Patterns of College Students' Moral Engagement with Socioscientific Issues

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Abstract: This study explored, through informal, conversation-type interviews, how college students relate to science in general as well as to two specific socioscientific issues: human cloning and animal dissection /experimentation. How students "relate" includes what kinds of attitudes they have toward science and socioscientific issues, how seriously they consider and want to engage with these issues, and how they express their opinions or make a decision. The sample (16 college students) was heterogeneous in terms of academic background, ethnicity, and school year. Each interview lasted for about one hour with audiotaping. Results indicated that most participants immediately brought in their own values and feelings in implicit or explicit ways. However, the depth of their personal engagements varied. Most of the participants either did not take socioscientific issues seriously or merely quoted their own values in resignation, seemingly not able to deal with the issues and overwhelmed by many other aspects of the issues. By reflecting on the participants' reactions, the discussion addresses some of the larger issues for current secondary science teaching that involve raising responsible democratic citizens.

Key words: socioscientific issues, decision making, college students

I. Introduction

Almost every day, individuals in contemporary society cope with multitudinous new topics in scientific and technological development. Science - in the sense of primarily trying to understand the natural world and seeking truth - has become an active partner and collaborator with all major societal sectors (business, industry, the military, etc.). In fact, the image of a "truth-seeking" science is not very visible today: the "ethos of science has changed... 58% of all research scientists are located in industry"(Hurd, 1990, p. 413). The initial question of this study is how individuals relate (or respond) to this new face of science and how they develop as responsible citizens in this contemporary society.

With the integration of science into rapid industrial changes, one of the major reactions in science education was to teach scientific literacy, which was identified as informing or empowering individuals about social incidents regarding science (Jenkins, 1992). According to Fensham(2002), this movement is based on two assumptions; one is the pragmatic assumption that "all future citizens will be better able to cope if they have some knowledge and confidence about science," and the other is the democratic assumption that the "quality of science education in schooling will enable citizens to participate meaningfully in the many decisions that societies and politicians must now make about a complex set of socioscientific and sociotechnical issues"(p. 15). That is, the primary concerns of science educators and professional organizations have become more directed to raising students as future citizens in a democratic society, being aware of the social implications of science and technology, and being capable of participating in investigations into and decision-making on socioscientific issues(SSI), and of taking action based on their values and skills.

II. Review of Literature

Educational policy makers and researchers in secondary school science have often stressed the need for creating responsible citizens in adulthood. STS (Science-Technology-Society) holds that students need

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to understand scientific knowledge within related contexts, to be aware of social implication of science, and furthermore, to become capable of making responsible decisions on social issues regarding science and technology(Hurd, 1986; Prewitt, 1983; Rubba, 1990; Yager, 1990). At the policy level, obtaining scientific literacy and responsible decision -making have been consistently mentioned. For instance, in Science for All Americans(SFAA)(AAAS, 1989), the first publication of Project 2061, the American Association for the Advancement of Science determined that a primary goal of science education should be "preparing people (citizens) to lead personally fulfilling and responsible lives"(p.12) and emphasized "helping citizens participate intelligently in making social and political decisions on matters involving science and technology" as one of the criteria in selecting science contents. The National Research Council(NRC)(1996) posited that the most important goal in science education is to raise scientifically literate students - namely, that they are able to "use appropriate scientific processes and principles in making personal decisions" and to "engage intelligently in public discourse and debate about matters of scientific and technological concern" as citizens(p. 13).

All of these reform efforts have resulted in a major call to include SSI in science curriculum. Zeidler *et al.*(2002) state SSI in terms of "the ethical dimensions of science, the moral reasoning of the child, and the emotional development of the student" (p. 344). SSI not only represents the interrelationships of science with different social forces well, but also responds to the need to raise citizens capable of making responsible decisions on a host of issues related to scientific development. In the past, efforts to produce responsible citizens have been motivated by two types of considerations. One is that students should have sufficient knowledge (be sufficiently informed) to understand the various social aspects and implications of these issues(e.g. Kolstø, 2001; Mertens & Hendrix, 1990), and the other is that they should able to reason, to clarify, and to sort out aspects of those issues in order to make their own decisions(e.g. Bingle & Gaskell, 1994; Gayford, 1993; Geddis, 1991).

