BIOETHICS IN SCIENCE EDUCATION

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ABSTRACT: Recent developments in science will impact the practice of teachers who teach bioethics in schools. There is a growing awareness of bioethical issues amongst the public and in the media, and an increasing level of debate about them. It is important that teachers and those who teach biology are aware of the ethical and social implications of their work. This paper reviews and critiques the existing research on some bioethics, which deals with ethics in the context of science instruction. First, bioethics and bioethical issues are described. This is followed by an importance of bioethics education. Then the existing studies (on bioethics) are reviewed and evaluated. Because of the gaps with the existing research in the literature, recommendations are made describing the need for more and better designed research.

Key words: Bioethics, bioethical issues, biology, biotechnology, science education

INTRODUCTION

In the last decades, technological developments have accelerated studies in biology and have enabled great improvements in genetics. It is important that biologists and those who teach science are aware of the bioethical and social implications of their work. The new developments in biotechnology such as isolating and combining genes, patenting life, secondary creation, eugenics and civilization, gene sociology, DNA computers etc. that can potentially shape this century also bring various ethical problems (Negrin, et al. 2007).

Scientific and technological developments lead to bioethical dilemmas that affect people's life. Like progress in molecular biology and genetic engineering and most recently, the human genome mapping topics may have already given rise to societal issues, which include bioethical aspects, as well as social and political ones (Larazowitz & Bloch, 2005). General scientific interest may play a role, as well as beliefs regarding science and technology (Osborne et al., 2003). Ajzen and Fishbein (2000) has stated that several background factors such as religious background, ethnicity, educational level, and gender also may influence people thoughts.

Today science curricula involve science and technology together with social, cultural, environmental, political, and ethical elements. It shows that importance of individual awareness of his/her own values and to explain them in a conscious way. Thus, today science education curricula highlight on the elements conducive to society-wide science literacy rather than conveying pure scientific knowledge to students. (Keskin-Samanci, Özer-Keskin & Arslan, 2013). Bioethics is necessary to advocate the relationship between the life sciences and values that are essential to society, and, at the same time, it is important that in the current context of the expanding applications of modern biotechnology and exigencies related both to human wellbeing and environment. In short, it is important that the public becomes more scientific literate in this respect. Science education occupies a central role in the development of scientific literacy (Driver, Leach, Millar & Scott, 1996). In recent years, the ethical topics in biosciences have become increasingly important in the field of science education as an important tool for improving students' scientific literacy (Kolarova & Denev, 2012).

Bioethical education among students and people is crucial that a necessity of contemporary moral education because of responsible for the future of humanity. In this article, we will describe the results of published literature on importance of bioethical education. The main aim of this study was to review and critique the existing research on bioethics, which deals with ethics in the context of science instruction.

What is Bioethics?

Ethics has long been an integral component of medical and nursing degree programmes (Downie & Clarkeburn, 2005). It is clear that moral laws should embed with biological, medical, agronomical laws and this is how bioethical education contributes to educating students. Ethics education has been espoused by a number of professions in an effort to raise awareness of social and ethical issues and to enable the ethical decisionmaking skills required of people (Lysaght, Rosenberger III & Kerridge, 2006).

Although the term bioethics has multiple origins, it has generally been taken to mean medical ethics (Bryant & Baggott la Velle, 2003). Bioethics, which can be classified as a branch of the ethics plays a key role in the development and implementation of the respective means (Urker, Yildiz & Cobanoglu, 2012). Bioethics combines biological knowledge and knowledge about life with knowledge on the human, moral and ethical values.

According to Potter (1975), bioethics is a new discipline which combines biologic knowledge with knowledge of human value systems, which would build a link between the sciences and the humanities, help humanity to survive, and sustain and improve the civilized world. Ethics education also has a positive influence on students' ability to make decisions about ethical issues to raise a moral induvial ethics and as a specifically bioethics educationist important in schools. (Pinch & Graves, 2000).

Why Bioethics Education is Important?

At the present time, the rapid growth of technology has produced great improvements in biotechnology techniques. These improvements have created new controversial issues in science. Therefore, there is a need in science education to consider scientific research and its applications beside ethical concord. Bioethics education enables lots of benefits to humanity. Bioethics education makes it possible for individuals to accept the value conflicts caused by biological sciences and to develop decision-making skills based on ethical theories and principles (Reich, 1995).

