

Effects of Bioethics Integration on the Critical Thinking and Decision-Making Skills of High School Students

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Abstract. Students nowadays are becoming responsive and aware of their rights and privileges. As such, educational institutions started to develop the cognitive skills of students such as their critical thinking and decision-making skills across disciplines. This study focused on Bioethics Integration in high school Biology classes to determine its effects on the critical thinking and decision-making skills of the students. Using a quasi-experimental research design, results of the *t*-test on the pre- and post-test mean scores of students significantly revealed that Bioethics Integration is another useful approach in teaching high school biology. Various teaching strategies were employed in teaching such as moral games, debates, and group case analyses. In this study, the positive effects of Bioethics Integration were influenced by factors such as interactive teaching strategies used, timeliness of the topics, and teacher's questioning strategies. Group work and collaborative effort in most of the activities of students enhanced their capacity to communicate well allowing them to gain respect from their peers for their opinions—the first step in developing ethics in the learning environment.

Keywords: bioethics; biology education; critical thinking skills; decision-making skills

Introduction

The continuous advancement of biotechnology and cell biology during the past decades has been coupled with ethical issues (Hails, 2004). The benefits and risks of these biotechnological advancements like genetic engineering, stem cell research, cloning, the Human Genome Project, Genetically Modified Organisms (Hails, 2004) and their social acceptance comprise most of the issues. This scientific dilemma has propelled educators to make their students more informed and critical in judging such issues. In scientific researches, ethics has emerged with the gruesome medical experiments on genetics concerning the

Human Genome Project and the clinical trials during its completion stages (Terec-Vlad & Terec-Vlad, 2013). Thus, there have been efforts to reinforce more of bioethics especially in research institutions.

Initially, with the aim to address and lessen public misinformation, bioethics education began to be included in the tertiary education curricula with emphasis on medical and health issues such as gene therapy and euthanasia. In these curricula, most of the topics are geared towards the training on heightened sensitivity of students on ethical issues and values in medicine. This is to ensure that science and technology are used to protect rather than endanger human dignity, health, well-being, and diversity (Selvakumar & Joseph, 2004).

Skills in dealing with ethical problems arising in the healthcare environment are given more emphasis and in fact taken as obligatory continuing medical education requirements (Robb, Etchells, Cusimano, Cohen, Singer, & McKneally, 2005). According to Turrens (2005), the inclusion of bioethics in the biomedical sciences program improved the awareness of students on the current bioethical problems and issues concerning professional integrity. In Malaysian Law schools, bioethics is simultaneously discussed with Medical Law courses focusing on medico-legal issues such as medical negligence, informed consent, euthanasia, abortion, organ transplantation, brain death, and stem cell researches (Kamilan, Ashiqin & Amin, 2011).

The burden of establishing morally acceptable practices falls on everyone. Thus, there is a need to extend beyond the professional communities of the bioengineering and biotechnology industries for thoughtful engagement in bioethical decision making (Lee, 2011). Since it has been offered in the tertiary education, secondary students also need to be informed not only about the significant facts and theories of the natural sciences but also the conflicts of values and ideals arising from the practical applications of these facts and theories.

Most of the time, students' curiosity is focused on the environment around them. In fact, the continuous advancement of biotechnology and bioengineering has caught a lot of their attention (Urker, Yildiz, & Cobanoglu, 2012). As a result, there is an inherent tendency for them to ethically question them and this can be answered and enhanced through bioethics integration in science classes. This may set the role of bioethics education to impart a set of skills and attitudes that may give students the opportunity to explore current social and ethical questions in a professional and personal way.

Value judgments in terms of stimulating the moral imagination of students through analysis of key concepts and principles and recognition of ethical issues may help students develop the responsibility to deal with moral ambiguity and disagreement. In fact, recognizing social norms is a secondary measure of performance in value-assessment and is necessary when one reflects on what others think (Parker & Fischhoff, 2005). It is also important to increase public awareness on the newly emerging trends in genetics and biotechnology not only

through media but with well-structured information dissemination in the education setting (de Castro, 2000).

One of the basic goals of education is to train students to become critical thinkers and decision makers. This is to equip them with the ability to assess increasing amounts of information they are presented with from a variety of sources in their everyday lives (Butchart, Bigelow, Oppy, Korb & Gold, 2009). Critical thinking and decision-making skills are two of the skills which can be enhanced through bioethics integration in life science classes because the application of scientific knowledge is one of the primary concerns of the subject matter. In this teaching approach, students will share the responsibility of valuing inquiry on moral issues quite urgent in the world today. This can lead them to better understand and simplify on their own the growing complexity brought about by technology.

