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SOCIOSCIENTIFIC ISSUES AND PRE-SERVICE SCIENCE TEACHERS' BIOETHICAL VALUES

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Abstract

Considering the recent rapid developments in science and technology, it is quite important for individuals to be able to make decisions about their own future and their children's future for the society in which they live and to know how to establish a balance of risk and decision. For this reason, teacher training programs should be planned to internalize pre-service teachers' awareness of responsibility. Regarding this point, the development of pre-service science teachers' bioethical values was examined on a class level basis using survey research. Research sample consisted total of 286 pre-service teachers of Science Teacher Training Program. Bioethical Values Questionnaire was applied to determine pre-service teachers' bioethical values. As a result of analyses, it was determined that pre-service teachers' bioethical values increased according to their class levels they attended. It was stated that pre-service science teachers' bioethical values related to sub-dimensions of "Benefits of Biotechnology Applications", "Science and Ethics", "Reproductive Technologies and Cloning" and "Control of Genetic Interventions" were increased based on participants' class levels. In addition, the results of the study revealed that pre-service teachers also had some concerns about the benefits of biotechnology applications.
Keywords: *bioethics level, science teaching, pre-service science teachers, socio-scientific issues*

Introduction

Human beings have been conducting studies to either find answers to their needs or to understand what is going on around them and to satisfy their sense of curiosity since the day of existence. Humans who explore, find as they investigate, and wonder more as they find out have altered living and inanimate beings around them to meet their needs. However, as with any developments and progress, advances in the field of science and technology have brought benefits as well as risk and will continue to do so. Especially rapid advances in genetic applications have brought along new complex ethical and political issues. For this reason, developments in these areas should be evaluated with their benefits and possible harms within the framework of scientific ethics and from an objective point of view.

It is known that science is shaped in line with the needs of societies and society is shaped in line with scientific developments, and today the social interest and need for scientific knowledge are increasing rapidly. Issues such as climate change, cloning, AIDS, armaments, genetically modified organisms, and nuclear energy are subjects of interest to society, and they have brought along several important issues. These problems are usually caused by social problems that involve dilemmas and are connected to science in theoretical and practical ways. Biotechnology-related issues including natural sciences such as genetics, molecular biology, microbiology, physiology, and biochemistry, as well as technologies that benefit from engineering disciplines such as mechanical engineering and computer engineering can be classified as "socio-scientific issues". These issues are not only associated with science but also controversial social issues that can be addressed from various perspectives, have no simple

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results, and often include moral and ethical rules (Sadler & Zeidler, 2004), and they define social dilemmas in conceptual, methodical, and technological ways concerning science (Sadler, 2004). In an environment where information is booming and information is spreading rapidly, it is crucial to question information and internalize it from a critical point of view (Kahyaoğlu & Çetin, 2015). Socio-scientific issues, which are inherently controversial, include the evaluation of an individual's moral judgment and ethical concerns in deciding on the resolution of dilemmas (Zeidler & Nichols, 2009). Individuals who are conscious of these issues are aware of the medical, ethical, legal, and psychological factors that play a role in decision-making processes and are aware of the effect of these factors on decision-making processes (Van der Zande, 2009). Today, it is also important to educate all individuals with all such awareness. Studies conducted on socio-scientific issues have revealed that frequent discussion of these issues in classroom environment helps students to increase their awareness of these issues and improves their decision-making skills, as well as offers a great contribution to their science literacy (Driver et al., 2000; Kolstø, 2001; Sadler & Zeidler, 2005a; Topçu, 2010). For this reason, some educators have advocated the inclusion of socio-scientific issues in the curriculum with reference to their positive impact on the training of responsible individuals who can apply scientific knowledge and skills (Driver et al., 2000; Kolstø, 2001a; Zeidler, 1984).

Research Problem

Controversial subjects of social importance related to science were referred to as socio-scientific issues by Sadler (2009) and as "socially acute questions" by Simonneaux (2013). In the years to come, students should be aware of socio-scientific issues, as well as important skills such as discussion, reasoning, and decision-making, as well as social, political, and scientific perspectives. They also gain awareness about mutual relations. In recent years, especially socio-scientific issues have been also included in science education to improve scientific literacy (YÖK, 2018). In this way, students will be able to learn about socio-scientific issues that fall within the scope of the community's area of discussion and will be able to develop their own views in a classroom environment supported by class discussions and express their views (Dawson & Shibeci, 2003).

