College Students' Decision-Making Tendencies in the Context of Socioscientific Issues (SSI)

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Abstract: This study aimed to identify some tendencies when college students got to making a decision on socioscientific issues. The guiding research questions were as follows. First, what are college students' tendencies in terms of their moral reactions and attitudes toward SSI when they get to making a decision? And second, how do their own circumstances, personalities, and values play a role in shaping their stance on SSI? Data was collected by individual interviews with thirty college students. The results indicated that most participants immediately brought in their own values, worldviews, and feelings in implicit or explicit ways when talking about SSI. Their reactions were influenced by their backgrounds such as religion, and family background, personality, past experiences, personal interests, and prior knowledge. In addition, the responses of the participants presented some tendencies in their decision-making process. The tendencies can be categorized into 1) bringing in personal values without further engagement, 2) being confused with incompatible values, 3) being overwhelmed by too many aspects to consider, and 4) trying to be detached from the issues.

Key words: Socioscientific issues, SSI, moral reasoning, decision-making, college student, qualitative research

I. Introduction

Teaching socioscientific issues (SSI) has stood out in relief as corresponding to the demands of current societies and as following the major trends in science education. A considerable number of studies have investigated students' decision-making on SSI. A big party of the studies has focused on students' learning specific knowledge (including the controversial nature of SSI, multiple perspectives, and the social and human aspects of contemporary SSI) and its effects on their decision-making on SSI (Kolsto, 2001; Mertens & Hendrix, 1990; Sadler & Zeidler, 2005). Another party of studies has categorized students' reasoning patterns in relation to their personal background, values, experiences, and emotions (Bingle & Gaskell, 1994; Fleming, 1986; Gayford, 1993; Geddis, 1991; Hogan, 2002; Ramsey, 1993; Ratcliffe, 1997; Zeidler, 1997). Using SSI as learning contexts, these studies suggest practical implications for enhancing students' knowledge and skills.

However, two concerns can be brought up from those common approaches to SSI. First, students may get to their own decision to please their teachers and do not try to focus on their own deeper values. As an example, Dawson and Taylor (1999) in their study on a 10th grade' biology class regarding bioethical dilemmas, quoted several student reactions. One of the girls named Katie said, "Now, I tend to think more about all sides of an argument. Like with transplantation, I think about the recipient, the donor, and others involved.… It didn't matter what your opinion was. It was the argument that was important" (p. 61). And Frances agreed with Katie and said "It [the course] made me think more carefully instead of deciding straight away…. I know you can be wrong, but most of it is your decision, and as long as you can explain your decision, it's okay" (p. 60-61).

Second, students get only a partial understanding of the issues by just practicing to link scientific knowledge and skills to real-world problems. During the class, students only focus on gathering balanced information and fitting it into the situation, rather than putting their

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efforts to understand why the issue occurred, how all the information is interrelated, what their priority is, and so on. For instance, Ratcliffe (1997) explored two levels of groups of students about their decision-making skills on the issue of energy efficiency. She pointed out that the lower level students seemed "happy to go along with the views of others with little questioning" (p. 174). Students tended to only look at the information they had, and trying to make a final solution without knowing how their activity or decision was meaningful to them, why they needed to think about different options, and how the activity related to their life in a broader view.

In order to lay a good foundation for educating responsible citizens, we need a broader vision of education that fosters the development of whole human beings beyond teaching knowledge and skills. A primary reason is that there are some phenomena suggested by the research (e.g. Connell, Fien, Lee, Sykes, & Yencken, 1999; Hillcoat, Forge, Fien, & Baker, 1995; Simonneaux, 2001). That is, some students may be overwhelmed by the magnitude and complexity of SSI, and the multitude of related issues which the given SSI immediately spawn (Sadler, Barab, & Scott, 2007). For instance, Connell et al. (1999) explored the environmental attitudes of 16 to 17-year-old students living in two cities in Australia — Hillcoat *et al.* (1995) is a pilot study of the study — and suggested the common reactions of these feelings (e.g. "I feel really helpless. What can I do? I'm a 16-year-old kid in a classroom. I've got all these views, but what can I do about it?" p. 100). Students in this study often expressed pessimism or cynicism about the inevitable consequences of rapid economic development (e.g. "What else can you do? People need homes," p. 100). Another interesting reaction which the authors mentioned was a strong sense of "ambivalence." It indicates that the students faced moral conflicts and so could not take a clear moral position. This is the general state of students in relation to environmental issues. Connell *et al.* (1999) recognized the seriousness of this phenomenon because it may bring about more serious problems such as helplessness and overwhelming feelings of environmental concern mixed with frustration and cynicism. A similar phenomenon is shown in Simonneaux's (2001) study which observed French second-year upper secondary vocational education students' ways of making decisions regarding animal transgenesis issues. She found that students used more "restrictions" or "guarantors" in their decisions after role-play and debates regarding the issues, such as "but," "unless" "in favor as long as" (e.g. "Only if the products are known to be 100% safe," "only if it's safe for nature, animals, and consumers," p. 922-923, see Tables 9 and 10). Such qualifications seem to indicate, on the one hand, that students are thinking more carefully after the activities, but on the other hand, they may indicate that students experienced conflict in their minds or difficulties in making a decision, and compromised their values to some degree by using the guarantors. Regardless of the significant phenomena, these studies did not much pay attention to their moral reactions and attitudes toward SSI. Without considering how students felt and morally reacted when encountering the issues, the authors tended to only look at their argument on the issues. However, it is definitely important to take account of students' inner state and attitudes in decision-making because decisions should be made on the basis of their deep-rooted ethics and values (Aikenhead, 2003).