While various learning strategies and approaches for teaching ethical aspects of science have been developed in recent years, Asada, Tsuzuki, Akiyama, Macer, and Macer, (1996) mentioned that the exploration of socio-scientific issues helps develop students' self-confidence, enhance critical thinking, enable more balanced consideration of socio-scientific issues, and stimulate sensitivity to the rights of others. Greater understanding and tolerance of the religious, spiritual or secular beliefs, and the cultural traditions and values of others may also be enhanced. Classroom-based resources produced for bioethics education can help build frameworks within which these tensions may be explored in a culturally-informed and respectful environment. This anticipates the involvement of biology teachers in raising controversial issues as well as stressing why decisions about science and technology are made (Jones, 2007).

Bioethics integration can therefore be a timely approach to enhance critical thinking and decision-making skills among secondary students. Science, which plays a major role in the changing physical world, can be taught in a proactive manner that aims to develop the critical thinking and decision-making skills of students.

Method

This study used the quasi-experimental design with non-equivalent group of research participants who belong to the Grade 8 level from two intact classes in a Philippine public school in Region 4A. In the Philippines, grouping of students in sections is usually done prior to the formal start of classes in June. Because of this, the researchers were not able to do discretionary measures to re-group the students. However, according to the school officials, the student groups were heterogeneous, meaning; these students were not grouped according to intellectual capability.

During the study, one group was exposed to Bioethics Integration (Bioethics Integration Group) while the other group was not (Conventional Group). Both

groups took the pre- and post-test of the Quantitative Critical Thinking Skills Survey (QCTSS) and Decision-Making Skills Survey (DMSS).

The QCTSS was an instrument designed around the cognitive processes of analysis, inference, and evaluation. Six passages on food biotechnology were presented followed by 2 to 4 multiple choice questions each. Each of the items in the instrument was worth one point with a maximum of fifteen (15) points.

The DMSS, on the other hand, is composed of items which were mostly focused on bioethical issues concerning biotechnology, environmental degradation and cancer research. Four scenarios with two (2) to three (3) open-ended questions were constructed that aims to measure the decision-making skills of students. Each of the questions ranged from 2 to 5 maximum points as indicated. In this instrument, students were required to process the information presented and make decisions considering scientific, technological, ethical, moral, and public policies. Three raters assessed the student answers using a rubric which was subjected to inter-rater agreement (Cohen's kappa).

The instruments were pilot tested to 30 peer-teachers in the field of Biology and 39 Grade 8 students of the school year 2011- 2012. Both groups were chosen based on the assumption that the lessons to where bioethics will be integrated were already familiar to them. Both instruments were subjected to item analyses followed by modifications based from the result of the pilot testing. Reliability and validity analyses were ensured prior to the start of the teaching intervention/data gathering. The difference between the pre-tests and the post-tests were compared within and across groups to determine if the intervention had an effect on the critical thinking and decision-making skills of the students.

Results and Discussion

The burden of establishing morally acceptable practices falls on everyone. There is therefore a need to extend beyond the professional communities of the bioengineering and biotechnology industries for thoughtful engagement in bioethical decision making (Sleeboom-Faulkner & Hwang, 2012). Since it has been offered in the tertiary level, secondary students also need to be informed not only about the significant facts and theories of the natural sciences but also the conflicts of values and ideals arising from their practical applications. In this quasi-experimental study, it was observed that the integration of Bioethics in the biology lessons of students significantly improved students' critical thinking skills as shown in the Table 1.

Table 1. Independent samples *t*-test for the pre- and post-test mean scores for the Quantitative Critical Thinking Skills Survey (QCTSS).

Measure	Group	Mean	SD	df	<i>t</i> -ratio	Sig. value
Pre-test	BI Approach	6.25	1.84	72	1.44	.153
	Conventional	5.61	1.99			
Post-test	BI Approach	8.14	1.73	72	2.25	.028
	Conventional	7.21	1.82			

Aligned with the objective of the TIMSS which is to train students towards higher-order 1 thinking skills in science, Bioethics Integration is therefore a very timely effort to address this objective as seen from the results of this study. This is in accordance to the objective of science which is to prepare students to become active and responsible within a technologically-based society. According to Nelson (1994), enabling students to think critically is one of the central objectives of liberal and professional education.

The results of the study support Kennedy, Fisher, and Ennis (1991) that the early training of students to think critically results to the appropriate use of their basic science process skills to find logical answers to everyday problems. It further supports the claim of Gleason, Melancon and Keline (2010) that the aim of scientific literacy should be the training of students to evaluate and express their positions on both local and international issues. In this study, the early exposure of the students to bioethical issues is a significant start to awaken their critical-mindedness in assessing socio-scientific issues.

Table 2 presents the related samples *t*-test which also supports the significant improvement of the critical thinking skills of students through Bioethics Integration.

Table 2. Related samples *t*-test for the pre- and post-test mean scores for the Quantitative Critical Thinking Skills Survey (QCTSS).