In order for the successful implementation of teaching based on socio-scientific issues, it is important for teachers to be aware of the possible political, economic, and moral dimensions on the subject. Teachers should have sufficient knowledge and awareness to direct their students to resources that will lead them to new knowledge and perceptions. Successful teachers allow their students to become experts in understanding scientific and social aspects of a particular topic and share knowledge, think about alternative perspectives, and develop consistent discussions. During classroom applications, students reach out to existing scientific information on socio-scientific issues and analyze the data on the subject and discuss them from a critical point of view. Students who are also familiar with the ethical dimensions of these subjects develop their high-level thinking skills through these practices (Presley et al., 2013). Thus, it will be possible for students to create their own scientific ethical perceptions. Teachers are the ones that will provide basic knowledge and ethical decision-making ability to enable social literacy and awareness. In order for teachers to raise qualified individuals who can adapt to the changing world, teachers themselves must possess such knowledge and skills in the first place and teacher education programs should be expected to provide these knowledge and skills to the teacher candidates. In this study, bioethical values of pre-service teachers in science teacher education program were explored based on their class levels.

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Research Focus

With the 21st century, humanity is looking at a rapidly changing uncertain future. The explosion of advances in biotechnology, including the Human Genome Project, has often occurred with limited respect for political, moral, and social impacts. These developments provide comfort and benefit to humanity, but also raise concerns about its ethical and moral dimensions. Therefore, people of all ages should be able to make ethical decisions about science, technology, and products (Macer, 2004). Society needs to be able to critically assess the potential benefits and risks of scientific developments (Dawson, 2001; Dawson & Schibeci, 2003). Given these advances in science and technology, it is very important that each community can make decisions about their own future and children's future, and know-how to establish a balance of risk and decision (Macer, 2008). Bioethics, which includes ethical discussions on biological sciences, appears where there is a danger to both the lives of human beings and other beings, as well as the freedom and dignity of human beings due to modern technologies results of which are unpredictable in scientific research. Rather than acting irresponsibly by applying what is possible and feasible thanks to technology, it has become a necessity to draw the boundaries of technological intervention by considering the interests of the public (Pieper, 1999).

In bioethics questioning, we can discuss what framework we can frame "desire to know" that motivates humans and that biotechnology applications will offer us. What will be the price of technology's contributions to humanity? Is society entitled to decide what is right or wrong in these matters? If so, is it possible to distinguish right from wrong? On what basis, if possible? For example, how specific are the limits of playing with the human genome? Will human beings know where and when to stop? Do human beings have the right to actualize everything that can be done using the possibilities of technology? Or should there be a "reasonable" limit to what can be done? In determining this "acceptable" line, of course, our "own" ethical values, norms, ethical problem-solving capabilities will guide us.

Bioethics deals with the development of people's capacity to judge, negotiate and imagine a subject rather than what they should or should not do about it. The fact that people living together as a social entity act using bioethical principles increases the possibilities of living together (Erol Işık, 2003). Chapman (1999) described modern biomedical science as "unprecedented options". Will society have ethical and legal means to handle these elections? Who is going to lead this debate? To answer these questions, educators have agreed that individuals who have to make decisions that directly or indirectly affect the future of society should use information morally, religiously, socially, and culturally and become conscious individuals (Yager & Hofstein, 1986; Yager & Penick, 1988; Samancı, 2010). Therefore, it is necessary to give students the opportunity to realize the social and ethical consequences of biotechnology. Future scientists, politicians, lawyers, business leaders, etc., will be involved in many different fields and will have to make direct decisions about the use of biotechnology. It is equally important that the group, often referred to as "the public", is well informed so that they can participate in the decision-making process. Because of a lack of understanding about biotechnology issues by society, alienation, fear, and anger can also spread to the world of science. It is a well-known fact that society influences scientific studies. Therefore, science teachers are obligated to help students develop their ability to assess ethical problems arising from biotechnology (Lock & Miles, 1993; Lock et al., 1995).

Research Aim and Research Questions

One of the foundations that constitute and strengthen societies is that each individual who constitutes that society fulfills his responsibilities (Doğan, 2002). For this reason, teacher training programs should be planned to internalize pre-service teachers' awareness of

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responsibility. Given teachers' responsibilities, it is important that pre-service teachers have the ability to make bioethical decisions. In addition, it is important to determine the values and skills that teachers take into account in the decision-making process. Because an individual who encounters a bioethical problem makes a decision based on knowledge, skills, and value judgments he has in this process. For this reason, this study aimed to explore pre-service science teachers' bioethics values on socio-scientific issues according to their class level. The research question was as below:

How did the pre-service teachers' bioethical values change according to their study year?

Research Methodology

General Background

The aim of this study is to evaluate pre-service science teachers based on bioethical values. Therefore, survey approach was used for the part where quantitative research method was applied. The simple descriptive survey approach is one-shot survey for the purpose of describing the characteristics of a sample at one point in time apart from the other approaches of survey research, namely cross-sectional and longitudinal (Mertens, 2014, p. 242). In this research, simple descriptive survey is conducted for the purpose of describing the bioethical values of science pre-service science teachers.