In this study, therefore, having informal conversations with college students where they feel secure to operate freely and to say whatever is on their minds, we attempt to explore their state of mind when they get to making a decision on certain SSI (e.g. animal testing/ experimentation, genetic engineering, and human cloning issues) and to identify some tendencies toward their decision-making process on the issues. It is expected that understanding students' inner reactions and its tendencies

would provide valuable implications on in what ways science educators can help them to be more responsible toward SSI as citizens. The guiding research questions are as follows:

First, what are college students' tendencies in terms of their moral reactions and attitudes toward SSI when they get to making a decision?

Second, how do their own circumstances, personalities, and values play a role in shaping their stance on SSI?

Ⅱ. Methods

1. Participants

This present study expanded the pilot study (Lee, Choi & Chang, 2006). In the previous study, we conducted one-hour interviews with 16 college students and identified overall patterns and characteristics of their decision-making with SSI. From the study, we found some tendencies in terms of their moral reactions and attitudes toward SSI. In order to confirm our findings and identify more general patterns, we recruited a new group of 14 students and conducted two times of individual interviews with them (about 40 minutes per each interview), and re-analyzed all the 30 college students (20 females and 10 males) together. They all were enrolled in Educational Psychology courses in U.S. and some of them were planning to get a teaching certificate, while others took the course because they were interested in teaching. The participants were heterogeneous in terms of academic background, ethnicity, and school year.

2. Interviews

Unlike the methods used in the previous related studies on SSI, specific contexts relating to the issues (e.g. Huntington disease, etc.) were not given to the participants because this study more focused on in what ways the students related to the issues using their own values in a natural atmosphere, rather than which specific decision on the issues they made. In addition, we believed that in the atmosphere where the participants could naturally talk about whatever feelings or thoughts came to mind, the overall state and reactions of the students could be more genuinely explored. Namely, we adapted the basic philosophy of the essentialist approach (Lee, 2008; Witz, Goodwin, Hart, & Thomas, 2001; Witz, 2006; Witz, 2007). The methodology is designed to explore fundamental and personal aspects of individuals (i.e. values, concerns, state of mind, personal experiences, feelings, philosophy, etc.). The essentialists try to understand a person as a whole, not a single response (or paragraph) from the person.

A semi-structured interview protocol was used. The participants were asked to respond to questions regarding their feelings and attitudes toward the issues of human cloning, genetic engineering, and animal dissection/ experimentation. The second interview for the fourteen students was sequential so that the later interview explored incrementally one or more specific hypotheses based on what had emerged in the preceding interview. All the interviews were audio-taped and transcribed and pseudonyms for each participant were used.

3. Data Analysis

The results were presented in the form of case studies which present details of each participant's decision-making process, and a cross-case discussion to identify themes and patterns across all 30 participants. First, we selected two students which could present clear tendencies. In order to construct the case studies we, carefully listening to the tapes and transcripts over and over, tried to identify major aspects of each person which relates to decision-making on SSI and to evoke the image of the participant's state of mind when taking a stance on SSI. Many excerpts with commentaries were

inserted for each case study to contain a richness and complexity of each individual's state of mind (Lawrence-Lightfoot, 1997; Witz, 2006, 2007). Cross-case discussion of the thirty participants followed the two case studies. Cross-case analysis does not merely pursue finding similarities and differences among the participants' responses to particular topics. Rather, we tried to rise above the individual cases and to identify larger patterns or tendencies that conveyed the current state of the students' thinking (Witz *et al.*, 2001). Since this study is an expansion of the previous study, some of the excerpts are used in both studies. In order to validate our findings, two authors kept collaborating in analyzing data and attempted to make a consensus on the interpretations.

