

***Promoting Bioethical Decision Making for Grade 10 Students
Through Socio-scientific Issues based Instruction***

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Abstract

This article describes bioethics that supports bioethical decision making skills and develops of social responsibility in biology classroom. Bioethical decision making of 10th grade students are studied through socio-scientific issues based instruction. Non-participant observation and in-depth interview are employed. The findings will be discussed and implied to biology classroom as well as 21st century learners should be.

Keywords: Bioethical decision making, socio-scientific issues, social responsibility,
21st century skills

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Introduction

During the 25 years after the Second world War (1939-1945), several factors came together to give rise to the birth of the discipline of bioethics. These were the rapid advances in biomedical science, the perceived inadequacy of traditional ethics, the Nuremberg war crime trials, decreasing paternalism and deference and concern for the environment (Bryant et al., 2005). From the 17th century onwards, there in planks of ethical decision making in the Western world were the Judaeo-Christian, philosophy and knowledge. Cultural diversity is something that decision makes in bioethical contexts. The field of bioethics continues to struggle with the problem of cultural diversity: can universal principles guide ethical decision making, regard less of the culture in which those decision take place or should bioethical principles be derived from the traditions of local culture, Cultural diversity is something that decision makers in bioethical contexts (Chattopadhyay & Vries, 2013). According to National Institutes of Health (2009) advances in the life sciences are giving humans new capacities. New medicines, biomedical procedures, and ways of altering plants and animals are bringing benefits to millions of people. However, these same innovations also have the potential to bring harms or to raise other kinds of ethical questions about their appropriate use.

Socio-scientific issues (SSI) involve the deliberate use of scientific topics that requires students to engage in dialogue, discussion and debate. They are usually controversial in nature but have the added element of requiring a degree of moral reasoning or the evaluation of ethical concerns in the process of arriving at decision regarding possible resolution of those issues. The intent is that such issues are personally meaningful and engaging to students, require the use of evidence-based reasoning, and provide a context for understanding scientific information (Zeidler & Nichols, 2009).

Ethics is a standard that guides our behavior, both as individuals and as members of organizations. The ethical principles for this discussion are simple standards of right and wrong that we learn as children, such as being honest and fair and treating others with respect. (FEMA, 2005) Bioethics deals with the complex issues arising from the rapid developments in biomedical science in the last 50 years. Its scope also extends to environmental and global issues.

SSI has been used in science classroom, and numerous published reports describe the resulting experiences with this education method. Several studies showed that positive impact of SSI on communication skills (Chung et al., 2016). In the study of Gutierrez (2015), presents the effects of integrating socio-scientific issues to enhance the bioethical decision-making skills of biology students. Bottcher and Meisert (2013) study the effects of different learning environments on the promotion of decision-making competence for the socio-scientific issue of genetically modified crops is investigated. The comparison focuses on direct vs. indirect instructions. In addition, Gunn et al., (2006) has been used empirically-based instructional techniques to studies the relationships between bioethical issues analysis, and a specific set of critical thinking (CT) skills and attitudes in the science classroom.

In this present study, we designed a SSI based instruction on invasive species explore in field, loss of biodiversity, water pollution, Ecological succession, Peat lands in

Southeast ASIA, Natural Resource conservation, and global warming and implemented it with grade 10 students in Northeast Thailand, with a focus on improving their bioethical decision making skills.

Literature Review

Student practice of scientific argumentation using socio-scientific bioethics issues affects both teacher expectations of students' general performance and student confidence in their own work. When teachers use bioethical issues in the classroom students can gain not only biology content knowledge but also important decision-making skills. Learning bioethics through scientific argumentation gives students opportunities to express their ideas, formulate educated opinions and value others' viewpoints (Hanegan et al., 2008).

When socio-scientific issues are integrated into the classroom biology students can use their scientific content knowledge to analyze complex social problems. Sadler and Zeidler (2005) stated that socio-science education shows students "dynamic interactions of science and society with emphases on not only the science behind contemporary issues confronting all citizens but also the associated social, political, economic, and moral challenges" SSI also, supports nature of science that is heart of science learning. It helps students meet science as it could be, where nature of science stands by socio-scientific issues-based instruction (Nuangchalem, 2010).