Sample

The population of this study consists of 600 preservice science teachers who continue their education in a state university Science Teacher Training Program in the 2016-2017 academic year. This research sample consisted of 286 pre-service teachers, attending Science Teacher Education Program at a state university in one of the cities located on the west part of Turkey, and who were willing to participate in the study. In order to represent a population of 600 people, the sample size to be selected should not be less than 230 ($n= N\ t^2\ p\ q/\ d^2(N-1)+ t^2\ p\ q$). Therefore, it can be said that the sample of the study represents the population. Of these teachers, 79 were first year student; 70 were second year student; 66 were third year student, and 71 were fourth year student. In the science teacher training program, field courses and professional knowledge courses, and general culture lessons must have taken by the students. In this way, pre-service science teachers who have completed their education can organize lessons by combining their field knowledge with pedagogical knowledge. The courses that pre-service teachers must take during the science teacher training program are presented in Table 1.

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Table 1
Courses at Primary Science Teacher Education Program

	First Year	Second Year	Third Year	Fourth Year	Total Credit
Field courses	• Physics I-II, • Laboratory Courses I-II (Physics) • Chemistry I-II, • Laboratory Courses I-II (Chemistry) • Mathematics I-II	• Biology I-II, • Laboratory Courses I-II (Biology) • Physics III, • Laboratory Courses III (Physics) • Chemistry III- IV • Introduction to Modern Physics	• Human Anatomy and Physiology • Special Topics in Physics • Special Topics in Chemistry • Statistics • Laboratory Courses I-II (Science) • Genetics and Biotechnology • Nature of Science and History of Science, • Earth Science • Environmental Science	• Special Topics in Biology, • Astronomy • Evolution • Elective Course I-II • Special Methods of Science Teaching II	84
Professional knowledge	• Introduction to Teaching Profession, • Educational Psychology	• Science Technology Program and Planning • Principles and Methods of Education	• Instructional Technologies and Material Designing • Special Methods of Science Teaching I • Assessment and Evaluation	• Special Education • Teaching Practice • Turkish Education System and School Management • Counselling • Classroom Management • School Experience	38
General Culture	• Turkish, Ataturk's Principles I-II, • Turkish I-II	• Computer I- II, • Foreign Language I-II, • Elective Course	• Scientific Research Methods, • Turkish Education History, • Community Service Applications	• Elective Course	30
Total Credit	42	40	39	32	

Reference: HEI (2007b, s. 210). Teacher training and education faculties (1982-2007). Ankara

Instrument and Procedures

Bioethical Values Questionnaire (BVQ)

In this study, the existing scales and questionnaire primarily developed and adapted for bioethics studies and that can be reached in domestic and international field literature, were examined. Unfortunately, enough information was not found about the development processes of the existing scales, their validity, reliability analyses and results. Therefore, to address this deficiency, Bioethical Values Questionnaire developed by Silva et al. (2011), who focused on bioethics values different from existing scales found in the international field literature, was applied with Turkish adaption by researchers (2016). In this study, BVQ was used to determine

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levels of pre-service teachers' bioethical values. BVQ is 4-point Likert Scale consisting of 18 items, which includes choices of I Strictly Agree, I Agree, I Disagree, I Absolutely Disagree. The undecided choice was removed from the questionnaire by developers because they wanted to prevent the choice not expressing an opinion. Total score achieved from the scale ranges from 18 to 72. BVQ has 4 dimensions: "Benefits of Biotechnology Applications", "Science and Ethics", "Reproductive Technologies and Cloning" and "Control of Genetic Interventions". Table 2 shows the names of sub-dimensions of the scale, descriptions of sub-dimensions, sample elements, and Cronbach alpha coefficients.

Table 2
Scale Names, Scale Definitions, Sample Items and Cronbach Alpha Coefficients

Scale	Definition of scale	Sample item	Cronbach α
Benefits of Biotechnology Applications	Treatment possibilities offered by biotechnology research	New therapeutic cloning techniques will provide treatment for many diseases.	.82
Science and Ethics	Social awareness of genetic engineering studies	I do not think that discussions on the use of embryonic stem cells in therapeutic studies are related to interpretations based on moral values.	.62
Reproductive Technologies and Cloning	Attitudes about human cloning and reproductive technologies	I am in favor of cloning humans if they will be people who are immune to diseases that arise.	.70
Control of Genetic Interventions	Results from genetic interventions and effects of genetic manipulation	I believe we can solve ethical problems by labeling genetically modified foods and giving the public the option of not consuming them or not.	.49

