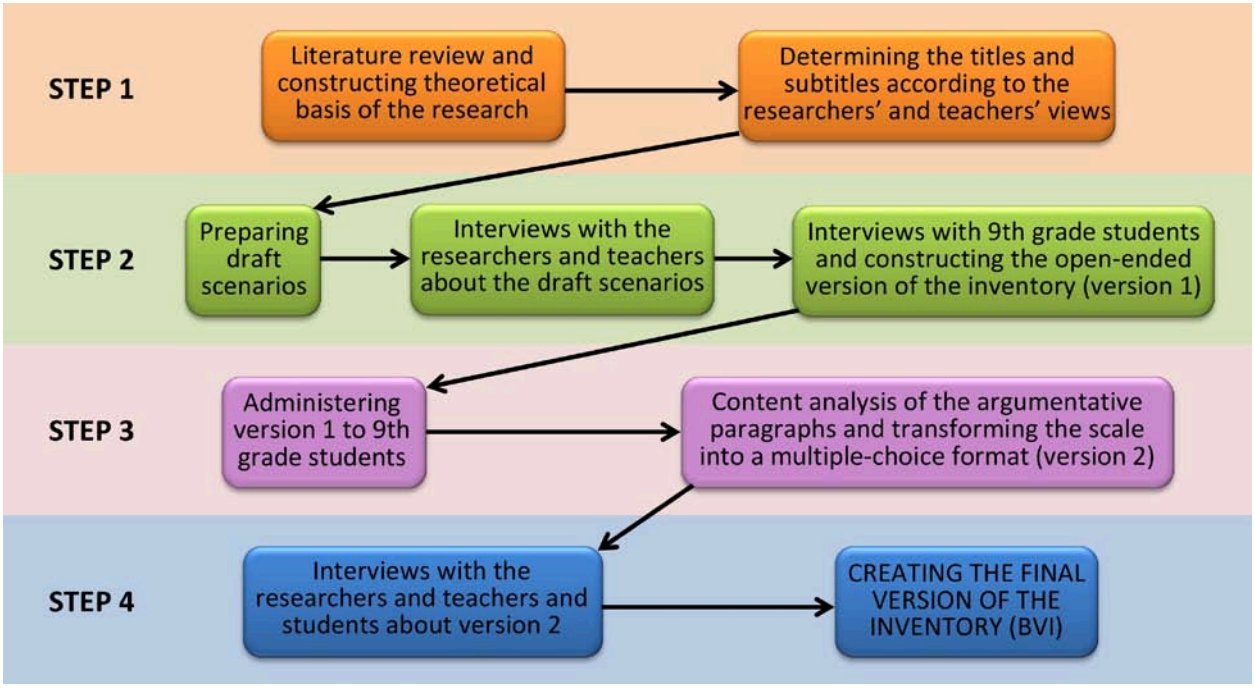

Figure 1. The Bioethical Values Inventory (BVI) Development Model based on the scale development models used by Saez, Nino & Carretero (2008) and Aikenhead & Ryan (1992)

difference (ambiguity) mostly stems from students' former sources of information (Lederman & O'Malley, 1990, p. 237). Designing the statements in this way carries the risk of unintentionally giving hints to the respondents, which would make it difficult for the researcher to get down to the bottom of what he or she is trying to uncover (Taşar, 2006). This is why the statements used and the questions asked in a scale/inventory are of utmost significance in scale/inventory development studies.

Various strategies are suggested in some studies for eliminating or minimizing the problems of 'misunderstanding' or 'ambiguity' due to the expressions used in the scale/inventory. These strategies cover the whole scale/inventory development process or the type of the scale/inventory. Focusing on these strategies, Aikenhead (1988) looked at the effects of the ambiguity problem resulting from the different uses of language by students and researchers. The Likert type, paragraph writing, semi-structured interview, and the experimentally developed multiple-choice scales were compared. According to this comparison it is clear that, experimentally derived multiple-choice items bring down the ambiguity problem to as low as 15-20%. Here, 'experimentally derived' means paragraph and interview data going through content analysis and changing into multiple-choice test items. So based on this comparison results, the inventory developed for this study was decided to have 'experimentally derived multiple-choice test items'. For this reason, for each scenario, paragraph writing and semi structured interviews were used to reveal the values of the students in the study group.