Bioethical education enables to students to make the 'right' decision in a given situation, beside this 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 (Sadler & Donnelly, 2006). Individuals can use these skills while interpreting scientific knowledge thus bioethics is important science education. Iancu (2014) stated that the purpose of the bioethical education is to educate students so as to apply moral laws in close correlation with the laws of biology in scientific research and scientific advances in biology, medicine, agriculture, and also in everyday aspects of their social, professional and family life and life in general on Earth.

Bioethical education is a bridge of some fundamental sciences, such as Education Sciences, Psychology, Biology (Greek bios=life; logos=science, speech), respectively, sciences that deal with the study of living creatures, Agronomy, Veterinary medicine and Human Medicine (Medical Sciences). The scheme is given below in Figure 1(Iancu, 2014).

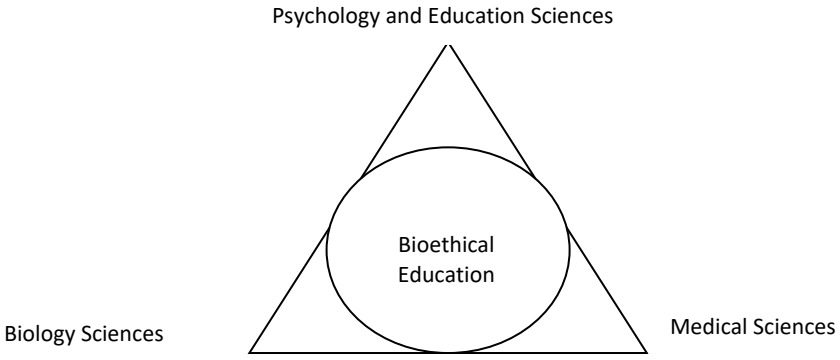

Figure 1. The scheme of the fundamental science of bioethical education

Fundamental aim of bioethics education 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 accomplish decision-making skills in problem-solving processes (Keskin-Samanci, Özer-Keskin & Arslan, 2013).

In literature, there are many studies which investigated importance of bioethics education in science. Another part of this paper is mentioned these studies.

REVIEW OF THE RESEARCH ON BIOETHICS EDUCATION

We searched Web of Science using the search term bioethics education. This search resulted in the retrieval of over 750 studies. Later we marked education and educational research area, article document types and English language. This search resulted in a total of 48 research articles that met our criteria. We went through each of these studies, selecting those that relevant to our review. Specifically, our criteria for inclusion included any study that had implemented bioethics education in science. In the literature there were many studies that described bioethics

education (e.g. Bradbury-Jones & Alcock, 2010; Howard, McKneally & Levin, 2010; Pinch & Graves, 2000; Mills, 2015). These studies were in many fields such as medicine, biochemical, law, nurse education. However, the goal of this research was to determine studies in science education disciplines. Our review of the research includes nine research articles.

The first of them is the inventory development article. Keskin-Samanci, Özer-Keskin and Arslan (2013) developed the Bioethical Values Inventory that can be used to reveal secondary school students in Turkey ethical values in decisions that they make during ethical debates regarding the application of biological sciences. In this study, researchers described the development process of the inventory step by step. The Bioethical Values Inventory indicated the students' values in their decision-making processes, considering the objectives and nature of bioethics education. The inventory topics of scenarios are use of animals in experiments, prenatal genetic diagnosis and abortion, determining the gender or physical appearance of unborn babies, genetically modified organisms, genetic screening tests and therapeutic cloning. Researchers have thought that by using this inventory, the ethical values affecting individual decisions in ethical debates caused by biological sciences can be revealed with greater convenience.

Dawson (2007) studied that the development of understandings and attitudes about biotechnology processes as students' progress through high school. The students at this school consisted of new migrants from Europe and South East Asia and also the offering of language scholarships in Italian, German, and Indonesian to students outside the local area. It was conducted the cross-sectional case study. Data were collected with interviews and written surveys. It was found that students' ability to provide a generally accepted definition and examples of biotechnology, cloning and genetically modified foods was relatively poor amongst 12–13 year old students but improved in older students. Most students approved of the use of biotechnology processes involving microorganisms, plants and humans and disapproved of the use of animals. In addition, 12–13 year old students' attitudes were less favorable than older students regardless of the context.