Benefits of Biotechnology Applications sub-dimension of scale consists of five items (item 1, item 9, item 10, item 11 and item 13); Science and Ethics sub-dimension consists of four items (item 3, item 4, item 7 and item 16); Reproductive Technologies and Cloning sub-dimension consists of three substances (item 15, item 17 and item 18); and Control of Genetic Interventions consists of six items (item 2, item 5, item 6, item 8, item 12 and item 14). To conduct an analysis according to Bioethical Values Questionnaire, the numerical values given from 1 to 4 were converted into score ranges, and levels of bioethical values were established. Score range coefficient, calculated according to the n-1/n ratio by subtracting the lowest value from the highest value and dividing the result by the highest value, was found to be 0.75 (Büyüköztürk, 2017); and according to this range, 1.00-1.75 was considered as "very low"; 1.76-2.5 was considered as "low"; 2.51-3.25 was considered as "moderate"; 3.26-4.00 was considered "high".

Data Analysis

Bioethical Values Questionnaire was applied to pre-service teachers under the guidance of the researcher. All the pre-service science teachers who participated in the study were informed about the purpose of the study and the rights of study participants. Pre-service science teachers were invited to participate voluntarily. The collected data were organized and stored electronically.

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Data from the Bioethical Values Questionnaire were evaluated using different analysis methods in the SPSS 23.0 package software. First, frequency and percentage distribution of data were examined using descriptive statistical tests. 'Single group Kolmogorov-Smirnov Test' was applied primarily to determine whether data sets demonstrated normal distribution with a view to choose between parametric and non-parametric tests to be used in the evaluation of the data obtained from the research. In cases where variances were not homogeneous, Kruskal Wallis *H*-Test, which is a nonparametric test, was used to test the significance of the difference observed between groups' scores from a variable. According to the Kruskal Wallis *H*-Test results, the Mann-Whitney *U* test was applied in groups of two to determine among which variables the difference between values was observed in groups with significant differences.

Research Results

First, value trends of the participants were determined by applying frequency analysis on each item in Bioethical Values Questionnaire. The results are presented below:

Benefits of Biotechnology Applications

The first item of this sub-dimension is related to the use of embryonic stem cells in therapeutic research. While research findings revealed that very few of pre-service teachers did not support the use of stem cells in therapeutic research (first year students by 1.4%; second year students by 1.4%; third year students by 4.5%; fourth year students by 5.6%); 35.4% of first year students, 51.4% of second year students, 36.5% of third year students and 63.4% of fourth year students thought that the use of embryonic stem cells in therapeutic studies was absolutely necessary. The second item of Benefits of Biotechnology Applications sub-dimension is the use of new cloning techniques in the treatment of diseases, while research findings revealed that the first year students (10.1%) and second year students (1.4%) did not support the use of new cloning techniques in disease treatment; 68.4% of first year students, 54.3% of second year students, 53% of third year students and 31% of fourth year students thought that new therapeutic cloning techniques would provide the treatment for many diseases. The third item of the sub-dimension was related to the protection of umbilical cord blood of newborns, while 59.5% of first year students, 45.7% of second year students, 48.5% of third year students, and 19.7% of fourth year students gave the answer "I agree"; it was observed that the number of pre-service science teachers who answered "I absolutely agree" increased on a class level basis. In addition, "I absolutely agree" choice for this item was the most preferred expression. This means that pre-service teachers support the creation of private banks to protect umbilical cord blood of newborns. It relates to the relationship of scientific developments in sub-dimension with social developments, 35.4% of first year students, 57.1% of second year students, 40.9% of third year students, and 57.7% of fourth year students responded to this article with "I absolutely agree". Among the answers given to this article, the most preferred options were "I absolutely agree" and "I agree". This shows that pre-service teachers think that scientific developments constitute social developments. The latest item of Benefits of Biotechnology Applications sub-dimension is related to the studies and treatment opportunities in the field of embryonic stem cells, while 1.3% of first year students and 1.4% of second year students gave the answer "I absolutely agree", the most preferred answer was "I agree"; 27.8% of first year students, 48.6% of second year students, 39.4% of third year students and 63.4% of fourth year students strongly agreed that studies in the field of embryonic stem cells would provide new treatment opportunities to reduce the suffering of people suffering from helpless diseases.