Group	QCTSS Pre-test Mean	QCTSS Post-test Mean	QCTSS Pre-test Standard Deviation	QCTSS Post-test Standard Deviation	df	<i>t</i> -ratio	Sig. value
BI Approach	6.25	8.14	1.84	1.73	35	4.46	.000
Conventional	5.61	7.21	1.99	1.82	37	3.58	.001

Questioning is considered to be one of the most important tools for educators to encourage critical thinking among students (Khan & Inamullah, 2011). In this

research, the teacher's questions were mostly focused on developing the critical thinking skills of students. Because of this, students were forced to do higher-order thinking skills in order to answer their teacher. When questions are structured at higher levels, there is more opportunity for the students to engage in critical thinking. This leads to increased class participation.

In this study, the teaching method employed by the teacher was augmented by the teacher's questioning skills where questions were mostly focused on analysis, synthesis, and evaluation. Kerry (2002) claimed that questions play an important role in the processes of teaching and learning. Moreover students' achievement and level of engagement depend on the types of questions teachers ask. It is therefore important that teaching and learning be set to a social activity where teachers and students construct and synthesize knowledge mutually through active processing, thinking about, and using information productively (Mauigoa-Tekene, 2006). This means that teachers' questions are imperative to students' learning. They mediate the interactive processes in the learning environment in a number of important ways and that questions that teachers formulate and ask are considered to be cues and clues which focus the students' attention on what needs to be learned.

Aside from higher-order questioning during lecture-discussions, the teacher also asked the students to do group analyses of socio-scientific issues with teacher-initiated questions and gave them the opportunity to do collaborative thinking. Through this method, the students were able to respond in a positive, more elaborate, wider range of explanation, and in-depth manner indicating improved critical thinking and decision-making skills. This is aligned with the results of the study of Macer (2004) that the use of socio-scientific issues made students aware of the balanced risks and benefits of science and technology development with reasoned arguments. In this study, the teacher's prompted questions therefore, served and led students in preparing their own related questions that eventually enriched the classroom interactions. This supports the claim of Khan and Inamullah that "questions should be asked to individual pupils, to the whole class, or to small groups to arouse curiosity, focus attention, develop an active approach, stimulate pupils thinking, structure the tasks, diagnose difficulties, communicate expectations, help children reflect, develop thinking skills, help group reflection, provoke discussion, and show interest in pupils' ideas."

According to Mauigoa-Tekene (2006), if students' learning is to be promoted in ways consistent with contemporary learning theories, then training teachers to ask high-level questions in appropriate ways is essential. Similarly, as the knowledge society dominates the new millennium, teachers need to make more informed decisions pertaining to students' learning for better achievement outcomes. Based from this study, by understanding the arguments and views of students through Bioethics Integration activities, students' academic performances can be improved.

In most of the group activities, case analyses of bioethical issues were presented to the students. This allowed them to experience real situations that offered them the chance for direct data analysis including consideration of the outcomes (Popil, 2011). This approach served as a venue for the students to experience a dynamic environment where they were exposed to decision-making and problem solving. Most of the time, students presented arguments that are in harmony with their group claims. According to Popil (2011), when students are subjected to analysis of issues in a democratic way, students give immediate feedback since it incorporates active learning and promotes decision making in a non-threatening environment. According to Kunselman and Johnson (2004), this approach is of great help in making teachers rethink their strategies of teaching, renew their interest towards the course material, and create a higher level of enthusiasm for them.

In the field of educational research, decision-making skills have gained attention. In science education, researches are focused on how students' decision-making skills would contribute to their values and enhance their critical thinking skills (Davies, 2004). Coles and Norman (2005) noted that these values have important influences on designing behavior. It can also be said that decisions are affected by preferences, opinions, emotions, and culture characteristics (Mettas, 2011). In this study, it is clear that since students were constantly trained to make decisions through class activities, they have developed the values necessary for positive cognition.

Since decision-making skills are considered higher-order thinking skills, it was assumed that only top performing students can acquire such skills especially in the basic education setting. In this study, results show that even students in the lower sections (students not included in the honors section) can also develop this skill if only given the chances by their teachers. Thus, teachers play a crucial role in developing this cognitive skill among their students. Their reflections about previous classroom interactions determine their plans and expectations of what they wish to happen next.

Similar to the results of the QCTSS, Table 3 reveals the significant improvement in the scores of the students in the DMSS.

Table 3. Independent samples *t*-test for the pre- and post-test mean scores for the Decision-Making Skills Survey (DMSS).