Ⅲ. Results

1. Two Cases

1) Suzanne

Suzanne is a Caucasian and a graduate student studying Agriculture Education. She reminds us of a watercolor landscape of farms. She grew up on a farm and her family members have been involved in agriculture for a long time. She was glad to tell stories of living on the farm, and sincerely told me whatever she felt.

a. Her Aspiration to Participate in Agriculture

Agriculture has always been around Suzanne. She has always been surrounded by soil and air, beans and corn, pigs and chickens, tractors and combines, and so on, and is used to seeing, smelling, touching, and riding on them. All her memory is filled with them. These are a force to lead her back to agriculture.

> Everybody's perception of it is that, you know, farmers plant corn, they plant beans, they harvest it. And it's so disheartening because people don't realize what agriculture entails, like agriculture is involved in everything in some form, and not just the normal perception of agriculture, you know. Agriculture is the soil, it is the air, the plants, like it's a whole — everything that affects you is related to agriculture somehow. A lot of people just don't make that connection.

Agriculture is the source of her inspiration. Most people are likely to come up with a simple image of agriculture; for instance, farmers plant corn and beans and harvest them every year and raise chickens, pigs, and cows. However, agriculture is much more than that. It has motivated her to devote herself to teaching people about agriculture and how closely they are related to agriculture. In spite of her aspirations to participate in agriculture, ironically, she has never actually been involved in farming: "I've never physically been planting the corn in the ground, or harvesting the corn, or spraying or whatever." Agriculture gives her a beautiful feeling or image such as that of a peaceful landscape painting that she holds in her mind, but she only appreciates the image from a certain distance and accepts it as part of her childhood environment and memories.

b. Her Way of Moral/Ethical Engagement on SSI

One of the dominant things in Suzanne's story is that, to her, science only becomes meaningful by being seen through and assimilated to agriculture.

> ···Raising a cow, raising a sheep, growing a stalk of corn, how the soil quality and soil run off and the environment have effect — and so I consider that all to be science. In my eyes I consider that to be science, and that's how agriculture relates to science because it is science. ··· The more I realized how related what I want to do is to science, I guess the more appreciation I have toward science··· And so I guess the fact that, for me personally the fact that agriculture is so closely related to science, makes me think

> that science is a worthwhile thing because it's a really easy way for me to get my personal opinions in without totally being out of the ball park on the relationships…..

In high school, science as a subject matter did not have any meaning for her. She just "hated science subjects." However, as she realized that agriculture is so closely related to science, her feelings toward science changed. Science has become meaningful and worthwhile.

Since science is practically absorbed in agriculture for her, her engagement with SSI — especially, animal dissection/ experiments and GMO issues — is assimilated to engagement with agriculture, which is always morally and ethically non-problematic. It is easily pictures of a small school in a rural community, where at least half of the students do farming and feeding cows or pigs is a part of their everyday life. They can see dead animals on the way to school or being killed for rural feasts. These things happen often on a farm; neither is a big issue. It is natural that the issue of animal dissection did not bother her or the other children.

> It (animal dissection) didn't bother me because I guess the way I figured it was animal control because, you know, there are a lot of cats out there, and the reason those cats probably got killed in the first place, you know, they weren't just killed for this purpose. I'm assuming, and maybe that's a big assumption, but I'm assuming they weren't just pulled off the street or pulled out of someone's back yard and killed for dissection purposes. I'm assuming they were strays, they were you know, in the pound and they were going to be killed anyway. I guess that's the way I rationalized in my head, you know they were going to be killed anyway, so at least we can use it to benefit from them. I know that sounds really bad, but…

The excerpt reveals how her moral values and her moral decisions are synchronous with her personal background. While dissecting animals, she did not feel any guilt. However, she would feel something was wrong if somebody bred and killed animals only for dissection — because this does not happen naturally on farms. This would cause a moral conflict in her. Thus, she immediately set up an assumption to justify her thoughts — "they weren't just killed for this purpose" and brought in a moral principle — "usefulness."

> If we can use them (animals) to benefit us in some way, then at least their life and death is worth it. If we're just breeding animals, like the pig hearts or whatever, whatever it is. I think it's pig hearts. If we're just breeding pigs to get their hearts for human animal transplants, I have a little bit bigger problem with that than I do with the random use of dissection.