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Science and Ethics

The first item of the second sub-dimension of the scale, "Science and Ethics", is related to the intervention of ethical and moral values of a society in stem cell research, and only 1.3% of first year students, 4.5% of third year students, and 4.2% of fourth year students believed that the ethical and moral values of society should not interfere with embryonic stem cell research. 31.6% of first year students, 50% of second year students, 69.7% of third year students, and 78.9% of fourth year students responded "I disagree" to this item of the scale, and they emphasized that ethical and moral values of society should interfere with embryonic stem cell research. The second item of Science and Ethics sub-dimension is related to the relationship between stem cell research and morality. 39.2% of first year students, 40% of second year students, 59.1% of third year students, and 50.7% of fourth year students thought that moral comments on the use of stem cells were related in therapeutic studies; 5.1% of first year students, 1.4% of second year students, 6.1% of third year students and 14.1% of fourth year students thought that discussions on the issue of stem cells use in therapeutic studies were not associated with moral comments. The third item in Science and Ethics sub-dimension is related to the place of ethics in science. According to research findings, while some of pre-service teachers certainly agreed that there was no room for ethics in science because scientists should be autonomous (first year students by 3.8%; second year students by 4.3%; third year students by 12.1%; fourth year students by 25.4%); 53.2% of first year students, 28.6% of second year students and 10.6% of third year students thought that scientists should not be autonomous. The final article of Science and Ethics sub-dimension is related to the impact of scientists' personal values on their work. Most pre-service teachers (first year students by 20.3%; second year students by 35.7%; third year students by 48.5%; fourth year students by 42.3%) thought that scientists were impressed by the personal value of their work; a substantial number of pre-service teachers (first year students by 40.5%; second year students by 34.3%; third year students 28.8%; fourth year students by 23.9%) thought that scientists were not affected by the personal value of their work. The number of pre-service teachers who supported and did not support this item was almost equal.

Reproductive Technologies and Cloning

The first item of "Reproductive Technologies and Cloning" sub-dimension of Bioethical Values Questionnaire is related to pre-embryo selection in test tube baby techniques. According to the research findings, 13.9% of first year students, 24.3% of second year students, 7.6% of third year students, and 32.4% of fourth year students supported pre-embryo selection because of the possibility of allowing people to choose their children's physical intellectual characters in the future. In addition, a growing number of pre-service teachers on a class basis (first year students by 15.2%; second year students by 38.6%; third year students by 53.0%; fourth year students by 52.1%) did not support pre-embryo selection from test-tube baby techniques. The second item in Reproductive Technologies and Cloning sub-dimension is related to human cloning. The number of pre-service teachers who supported this item (I agree, I strongly agree) and did not support (I disagree, I strongly disagree) was almost equal. While 29.1% of pre-service teachers who expressed their opinion as "I absolutely disagree" in this item were first year students, 18.6% of them were second year students, 9.1% of them were third year students, and 1.4% of them were fourth year students, and they did not support human cloning under any circumstances. The third item of this sub-dimension is related to the selection of zygote before transfer to the womb to eliminate undesirable properties. With regard to this item, 17.7% of first year students, 22% of second year students, 31% of third year students, and 39% of fourth year students indicated that they did not support the idea of selecting zygote in IVF clinics before transferred to mother's uterus. Examining the findings related to the items of this sub-dimension in general, it can be said that pre-service teachers had some concerns about reproductive technologies and cloning.

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Control of Genetic Interventions

The first item in "Control of Genetic Interventions" dimension, the last sub-dimension of Bioethical Values Questionnaire, is related to genetically modified foods. Most pre-service teachers (first year students by 32.9%; second year students by 55.7%; third year students by 74.2%; fourth year students by 83.1%) did not think that labeling genetically modified foods and providing the public with the option of not consuming them would not solve ethical problems on this issue. The second item of this sub-dimension is related to the drafting of an ethical and moral regulation for biotechnological problems, and the vast majority of pre-service teachers (first year students by 60.7%; second year students by 64.3%; by 74.2%; fourth year students by 74.6%) believed that ethical and moral regulation should be regulated for biotechnological problems. In addition, there were pre-service teachers thinking that genetic interventions were developed to improve the quality of life. 43% of first year students, 32.9% of second year students, 25.8% of third year students, 43.7% of fourth year students expressed their opinion that "I absolutely agree" with this item. 43.0% of first year students, 51.4% of second year students, 62.1% of third year students, and 62.1% of fourth year students gave the answer, "I strongly agree" to the fourth item of Genetic Interventions sub-dimension related to the use of technology, pre-service teachers expressed their opinions that technology could not be referred to as good or bad, but it should be noted how to use technology. The fifth item of this sub-dimension is related to the therapeutic cloning for organ and stem cell production, and the number of pre-service teachers who supported cloning for therapeutic purposes was considerably higher than those who did not support it. 22.8% of first year students, 48.6% of second year students, 39.4% of third year students, and 52.1% of fourth year students strictly supported therapeutic purpose cloning to ensure the production of organs and stem cells. The last item in Control of Genetic Interventions sub-dimension is related to the drugs tested on living things. While 16.5% of first year students, 35.7% of second year students, 51.5% of third year students, 80.3% of fourth year students were keen to use untested drugs on another living creature; 2.5% of first year students, 5.7% of second year students, 4.5% of third year students, and 9.9% of fourth year students were strongly opposed to this idea.