Common observations, however, suggest that when a student or an adult looks at a controversial SSI, the individual immediately brings in his or her own feelings of right and wrong, personal moral-ethical and social values, and other personal priorities. This highly subjective system produces a variety of ways to see and judge the relation between science, technology, and society or specific SSI. Dass(1997) emphasizes the role of students' value systems in decision making about SSI, and even claims that the value system is much more influential on making moral decisions on issues than intellectual reasoning. A considerable number of empirical studies (e.g. Bell & Lederman, 2003; Fleming, 1986; Pedretti, 1999; Zeidler & Schafer, 1984) on SSI support this view. However, these studies initially intended to explore students' reasoning on SSI, and tangentially noticed the natural involvement of morality and other personal factors in the decision-making process. For instance, Bell & Lederman(2003) intended to assess the influence of the understanding of the nature of science(NOS) on decision-making regarding SSI. They reported that regardless of the degree of understanding of NOS, the participants (adults - professors and scientists) "commonly spoke of using personal values to guide their decision making" and "personal values were much more prevalent in the decision making of the members of the two groups than their understandings of the nature of science" (p. 17).

In order to get an idea of, or evaluate, how successfully science education has promoted to raise responsible citizens who make responsible decisions, it would be important to obtain a more detailed picture of how college students - who have gone through secondary science education - react to science and specific SSI. The basic approach of this present study, therefore, is to have informal conversations with college students. One way to motivate this approach is by making an analogy with the small group peer discussions of 17 year-old high school students studied by Solomon(1992). The reason that these discussions are so interesting is that since there was no teacher influence: students operated very freely to pursue whatever was uppermost in their

mind at the moment. The students checked with each other over whether they understood the issue, they were completely open to each other and accepted with sympathetic and non-judgmental attitudes whatever others were doing, and negotiated different points of view. Sometimes students reacted on "the basis of the values position they had reached and some began to make broader moral judgment"(p. 438) or showed their own commitments.

To obtain an idea of how students relate to science and SSI, therefore, the aim should be to have informal conversations with them in a space where they feel secure to operate freely and say whatever is on their mind. In effect, the interviewer would be like a peer. Looking informally at their general attitudes toward science and the way they approach specific SSI may give us an idea of how they have grown into the role of citizens who make responsible decisions, and to what extent science education or education in general has contributed or can contribute to this end. More specifically, by reflecting on their reactions, we may develop a general idea of what could be done in secondary science education to raise students who are responsible in their decisions about SSI.

Ⅲ. Purpose of Study

The present study tries to involve students and adults in informal conversations about how they feel and where they stand regarding science and technology in general as well as on two specific SSI(i.e. human cloning and animal dissection/experimentation). In such conversations one could see whether, how, and to what extent students bring in their own values, how seriously they take the issues, how fully they want to be engaged with the socioscientific issues, and how their own circumstances, personalities, and values play a role in shaping how they relate to these issues. The guiding research questions are:

1. What are the overall characteristics of college students' engagement with SSI?

2. How and to what extent do college students' own values, circumstances, and personalities play a role in making a decision about SSI?

Ⅳ. Methodology

1. Participants

Sixteen college students (nine females and seven males) volunteered to participate in this study. They enrolled in elementary Educational Psychology courses (e.g. Child Development for Elementary Teachers, Career Development Theory and Practice, etc.) offered by a large state university in the Midwestern United States. All students in these courses took the courses because they intended to pursue a teaching certificate or were interested in teaching in general, and were supposed to serve four hours as subjects in research studies. Sixteen students signed up for this study. The participants were heterogeneous in terms of academic backgrounds, ethnicities, and school years (see Table 1).

2. Data Sources

One-hour individual interviews with 16 participants conducted by the first author were used as a data source. A semi-structured interview protocol, which consisted of a carefully developed sequence of phases, was used. First, there was an introductory period to become acquainted, where we discussed the participants' majors and how they were attracted to their majors. Then, the authors asked questions regarding their feelings and attitudes toward science and technology in general, including how science and technology influenced their lives. In the final phase, the authors or the participants raised issues of human cloning and animal dissection/experimentation. Since the major aim of this study was not to ask their final decisions on the issues, but to explore the overall shapes or characteristics of their engagement with the issues, the authors did not provide specific scenarios. Rather, by asking more general questions about their personal feelings and opinions on the issues (e.g. Have you ever thought about cloning?, How do you feel about human cloning?, etc.), the authors created atmosphere to help the participants easily approach to the issues and express their thoughts. The overall tone of the interviews, therefore, was similar to informal conversations (neither asking specific scien-

tific knowledge nor forcing them to take a specific position). During the interview, the authors consciously attempted to let the participants talk about their feelings and develop their own thoughts in the manner of a conversation, rather than lead them to make an explicit decision about SSI. The specific results of their decision-making were not the focus. "Go with the flow"(Johnson, 2002, p. 111) was used to lead the participants. All interviews were audiotaped and transcribed.