According to Zeidler and Nichols (2009), we present the role of the context (SSI context): "Teachers looking to the Web for SSI fodder may recognize that Internet and issues-based learning activities can also be an invaluable resource in terms of exposing students to diverse perspectives on current scientific reports and claims. Again, current research can suggest important ideas to inform practice. With scaffold learning interfaces, students can spend their time reading and evaluating the multiple perspectives of a given socio-scientific issue instead of "surfing" through a plethora of sometimes misleading information. Of course, this requires that teachers invest the time upfront to find both reliable as well as potentially unsound sources of scientific data and perspectives, so students may be confronted with mixed evidence and learn to assess the validity of varied claims and data." and role of the teacher: "While encouraging students to consider evidence-based alternative arguments is of primary importance, it is equally important that teachers who are interested in using debate or discussion-focused activities also consider the match between their own pedagogical expectations and the theory base guiding the research.

For example, a teacher engaged in SSI would need to rely on research and current information about a given topic to better direct classroom debates through various lines of questioning (e.g., epistemological, issue-specific, role reversal, and moral reasoning probes). The importance of exposing students to discursive activities in the science classroom cannot be overstated if our goal is to increase SL. Putting together an SSI module does not simply mean selecting a scenario where science or technology can save the day. In addition, role of the students: Moving SSI from theory to practice is essential in contemporary classrooms. Science education that includes SSI offers unique opportunities to challenge students' moral reasoning and, in the process, presents concepts that seem to make sense because of the relevance and individual interest. Consistently, we have found that the main competition to

understanding and coherence are core beliefs, pseudoscience, and lack of personal experience in moral decision-making. The challenge to science teachers is to allow students to discredit their own belief system by having opportunities to formulate new perspectives. Our experiences have allowed us to identify several areas that are potentially problematic for students when engaging in SSI. Student impediments to success tend to include moral (core) beliefs, scientific misconceptions, lack of personal experiences, lack of content knowledge, underutilized scientific reasoning skills, and emotional maturity. In presenting this list, we do not mean to dissuade teachers from attempting an SSI approach. In fact, it is our position that insofar as students have such impediments, that we have a responsibility to provide them with opportunities to challenge their personal belief systems about the social and natural world in order to make connections. As the examples in the companion piece will show, the moral component of SSI is what triggers the students' need for more (content) information, critical thinking, constructive argumentation, and compromise.

Bioethics is the critical examination of the moral dimension of decision making in health related contexts and in contexts involving the biological sciences. Many of the problems of bioethics are perennial, and those who have been involved in clinical medicine and in biological research have reflected on the moral limits on their activities as long as those activities have existed medical aspirations that there was rarely any question about whether or not medical intervention ought to be employed (Gorovitz, 1997). National Institutes of Health (2009) found that of four important reasons to teach bioethics: advance students' science understanding, prepare students to make informed, thoughtful choices, promote respectful dialogue among people with diverse views, and cultivate critical-reasoning skills.

When the first papers on genetic modification were published they raised a huge flurry of interest across the bioscience and biomedical communities. Some of this was related to the research potential of these new techniques. Some was related to its commercial potential. However, some of the interest was certainly ethical. Indeed, in the UK in the late 1970s it was not uncommon for students to be set essays along the lines of "Discuss the ethics of genetic engineering", even though most biological scientists were unaccustomed to talking about ethics and many would have been out of their depth in discussion of ethical theory or moral philosophy. Nevertheless, it is from this ethical interest that we can trace one of the strands of bioethics as it is now practiced (Figure 1) (Bryant et al., 2005).

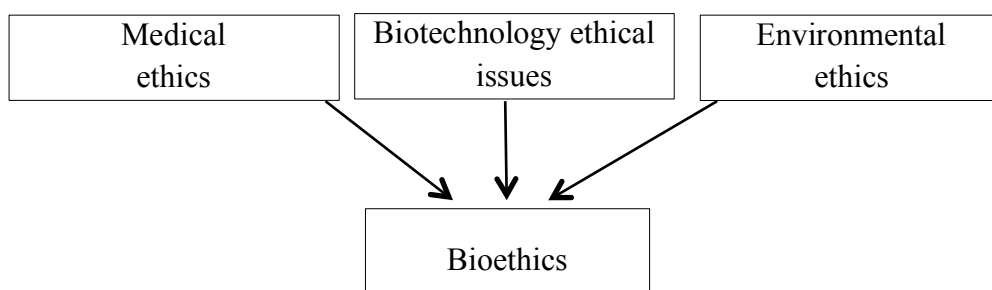


Figure 1: Evolution of Bioethics

Bioethics is a subfield of ethics that explores ethical questions related to the life sciences. Bioethical analysis helps people make decisions about their behavior and about policy questions that governments, organizations, and communities must face when they consider how best to use new biomedical knowledge and innovations (National Institutes of Health, 2009). According to FEMA (2005), "Decision making is a mechanism for making choices at each step of the problem-solving process. Decision making is part of problem solving, and decision making occurs at every step of the problem-solving process." Decision-making process in this study consists of three steps 1) identify the problem: Problem identification is undoubtedly the most important and the most difficult step in the process. 2) Explore alternatives: The second step in the decision-making process is to explore alternative solution to the problem identified in step 1. Techniques for explore alternatives in biology classroom is brainstorming, surveys, and discussion groups. And 3) select an alternative: Selecting an alternative is a critical step in the problem-solving process. When selecting an alternative, student will encounter factors that affect their decision making. These factors may include; Political factors, Safety factors, financial factors, Environmental considerations, and Ethical factors.

