



PRESERVICE SCIENCE TEACHERS' OPINIONS AND ETHICAL PERCEPTIONS IN RELATION TO CLONING STUDIES

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ABSTRACT

Cloning is a reproductive method that raises many important ethical questions. As our future science teachers, preservice science teachers will experience with cloning technologies in their lessons and also part of the society, many of them may become decision makers related these issues. Therefore preservice science teachers need have scientific literacy about cloning studies and also they need to be able to evaluate critically the potential benefits, risks and ethical implications of these technologies.

Considering the importance of these issues, the aim of this study is to find preservice science teachers' ethical perceptions and knowledge in relation to the application of cloning technologies. 112 preservice science teachers attended to this study, their perceptions and knowledge were assessed using dilemmas and questions. It was found that most of the preservice science teachers get their knowledge on cloning technology from informal resources, their knowledge were found limited and they found cloning as risky. In addition, their opinions and reasons related to the dilemmas were differentiated.

Keywords: Cloning technology, Preservice science teachers, Ethical concerns.

INTRODUCTION

In recent years there has been a rapid increase in the development of biotechnological studies all over the world. Genetically modified foods, treatment of genetic disorders, stem cell research, gene therapy, cloning and environmental issues are some of the biotechnological studies. These studies provide comfort and benefit for mankind, however they also give rise to concerns about ethics and moral issues.

Issues related to biotechnology, can be classified together as "socioscientific issues", and it means that all aspects of science are inseparable from the society from which they arise. Socioscientific issues are typically contentious in nature, can be considered from a variety of perspectives, do not possess simple conclusions, frequently involve morality and ethics (Sadler & Zeidler, 2003), and also describe societal dilemmas with conceptual, procedural or technological associations with science (Sadler, 2004).

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Socioscientific issues have become increasingly more important in the field of science education to make science learning more relevant to students' lives (Cajas, 1999; Pedretti, 1999); to improve dialogical argumentation (Driver, Newton, & Osborne, 2000; Zohar & Nemet, 2002), to evaluate scientific data and information (Jimenez-Aleixandre, Rodriguez, & Duschl, 2000; Kolsto, 2001) and to improve scientific literacy (Pedretti & Hodson, 1995). Citizens of all ages need a high level of scientific literacy to address socioscientific issues (Dawson and Schibeci, 2003) and also they need to make ethical decisions on how they use science and technology and its products (Macer, 2004). Studies suggested that society needs to be able to evaluate critically the potential benefits and risks of scientific advances (Dawson, 2001; Dawson and Schibeci, 2003). University students are also experienced with socioscientific issues in their lessons and as they are part of the society, in some situations many of them become position of decision makers on these issues.

In literature, many studies have been done to determine students' knowledge, attitudes towards biotechnology. Chabalengula et al. (2011) searched 88 elementary education preservice teachers' understanding of biotechnology and its related processes. The results of this study indicated that preservice teachers had limited understanding of biotechnology and its related process. In addition, it was found that the majority of the preservice teachers provided poor definitions, explanations and examples of biotechnology, genetic engineering and genetically modified foods. Concannon, et al. (2010) also studied with 96 undergraduate non-science majors' to find their conceptions of stem cells, stem cell research and cloning. Participants were asked questions related to these issues before and after instruction which was aimed to help students construct scientific ideas and enhance their reasoning about socioscientific issues. It was found that overall, students' understandings of stem cells, stem cell research and cloning increased. For example, on the post test, it was found that students gained knowledge concerning the age of an organism related to the type of stem cell it possesses. Balas and Hariharan (1998) explored the knowledge and attitudes of the general population contained 156 individuals, 76.3% of which were associated with a college or university regarding cloning. They found that attitudes toward cloning were not correlated to gender, however, occupation and academic association were strongly correlated to attitudes. Unlike these studies, Dawson (2007) examined development and understandings and attitudes about biotechnology process as students progress through high school by doing cross sectional case study. She found that most students approved of the use of biotechnology processes and determined that overall, 12-13 year old students' attitudes were less favourable than older students regardless of the context.