3. Data Analysis

This study paid attention to the fundamental inner aspects of individual students such as values, emotions, and other personal entities; how they came to a decision based on these aspects; and furthermore, how clearly they stood on the issues in terms of values. In this sense, the essentialist approach(Witz *et al.*, 2001) is suitable. The essentialists attempt to develop an intuitive holistic understanding of the nature and essence of an individual person by sharing with sympathy and empathy ("the participant as ally," Witz, 2006) the individual's feelings, past experiences, and his or her state of mind. This means that, during the interview, the researcher keeps trying to subjectively understand a person(participant) and encourages him or her to discuss his or her feelings. A participant reflects on previous experiences and expresses them in his or her own words in the present. From these direct and spontaneous utterances and nuances or from unusual verbal expressions, the researcher is able to discover the participant's inner aspects. While listening to their audiotapes repeatedly, therefore, the authors tried to immerse ourselves in each individual in order to draw their pictures in our mind. In this way, several themes and phenomena regarding their engagement emerged over the 16 cases. All participant names used in this study are pseudonyms.

V. Results

In this section, the authors first point out some patterns in the 16 participants' overall responses to the main questions in the interviews, and then discuss three themes that emerged from a more holistic reading of the transcripts. In order to provide readers an idea of how frequent these themes and patterns were, they are summarized, to the extent it was possible to categorize them, in Table 1.

1. Reactions to Science in General and to the Two Specific SSI

1) Science and Technology in General

When asked about their attitudes toward science or technology in general, the first things that came to the students' minds were the enormous conveniences that science and technology provide. Even though somebody noted the negative consequences of science, they were not generally regarded as a significant problem compared to these benefits. The benefits led the students to feel that most science and technological developments are justifiable and worthwhile. Only three participants were partly skeptical about the current trend of over-development and asked themselves "Is it a real benefit?", "Is it really necessary?", or "Isn't it too much?"

> [If science and technology stopped one hundred years ago] We would be lost today I think. There might not be any internet. There might not be any cell phones, so yeah. I think that people don't realize it everyday because they just take the advantage of what they have, and don't really think about it because they're so accustomed to it now. (Lori)

> When technology is used to make life more comfortable, you know, make life easier, I think that there's more importance on like family, and discipline and you know, hard work. Even though they didn't have all the fun things to do and you know, I think people back then had a better idea of the type of person that everyone should be. (Jeff)

Lori thought of convenient devices such as cell phones and the internet. On the contrary, Jeff was partly skeptical about the changes which technology has brought. He believed that family and inner values were more important than simple conveniences.

2) Animal Dissection/Experimentation Issue

Almost all of the participants, with the exception of Jeremy, had experience dissecting a wide range of animals, from small worms to pigs, in school. Twelve participants had no moral conflicts with

Table 1

Participants' Response Patterns regarding Science and SSI

Name	Sex	Major	Yr.	Reactions to science / SSI			[3] Not adequately informed	[3] Science force in engagement	Personal value engagement		
				[1] Science & Technology	[2] Animal Dissection / Experimentation	[2] Human Cloning			[4] Bring in values	[5] Unable to make a decision	[5] Resignation
Kim	F	Math Ed	4	Accept +	N-P / P_{OK}	P_{DK}(B)	√	√	√	√	
Jeanette	F	Art sculpture	4	Accept -	N-P/ N-P	P		√	√+		
Samantha	F	Agriculture Ed	Grad	Accept +	N-P / P	P(B)			√		
Jay	M	Advertising	4	Accept +	N-P / P	P_{DK}(B)	√		-	√	
Suzanne	F	Agriculture Ed	Grad	Accept	N-P / P	P	√		-		
Marie	F	Marketing	4	Accept	P / P_{DK}	P			√	√	
Greg	M	History	4	Accept	N-P / N-P	DK	√		-		√
Laura	F	History/ Secondary Ed	4	Accept -	N-P / P_{DK}	P			-	√	
Carl	M	Elementary Ed	2	Accept	N-P / N-P	P_{OK}		√	-		
Kathy	F	Art Ed	4	Accept	N-P / P_{OK}	P(B)	√		√		
Lori	F	Liberal Art & Science	2	Accept +	N-P / P_{DK}	P	√		√	√	
Jeremy	M	Math Ed	3	Accept +	- / P_{OK}	P_{OK}(B)	√		√		
Jeff	M	Math	2	Accept -	N-P / DK	P			-		√
Chad	F	Secondary Ed/ English	2	Accept	N-P / N-P	P_{DK}(B)	√		-		
Andy	M	Psychology	4	Accept	P / DK	P			-		√
John	M	Chemistry Ed/ Philosophy	4	Accept +	N-P / N-P	P_{OK}		√+	√+		

[1] Accept +: Positively accepts
Accept: Acknowledges contributions
Accept -: Accepts, but is concerned with negative results