Table 2. Thematic Classification of the Responses to the Scenarios

Themes	Scenario Number / Answer									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Utilitarian Approach		G, H, I, J	F	A, D, G, H, I	A, B, H	A, B, E	A, B, F, G, H	A, B	C, D, E	F, G
Rights Approach	C	A	C,G			D	J	E	B, F	A, D
Justice Approach	A		E		G	C			A	
Virtue Approach			D		E					C
Principles Approach	H,I		I	K,L	I,J,K					H
Theological Approach	D	B,D	B	C	D			C		B
Preference for the Natural	B	C	A	B,E	C		C,D	D		
Scientific Approach	E	E	H	F	F		E,I	F	G	E
Belief in Humans' Superiority to Other Living Beings.	F,G									

Composition of the Study Group

The variety of the decisions and the rationale obtained from the students' argumentative paragraphs are highly important to determine the multiple choices related to each scenario to appear in the inventory. So in order to capture the variety of responses, schools of different socio-economic parameters in Ankara were targeted. According to DPT (The State Planning Organisation), province of Ankara is divided into five regions based on socio-economic parameters (there are eight districts in these five regions). In total 20 schools were selected in the province of Ankara according to a proportional sampling method.

Step 3

After the study group was composed, the first version of the inventory was applied to 556 students in 20 schools in Ankara. However, the data obtained from two schools were taken out of the sample since the problems raised during the applications of the first version of the inventory. Finally the data of a total of 493 students from 18 schools were analyzed.

The researcher personally took part in the administeration of the first version of the inventory at various schools in the sample, explained the objectives and significance of the study in the classrooms, and asked the students to write short paragraphs including their views, beliefs, and attitudes on the open-ended questions in the scenarios. Before the application of the scenarios, the students were asked to fill in the 'Personal Information Survey' given out with version 1. According to data gathered from the personal information survey, the average age of the study group was 15 (76%) and 55% of the students were female.

Transforming the Inventory into a Multiple-Choice Format

This stage of the development process of the 'Bioethical Values Inventory' (BVI) involves analyzing the paragraphs following the application of Version 1 to the research group and transforming the BVI into a multiple-choice format. To this end, 'content analysis', which is one of the qualitative data analysis techniques, was used. In this process, for the analysis of the paragraphs written by the students on the scenarios, codes were assigned to each scenario. The codification process was flexible and codes were assigned both to concepts in the literature and to concepts gathered from the students' answers.

The codification was for 'sentences' of possible answers to the question about the scenario rather than for single words. For coding, focus was on the values underlying the students' attitudes in their answers to the questions.

This process will be explained in more detail with an illustration from a sample scenario in the BVI. The case included in Scenario 4 on 'genetically modified organisms – agricultural biotechnology and economy' in the BVI (Version 1) is given below:

"Consider you are the president of a country which is the primary producer of tomatoes in the world. Tomatoes you export usually go bad on the way before they even reach their destinations. A scientist claims it is possible to lengthen the shelf life of tomatoes by modifying its genetic structure.

Would you support production of genetically modified tomatoes, why?"

Prior to content analysis, possible answers to the question about the scenario were coded by the researchers taking relevant literature and ethical principles into account.

The coding scheme is given below:

I think that genetically modified organisms (GMOs) are harmful to human health.

I think that natural products are healthier and taste better.

I am against such research because of my religious belief.

I think that GMOs pose a risk for the environment.

I think that GMOs are not harmful to human health.

What matters is the national economy.

If there is such a technology it should be made use of.

These codes were transferred to an Excel table for ease of analysis by the researchers. The table had an extra column (other) for codes for students' answers and content analysis was proceeded to. Codes for students' answers following the content analysis are presented below:

I think that, no matter for what reason, humans have no right to disturb nature's design.

I think that other technical solutions, like improving transport conditions, can be found for this problem.

I don't think that GMOs pose a risk for the environment.

I think various studies should be conducted before starting the production of genetically modified tomatoes. I would permit the production of genetically modified tomatoes if the results of these studies indicate that they do not pose any risks for human health and the environment.

I would permit the production of genetically modified tomatoes only after making necessary legal arrangements for them to be labeled as "Genetically modified".