Measure	Group	Mean	SD	df	t-ratio	Sig. value
Pre-test	BI Approach	11.03	2.51	72	1.29	.202
	Conventional	10.39	1.65			
Post-test	BI Approach	22.39	1.78	72	10.78	.000
	Conventional	18.29	1.49			

Prior to this study, it was hypothesized that students could not possibly express their opinions on issues they were presented with. Because of this, the teacher decided to accept all students' responses to arrive at a unified decision during informal debates. Through this approach, students became more open and confident in communicating their opinions. This accounted for the positive effects of Bioethics integration on the students' performances. This result is supported by the study of Pomahac, Gunn, and Grigg (2007) that bioethical issues established deeper critical thinking and respect of the diversity of opinions among students. Moreover, Quitadamo, Brahler, and Crouch (2009) confirmed that when group work is applied in most classroom activities, students' performance is enhanced due to the opportunity to solve problems in an interactive manner.

Similar results were drawn from the study as shown in Table 4.

Table 4. Related samples *t*-test for the pre- and post-test mean scores for the Decision-Making Skills Survey (DMSS).

Group	DMSS	DMSS	Standard	Standard	df	<i>t</i> -ratio	Sig. value
	Pre-test Mean	Post-test Mean	Deviation Pre-test	Deviation Post-test			
BI Approach	11.03	22.39	2.51	1.78	35	24.00	.000
Conventional	10.39	18.29	1.65	1.49	37	23.43	.000

In this study, Bioethics was integrated in the BI Group through various ways such as argumentation/debate activities, case analyses, and moral games to enhance the students' critical thinking and decision-making skills. It is the aim of Bioethics Integration to minimize rote learning and teacher-centeredness so as to make students more aware and responsible regarding the emerging trends in Biology.

During the early classroom sessions, it was observed that students were slightly passive but as the intervention went along, they openly communicated with their teacher leading to an active learning environment. This can be attributed to the teaching approaches used to which the students were exposed. Because of the constant interactive activities in class, students had sufficient opportunity to develop their critical thinking skills as they participate actively in the learning process (Yahya, Sidek & Jano, 2011). Studies claim that the social interaction between students has a positive effect on the development of critical thinking and decision-making skills both of teachers and students. Van Amburgh, Devlin, Kirwin, and Qualters (2007) claim that in this teaching approach, active learning is emphasized so that students think about what they are doing. As such, since students are trained to manage their own opinions, they develop the ability to work collaboratively with enough consideration of others' opinions which is a component of ethics in the learning environment. Proponents of collaborative thinking (Totten, Sills, Digby & Russ, 1989) claim that through collaborative thinking, "students are actively exchanging, debating, and negotiating ideas within their groups, thus increasing their' interest in learning."

Most of the time, students' curiosity is focused on the environment around them. In fact, the inevitable advancement on biotechnology and bioengineering has caught a lot of their attention. As a result, there is an inherent tendency for them to make sense of it through ethical questioning which can be enhanced through Bioethics Integration. This may set the role of bioethics education to impart a set of skills and attitudes that may give students the opportunity to explore current social and ethical questions in a professional and personal way. Value judgments in terms of stimulating the moral imagination of students through analysis of key concepts and principles and recognition of ethical issues may help students develop the responsibility to deal with moral ambiguity and disagreement. In fact, recognizing social norms is a secondary measure of performance in value-assessment and is necessary when one reflects on what others think (Parker & Fischhoff, 2005). It is also important to increase public awareness on the newly emerging trends in genetics and biotechnology not only through the media but with well-structured information dissemination through education (de Castro, 2000).

While various learning strategies and approaches for teaching ethical aspects of science have been developed in recent years, Asada, Tsuzuki, Akiyama, Macer, & Macer, (1996) mentioned that the exploration of socio-scientific issues helps develop students' self-confidence, enhances critical thinking, enables more balanced consideration of these issues, and stimulate sensitivity to the rights of others. Greater understanding and tolerance of the religious, spiritual or secular beliefs, and the cultural traditions and values of others may also be enhanced. Classroom-based resources produced for bioethics education can help build frameworks within which biology lessons may be explored in a culturally-informed and respectful environment. This anticipates the involvement of biology teachers in raising controversial issues as well as stressing why decisions about science and technology are made (Jones, 2007).

Conclusion

One of the basic goals of education is to train students to become critical thinkers and decision makers. This is to prepare students to become more informed of the issues which the current society is facing because of biological advancements. Critical thinking and decision-making skills are two of the higher-order thinking skills which can be enhanced in the life science classes because the application of scientific knowledge is the primary concern of the subject matter. In this teaching approach, students will share the responsibility of valuing inquiry on moral issues quite urgent in the world today. This can lead them to better understand and simplify on their own the growing complexity brought about by technology. Bioethics integration can therefore be a timely approach to enhance critical thinking and decision-making skills among secondary students. Science, which plays a major role in the changing physical world, can be taught in a proactive manner that aims to develop their higher-order thinking skills.

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