[2] N-P: Non-Problematic; "I do not have any problem with it"
P_{OK}: Problematic, but Okay; "I know it is problematic, but it is partly acceptable to me"
P: Problematic; "It is problematic, I do not agree with it"
P_{DK}: Problematic, but Don't Know; "I know it is problematic, but I cannot make a decision"
DK: Don't Know; "I do not know or I cannot make a decision"
B: Draws Boundary; "This might be okay, but that case is not okay"

[3] √+: Strongly Yes
√: Yes
Empty : unclear

[4] √+: Strongly Yes
√: Yes
-: Bringing in personal values without further engagement

[5] √: Yes

dissection. The remaining four participants mentioned that they preferred using pictures in an encyclopedia or a web site, even though animal dissection provides a hands-on experience to see the insides of animal bodies.

> I always wanted to know what made them tick and what their insides were like and how they work together to make the animal living, and a dissection was just a great way to find that out. (Chad)

> It's kind of like, we could just look in the encyclopedia and there's like a frog, and you don't actually have to do it. Like, I don't really know why we do it. I really don't know why we have to do that, because it's just the same thing as looking at a diagram with pictures I think. (Marie)

Regarding animal experimentation for medicines or cosmetics, the participants' feelings and values were more involved than with respect to animal dissection. Eight participants felt the issue was problematic and they experienced some degree of moral conflict; however, their decisions varied. For instance, Jeremy was concerned over the fact that some species are being extinguished by selfish human actions. However, he felt that testing animals is definitely a necessary step for human beings, and so it could be okay. Jay said that animal testing is morally wrong because it hurts animals, and so he drew a negative conclusion. In addition, Marie made some distinctions in her decision. She felt that cosmetic purposes alone are not enough to justify testing animals. However, for medical purposes, she could not make her decision because both morality and medical benefits are equally valuable to her, and so she threw up her hands. Five other participants did not experience much moral conflict on the issue. Furthermore, the remaining three tended to avoid seriously considering the issue, and said "I don't know." Here are some examples.

> I know that whales were almost on the verge of being extinct, right, because of cosmetics. I think I disagree, with using animals, but at the same time…. The truth of the matter is that we must experiment on some type of living organism because they are truly what could give us the closest results close to human beings, like we always use like monkeys, mice and stuff, you know. We don't want to use human beings. (Jeremy)

> I think it's okay. I mean, that like if you don't, if things aren't tested on animals, like where are they going to be tested? And it's like you can't just put something in the marketplace without having it tested at all. (Carl)

> Umm, I really don't know how I feel about it. Part of me doesn't really agree with it. But at the same time, these animals are bred for the testing, so they shouldn't even be within the ecosystem anyway, because that would be overpopulation of that animal, so but umm, yeah I don't know. That's kind of a hard one. (Laura)

Jeremy was concerned about the fact that some species were being threatened. However, he felt that testing animals was definitely a necessary step for human beings; thus, it could be acceptable. Carl insisted that drugs had to be tested and there was no alternative to testing them on animals. Laura did not agree with animal testing, but she could not articulate her feelings.

3) Human Cloning Issue

The human cloning issue was even more controversial and problematic than the animal experimentation issue. Many of the participants felt relatively serious moral conflicts, and even fell into resignation, as will be discussed below. A common pattern in the reactions to human cloning was to draw a moral boundary as in "this might be okay, but that case is not okay"(six participants). However, a clear explanation for their moral boundaries was hardly seen. Even though the participants could not explain their reactions logically, they felt them and, furthermore, they were even sure of certain cases. Here are some examples.

> I have mixed feelings with that because of my religion because I'm Christian and I believe that God should create animals or whatever and I don't think that we should do that, but if you could clone like a piece of the animal and not the whole animal in order to transplant or things like that, I see nothing wrong with that because you're not making an entire life, you're just making a piece of what you need to help another living thing. (Chad)

> I think I only would agree with it if it's like for saving someone's life. Like if they need to clone me for a heart transplant because my heart's dying out or something, or a brain, if I'm suffering from brain damage, no not even, because who knows that will heal things, who knows what I'm thinking, my clone thinking, you know, so not even that's in there, but if I was on the verge of dying and if it's like the last resort you know, between life and death, I could see I could agree with it,

but for other purposes like, just to examine, stuff like that…. (Jeremy)

Chad felt conflict because of his religious belief. Jeremy constantly fluctuated, and ultimately he agreed to cloning only in a life and death situation. A clear explanation for drawing moral boundaries is hardly seen in the excerpts.