In order to ensure the internal validity of the research, the students' answers were coded by three independent researchers. Upon completion of the coding, a fourth researcher randomly chose 10% of the data and studied the coding tables for consistency with the content analysis. The results of the content analysis were found to be 90% consistent.

When coding for all scenarios and consistency analyses were complete, these codes were stated as possible answers to the questions about the scenarios. These answers were revised according to the question and all answers in the BVI were grouped as:

No, because

Yes, because

I'm not sure, because

After all possible answers were grouped in the multiple-choice format above, the following two choices were added in a standard way to each scenario so as to allow for unforeseen student responses to be also used in the study:

I don't have enough knowledge on this subject to make a choice.

None of the above statements reflects my point of view. In my point of view,……

In this way we included a scenario related to each one of the topics and the questions are out in context. The possible answers are presented in multiple-choice format as in the sample in Box 1.

BOX 1:

Scenario 4: Consider you are the president of a country which is the primary producer of tomatoes in the world. Tomatoes you export usually go bad on the way before they even reach their destinations. A scientist claims it is possible to lengthen the shelf life of tomatoes by modifying its genetic structure.

Would you support production of genetically modified tomatoes, why?

No. Because

A) I think that genetically modified organisms (GMOs) are harmful to human health.

B) I think that natural products are healthier and taste better.

C) I am against such research because of my religious belief.

D) I think that GMOs pose a risk for the environment.

E) I think that, no matter for what reason, humans have no right to disturb nature's design.

F) I think that other technical solutions, like improving transport conditions, can be found for this problem.

Yes. Because

F) I think that GMOs are not harmful to human health.

G) I don't think that GMOs pose a risk for the environment.

H) What matters is the national economy.

I) If there is such a technology it should be made use of.

I am not sure. Because

J) I think various studies should be conducted before starting the production of genetically modified tomatoes. I would permit the production of genetically modified tomatoes if the results of these studies indicate that they do not pose any risks for human health and the environment.

K) I would permit the production of genetically modified tomatoes only after making necessary legal arrangements for them to be labeled as "Genetically modified".

L) I don't have enough knowledge on this subject to make a choice.

M) None of the above statements reflects my point of view. In my point of view, ……

Following the formation of the multiple-choice structure of the BVI, each response in it was examined by taking into account the nature and development objectives of the BVI and the ethical values it represents. These were grouped according to the nine themes explained below.

Utilitarian Approach

Rights Approach

Justice Approach

Virtue Approach

Normative Approach

Theological Approach

Preference for the Natural

Science and Technology Based Approach

Belief in Humans' Superiority to Other Living Beings

In determining these suprathemes, the Principles of Biomedical Ethics (i.e. usefulness, harmlessness, respect for autonomy, and justice) were laid out by Beauchamp and Childress (1994) and the Basic Ethical Approaches (i.e. utilitarian, rights, justice, goodness of all, virtue) used in ethical decision-making processes and in ethical standard-setting (Velasquez *et al.*, 2009) were taken as a guide.

In line with the topics set for the BVI, the themes used in individual decision-making processes are described as follows:

The Utilitarian Approach is concerned with doing the most good and causing the least harm for all those concerned – customers, employees, shareholders, the community, and the environment. It tries both to increase the good done and to reduce the harm caused.

The Rights Approach is concerned with the duty to respect others' rights.

The Justice Approach is concerned with the idea that all equals should be treated equally.

The Virtue Approach: Honesty, courage, compassion, generosity, tolerance, love, fidelity, self-control, and prudence are all examples of virtue. The virtue approach asks of any action "What kind of person will I become if I do this?" or "Is this action consistent with my acting at my best?"

The Normative Approach sets forth specific conditions that label actions as ethical or unethical.

The Theological Approach deals with actions motivated by religious rules.

Preference for the Natural: In this approach, people prefer natural things. The important issue is not to pose a risk for the environment or the order of the nature.

The Science and Technology Based Approach deals with scientific developments. According to this approach, science and technology contribute to human life.

Belief in Humans' Superiority to Other Living Beings: This anthropocentric approach assumes that human beings are superior to other living beings which are merely at the service of humans.

The classification of the responses to all scenarios in the inventory according to these suprathemes was made by two researchers. The thematic classification of the reponses for the scenarios is shown in Table 2.