Methods

This research was one group post-test only design aims to study effects of Socio-scientific issues based instruction in 30 grade 10 students of Thailand. Strategies to promote bioethical decision making skills consisted of contexts about of life and environment theme such as invasive species explore in field, loss of biodiversity, water pollution, ecological succession, peat lands in Southeast ASIA, natural resource conservation, and global warming with a teacher who was a facilitator when they were practice.

A socio-scientific issues based instruction was implemented in 3 periods each week in total of 4 week for life and environment lesson in basic of biology course. We discussed the problems caused by the increasing human population: loss of natural environments to supply human needs for housing, agriculture, leisure and transport and because of the over-use of other natural resources. In addition to these, human activity has also caused direct damage to the natural environment.

Outcome has been evaluation at after Socio-scientific issues based instruction implementation in bioethical decision making. In data collection, 30 student who had participated in the Socio-scientific issues based instruction completed a 5-items bioethical decision making test with open ended question consisted of 1) identify the problem 2) explore alternatives And 3) select an alternative. In addition, they also completed 4-items open ended question in-depth interviews for the qualitative results.

The inferential statistics (F-test) was used to compare mean score between subscales of bioethical decision making: identify the problem, explore alternatives, and select an alternative. Descriptive statistics such as mean, standard deviation and percentage.

Results

Table 1 was shown demographic data sample size which consisted of 30 student who learned in life and environment lesson in basic of biology course by Socio-scientific issues based instruction. There were 9 male (30%) and 21 female (70%). Grade Point Average (GPA) of them were 3.90 ± 0.11 .

Tale1. Demographic data of samples

Characteristics		Students
Sex	male	9 (30%)
	female	21 (70%)
Grade Point Average		
Mean \pm SD		3.90 ± 0.11

Table2. Was shown bioethical decision making score after 4 weeks of Socio-scientific issues based instruction implementation.

Bioethical decision making	Mean	SD
Identify the problem	11.53	1.40
Explore alternatives	12.33	2.15
Select an alternative	12.27	1.31
Total	12.04	1.68

From table 2 shown that bioethical decision making score after 4 weeks of Socio-scientific issues based instruction implementation. All of bioethical decision making subscales have found explore alternatives were highest of mean score (12.33) and highest of SD (2.15) shown in Figure 2

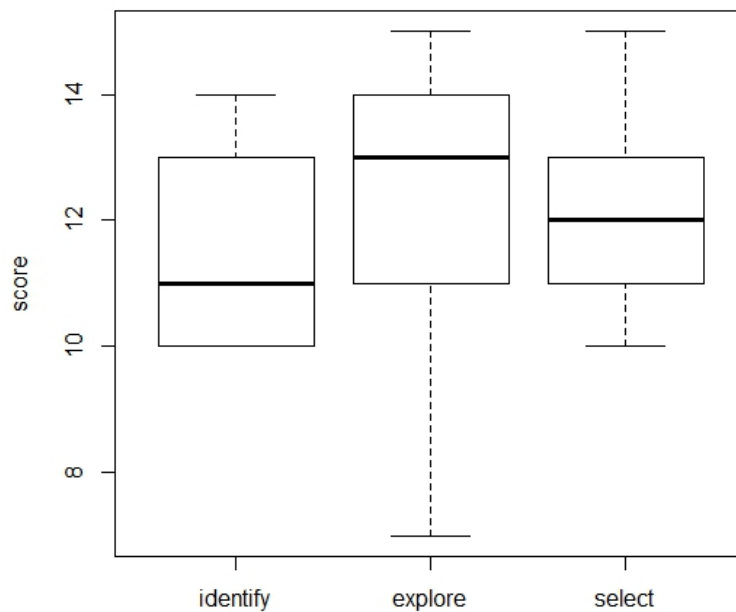


Figure 2: bioethical decision making score.

Table3. Compare mean score between subscales of bioethical decision making in 3 subscales (F-test).