A study reported by Sadler et al. (2006) investigated that teacher perspective on the use of socio−scientific issues (SSI) and on dealing with ethics in the context of science instruction. Middle and high school science teachers from three US states participated in semi-structured interviews. They found out two research questions: How do science teachers conceptualize the place of ethics in science and science education and how do science teachers handle topics with ethical implications and expression of their own values in their classrooms? As a result of the study five teachers' profiles emerged. Participants also expressed a wide range of perspectives regarding the expression of their own values in the classroom.

In 2005, Larazowitz and Bloch investigated awareness of high school biology teachers are of societal issues (values, moral, ethical and legal issues). The sample consisted of biology teachers. Data collected with questionnaires and personal interviews. Teachers' answers were analyzed in relation to years of teaching experience, gender and religion faith. The results show that amongst the teachers there is a medium to low level of awareness of societal issues. No differences is seen that teachers' opinions to societal issues were found in relation to gender or religious faith. The majority of the teachers do not include societal issues in their teaching. Teachers with more years of teaching experience tend to teach with a more Science, Technology, and Society (STS) approach than novice teachers.

Sadler and Zeidler's (2004) study examined the extent to which college students construe genetic engineering issues. Sample consisted of college students in United States. Data were collected with interviews. The study specifically addressed gene therapy and cloning. It was found that students' responses were influenced by affective features such as emotion and intuition. In addition to moral considerations, a series of other factors emerged as important dimensions of socio-scientific decision-making. These factors consisted personal experiences, family biases, background knowledge, and the impact of popular culture.

A bioethics module has been established by Bryant and Baggott la Velle (2003) at the University of Exeter in UK. The sample consisted of science and biology education students. The course was divided into four general topic areas (sociological, philosophical and ethical background; interactions of humans with the 'natural' world; biomedical topics; aspects of biotechnology). In this study, the syllabus was designed to give students the tools to at least begin to develop their thinking about and understanding of bioethical issues. In addition the course moved on to more specific topics, starting with environmental ethics as an issue with global implications, and then going on to deal with areas of medical, biomedical and biological science and biotechnology. Students carried out more detailed case studies in small groups, mentored by postgraduate students, and present posters on their case studies.

In a study conducted by Dawson and Taylor (2000), science students in two schools in Australia were taught biotechnology courses that introduced them to bioethics. At the end of the course, students completed a survey in which they made a decision about three bioethical dilemmas. They were asked to give reasons to support their decision. The students' answers and reasons were compared with those of three experts. Researchers found that the majority of students tended to resolve and justify their decisions in a way that was naive, idealistic, and rights based. Compared to the experts, the students seemed to give inappropriate emphasis to the bioethical principle of autonomy. Beside this, the explanations of students supplied to support their decisions suggested that they did not consider long term consequences.

Tsuzuki et al. (1998) investigated attitudes to animal experiments in Australia, Japan and New Zealand. The sample consisted of biology and a social studies teacher at randomly selected schools. Data collected with mail response questionnaires. Researchers surveyed the opinions of teachers in Australia, New Zealand, and Japan about bioethical issues in an International Bioethics Education Survey (Macer et al. 1994). Results indicated that almost all of the teachers thought bioethics were needed in education; found more teachers expressed concerns about animal rights or experiments in New Zealand, than Australia, and least in Japan. Among the biology teachers, 90 percent in New Zealand use animals in class, 71 percent in Australia and 69 percent in Japan. More than half of the samples said that they had ethical concerns about animal experiments, which were examined in responses.

Last study, was examined, reported by Asada et al (1996), compared knowledge and teaching of 15 selected topics related to bioethics and biotechnology, with particular focus on the teaching of social, ethical and environmental issues of in vitro fertilization, prenatal diagnosis, biotechnology, nuclear power, pesticides and genetic engineering. The sample consisted of biology and social studies teachers at high school in New Zealand, Australia and Japan. Data collected with International Bioethics Education Survey (Macer et al. 1994) via mail response like a Tsuzuki et al. (1998). It was found that bioethical issues were, generally, covered more in biology classes than in social science classes; and that there were differences in coverage among the three countries, with most coverage in Australia and least in Japan. Open questions looked at images of bioethics, and the reasons why about 90 percent of teachers thought bioethics was needed in education.