Biotechnology raises various socioscientific issues with regard to ethics, the level of acceptable risks and usefulness of the new products (Reiss & Straughan, 1996). Therefore young people need to be informed, not only about the practical applications of biotechnology, but also they need to appreciate the social and bioethical implications. In that way, they can make wise personal choices and contribute to public debate in the future, and they can also become informed decision makers (Dawson & Taylor, 2000; Dawson & Schibeci, 2003). Dybas (2003) defined bioethics as below;

“Bioethics is the symbiotic relationship between biology and ethics, encompasses everything from well-known debates on the use of stem cells in medicine, to the impact of terrorism and war on Earth's environment, to how human populations alter the landscapes around them, to how research into these questions is conducted and results are shared”. (p.798)

Macer called the term of bioethics more simplistic way. According to Macer, bioethics is the love of life. This researcher mentioned the three ways to view bioethics; descriptive bioethics, prescriptive bioethics and interactive bioethics and stressed that developing and clarifying

prescriptive bioethics allow us to make better choices, and choices that we can live with, improving our life and society (<http://www.biol.tsukuba.ac.jp>).

Three general moral principles have proved to be serviceable as a framework of principles for bioethics: respect of autonomy, beneficence and justice. These principles can provide a framework which begin to reason about problems in bioethics (Beauchamp and Kahn, 2008). In the area of ethics, cloning has created serious dilemmas such as the morality behind the use human embryos for scientific purposes, the disposal of unused embryos, the lack of safe scientific measures to support the techniques used. Moreover considering that a clone is a person and not a thing, he/she has all the rights inherent to human being. He/She will have, as any other individual, judicial personality, different from the person who gave him/her the genetic material, in other words, he/she will become a new individual with its own rights and obligations (Costa et al, 2006).

Of the many controversial issues in science, advances reproductive technologies have a personal relevance for students. Students are curious about these technologies and require guidance to comprehend the impact of these technologies in their lives (Russo, et al.,2004). On the other hand, cloning technologies is a serious matter in reproductive technologies. Especially, the aim of cloning humans is in conflict with the right of the individuals to become single and unique. Moreover, copying procedure means the intentional transfer of the defect to the next generation (Arda, 2004). Dawson and Taylor (1997) mentioned that; "...within the next decade people will need to consider the ethics of cloning humans and unless all students are taught about the process of biotechnology they are in danger of being woefully ignorant about the technology involved. They also argued that the lack of understanding and associated fear may contribute to an anti-science backlash where society rejects rather than confronts the ethical issues." (p.171)

Considering these issues, our future teachers' of science have responsibilities as citizens and as teachers to prepare the next generation of citizens to be component in the consideration of cloning technologies and help their students discuss ethical implications of cloning technology even when these are controversial and contested. In accordance with these responsibilities, we need to learn preservice science teachers' perceptions of cloning technologies and it is important to find whether they are able to think ethical issues of cloning technology.

Aim of the Study

This study aims to evaluate preservice science teachers' opinions and ethical perceptions in relation to the application of cloning technologies. The study addresses the following research questions:

1. What are the opinions and knowledge of preservice science teachers' related to cloning studies?
2. What are the ethical perceptions of preservice science teachers' related to dilemmas about cloning studies?

METHOD

Study Group

This study is conducted during the spring semester of 2006-2007 academic year. The students who comprise the sample includes 112 preservice science teachers in a four year science

teacher preparation programme at one university in the Marmara region of Turkey. All of the preservice science teachers (58 girls and 54 boys) were in their fourth year of their study and they would be science teachers in the next year. The major fields of the participants were biology, chemistry, physics and general sciences. They also attended genetic course including definition, scope, importance of genetics and its influence on our lives, provide information related to historical development of genetics and also raise awareness of genetics studies.

Instruments

The research instrument was designed to address the research questions. Making the issue more relevant two dilemmas were used to get preservice science teachers' perceptions about cloning studies. Of the two dilemmas, one was regarding human cloning used before in literature (<http://gslc.genetics.utah.edu>) and the other one was regarding animal cloning a science news obtained from a scientific journal popular in Turkey. Students were directed to read each dilemma and chose one of the three choices "yes", "no", "I can't decide" and then write a response what should do to resolve the situation. Two of the dilemmas were given in the appendix.

Open-ended and a multiple responses questions were also administrated to the students to understand their opinions related to potential risks, utility and control of these studies, to assess their knowledge about cloning technology, and also to understand their knowledge related to resources they learnt about cloning technology. The validity and reliability of open-ended questions provided by taking views of two researchers whose profession were biotechnology and by doing pilot. Since multiple question was used in previous studies a new study was not been done on reliability and validity of this question. However this question was also consulted to the biotechnology specialists.

All of the instruments were in Turkish. After open ended and multiple choice questions were performed dilemmas were applied to the students.