She continues to develop and justify her thoughts. She knows that breeding and killing animals for a certain artificial purpose is not morally right, but she closes her argument with the justification; if the animal was abandoned by its owner and it is going to get killed, then at least it can go to a good purpose. Animal dissection may be another way to get benefits from them.

Suzanne responds to the genetically modified organism (GMO) issue in a similar way. Presumably, raising healthy animals, increasing crop production, and maintaining rich soils are major concerns for farmers. In this sense, this issue is not as problematic to her, just as animal dissection.

> I guess, if we have that luxury now, we may as well use it (GMO) and not worry about what's going to happen because we're all going to die some day. It's no little fact. You know, if you eat modified corn oil in your French fries, what difference is that going to make than eating regular corn oil and

> French fries, because it's still French fries. The only difference is what it's cooked in. I guess it doesn't bother me having hormones in cows, in my beef, in my dairy. I guess it doesn't bother me, because I just figure that's just part of it, and if it makes the production line better, for the beginning and the end, then that's what's important.

Both her general view on her life and her assertion about the GMO issue are revealed. To her the issue is not problematic. She strongly says, "It's still French fries" as if asking what the problem is. Rather, technology is useful for increasing the yield of potatoes and improving the taste. She seems to make her own peace about complex social issues.

2) Greg

Greg is a senior who is studying history as a major and getting secondary education certification as a minor. He is an European American, and his parents immigrated to the U.S. before he was born. His parents had lived in the countryside in the south of Italy, which was a poor area, and then moved to the north, and then came to the U.S. in the 1970s. He seemed so proud of his parents' country; he said, "Wow, history's really cool. You go to Italy. You see these buildings that are two thousand years old." He had immersed himself in the history of Italy.

His predilection for history and politics seems to have come from his family. Whereas his mother comes from a family active in the Communist Party, his father is a capitalist. His parents often discuss the Italian politics with him. In that atmosphere, he formulated his general assumptions about the world even though he does not specifically articulate them. The world is made up of innumerable social systems which incessantly interact with each other in certain ways. His favorite activity is comparing and discussing different systems and their interactions, such as how a system (e.g. Communism or Capitalism) works or how a system is different from others.

a. His Image of Science

How does a student who is fond of talking about history and politics feel about science? In what ways does he accept science compared to history or politics? He started to tell his school experiences, which probably influenced his attitudes toward science.

> Um, I think I'm a little biased. Like, I'm not a big fan of science. I think a lot of it has to do with, like I went to a Catholic school first through twelfth grade. So in my case, I think there was less of an emphasis on science and more of an emphasis on religion. I think, like a lot of the teachers I don't know if they didn't want to discuss science, but like they were paid to make us into good Catholics, and they didn't want to, like, teach us controversial science, or technology science that might conflict with our Catholic world.

He went to Catholic schools; however, he does not believe in God. From his tone at the end of the excerpt, he seems a little cynical about Catholics. His image of science is implicit in his views of Catholicism. First of all, science is controversial, whereas Catholicism pursues an absolute principle, and so a conflict area might exist between science and religion. The following excerpt shows his stance on science more clearly.

> I'm sure science interferes with our life, but like I don't think about it. Like, I just don't think like, I know that chemicals are all around us and everything, but I take more of like a social aspect of how things interfere with our lives as opposed to a science aspect.

He knows that science has permeated people's lives, but exploring science itself is not his interest. He is more enthusiastic in arguing how science, as one system, relates to society or other

systems. He gives supporting examples during the interview. For instance, he was taking a "Race and Science" class. From the class, he heard that science is not an absolute truth and is used as a tool to rationalize the inequity among different races. To him, science alone is meaningless. This pattern resonates in the next excerpt.

> Science is like such a broad term, just like society's a broad term. Philosophy's a broad term. Like, science is — I don't know. But I think when people hear the word 'science' they think it's more reliable, it's more trustworthy, there's evidence, there's proven theories, there's whatever, so. (Interviewer: How about you?) I think it is. I think that the evidence, not only with like religion, like now I don't believe in God, and I look more towards like a scientific aspect. ….When I think (about science), I don't think about science like chemistry or physics. When I think about science I talk about religion. Like, I'm really — Like I don't believe in God, and whenever I discuss science, it will be in the context of like arguing about religion.