2. Major General Themes

1) Not Adequately Informed about SSI

Most participants were too insufficiently informed about the issues to make a clear decision. This lack of information is particularly true regarding the cloning issue. One of the popular arguments against cloning was "over-population", for example, "we're already pretty populated, so we don't need to start having doubles of people." Most of the participants imagined fictitious situations, but no one sincerely considered a clone to have the moral capabilities of a human being. Some of the more unusual responses to cloning might have been encouraged by the very informal nature of the interviews. Examples:

Human cloning, well I don't know. I think eventually it could be a good thing, but at the same time, I don't want another one of me running around. I see a lot of genetic issues from that because, I mean, it's not like having a sister, it's like having - you know? (Kim)

Human cloning…. I think it'd be good and bad because you can go clone a bunch of like Adolph Hitlers or something bad, or you can clone, like Michael Jordans, or good people, people that could benefit society. You can clone like organs too, so I think there are goods and bads. (Jay)

2) Science as a Force in Their Engagement

One interesting issue that emerged from the interviews was variability in the degree to which the participants saw science as an independent force, standing for certain principles (truth, a way to obtain reliable knowledge, scientific methods, particular type of understanding, etc.). To what extent was science a definite entity to them, standing for certain things or representing certain things? Did the participants construct their own image of science so that it played a role in their understanding of SSI? Here are some examples.

Science is more of the study of truth I think, the absolute truth of how something will work, and technology is implementing it and applying it to daily life and sometimes we let, the difference is that technology is more dangerous than science because science is only knowledge and technology is using that knowledge and a lot of people can use that knowledge to bad end as well as good end, and you can just look at like the atomic bomb for one. I mean, that's science when you look at how we learned how to do it, but then it's technology by how we made it and used it and that's unfortunate, you know, that's the unfortunate side of technology and though it will give us the internet, it'll also give us, you know, viruses and hackers, and there's always a bad part to technology. It's got a dark side and a good side. Knowledge doesn't really have that. (John)

In the case of John, he had clear image of science as an absolute truth. His image of science related directly to his decision; for example, even though other people regarded the human cloning and animal dissection/experimentation issues as controversial, he did not have any problem with them because these issues may occur in the process of pursuing new scientific knowledge, which has a higher value. As a consequence, in many SSI, his focus went immediately to the transcendental principle that represents his highest values. This consequence tends to have the effect that the human aspects of the situation are never able to constitute a direct force in his view of the situation on a par with science and knowledge, which are always above good and evil and therefore blameless. Among 16 participants only Jeanette, Kim and Carl showed similar responses to John, even thought their beliefs were not as clearly articulated as John's.

On the other hand, the interview with Greg did not suggest a clear image of science, or that science stood for something with which he personally engaged.

I think we've made so much progress in the wave of scientific thought and like everything around us something science based, like that chair just the way it was structured. The photocopy machine, imagine I mean, it's imagine what that can do, like touch it, like all the things. It just amazes me. Just everything around it has some sort of like, science formation [i.e. everything is in part formed by science] or science base. Like, it had to go to a scientist to get developed or structured. We'd be nowhere without it, like everything revolves [around it], like architecture, like buildings. Food, the way we eat, the way we live. Clothing, like everything. Like I think everything is all interrelated. (Greg)

Greg regarded science as one social phenomenon in a vast field of many other social phenomena. In other words, science does not have an independent, clear image in his mind, and always exists among other entities. Therefore, he cannot take a certain position on science itself, or furthermore, on SSI. For most other participants, their images of science tend to be combined with other entities, such as agriculture or technology. Science is resolved as a medium that brings convenience and benefits, not as an independent activity with its own principles and goals.

3) Spectrum of the Depth of Personal Engagement

When the participants talked about SSI, the depth of their personal engagement on the issues varied. "Personal engagement" here relates to whether they bring in their values, and whether their values play a significant role as a force for taking the issues seriously and making commitments. An individual who is "personally engaged" is not necessarily more knowledgeable, logical, or emotional than one who is not. If a person personally engages in the issues, all of her values, larger worldviews, emotions, and reasoning come into play in moral decision making. Among the all participants, only Jeanette and John were fully personally engaged.

> I would say because even though we could use cloning to treat someone, because if we had our hands on researching about cloning and developing our techniques and stuff, it could lead to dangerous results, for people abuse what they create, like, another human being, you know? Destruct someone or something like that, so I think for the future reference, like to prevent those kinds of dangers I would say…. And because I know, and like I said before-I'm leading back to my religion. You know, God has planned for each and everyone so if God calls you then you're going and because we have, Christians have a hope in heaven that we can all see each other, so we should just submit to whatever happens. Not that I don't love my family, but you know, it's just how it is, and that's how it's been for whole humanity until now, so yeah. (Jeanette)

In this short excerpt, Jeanette's religious beliefs, pessimistic feelings, caring personality, and personal values were clearly expressed. She was far more insightful than other participants. She constructed her own view on SSI; namely, that science and technology lead to negative consequences. Even if she faces a situation directly related to her family, she would submit to whatever was naturally given by God.