Data Analysis

Quantitative and qualitative analysis were used for the analysis of the results. Firstly, preservice science teachers were asked to define the term cloning. Data obtained from this open-ended question were analysed by considering a definition of cloning. According to this definition, cloning term has three significant parts which include organisms or cells arising from a single individual, by asexual reproductive and therefore genetically identical (Mascazine et al., 1998). Considering these parts as indicators each students' definitions were analysed and determined if they had given true, partially true or false definitions. If students gave the one or two parts of these definition their definitions were accepted partially true, if they gave the three parts of this definition their definitions were accepted true and if their definitions were quite different from these parts, they were accepted false.

Secondly, two multiple choice questions were asked to the preservice science teachers to learn their conceptual knowledge about risks and benefits of cloning technologies and also resources they learnt about these technologies. For data obtained from these questions descriptive statistics and comparison analysis were used for quantitative data analysis. The results were analyzed using the SPSS 12.00 for Windows software.

Lastly, to learn preservice science teachers' bioethical perceptions about cloning technology two dilemmas were presented to the students. Data obtained from two dilemmas were analyzed

by using qualitative analysis methods. Preservice science teachers' responses were first separated as "yes, no, I can't decide", then frequency of each response (yes, no, I can't decide) was counted and calculated. The written statements supporting each response were categorised and their frequencies calculated for each category. Preservice science teachers' responses were analyzed iteratively and they were read several times and categorised independently by two different researchers.

RESULTS

Table 1. Frequency of responses about definition of cloning

	Responses	Preservice science teachers	
		f	%
Cloning	True	20	17.8
	Partially true	61	54.4
	False	26	23.2
	No responding	5	4.4
	Total	112	100

Table 1 provide preservice science teachers' definitions of cloning. The table shows that of the 112 students only 17.8% of them defined the cloning term as true while 54.4% of them defined as partially true. On the other hand, it was found that significant part of preservice science teachers' (23.2%) definitions were not found correct.

Table 2. Preservice science teachers' perceptions of risks and benefits associated with cloning studies

Perceptions	f	%
Risks outweigh benefits	57	50.8
Benefits outweigh risks	16	14.2
Risks and benefits are equal	33	29.3
No responding	6	5.3
Total	112	100.0

Table 2 shows preservice science teachers' perceptions of risks and benefits associated with cloning studies in general. According to the table it was found that half of the preservice science teachers (50.8%) thought that risks outweighed benefits while 14.2 % of them thought that benefits outweighed risks. In addition 29.3% of the students thought that risks and benefits of these studies were equal.

Table 3. Resources preservice science teachers' learned about cloning technology

Resources	f
TV news	91
Internet	88
Newspapers	87
Scientific journal	77
Courses	59
Documentaries	52
Social organisations	4

Table 3 shows that most of the students acquire their knowledge on cloning from formal and informal resources. While most of the students get their knowledge from TV news (91), the internet (88), newspapers (87) and scientific journals (77), some of them learn about these issues from their courses (59), documentaries (52), and few of them learn from social organisations. Since a students marks more than one option we did not percentages values were not used in this table.

Table 4. Frequency and percentages of students' responses associated with human cloning and animal cloning dilemmas

Students	Responses	Dilemmas			
		Human Cloning		Animal Cloning	
		F	%	f	%
Preservice science teachers	Yes	25	23.8	71	66.9
	Can't decide	23	21	8	7.5
	No	58	55.1	17	16.0
	No responses	-	-	10	9.5
	Total	106	100	106	100

From the table (4), it can be seen that, while most of the students (55.1%) gave "no" responses regarding with human cloning dilemma they (66.9%) gave "yes" responses regarding with animal cloning dilemma. Considering this results, it can be concluded that while most of the preservice science teachers' had negative perceptions about human cloning studies, they had positive perceptions about animal cloning studies.

Table 5. The reasons of students' responses related to human cloning dilemma

Responses	Preservice science teachers	
	No f	Yes f
Related with cloning mechanism	15	4
Related with nature	27	-
Related with human characteristics	5	-
Related with ethics	10	-
Related with the character (mother)	10	28
Related with clone	19	-
Related with society	5	-

In this table students' responses put in more than one category. That's why, frequency of responses were not equal with the sample. Results seen in this table (5) indicated the most frequently negative and positive reasons regarding the dilemma of human cloning. From this table it can be understood that negative reasons had more frequency compared to positive reasons. It was found that the most frequently mentioned negative reasons were related with nature, cloning mechanism, clone and ethics. Students' explanations regarding these reasons were given below.

One of the students explain her reasons related with nature as follows;
If I look at this event emotionally, my answer was "yes", but if we objectively evaluate the world continues with a very nice cycle and in this ecological cycle someone gets, someone dies. If cloning gets common, population will inevitably increase and also this brings the end of the world. It will be meaningless putting billions of peoples at risk for one person.

