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ABSTRACT

The ability to negotiate and resolve socioscientific issues has been posited as integral components of scientific literacy. Although philosophers and science educators have argued that socioscientific issues inherently involve moral and ethical considerations, the ultimate arbiters of morality are individual decision-makers. This study explored the extent to which college students construe genetic engineering issues as moral problems. Twenty college students participated in interviews designed to elicit their ideas, reactions, and feelings regarding a series of gene therapy and cloning scenarios. Qualitative analyses revealed that moral considerations were significant influences on decision-making indicating a tendency for students to construe genetic engineering issues as well as the application of principles. Issue construal was considerations, a series of other factors emerged as important dimensions of socioscientific decision-making. These factors included personal experiences, family biases, background knowledge, and the impact of popular culture. The implications for classroom science instruction and future research are discussed. (Contains 15 references.) (Author)

# Weighing in on Genetic Engineering and Morality:

# Students Reveal Their Ideas, Expectations, and Reservations

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## Abstract

The ability to negotiate and resolve socioscientific issues has been posited as integral components of scientific literacy. Although philosophers and science educators have argued that socioscientific issues inherently involve moral and ethical considerations, the ultimate arbiters of morality are individual decision-makers. This study explored the extent to which college students construe genetic engineering issues as moral problems. Twenty college students participated in interviews designed to elicit their ideas, reactions, and feelings regarding a series of gene therapy and cloning scenarios. Qualitative analyses revealed that moral considerations were significant influences on decision-making indicating a tendency for students to construe genetic engineering issues as moral problems. Students engaged in moral reasoning based on utilitarian analyses of consequences as well as the application of principles. Issue construal was also influenced by affective features such as emotion and intuition. In addition to moral considerations, a series of other factors emerged as important dimensions of socioscientific decision-making. These factors included personal experiences, family biases, background knowledge, and the impact of popular culture. The implications for classroom science instruction and future research are discussed.


## Introduction

Socioscientific issues have become increasingly more important in the field of science education as a means to make science learning more relevant to students lives (Cajas, 1999; Pedretti, 1999); as a vehicle for addressing learning outcomes such as an appreciation for the nature of science (Bell & Lederman, in press; Sadler, Chambers, & Zeidler, 2002; Zeidler, Walker, Ackett, & Simmons, 2002), improved dialogical argumentation (Driver, Newton, & Osborne, 2000; Patronis, Potari, & Spiliotopoulou, 1999; Zohar & Nemet, 2002), and the ability to evaluate scientific data and information (Jiménez-Aleixandre, Rodríguez, & Duschl, 2000; Kolstø, 2001; Korpan, Bisanz, Bisanz, & Henderson, 1997); and as an important component of scientific literacy (Driver et al., 2000; Pedretti & Hodson, 1995; Zeidler & Keefer, in press). Given the significant role played by socioscientific issues in science education, it is important to understand how learners perceive, negotiate, and resolve these issues. This investigation seeks to contribute to the area by focusing on how students perceive the moral aspects of socioscientific issues (viz, genetic engineering dilemmas involving gene therapy and cloning) and how student perceptions of morality influence their decision-making regarding these issues. In the following section, the theoretical framework from which this research stems will be presented. The framework describes what socioscientific issues are and the areas from which they arise. It will explain why morality is linked to socioscientific issues and how construal, the process by which individuals decide whether an issue involves morality, contributes to decision-making. The framework also reviews the current state of literature regarding socioscientific issues and morality which leads to the specific research questions addressed by the current study.

## Theoretical Framework

Socioscientific issues describe societal dilemmas with conceptual, procedural, or technological associations with science. Many socioscientific issues stem from dilemmas

involving biotechnology, environmental problems, and human genetics. The suggestion that issues such as those related to genetic engineering and environmental challenges can be classified together as "socioscientific issues" is not meant to imply that science and society represent independent entities. On the contrary, all aspects of science are inseparable from the society from which they arise. However, the topics described by the phrase "socioscientific issues" display a unique degree of societal interest, effect, and consequent.