CRITIQUE OF THE RESEARCH ON BIOETHICS EDUCATION

This paper began importance of bioethics education in science disciplines. Then, it was informed about the studies examined the literature.

According to findings of articles reported here do indicate that it can be difficult to appropriately assess students' socio–scientific discourse. Bioethics arguments can be useful for improvement of students' cognitive ability, and topics such as genetic engineering provide useful ways to stimulate this (Lucassen, 1995). Larazowitz and Bloch (2005) highlighted the need for the implementation of discussions on societal issues related to science, technology, and environment.

When examining the literature review with respect to bioethical issues, it was seen that these studies deal with use of animals in experiments, prenatal genetic diagnosis and abortion, determining the gender or physical appearance of unborn babies, genetically modified organisms, genetic screening tests and therapeutic cloning, gene therapy and cloning, sociological, philosophical and ethical background; interactions of humans with the 'natural' world; biomedical topics; aspects of biotechnology, ethical concerns about animal experiments, environmental issues. It can be said that the scope of this studies is wide.

Studies were performed in many counties (e.g., Turkey, US States, UK, Australia, Japan, New Zealand). It was generally found that individuals' responses were influenced by affective features such as emotion, attitude and intuition (e.g. Dawson & Taylor, 2000, Sadler & Zeidler, 2004). Although individuals' opinions also differ according to their country, generally the explanations of them supplied to support their decisions suggested that they did not consider long term consequences. Thus, it can be said that teachers need more teaching materials to discuss the bioethics values and ideas on further ways to teach biology and use animals in school (Tsuzuki et al., 1998). In this way they can put into practice a more effective ethic teaching.

The sample of studies was examined during the review. Keskin-Samanci, Özer-Keskin and Arslan (2013) study with secondary school students. Dawson's (2007) sample is 12-13 years old and older children. Bryant and Baggott la Velle (2003) emphasize the importance of awareness among biology science and biology education students of the ethical and social implications of their work. Dawson and Taylor (2000) worked with also science students. In Sadler and Zeidler's (2004) study college students were used as a sample. Sadler (2006), Larazowitz and Bloch (2005), Asada et al (1996) and Tsuzuki et al. (1998) worked with teachers. When the literature examined, It has

not been found to study at primary level. Therefore, it can be said that, studying with students at this level should be increased.

In these studies data collection method generally was interviews (e.g. Dawson, 2007; Sadler et al, 2006; Sadler & Zeidler, 2004) and some of the studies used the surveys (e.g. Dawson & Taylor, 2000; Tsuzuki et al., 1998). The bioethics education is also important as well as determining individual's views on bioethics. Bioethics education also can be done through the adequate scenarios while the students understand the relevant scientific facts and notice the ethical dilemmas in the scenarios (Keskin-Samanci, Özer-Keskin & Arslan, 2013).
This literature review highlighted the importance of scenarios of ethical dilemmas in bioethics education both for teaching and for reveal students' attitudes, values, and opinions (e.g. Dawson & Taylor, 2000; Keskin-Samanci, Özer-Keskin & Arslan, 2013).

RECOMMENDATIONS

The main limitation of the study was that the number of articles which were examined was very small. For this reason, this study can only be regarded as restricted. For the future research, it can be reviewed that another indexes such as SCOPUS, ERIC and thesis. Although limitations have to be taken into account, the findings of this study highlight issues that may have to be considered by curriculum planners and science teachers who wish to incorporate scientific literacy into science curricula.

The results of this study provide some perspective in terms of bioethical issues. In the light of this study, the following recommendations can be given.

- Students should be given more opportunities to discuss bioethical issues. That is, bioethics should be a subject for study in science education.
- It can be recommended that teachers can do the 'bioethics education' through the scenarios.
- Science curricula at all levels of education should incorporate ethical issues of science.
- Discussion of ethical issues in science education should also be helpful to students understanding scientist because some of the students can be the future scientists.

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