In addition to the percentage distributions obtained as a result of all these descriptive analyses, the results obtained from averages of the answers given by pre-service science teachers to Bioethical Values Questionnaire are also presented in Table 3. When arithmetic averages are examined based on class level, it is stated that the average of pre-service teachers' bioethical values increased from first year students to senior.

Table 3
Descriptive Statistical Values regarding Bioethical Values Questionnaire

	Study Year	*N*	Minimum	Maximum	$\overline{X}$	*SD*	Bioethical Value level
Bioethical Value	1	79	1.79	3.42	2.48	0.32	Low
	2	70	2.09	3.33	2.71	0.27	Moderate
	3	66	2.26	3.19	2.73	0.19	Moderate
	4	71	2.32	3.54	2.92	0.24	Moderate

According to Table 3, Bioethical Values Questionnaire score average of first year students is 2.48. This median indicates that first year students are at "low" levels. The average score scoring of the second year students, third year students and fourth year students was found

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as 2.71, 2.73 and 2.92, respectively, indicating that pre-service teachers' bioethical values are "moderate" and that the average value increases by class.

Considering average scores given to the lower dimensions of Bioethics Value Questionnaire on a class basis, it is seen that, as class levels increase, the averages increase despite not at the desired level (Table 4). Looking at the increase in score averages by class basis according to the lower dimensions, the maximum increase was in the sub-dimension of science and ethics with a value of 0.58. Nevertheless, this increase did not take out the average scoring in the science and ethical sub-dimension from the "low" category.

Table 4

Descriptive Statistical Values by Classes for Lower Dimensions of Bioethics Value Scale

	Study Year	*N*	Minimum	Maximum	$\overline{X}$	*SD*	Bioethical Value level
Benefits of Biotechnology Applications	1	79	2.00	4.00	3.19	0.35	Moderate
	2	70	2.20	4.00	3.38	0.42	High
	3	66	2.40	4.00	3.28	0.43	High
	4	71	2.40	4.00	3.51	0.42	High
Science and Ethics	1	79	1.00	3.75	2.01	0.61	Low
	2	70	1.00	3.25	2.15	0.49	Low
	3	66	1.75	3.50	2.39	0.41	Low
	4	71	1.50	4.00	2.59	0.47	Low
Reproductive Technologies and Cloning	1	79	1.00	4.00	2.18	0.80	Low
	2	70	1.00	4.00	2.53	0.81	Moderate
	3	66	1.00	4.00	2.44	0.57	Low
	4	71	1.67	4.00	2.66	0.67	Moderate
Control of Genetic Interventions	1	79	2.00	3.33	2.54	0.29	Moderate
	2	70	2.00	3.50	2.75	0.35	Moderate
	3	66	2.17	3.67	2.82	0.32	Moderate
	4	71	2.17	3.83	2.93	0.31	Moderate

After analyzing descriptive study, Kruskal Wallis *H* Test was conducted. In the analysis of the data, the Kruskal Wallis *H* Test, which is a nonparametric test, is used to test the significance of the difference observed between the scores of the variables of the groups. According to the results of the Kruskal Wallis *H*-Test, findings stated that there are significant differences between study years regarding sub-dimensions of BVQ. For this reason, the Mann-Whitney *U* test was applied in study years of two in order to determine among which variables the difference between values was seen in groups with significant differences. The findings are presented in Table 5.

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Table 5

Mann Whitney - U Test Analysis Results for Pre-service Science Teachers' Scores for Bioethical Values Questionnaire Sub-Dimensions as per their Class Levels

	Study Year	*N*	Order Average	χ^2	*p*	Difference
Benefits of Biotechnology Applications	1	79	112.93	26.333	.001	1-2, 1-3, 1-4
	2	70	152.21			
	3	66	132.62			
	4	71	179.04			
Science and Ethics	1	79	107.03	43.971	.001	1-3, 1-4, 2-3, 2-4,
	2	70	124.68			
	3	66	157.58			
	4	71	189.56			
Reproductive Technologies and Cloning	1	79	115.92	13.999	.001	1-2, 1-3, 1-4
	2	70	152.46			
	3	66	145.69			
	4	71	163.31			
Control of Genetic Interventions	1	79	93.35	50.065	.001	1-2, 1-3, 1-4, 2-4
	2	70	143.78			
	3	66	158.68			
	4	71	184.92			