Considering this answer we can say that this student evaluate the dilemma in terms of positive and negative sides, but her opinions regarding nature looks more important.

On the other hand, another student expressed his reasons related with clone in the following way:

..I don't know if he/she will be completely a person. Probably he/she will not be like a robot. He/she may have the same status as a physical entity, but he/she may not have the same brain or same attitudes with the other child.

It seems that this student think the physical and biological characteristics of a clone, but it can be understood from his responses that he is not sure about his knowledge or his knowledge is not enough to understand the characteristics of a clone.

In addition to these, one student expressed her reasons related with cloning mechanism in that way:

Clone's life durations is short, so they may not live for a lomg time and also applications of this technique may have bad results and this can also affect the individuals

This student can think one of the ethical result of cloning mechanism which can be associated with the lack of safe scientific measures of cloning.

In contrast to these negative reasons the most frequently mentioned positive reason was related with a character (mother) found in dilemma story. One of the preservice science teachers mentioned her feelings as follows:

...if you look at the aim of this story, you can think what kind of aim it include, is it good or bad?..For instance, this woman does not deal with weapon trade, she is a normal housewife, she also lost her husband, and she has no other chance to be a mother biologically...If she wants to have a chid from her husband- she also lost her chid which is another depression...I think it should be allowed...because she wants to have a target to connect the life.. She wants a rest from them.

Table 6. The reasons of students' responses related to animal cloning dilemma

Responses	Preservice science teachers	
	No	Yes
Related with naturel process	16	75
Related with cloning mechanism	3	-
Related with ethics	-	1

As can be seen from the table (6), positive reasons had the highest frequency. According to this table these reasons were relatated to naturel process which include ecological balance of the nature. Negative reasons were also determined regarding the nature, however the frequency of these reasons were found lower.

DISCUSSION

The results found in this study showed that most of the preservice science teachers were able to define cloning term partially true (54.4%) and few of them (17.8%) were able to give true definitions. Considering this result it can be thought that preservice science teachers had little

knowledge, for this reason they need to take courses including cloning studies to be aware of technological developments about cloning technologies. When we consider the results of resources they require their knowledge which showing that most of them learn these issues from informal resources, their limited knowledge was an expected result. Although significant number of them used journals to learn about cloning technology, most of them were not able to give true definitions. Therefore it should be our responsibility make them conscious of reading useful journals to obtain accurate information.

Mascazine (1998) explored the knowledge of the general population regarding cloning. In this study researcher indicated that a significant number of individuals had not know how to define the term cloning, they (17.9%) had not given an accurate definition of cloning, over 38% were able to define cloning, 28% were able to give the complete definition of cloning and over 14% were able to give a complete definition of cloning including the important elements. In these studies individuals described their understanding with the rating of five choices. Most of them (%60.3) selected "little knowledge" as the most appropriate descriptor of their understanding however, they were lacking a basic understanding of the basic elements of cloning. In addition only 3.2% rated themselves as very knowledgeable about cloning and 3.8% rated themselves as having not knowledgeable (Mascazine et al., 1998). In contrast these results, another study indicated that students' ability to provide a generally accepted definition and examples of cloning were found relatively poor amongst 12-13 year olds, but improved in older students (Dawson, 2007). Nevertheless, some reserachers examined elementary education preservice teachers' understanding of biotechnology and its related processes and found that a moderate number of preservice teachers correctly defined cloning and also provided correct examples of cloning (Chabalengula et al., 2011). The differences among these studies results may be related to the quality of the instructions. In a study, researchers examined undergraduate non majors' conceptions of cloning before and after the instruction, including interactive lectures, case discussions, hands on activities, independent projects and they found that students' understanding of cloning increased (Concannon, et al. 2010).

Studies in literature showed that individuals were concerned about cloning. Balas and Hariharan (1998) revealed that people concerned about cloning and they indicated that more research needed to be done about cloning. In this study the question assessing the students' opinions of risks and benefits were intended to discover whether students found cloning studies risky or beneficial. From the results of this study it was found that students' perceptions of cloning were found negative. The results indicated that most of the preservice science teachers thought that risks outweighed benefits. Another study also revealed that teenagers were more likely perceive risks rather than benefits in relation to the cloning studies (Gunter et al., 1998).