Science has its own qualities; it is more reliable and trustworthy, but it is not an independent entity. His image of science is as broad — neither clear nor indefinable — as that of society or philosophy. Thus, he tries to look more towards the scientific aspect, but science is not easily visible to him.

b. His Stance on SSI

Greg does not have a clear image of science as an independent principle or force, and it always exists with other entities. Thus, he cannot take a certain position on science itself or on SSI.

> I1: How do you feel about human cloning?
> G1: There's a lot of politics involved, but I don't know all the details about human cloning, like I don't when they clone someone, does the person still have feeling?
> I2: Yes.
> G2: Yeah, like or is it just a body? Can it think?
> I3: Yeah.
> G3: Do they experience pain?
> I4: Yeah.
> G4: Hmm, see I don't know. Because, like, I respect human life, but at the same time, like if I had to make a decision right now I would have to say it's okay human cloning is okay just because well, I think it's okay if like certain policies are set in place, like you can't I don't know, it's really tricky because whatever you say, like people are probably going to violate the rules, so it's really hard to say. Just because you have this thing in play saying don't do this, don't do this like people are going to violate those laws, and you have to like, I don't want to say expect those, but it's going to happen. But I think if our goal in mind is to help, like human disease and develop new cures, and whatever, to help humans, then human cloning is okay.

First, it is clear that he does not have enough knowledge about human clones. And in G1, his general assumption is applied, similar to his way of taking a position on science (see the previous excerpt). An absolute and isolated social entity cannot exist. Science is not an exception. So, he speaks about his assumption that the human cloning issue involves politics, even though he does not articulate how politics is involved. And then, he seriously asks several questions about cloning (G1-G3). He is curious about whether the clones look alike and whether they can think, behave, and feel. Although he still seems to be in doubt, he immediately comes up with some responses for me in the beginning of [G4] and justifies them. In the middle of [G4], however, it is clear that he is resigned, giving the sense that his feelings and values do not matter much on the issue. He feels that cloning will continue to

proceed rapidly regardless of his decision on the issues. He feels he cannot make any real difference, and so hesitates to consider the issue further.

With regard to animal dissection and experimentation, Greg responds in a similar way. He brings up his dissection experience in high school, with a frog, a worm, a crayfish, and a fetal pig.

> I'm not scared [in doing animal dissection]. Maybe if it was a bigger thing… [I might be scared]. I didn't have a problem with the fetal pigs, like I didn't recognize it as a real pig, just because when you see pigs on TV, or when I've been around pigs on the farm, like they're big, like this high, three hundred pounds. This, like I didn't view it as a pig. I just viewed it as a plastic thing.

He does not perceive any problem in dissecting animals. He justifies his perception. The pig he dissected was much smaller and did not seem different from a plastic replica. So, the dissection was not problematic and did not bother him. Another justification comes in the next excerpt.

> Umm, I don't think it (animal experimentation) is a big deal. Like I understand that if you don't want to do it, I think there should be alternatives, like if you have like moral or ethical problems with dissection I think those alternatives should be made available, but for me it's not a big deal, like I don't like, I really don't care too much about animal rights. I think humans have their own problems to worry about, so I'm like, yeah, there should be organizations that respect and provide protection to animal rights, but for me, it's not for me.

The excerpt clearly shows his position on the animal dissection/ experimentation issue. He believes that there should be alternatives to animal testing. However, note his response at the end of the excerpt. Everybody has his or her own concerns which are more important to them. Those who are interested in protecting animal rights should have the freedom to do it. But, it is not his concern. He does not want to be involved.

2. Cross-Case Discussions

In general, most participants immediately brought in their own values, worldviews, and feelings in implicit or explicit ways when talking about SSI. Consistent with the previous studies (e.g. Krebs, Denton, & Wark, 1997; Zeidler & Schafer, 1984), their reactions were influenced by their backgrounds such as religion, and family background, personality, past experiences, personal interests, and prior knowledge. For Suzanne, agriculture was the source of her inspiration and so she naturally accepted GMO and animal experiment issues without any problems. And Greg's interest was seeing how everything related to each other. To him, science is an entity that also interacts with other systems such as religion, politics, and society. For this reason, he could not go deeply into the issues or take a certain position on SSI. This phenomenon was also generally shown in other cases. Beyond this, the responses of the students presented some tendencies in their decision-making process. The tendencies are 1) bringing in personal values without further engagement, 2) being confused with incompatible values, 3) being overwhelmed by too many aspects to consider, and 4) trying to be detached from the issues.