Examining the Table 5, pre-service teachers' sub-dimension values for Bioethical Scale showed a significant difference at a level of 0.05 as per their class level ($\chi_{bio\ bba}^2 = 26.33$, $\chi_{bio\ se}^2 = 43.97$, $\chi_{bio\ utk}^2 = 13.99$, $\chi_{bio\ gmk}^2 = 50.06$; $p<.05$). Kruskall Wallis and Mann-Whitney *U* tests was used in groups of two to determine in which class levels this difference was seen. As a result of the analysis applied, the difference between first year students' scores and scores by second year students, third year students, and fourth year students was found to be significant in Benefits of Biotechnology Applications sub-dimension of Bioethical Values Questionnaire. In Science and Ethics sub-dimension, a significant difference was found between third year students and fourth year students' scores and first year students and second year students' scores. There was a significant difference between first year students' scores, and second year students, third year students, and fourth year students' scores obtained from in Reproductive Technologies and Cloning sub-dimension. A significant difference was found between first year students' scores and score averages achieved by pre-service teachers in all class levels in the Control of Genetic Interventions sub-dimension; as well as between scores achieved by second year students and fourth year students. Based on all these results from the research, it can be said that a four-year science teacher training program positively affects pre-service teachers' bioethics values.

Discussion

Today, science education curriculum includes science and technology together with social, cultural, environmental, political, and ethical elements. Therefore, it is important for students to be aware of their own values in science education and to be able to explain them consciously. Bioethics is also required to balance the relationship between the values required for science and society. In recent years, bioethics-related topics have gained considerable importance in science courses (Kolarova & Denev, 2012; HEI, 2018). Teachers who will provide students with basic knowledge and ethical decision-making skills need to be individuals with this knowledge and skills in the first place to educate their students as individuals with bioethical values. For this purpose, a change in pre-service teachers' bioethics values during the four-year teacher training

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program was examined. In this study, pre-service teachers' bioethical values were examined in four sub-dimensions.

Research findings showed that pre-service teachers had a high level of bioethical values towards "Benefits of Biotechnology Applications" sub-dimension, the first sub-dimension of the Bioethical Values Questionnaire. In addition, it was observed that pre-service teachers' average scores for this dimension increased during the teacher training program. Similarly, Turan and Koç (2012) indicated that pre-service teachers' attitude scores for biotechnology applications increased according to their class level. This increase based on class levels was explained by the researchers with the biology lessons taken by students in the teacher training program. Likewise, Gunter et al. (1998) stated in their work that upper-class students have a more positive attitude towards biotechnology applications (Cited by Turan & Koç, 2012). An increase in pre-service teachers' bioethical values in biotechnology applications such as use of embryonic stem cells, use of cloning techniques, necessity of protecting umbilical cord blood can be explained by the fact that pre-service teachers encounter many written and visual sources and contents related to these subjects in courses such as "General Biology", "Special Topics in Biology", "Genetics" during their teacher training program. Pre-service science teachers are also included in discussions in many courses about the benefits and harms of these interventions and prepare a lot of research assignments on these topics. Thanks to these research assignments, many sources on the subject are scanned and read a lot. Thanks to in-class discussions, they also learn to consider these issues from very different perspectives. All of these practices may have influenced pre-service teachers' bioethical levels regarding this dimension. One of the opinions expressed by pre-service teachers about this dimension is that scientific developments constitute social developments. For example, IVF applications in Turkey are now more mentioned in society than before, this subject has become a subject heard and that people are now aware of. Many of us have surely witnessed a success story about this subject. As a result of the study, it can be considered that these success stories may have a share in the courses taken by pre-service science teachers. Similarly, Aikenhead (1987), Doğan Bora (2005), Beşli (2008), Aslan (2009) and Çınar and Köksal (2013) emphasized that scientific developments affect society.

Another result of the study was that pre-service teachers' average scores for "Science and Ethics" dimension, another sub-dimension of the Bioethical Values Questionnaire, increased throughout the teacher training program. However, despite this increase, pre-service science teachers generally have a low level of bioethics in this dimension. Pre-service science teachers oppose embryonic stem cell use even if it is for therapeutic purposes and believe that society's ethical and moral values should interfere with stem cell research. In this case, it can be said that pre-service teachers have a number of ethical concerns about the use of embryonic stem cells. The main reason for these concerns may be due to the value given to science and scientific studies in Turkey and the trust in ethical understandings of society and scientists. In addition, the lack of knowledge about stem cell therapies among pre-service teachers may be a factor affecting the average score in this dimension.

In this study, it was determined that pre-service teachers' scores in "Reproductive Technologies and Cloning" sub-dimension of Bioethical Values Questionnaire increased on a class level basis, but their scores were generally low. It was observed that teachers did not support pre-embryo selection in IVF techniques and did not approve of the idea that this technology would allow people to choose their children's physical and intellectual characteristics in the future. Likewise, pre-service teachers did not believe that pre-embryo selection would allow unwanted character traits to be eliminated. Pre-service teachers' religious and cultural beliefs may be the main reason for this result. In addition, pre-service teachers may think that such pre-embryo choices will have negative effects on the natural balance and that these practices will be contrary to the natural functioning. This result of the research is similar to the results of studies conducted by Keskin et al. (2013) and Meisenberg (2008). In addition, pre-service teachers

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opposed the idea of cloning people who are immune to the disease. This result of the research is similar to the study findings obtained by Sliding (2008). In the study conducted by Sürmeli (2008), university students studying in different faculties responded positively to dilemmas related to diseases and animal cloning, and they negatively responded to the dilemmas such as human cloning, gender determination, and transgenic animals.