The results of this study revealed that preservice science teachers' perceptions differentiated according the tpye of cloning study. They had negative perception when the study was dealing with human cloning, on the other hand, they had positive perceptions when the study was dealing with animal cloning. When it came to giving the reasons of each dilemma, students responded in various ways. It was found that most of the reasons associated with the human cloning dilemma were found negative and these reasons were related to the implementation of the cloning mechanism, naturel process and clone himself/herself. Besides, the term of ethics was also mentioned by some of the preservice science teachers and these students thought that the situation was not ethically right. However students who mentioned that cloning studies were not ethically right could not explain their expression in detail. By considering this point it can be thought that most of the preservice science teachers were thought the ethical issues of cloning study, on the other hand their explanations were not enough to explain human cloning issue in an ethical way. In addition it was found that few students tended to resolve dilemmas

and justify their reasons by considering some of the bioethical principles. They seemed to give undue emphasis to the principles of beneficence and non-maleficence solving both of the dilemmas. However it seems that they could not give emphasis to principles of the respect of autonomy and justice.

In this study some of the preservice science teachers gave positive decisions regarding human cloning dilemma and they showed the reasons related with the character found in dilemma story. According to their reasons this person should not have been upset. With this reason it is thought that preservice science teachers could not give decisions considering the future of the situations, instead their emotionally considerations were significantly influence their decision makings. Similar results also found in a study which was related to explore preservice science teachers' informal reasoning regarding socioscientific issues. In this study, researchers identified that patterns of informal reasoning emerged as rationalistic, emotive, and intuitive reasoning and students' informal reasoning were influenced from their personal experiences, social considerations, moral-ethical considerations and technological concern (Topcu, et al., 2011).

Gunter et al (1998) asked all the individuals to rate the relative benefits and risks associated with cloning of animals. They found that all age groups of individuals saw more risks than benefits regarding animal cloning. In this study, in contrast to the human cloning most of the reasons associated with animal cloning were found positive. It can be understood that students' thought about the risks of human cloning outweighed than animal cloning. However the reasons giving by them were found quite same with the reasons regarding human cloning dilemma. It was found that many of these reasons were related to the natural process which include protecting ecological balance of the nature by cloning extinction of the species and it was also found that almost all of the preservice science teachers were agree with this reason. Balas and Hariharan (1998) found in their study that most of the peoples' responses to the benefits of cloning centered around the possible medical applications or food production of this technology. It can be concluded from these results that individuals' thoughts regarding benefits of cloning technology can be related with nature, medical applications or food production, which means that they can consider the utility of this technology for nature and human beings as well.

In conclusion, it is important to make individuals aware of the practical applications of current developments in bioethical implications and also to make them become well informed decision makers on these issues, especially about cloning studies, considering the important attributes of scientific literacy and bioethical principles. Therefore it is suggested that these students need to be supported with biology courses including cloning studies and also to make them learn the principles of ethics, bioethics courses or biology courses including ethics issues should be added to their programmes.

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APPENDIX

Human cloning

By many accounts, Mr and Mrs M were the happiest married couple in history. Their happiness was only compounded by the birth of their son.

Sadly, this happiness ended tragically while on holiday. A terrible boating accident claimed the lives of both Mr M and his son. Mrs M survived, but was absolutely devastated by the loss of her precious son and loving husband.

Stricken with grief and unable to move on, Mrs M knew she would never feel "normal" again without a child to raise and love. Mrs M could not bear the thought of having a child that was not her husband, however. A local biotech company had been advertising breakthrough advances in cloning technology that enabled them to clone organisms from very small samples of DNA. According to the company, a small sample of bodily fluid, tissue, or hair from an organism yielded enough DNA to successfully produce a clone. This gave Mrs M a wonderful idea.

She rummaged through the house until she found her son's hair brush. Trapped in the bristles was enough of her son's hair to produce a clone. Mrs M contacted the biotech company immediately and was informed about an important process they must go through before they can begin.

In an effort to regulate human cloning, the federal government has set up a new Human Cloning Ethics Committee to oversee all cloning practices. The Human Cloning Ethics Committee consists of a research scientist, a doctor, the president of a biotech company, a psychologist, a member of the clergy, and a member of the community. Biotech companies must receive approval from the Committee before they begin any cloning projects. Mrs M's request is the first of this type the Committee has considered.

Is this a case where human cloning should be allowed?

Animal cloning

In the United States genetically cloned wild African cats were kitten. Following one male and two female mating of wild cats, all of them were cloned, 8 puppies was born. Thus, it was found that copy animals have the ability to produce. With this development, researchers agreed that this development can provide population proliferation of the risk of extinction animal species. Is this a case where animal cloning should be allowed?