1) Bringing in personal values without further engagement

The responses of the participants suggested that most of them did not take the SSI seriously or merely quoted their own values without any further engagement. At least thirteen out of 30 clearly showed this. Students who were included in this category tended to easily come to a final decision on the issues because they counted on the issues on a superficial level without making a connection with their deeper values. Rather, they

immediately set up their own argument to support their spontaneous decisions based on their feelings, knowledge, personal experiences, and interests. In many cases, therefore, they did not experience serious conflict in their mind. Both Greg and Suzanne exemplified this. For instance, even though Greg had not thought much about the cloning issue, he immediately came up with some responses right after asking some basic questions about clones. Suzanne, without any conflict, came to a conclusion based on her image of agriculture. Here are some other examples.

> I'm leaning towards against it. Like just ethical-wise, like animals don't have a voice. They can't really speak for themselves. It depends on what kind of animal, too, that they're using, really. Like rats, I guess it's okay, because they breed rats for that. So it's not like they're taking rats from the wild and just experimenting on them and just doing things to them and then releasing them back out into the wild. But I really don't like it. It doesn't really make me too happy. (Marlin)

> I think, it (human cloning) is unfair to the person who's being cloned. I think it's unfair to the clone itself. Well, I mean, it depends on the research being done. If this clone is supposed to like grow up like a normal human being, it's unfair because it doesn't have the lifestyle of a normal person, and it's not its own person. It doesn't have parents exactly. I don't know. Ugh! I don't like it. (Amy)

> I'm for it like do it, because that would be neat but I don't think it's a great idea. I don't know. It can go either way with me. I have to read more on it, but I'm in the middle right now. I think if you can do it it gets into really tough things. I'm fairly religious, so it's almost like playing God, and I don't believe in that. But for some people, I don't know, it might be good. Like I don't see where it's going to go if we can clone a human, why? Because their personalities aren't going to be the same. They'll be the same looking, but they won't be the same mentally. (Sharon)

Marlin proposed two pieces of evidence to support her position. The first one was from her caring about animals in that animals do not have any right to reject the experiment. And the second one, which seemed somewhat incompatible with the first one, was that her principle could be applied only to certain animals treated in research labs. This way of argument proved that she had merely quoted her values to justify her position and feelings. She did not go into the issue further and rapidly moved to other evidence. Amy was basically against the idea of cloning. She mentioned, "It's unfair" three times. She attempted to explain the reasons why she believed that it was unfair, but she rambled on and finally made a decision based on her feelings — "Ugh! I don't like it." And Sharon did not have a clear idea on the issue: "It can go either way with me" and kept going back and forth without further engagement. She brought in her religious values, but did not get fully into the issue. Instead, she spontaneously spouted whatever thoughts came to her mind.

2) Being confused with incompatible values

The other tendency was that some participants felt unable to make a decision on the issues, and so they blew them off. At least twelve out of 30 clearly showed this pattern. Compared to the first one, students in this pattern attempted to take the issues seriously and bring in their values to some degree, but they could not take a position. They kept going back and forth among their main personal values which are often incompatible, and seriously experienced moral, ethical conflict. Here are some examples.

> Well that's like, I think medicine is like more important because, I mean that's like people's lives are, they want to help people, which I think that they should maybe dissect

> animals for medicine because that's more like of a more special issue because it's like if they were to help people, then I think they should do it, but if they didn't help people then they shouldn't, you know? I don't know. I'm like, I don't know. I'm probably like contradicting myself like five million times, but I don't know. (Marie)

> I really don't know because, I mean, I really have a passion for animals. But you know, the whole thing about it is that we do use the animals to come up with cures for humans. So it's kind of like Do you know what I mean? It's hard because I do have a passion for animals, and I think that their life is worthy of being here. But you know, if you take a human Do you know what I'm saying? It's like how much do you value a human life? So that's a hard thing for me, you know, it really is. (Claudia)

Elsewhere in the interview, Marie was definitely against animal testing for cosmetics because she did not want to hurt animals, but in the case of medicine, she could not make a clear decision. She felt a moral conflict because helping or healing people was more valuable to her even though she felt sorry for the animals. Claudia also had a similar response. The issues were too much for both of them to handle even though they tried to explain them. As shown in the excerpts, they repeated "I don't know" as representing their state of mind. They fell into a serious moral dilemma and so could not find any definite answers.

3) Being overwhelmed by too many aspects to consider

Another similar tendency was that some students felt that the issues were too big to deal with because science and technology development are so rapid and they overwhelmingly have ethical, moral, and social ramifications. Thus, they gave up considering the issues further. This pattern is somehow distinguished from the prior one. Students in this pattern may not seriously encounter moral conflict between their equivalent personal values; rather, they first think of the possible ramifications to be considered and feel overwhelmed by them before experiencing moral conflict. And so they may not attempt to make a connection between their personal values and the issues. Here are some examples.