Step 4

After the multiple-choice structure of the inventory was formed, the whole inventory was reviewed by an academician from the Department of Turkish Language Teaching, and checked for any language, expression, or spelling mistakes (Version 2). Later on, semi-structured interviews were conducted at a school from the sample about the intelligibility of the inventory. In these interviews, five students were asked their opinions on each scenario. They were first asked to carefully read the scenario on the inventory form and answer the question. The researcher later read out the relevant scenario and the answer choices. At each stage, the student was asked if any item was unintelligible or could have been expressed better. Each interview was recorded and subsequently analyzed. The scenarios and the responses were reorganized according to the data gathered from the analysis of the recordings. The inventory was later reviewed by a Turkish language expert. Amendments were made in light of the expert opinions and the inventory was finalized. The complete 'Bioethical Values Inventory (BVI)' can be found in Turkish in Kesin-Samanci (2009).

CONCLUSION AND DISCUSSION

The BVI aims to reveal secondary school pupils' values in their decision-making on ethical problems resulting from biological sciences and certain applications of genetic technologies, within the framework of 'bioethics' and 'bioethics education' and the value problems caused by biological sciences.

While the scale development processes used by Aikenhead & Ryan (1992) and Saez, Nino, & Carretero (2008) were taken as models in this inventory development process, it can be said to be a quite original process considering the 'BVI' as a whole and the techniques used.

In terms of the development process, another feature of the 'BVI' that makes it diferent from other inventories in this field is the methodology used in the development of its multiple-choice format. Traditional attitude assessment inventories involve presenting students with statements from a pool formed by the researchers. The students are then expected to agree or disagree with the statements on a 3 or 5 Likert scale (Aikenhead & Ryan, 1992). The BVI includes experimentally developed multiple choice items carefully designed taking into account both the literature and the answer paragraphs written by the students themselves in terms of intelligibility. They are also quite significant in that they reflect possible answers from various socio-economic groups. So, BVI may minimize ambiguity problems. In addition BVI considers 'why' the students agree or disagree with the statements designed by the researchers and the reasons underlying their responses. Bioethics education primarily aims to allow students to discover their own values regarding existing ethical problems, to question and evaluate them in light of universal ethical values, and to gain decision-making skills in problem-solving processes. From this point of view the BVI reveals the students' values in their decision-making processes, considering the objectives and nature of bioethics education. With its structure, the BVI can be used in large-scale studies.

As has been explained so far, the inventory development model selected in this research and the resulting inventory have many educational strengths.

Another strength is the diligence shown in the validity and reliability studies, which is not often stressed in inventory development processes in bioethics. Validity and reliability strategies were carefully followed in this study which mostly used qualitative research methodology. Considering statistical analyses of the reliability of inventories, the weakest point of the present inventory is perhaps the lack of a numerical scoring key and the consequent inability to do statistical analyses of reliability. However, considering the inventory development process, the strategies followed in the qualitative research methodology are the evidence of the validity and the reliability of our inventory. Just like the BVI, the VOSTS (Aikenhead & Ryan, 1992) also has no mumerical scoring key but is commonly used worldwide, which supports our case above.

In conclusion, by using the BVI, the ethical values affecting individual decisions in ethical debates caused by biological sciences can be revealed with greater ease. At the same time, this inventory can be utilized as an educational material in argumentation-based tackling of socio-scientific issues. The teachers can do the 'bioethics education' through the scenarios involving the topics of the scale while the students understand the relevant scientific facts, notice the ethical dilemmas in the scenarios, and realize the conflicting views.

REFERENCES

Aikenhead, G. S. (1988). An analysis of four ways of assessing student beliefs about STS topics. *Journal of Reserach in Science Teaching, 25*(8), 607-627. doi:10.1002/tea.3660250802

Aikenhead, G. S., & Ryan, A. G. (1992). The development of a new instrument:"views on science-technology-society" (VOSTS). *Science Education, 76*(5), 477-491. doi: 10.1002/sce.3730760503

Beauchamp, T. L., & Childress, J. F. (1994). *Principles of Biomedical Ethics*. Newyork: Oxford University Press.

Cavanagh, H., Hood, J., & Wilkinson, J. (2005). Riverina high school students' views of biotechnology. *Electronic Journal of Biotechnology, 8*(2), 121–127.