John also took the issues seriously based on his values. He was more aware of SSI than other participants. However, his way of engagement was quite different from that of Jeanette.

> It's hard to feel sorry for something that's dead and even if it was alive and we killed it to dissect it, that, it's serving a purpose, and you know I don't think we should kill every animal and dissect it in the world, but I think that these animals, these whatever it is, these rats or these worms, they're not going to go anywhere, I mean they're there, I mean they're taken out of their habitat, and so it doesn't make any sense not to use them for knowledge and just to let them die would be to kind of neglect their usefulness, so I see that they're a living thing, but I also see that they're useful just like any living things, and we dissect ourselves. We have autopsies and we do that to ourselves, granted we don't grow ourselves in little gardens or whatever, cages and then kill ourselves to dissect, but I think, you know, that is an okay thing to do in the name of science as long as there's some goods that someone's getting out of it, some knowledge. (John)

John rationally approached the issues. Science as an absolute entity was the justification for his decision. His approach to the issue was the rooted in his fundamental vision of science.

Greg took an opposite position to Jeanette and John.

> 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. (Greg)

Greg did take specific positions on SSI - he believes that alternatives to animal testing should be made. However, the issues were not meaningful enough to lead him to be personally engaged. Those who are interested in protecting animal rights should have the freedom to do it. However, he does not view this matter as his concern: he does not want to be involved.

In general, most participants immediately brought in their own values and feelings in implicit or

explicit ways when talking about SSI. This tendency was always influenced by their backgrounds such as religion, and family background, personality, their interests, and knowledge. Responses of other participants showed a wide spectrum in their engagement. Here, I present two noticeable patterns: 1) bringing in personal values without further engagement, and 2) unable to make a clear decision and resignation.

1.1) Bringing in personal values without further engagement

Each student brought in personal moral/ethical values, larger worldviews, and feelings to varying degrees. These considerations were always influenced by their backgrounds such as religion, family background, personality, their interests, and knowledge. 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. The following excerpts - Kathy, Laura, Carl, Chad, and Jay - show how and to what extent they brought in their own values.

> I don't believe in that (human cloning). Umm, I really have a hard time with that, especially with just in my religion, you know. [I believe in] God. I don't believe that we should mess with the things that he's created, and I don't believe that like being able to make a perfect person, or like choose what your kids are going to look like or how they're going to be blessed, or boy or girl, you know? I don't think that it's our decision to do that kind of stuff, and I don't really, like just because we may have the technology to do it, like I don't understand what the reasons are why, you know, like what are the benefits or it really. We're already over-populated. (Kathy)

Kathy brings in her religious values here. Human cloning is in conflict with her religious beliefs. She believes that each human being deserves to remain just as he or she is. For her, making a perfect child by choosing better genes is against God. However, she does not delve into the issue more deeply with her religious values. Her feelings are clear, but she does not know what to do with them, and moves on to another reason: "We're already over-populated."

In the following excerpts, Laura, Carl, and Chad take a strong position without serious reasoning or consideration.

> I think there's no need to clone humans. First of all, there's total over population already in the world, so there's no need to clone more humans. And everybody dies at certain times, and the only reason why people want to clone humans is so that they feel better, like if somebody dies, then you can clone them, or if somebody's sick, you can clone an organ so that we can continue our relationship, but that's really selfish. That's just for your personal gain. Totally ignoring the effects of what's going on, and cloning in and of itself can - it's a human experiment. It can never be perfected, so you never know what may happen. (Laura)

> This is the only opportunity that we really have. If there was a better alternative, then it would be different, but I don't see another way to do it really…. A lot of animals are going to be killed for, you know, eating too, and that's, well you know, it's by the same token. (Carl)

> If technology stopped a hundred years ago I wouldn't be alive because of all of the things that medicine has done for me because I'm in a wheel chair. People in wheel chairs and with disabilities a hundred years ago just didn't live because there wasn't a way to keep them alive, so I'm glad that they continued. (Chad)

Laura takes a clear position on human cloning and provides argumentation to support her feelings. She claims that there is no need to clone humans because 1) we are already overpopulated, and 2) humans naturally die at certain times. Both pieces of evidence are described on a superficial level, not based on her personal values. Carl also clearly makes a decision here on animal testing. His moral values are partly represented in the excerpt, in terms of admitting that it is wrong to test animals but human beings are more valuable. However, he is not willing to engage in the issue any deeper. Moreover, Chad's stance depends on his personal circumstances. Technology - such as medicines and wheel chairs - have helped him to survive, which he appreciates. Technology has brought him critical benefits; thus, he is pleased with the continuing technology developments, without considering any other aspects.