> I can't really explain it. It's a tricky issue, because it's like, what do you believe, like, where are the boundaries, like how far can you go, but I think it gives, it sort of gives people too much freedom in everything. (Jeff)

> I am still against it because you end up creating an entire human body and I think that humans aren't meant to live forever and we keep going on that ideal that we need to live the longest we possibly can, that will have like major repercussions on society and I just think that cloning in general is a bad idea. (Andy)

Jeff felt that the issue brought up a lot of questions. He was at a loss, and so threw up his hands saying, "I can't really explain it." He did not show a desire to resolve the issue any further. On the contrary, Andy showed strong convictions about human cloning. He affirmed that the ideal of people to want to live forever is wrong. He was afraid that the wrong ideal will lead to unexpected consequences. Even though he strongly believed that it is wrong, he resigned himself because he was overwhelmed by the endless development. People would end up creating an entire human body whether or not he was against it.

4) Trying to be detached from the issues

Some students tried to detach themselves from the issues or did not want to deal with the issues. At least five out of 30 clearly showed this

phenomenon. The students accepted that science has brought many conveniences and benefits to people's lives and deeply permeates their lives, while at the same time, its development has created negative consequences. However, these students hardly regarded SSI as the ones that they needed to be seriously concerned with or feel responsibility for because they already had enough personal concerns to worry about. Thus, they tended to avoid final decision-making on the issues, which usually entails the process of undergoing moral conflict. When asked to talk about animal experimentation, for instance, Greg said that there should be alternatives to animal testing, and he continued: "I think humans have their own problems to worry about…" He did not want to seriously get involved in this issue because he already had too many things to consider in his life. Although he had reached his own conclusions on the issue, he did not make any commitment as to his decision because "it's not for me." Here are some other examples.

> I don't see a problem with it (animal experiments for medicine). I'm not necessarily what you would call like a major animal activist or whatever, like I like dogs. A dog is nice; a cat is nice. But I don't love animals. Animals just aren't my thing. And another reason, I just never had the time throughout my life, with all the athletics, with the different things going on, I've never had the time to pay close attention to those sorts of things. And because I haven't had a lot of experience with them, then I can't really say I love 'em or I hate 'em. They exist. Good! They make other people happy. Great! You know, but it's not a necessity for my life. (Mia)

> I don't think I really think about it (SSI) all that much. It's not that big of a deal to me. I guess I have bigger things to worry about. Just getting through school and paying for school and getting a job after school, so it's not really at the forefront of what I'm thinking about right now. (Bob)

Mia and Bob showed similar reactions to Greg's. They might know that several moral, ethical issues surrounding scientific and technological development were happening out there, but basically the issues to them were issues that had always existed in society. They did not necessarily have problems with the issues because they were already overwhelmed by personal issues. They wanted to be detached from them.

Implications

This study has presented some tendencies that emerged when the college students reacted to SSI in a natural atmosphere. Findings were not very different from those in previous studies of Connell et al. (1999) and Hillcoat et al. (1995). One of the reasons for this phenomenon may be that students are not often exposed to the opportunity to be grounded in terms of their values and morality. They may have learned how to resolve the issues in more efficient ways using appropriate information and skills, but their values are not integrated or not necessarily strong so they have trouble in making connections between a sense of self and issues of the contemporary society. Responding to this situation, Miller (1999) wrote,

> … students should connect with their deeper sense of self, the source of wisdom and compassion. If we are to build a less violent and more compassionate world, we need to nurture this deeper sense of self in our children. Legends and myths often convey in rich images how a hero or heroine overcomes a narrow sense of self and reaches that deeper self, maturing into a full, complete human being. Science can also have a role in developing this part of ourselves. (p. 48)

In order to educate students who are able to relate (or respond) to this condition of the society

and evolve with their attitudes and values in their own spheres, Miller emphasized their "connection" between the deeper self and the environment. Only when making this connection, learning can be deeply integrated in them. Too often science educators overlook this, and instead, see the lack of scientific knowledge and skills as a primary problem. If students cannot answer clearly and logically, science educators suggest that students need to learn more basic knowledge to be informed. However, more information about science does not always ensure holistically developed individuals (Trachtman, 1981). As Miller (1999) said, "we need a broader vision of education that fosters the development of whole human beings" (p. 48).