Another result obtained in the study was that pre-service teachers' average scores for "Control of Genetic Interventions" dimension, another sub-dimension of the Bioethical Values Questionnaire, increased throughout the teacher training program. When pre-service teachers' average scores for this dimension were examined, it was seen that pre-service teachers' bioethical values for the control of genetic interventions were at "moderate" level. Although most pre-service teachers believed in the benefits of genetic engineering studies, when responses to scale materials were examined, it was determined that pre-service teachers' thoughts on the control of biotechnology applications varied. For example, while most pre-service teachers supported therapeutic cloning and new therapeutic cloning techniques to produce organs and stem cells, it was observed that a number of pre-service teachers rejecting the idea of human cloning that included many bioethical elements and the number of pre-service teachers supporting such practices was generally close to each other. It was also determined that the number of pre-service teachers who rejected the idea of human cloning increased on a class level basis. It can be said that courses such as Biology, Genetics, Special Topics in Biology and Evolution during the program were effective in pre-service teachers' answers, and their bioethical values for the control of genetic interventions sub-dimension were effective in their positive development in this direction. Chen and Raffan (1999) made similar conclusions in their work. In the light of all these results of the research, it is possible to indicate that applications made in the science teacher training program have a positive effect on pre-service teachers' bioethics values in general.

People are born with curiosity. We read, watch, and research more or less about the subjects we are interested in. But to wonder, we need to cross paths in any way and to get into our interests. Here, we can ask this question: Does each individual only investigate the subject of interest? Or does the individual just look for what he needs? It is possible to answer such a question with "Yes" at first glance. But to put it this way, some stimuli such as just a newspaper headline that we read, an advertising poster or a book cover, or an advertising program that we watch on TV lead us to research a lot of things. Therefore, an individual's sense of curiosity must be stimulated in some way. When an individual's sense of curiosity is stimulated, the individual investigates, questions, evaluates, and makes a decision about it, and he is expected to take responsibility for that decision. The more an individual investigates and questions about subjects he is curious about, the more sensitive and ethical decisions he can make about it. At this point, an important task falls to teachers and educators who train future teachers. For this reason, scientific and technological developments and the impact of these developments on society and the impact of society on these developments should often be discussed in courses. During some courses, bioethics training should be part of the existing teacher training program given considering the necessity of ethics education which is only tried to be given to pre-service teachers within other subjects. Such learning environments will help students gain the ability to discuss, reason, respect other people's opinions, and evaluate events from different angles.

Conclusions and Implications

In general, based on this study results, it is possible to say that the teacher training program contributes positively to the development of pre-service teachers' bioethical value levels. While the bioethical value level of pre-service science teachers who have just entered the program was "low", it was determined that this level increased to "medium" at the end of the program,

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especially for the teacher training program. It can be said that the benefits of biotechnology applications of pre-service teachers, the use of embryonic stem cells in therapeutic research, the effect of the ethical and moral values of the society on the research, the place of ethics in science, the work values of scientists positively affect the bioethical values. Unfortunately, it is not possible to say that this effect is sufficient.

Today's bioethical problems pose problems that future generations will encounter in the future. Making effective decisions about these problems will require ethical value, which is an important element for the development of scientific literacy. Bioethics education should be a part of the current teacher training program for pre-service science teachers who will undertake the task of raising individuals with these values. For this, scientific and technological developments and the impact of these developments on society and the impact of society on these developments should be discussed more frequently in the lectures, and research and project assignments should be given more often on these issues. Such learning environments will provide students with the ability to discuss, reason, respect the opinions of others and evaluate the event from different angles. For this reason, educators should include these practices more frequently in the lessons included in the science teacher training program.

The current research was conducted with pre-service teachers. It is thought that the results of the study will provide experts and educators working in the field of curriculum development with a new perspective on the inclusion of bioethics subjects in teacher training programs as a course content or in the curriculum as a new course. In the future, this study can repeat with teachers, middle school and high school students and with gender variable considered. In addition, their relationship with different skills and competencies that affect and is thought to affect bioethical value can also be investigated.

Author's note

This article is derived from Duygu Turgut's Master's thesis entitled "Investigation of class-based to science teacher candidates' bioethical values, scientific literacy levels and empathy skill", conducted under the supervision of Zeha Yakar.

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Declaration of Interest

Authors declare no competing interest.

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