Chen, S. Y., & Raffan, J. (1999). Biotechnology: Students knowledge and attitudes in the U.K. and Taiwan. *Journal of Biological Education, 34*(1), 17–23. doi:10.1080/00219266.1999.9655678

Dawson, V. M. (1999). Bioethics education in the science curriculum: evaluation of strategies for effective and meaningful implementation. Unpublished Doctoral Dissertation, Science and Mathematics Education Centre, Curtin University of Technology, Austarlia.

Dawson, V. M. (2007). An exploration of high school (12-17 year old) students' understandings of, and attitudes towards biotechnology processes, *Research in Science Education, 37*, 59-73. doi: 10.1007/s11165-006-9016-7

Dawson, V., & Soames, C. (2006). The effect of biotechnology education on Australian high school students' understandings and attitudes about biotechnology processes, *Research in Science & Technological Education, 24*(2), 183-198. doi:10.1080/02635140600811569

Doğanay, A. (2006). Değerler eğitimi., Cemil Öztürk (Editör). Hayat Bilgisi ve Sosyal Bilgiler Öğretimi. Ankara: Pegem A Yayıncılık.

Güngör, E. (1993). Değerler psikolojisi. Hollanda-Türk Akademisyenler Birliği Vakfı Yayınları, Amsterdam.

Keskin-Samanci, N. (2009). Biyoetik eğitimi kapsamında ortaöğretim öğrencilerine yönelik "biyoetik değer envanteri" geliştirilmesi (Development of "bioethical values instrument" for secondary education students within bioethics education) (Doctoral thesis, Gazi Universitesi Eğitim Bilimleri Enstitüsü, Ankara, Turkey). Retrieved from http://www.acikarsiv.gazi.edu.tr/index.php?menu=2&secim=10&YayinBIK=5864#.

Kormondy, E. J. (1990). Ethics and values in the biology classroom, *The American Biology Teacher, 52*(7), 403-407.

Lederman, N. G. & O'Malley, M. (1990). Students' perceptions of tentativeness in science: Development, use, and sources of change. *Science Education, 74*(2), 225-239. doi: 10.1002/sce.3730740207

Macer, D. (2008). *Moral games for teaching bioethics*, UNESCO Chair in Bioethics Office. The University of Haifa, Israel.

Macer, D., Asada, Y., Tsuzuki, M., Akiyama, S., & Macer, N. (1996). *Bioethics in high schools in Australia, Japan and New Zealand*. Christchurch, NZ: Eubiouts Ethics Institute.

Özgüven, I. E. (1999). *Psikolojik Testler*. Üçüncü Baskı. Ankara: PDREM.

Reich, W. T. (1995). *Encyclopedia of Bioethics*, 1-5, New York, NY: Simon and Schuster MacMillan.

Rest, J. (1979). *Development in judging moral issues*. Minneapolis: University of Minnesota Pres.

Rest, J., Narvaez, D., Thoma, S. & Bebeau, S. (1999). DIT2: Devising and testing a revised instrument of moral Judgement, *Journal of Educational Psychology, 91*(4), 644-659. doi:10.1037/0022-0663.91.4.644

Sadler, T. D., & Donnelly, L. A. (2006). Socioscientific argumentation: the effects of content knowledge and morality, *International Journal of Science Education, 28*(12), 1463-1488. doi: 10.1080/09500690600708717

Saez, M. J., Nino, A. G., & Carretero, A. (2008). Matching Society Values: Students' views of biotechnology, *International Journal of Science Education, 30*(2), 167- 183. doi:10.1080/09500690601152386

Taşar, M. F. (2006). Probing preservice teachers' understandings of scientific knowledge bu using a vignette in conjunction with a paper and pencil test. *Eurasia Journal of Mathematics, Science and Technology Education, 2*(1), 53-70.

Taylor, P. W. (1975). *Principles of Ethics: An introduction*. Bemont, Ca: Wadsworth Publishing Company.

Velasquez, M., Moberg, D., Meyer, M. J., Shanks, T., McLean, M., DeCosse, Andre, C. and Hanson, K. (2009). *A Framework for thinking ethically*, Markkula Center for Applied Ethics at Santa Clara University. Retriwed from http://www.scu.edu/ethics/practicing/desicion/framework.html

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