As the two case studies and cross-case analysis had shown, the students' values were not genuinely a part of themselves enough to enable them to use them in their thinking about issues. Some students overlooked the issues, while other students were interested in the topic; for example, they said that human cloning "sounds cool" or "scary." Most of them neither engaged in the issues further nor made a commitment about their value judgment. Just like the Australian students (in Connell, *et al.*, 1999; Hillcoat, *et al.*, 2001), the students themselves did not have enough motivation to change their own habits. This kind of condition can not easily be changed through teaching or through modeling responsible decisions. The educational focus should not be on merely seeing how students make decisions on particular topics, but on to what extent they naturally engage with the issues of society using their own values as whole human beings.

If they do this, how can we help students to make connections between self and the issues of the contemporary society? This study suggests that students should have opportunities to form personal values and orientations in natural engagement. To give an example of what this might mean, we can use Solomon's (1992) descriptions of student discussions of controversial scientific issues in the DISS (Discussion of Issues in School Science) project. In this project, students from 14 secondary comprehensive schools in the UK that were teaching STS watched 20-minute excerpts from general public TV programs on topics such as genetic engineering, abortion, and nuclear power plants (Solomon, 1992). Immediately after each program, teachers "encouraged the students to form friendship groups, to talk together [about the program] and to record their discussion" (Solomon, 1992, p. 433). The teacher would only help by getting the discussion going but did not participate thereafter. Each class played six videos over the course of a year, resulting in a corpus of over 200 tapes. These discussions, which Solomon categorized as "public understanding of science in the making," were remarkable for two reasons. First, since the teacher was only present but did not participate, the students tended to freely pursue what was uppermost in their minds at the moment. For example students checked with each other about whether they understood the problem (e.g. "R: … and the smoke. Is that what caused it" "J: I think so, yeah." [p. 437]), an example of what Solomon calls "framing discourse." In discussing, they were open to each other and often accepted with sympathetic and non-judgmental attitudes whatever others were doing (e.g. "S: Are you in favor or not?" "P: I'm discussing, I'm discussing." "S: All right." [p.439]). "They exchanged opinions and offered each other hypothetical incidents to see how they might feel and how they would react" (Solomon, 1992, p. 438); and they negotiated different points of view (e.g. "S: Polluted rivers, you'd want more equipment and more money towards it." "W: Yeah, but the biggest challenge they've got though is to try and educate them" [p. 483]). In other words, with the teacher present and listening, it seems students would use natural or normal ways of communicating with each other and would feel safe and secure enough to concentrate on their own understanding and relationship to what

they had seen. Not surprisingly, some of them reacted "on the basis of the value position they had reached and some began to make broader moral judgment" (p. 438) or showed their commitments (e.g. "C. Well, I suppose it is a bit heart-breaking because··· say for instance that you know your child's got some disease and the only thing you can do is terminate it. It feels a bit sad, doesn't it?" "G: Yeah, It's a big commitment." [p. 438]).

And second and equally important, the experience was meaningful to the students and stayed with them. When teachers asked them a week later to write a short piece about the experience, the results fell into three categories: "1. inconclusive - no more than a brief description of the video; 2. a repetition, almost word by word, of the points made by the students during discussion; 3. a repetition of the students' previous argument with more development" (Solomon, 1992, p. 441). So in many cases "the process of reflection continued, ensuring that the ideas were built upon. Even several months later the teachers reported their students referring back to the video topics. This suggests that taking part in small group discussions on such issues can be a durable educational experience" (Solomon, 1992, p. 442). Presumably the students remembered the issues and their feelings, and stands on some of the more detailed aspects connected with the topics. In other words, it is probable such discussions help students realize how they feel and they become clearer about some of their own values connected with the issues.

Another implication is for science educators and teachers. Noddings (2005) critically commented on current educational movements as follows.

> Even when educators recognize that students are whole persons, the temptation arises to describe the whole in terms of collective parts and to make sure that every aspect, part, or attribute is somehow "covered" in the curriculum. [For instance] Children are moral beings; therefore, we must provide character education programs. Children are artistically inclined; therefore, we must provide art classes··· (p. 12).

She seems to ask, "if we teach students science content knowledge and reasoning skills in relation to SSI and provide them moral or character education programs in a collective manner, can we achieve the goal to educate students as "truly responsible" citizens in the future?" She suggests that the current reforms may lack a holistic vision for students and the effort of science educators to lay a good foundation for educating "responsible" citizens also needs to be carefully examined in this sense.

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