	SS	df	MS	F	Sig.
Between Groups	11.822	2	5.911	2.125	0.126
Within Groups	242.000	87	2.782		
Total	253.822	89			

From table 3 it can be shown that bioethical decision making compare mean score between subscales of bioethical decision making in 3 subscales: identify the problem, explore alternatives, and select an alternative. The score of subscale did not differ statistically significance at the 0.05 level.

The qualitative results of this study in Table4 showed student's answers of 4-items open ended question in-depth interviews after 4 weeks of Socio-scientific issues based instruction implementation.

Table4. Coding of 4-items open ended question in-depth interviews

Items	Criteria modified for coding	Coding
1. What is the environmental problem in your locality?	pollution of air, water and soil. heavy metals, nitrates and plastic are toxins. climate changes, overpopulation, Natural resource depletion, waste disposal, loss of biodiversity, deforestation, ocean acidification, ozone layer depletion, genetic modification of food	Student A: Farmers clear organics leaving before start farm with fires cause of desertification and loss of biodiversity in field, air pollution. Student B: My village has sugar production factories, it produce pollution of air, water and soil, and many invasive plant species in canal. Student C: Farmers use pesticides in the cultivation of vegetables. Student D: There is a lot of garbage each day in village, Noodle factory leave waste water into canal.
2. What is the importance environmental problem in your locality?	deforestation, pollution of air, water and soil, climate changes. (personal)	Student A: Air pollution Student B: Air pollution Student C: Farmers use pesticides Student D: A lot of garbage
3. What is the alternative for problem-solving?	reduce amount of garbage, avoid cutting down trees, protect natural areas. (personal)	Student A: Decomposer and earthworm activate and storage for herbivores in dry season. Student B: Factory audit quality check for social responsibility.

Items	Criteria modified for coding	Coding
		<p>Student C: Made organic farm, balance in ecosystem by predators and producer, use garbage for fermented water.</p> <p>Student D: Reduce garbage for plant nutrients.</p>
<p>4. Which are the possible solutions for the environmental problem?</p>	<p>When selecting an alternative, student will encounter factors that affect their decision making. These factors may include; political factors, safety factors, financial factors, environmental considerations, and ethical factors.</p>	<p>Student A: storage herbs for herbivores in dry season because safe to price of food pet and reduce air pollution.</p> <p>Student B: Factory audit quality check because all participant to help control and citizen no risk respiratory disease.</p> <p>Student C: Made organic farm because reduce toxin in air, water and soil.</p> <p>Student D: Reduce garbage for plant nutrients because safety and good for the environment.</p>

Conclusion and Discussion

Science education must teach students proper decision-making skills that will help them make intelligent choices as both professionals and citizens. Scientific argumentation gives students needed experience in forming educated opinions based on supporting evidence. Most of the students enrolled in this bioethics course will become biology teachers, medical professionals or other biology professionals. Clients and the general public will seek out their opinions and counsel about the controversial issues covered in this class. If their course work incorporates socio-scientific learning throughout the semester and provides them the ability to argue these issues, students will be better prepared to face future bioethical controversies. (Hanegan et al., 2007)

The socio-scientific issues based instruction method has multiple benefits. Engaging in bioethics discussions helps develop students' ability for reasoned dialogue, especially among students with different perspectives. It also encourages students to think about choices from a variety of viewpoints and interests, thus facilitating respectful discussions of potentially contentious issues. These skills are fundamental for an effective democracy.

From the result shown that table 2 shown that bioethical decision making score after 4 weeks of Socio-scientific issues based instruction implementation. All of bioethical decision making subscales have found explore alternatives were highest of mean score (12.33) and highest of SD (2.15). This also supports the study of Gunn et al., (2006) that socio-scientific issues can establish deeper critical thinking and respect of the diversity of opinions among students when they are free to express themselves. The qualitative results of this study in Table4 showed student's answers of 4-items open ended question in-depth interviews after 4 weeks of Socio-scientific issues based instruction implementation. This also supports bioethics provides a real world context for introducing and underscoring the "need to know" science concepts, this supplement gives students an opportunity to prepare for the scientific, medical, ethical, personal, and public-policy choices they will face as adults in the 21st century. Moreover, how the teacher processed previous events in the classroom played a very important role in making students more engaged in their classroom activities.

However, interpretation and generalization of the result should be done with the concern of some limitations. First, outcome assessment of this study has based on perceived skill or perceived knowledge not based on actual knowledge which measure by score on examination. Second, this study was one group posttest only design which have not had control group such as traditional teaching group for true comparison.

The socio-scientific issues based instruction can therefore be a timely approach to enhance the bioethical decision making of high school students. This expands the strategies in basic of biology classroom to be taught in a proactive manner focusing on the enhancement of students' bioethics decision making skills.

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