Compared with Laura, Carl, and Chad, Jay does not take any position:

> Human cloning…. I think it'd be good and bad because you can go clone a bunch of like Adolph Hitlers or something bad, or you can clone, like Michael Jordans, or good people, people that could benefit society. You can clone like organs too, so I think there are goods and bads. I don't know which one outweighs the other, but…. Well, population. That'd be [bad], I mean, we're already pretty populated. And I mean, like in society, or humans in general. (Jay)

Jay does not take the human cloning issue seriously, nor does he show his own values even in an implicit way. He simply enumerates the pros and cons of cloning - which might come from science fiction movies or novels - without moral engagement or feelings.

1.2) Unable to make a clear decision and resignation

The other phenomenon that emerged was that if the participants felt unable to make a decision on an issue, they simply ignored it. Compared to the previous examples, they take the issues seriously and bring in their values to some degree; however, they are unable to take any position because they feel the issues are too big to deal with. Here is one example.

> 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)

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 is more valuable to her even though she feels sorry for animals. The issues are too much for her to handle even though she tries to explain. As a result, she keeps saying, "I don't know." Similar to Marie, Lori onestly expresses her feelings.

> Um, I think it is a very controversial issue right now and I think it has been for a long time, and I think that the extent, maybe it's happening too much, like they're killing too many animals to find cures and everything, and doing all kinds of experiments on animals because, and not giving them a normal life, which I think is very frustrating sometimes, but then sometimes I know people think of it, well, if it, let's say if they use rats or whatever, it's like killing one rat to maybe saving your mom, you know, like and some people I'm sure who maybe have had that chance like if you were able to save your mom's life, then they might not so much, they might be thankful for the fact that someone did experiments on rats, so I don't know. (Lori)

Lori finds it hard to decide whether the animal experimentation issue is wrong or not. She feels sorry that so many animals do not have a normal life and are going to die in an unnatural way. She feels that these unnatural deaths are wrong. However, what if it saves the life of one of my family members? She feels that this factor also needs to be considered. She continues to think about both values, but she cannot decide between them.

Another interesting observed attitude is resignation when making decisions concerning SSI. Since science and technology development are so rapid and sometimes overwhelming to deal with, some students seem to feel a sense that their feelings and values do not matter much on the issue, and thus give up considering the issue further.

> I'm kind of against cloning. I think it's, um, I mean I guess it's, 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, and then 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 feels that cloning is wrong somehow because it seems to give people too much freedom. He feels that the issue brings up several questions, he is at a loss, and so he throws up his hands saying, "I can't really explain it." He does not show desire to resolve the issue any further. In contrast, Andy shows strong conviction about human cloning. He affirms that the ideal of people to want to live forever is wrong. He is afraid that the wrong ideal will lead to unexpected consequences. Even though he strongly believes that human cloning is wrong, he resigns himself because he is overwhelmed by the endless development: people will end up creating an entire human body whether or not he is against it.

VI. Discussion

A one hour interview might be insufficient for

completely describing a given participant. Regardless of this limitation, informal conversations with sixteen college students revealed several phenomena regarding their engagement with SSI. One issue is students' lack of intellectual and ethical maturity in decision -making on SSI, which was Dass'(1997) criticism. Even though the students have frequently encountered the issues through mass media or in class and even though current school science has emphasized intellectual reasoning when dealing with the issues, a significant number of students responded with "over-population" as the main supporting evidence why human cloning should be prohibited. This finding is consistent with the previous studies of Fleming(1986) and Solomon(1992), which pointed out a lack of logical reasoning, argumentation, and scientific knowledge in students' discussions of SSI.

More seriously, this study brought to light two major problems. First, when making moral decisions about SSI, the students did bring up their personal value frameworks, which include their individual moral/ethical values, social ideals, and emotions. Like the high school students in Solomon's study (1992), the college students engaged in the SSI to some degree as moral beings. However, the depth of their personal engagement varied greatly. Most students merely quoted their values and did not consider issues seriously. Their own values, larger worldviews, emotions, and reasoning hardly came into play when making a moral decision.

Second, the most pervasive general impression from the conversations is the feeling of student helplessness, not wanting to deal with issues, resignation, and anomie. The students felt unable to form decisions on the issues, so they tried to detach from the issues or threw up their hands as if dramatic scientific and technological developments were too ubiquitous and too pervasive, and there were too many aspects to be considered(such as the ethical, moral, cultural, and sociological aspects). Even if the students were interested in the changes and tried to become intellectually acquainted with them, the changes are happening too rapidly and always trigger additional concerns, other SSI. The students of this study seemed to be overloaded and not able to digest the issues easily. As a result, in resignation they stopped trying to consider more because they felt that the issues were too large to address. This overloading partly relates to the first problem. Students feel so much apathy and anomie that they either could not formulate their own perspectives enough to deeply bring in their values regarding the issues or their social, moral values actually became weaker.

Overall the study suggested that college students often do not make much headway in coming to a "responsible" resolution of SSI issues. Similar to the approach to other social phenomena, some students overlook these issues, and some feel interested in the topic; for example, human cloning "sounds cool" or "scary" when seen on TV or in the newspapers. More than a simple interest, some people show strong value convictions when making decisions about SSI, like "I am against it because the dignity of humans is more important than anything" or "I think it is okay as long as it contributes to a greater good." However, most of them stop engaging in the issues here - or even before - and do not make a commitment based on their value judgment. Studies on pubic understanding of science (e.g. Cross & Price, 1999; Jenkins, 1999) show that these phenomena are not just limited to college students. For instance, Cross & Price (1999) point out that "the majority of the people (adults or citizens) are not motivated to question and they see controversial scientific issues as outside their need and competence to judge" (p. 238). These studies seriously underline the need to look deeply into the current state of individual students and re-evaluate current science education for scientific literacy.

Why is it that we are seeing such a state of affairs? Are secondary science educators missing something in their science teaching practice? Is current secondary science education truly heading students toward achieving responsible citizenship? The current approach to SSI in secondary education focuses mainly on two aspects in order to lay a good foundation for citizenship and to satisfy the requirements of a democratic, scientific, and technological society. One is that students' understanding of the various social aspects and implications of science

should be sufficiently informed(Geddis, 1991; Kolstø, 2000; Mertons & Hendrix, 1990). The other aspect is that it is important to develop students' reasoning skills - to clarify, to sort out aspects of those issues, and to defend their position in a discussion(Zeidler, 1997; Zeidler *et al.*, 1992) - in order to reach the most reasonable, not responsible, decision regarding SSI as a citizen.

No doubt, for students being adequately informed and being able to perform intellectual reasoning are important. For instance, John, who majors in chemistry, might feel more comfortable dealing with SSI than Greg or Laura in history major because of his prior knowledge and familiarity to SSI. However, too often science educators who are concerned with students' engagement with SSI see the lack of scientific knowledge and skills as the primary problem. If students cannot answer clearly and logically, science educators suggest that students need to learn more basic knowledge in order to become informed. This response exacerbates students' detachment from deep personal engagement on the issues, and finally, brings apathy, anomie, and resignation.

> A person drowned in information about science may be in no better position to make choices than an almost totally uninformed person(Trachtman, 1981, p. 12).

Trachtman(1981) argues that more science information does not always ensure good decision-making; furthermore, it does not always raise responsible citizens. Indeed, the notion of "responsible" is not a synonym of being intellectually "informed." A broader view on raising students who are more responsible in their decision is necessary.

Both the literature and the general picture that emerged from this study suggest that a larger perspective needs to include the following three considerations. First, students who are responsible will keep developing their moral value framework, and their values, emotions, and reasoning will come naturally into play in their decision. This finding suggests that it is important that secondary students have opportunities to develop their own personal values. For example, the peer discussions in Solomon's study seem to provide such an opportunity. She notes that the "even several months later (after the small group discussions) the teachers reported their students referring back to the video topics"(p. 442). Presumably the students remembered the issues and their feelings about some of the more detailed aspects connected with topics. In other words, it is probable that such discussions helped students to realize how they feel and to become clearer about some of their own values connected with the issues. Another practical suggestion might be that teachers should become sensitive to the fact that in class discussions on SSI, students may be just becoming aware of their own personal values and developing them. Teachers could then play some part in promoting this process.

A second issue pointed out by the study is that students tend to feel that their opinions, which are based on their values, do not matter. Therefore, there is a need that students come to feel that their own opinions, involving their personal values and overall judgments, are important in the democratic process. One practical suggestion may be that in class discussions when a teacher sees a student trying to articulate some of his or her values in connection to SSI, they teacher could appreciate and highlight these efforts and help the student articulate his or her general point.

A third problem highlighted by the study is that students feel overwhelmed by the magnitude and complexity of a socioscientific issue, and the multitude of related issues which one given socioscientific issue immediately spawns. These feelings and perceptions lead the students to feel apathy and resignation. There is a need of tools to help them in deal with this feeling. However, how can science educators provide such tools when they themselves are surrounded by a constant proliferation of scientific and technological developments? This question still remains.

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