Socioscientific issues are typically contentious in nature, can be considered from a variety of perspectives, do not possess simple conclusions, and frequently involve morality and ethics. Human genetic engineering, the socioscientific issue used for this investigation, highlights the significance of moral and ethical considerations in decision-making regarding science-related issues. Bioethicists have inextricably linked issues subsumed by the heading genetic engineering, such as cloning and gene therapy, to moral reasoning (Evans, 2002; Haker & Beyleveld, 2000; Stock & Campbell, 2000). The message made implicitly by the arguments of bioethicists as well as articulated explicitly by some science educators (Pedretti, 1999; Zeidler, 1984) suggests that socioscientific decision-making, particularly when dealing with issues like genetic engineering, must involve the consideration of morality and ethics. Phrased differently, in order for an individual to make informed decisions regarding socioscientific issues, s/he needs to have considered the moral ramifications of those decisions. Conclusions drawn in ignorance of the moral and ethical dimensions of socioscientific issues fetter the efficacy of those conclusions. Consider the issue of gene therapy. Scientific researchers and policy-makers are currently embroiled in a debate over whether or not germ-line gene therapy should be permitted. Under current guidelines, somatic cell gene therapy, which amounts to the genetic manipulation of non-reproductive cells, is permitted. However, this mode of therapy provides only temporary treatment; whereas, germ-line gene therapy, which involves modification of reproductive cells, could potentially eliminate undesirable conditions (Friedmann, 1999). Ethical ramifications associated with the approval (or disapproval) of germ-line therapy projects abound. Some questions raised by the ethical components of this issues include the following: Do medical scientists have a right or duty to explore all treatment options? Do parents have the right to unnaturally alter the genetic composition of their children? Should the human genome be subjected to artificial manipulation? What role should the government play in regulating gene therapy? How should gene therapy information be managed with respect to insurance companies, employers, and other interested parties? Can gene therapy be used to eliminate suffering and pain? What conditions qualify for therapy and who decides? These comprise only a small sample of the many ethical concerns central to gene therapy. Although the contexts of additional genetic engineering dilemmas as well as other socioscientific issues may differ, they too can spawn hosts of moral and ethical questions.

The assertions just made linking socioscientific issues like genetic engineering with morality beg the question: why are these issues moral? This in turn raises the question, what makes any issue moral? Domain theorists suggest that morality is an intrinsic aspect of particular events, situations, or issues irrespective of the culture from which the incident arises (Blair, 1997; Nucci, 2001; Tisak, 1995; Turiel, 1983; Turiel & Smetana, 1984). They suggest that social knowledge and decision-making reside in one of three universal domains: conventional, personal, and moral. The conventional domain subsumes issues best resolved with the application of social norms. Students raising their hands in a classroom to gain teacher recognition exemplifies the conventional domain. Speaking without raising one's hand is not inherently wrong, but in a classroom, doing so may violate normative procedures. The personal

domain represents decisions which are subject to an individual's personal choice and preference. In modern Western societies, individuals usually select their own clothing, and this represents the personal domain. Although social norms impose boundaries on what constitutes acceptable attire, individuals typically make everyday wardrobe decisions, within the limits set by society, according to their own preferences. In contrast, the moral domain is defined by universally recognized prescriptions based on conceptions of human welfare, justice, and rights. In the excerpt below, Nucci (2001) describes the moral domain as it differs from the other domains of social knowledge.

> A moral judgment about unprovoked harm ("It is wrong to hit.") would not be dependent on the existence of a socially agreed-upon norm or standard but could be generated solely from the intrinsic effects of the act (i.e., hitting hurts). In this example, the prescriptive force of the moral standard "It is wrong to hit." is objective in the sense that the effects of the act are independent of the views of the observer, prescriptive in the sense that the issue of wrong stems from the objective features of the act, and generalizable in the sense that the effects of the act hold across people irrespective of background. (p. 7)

The domain account of social knowledge would suggest that socioscientific issues are inherently moral because they involve objective, prescriptive, and generalizable standards. Although domain theory has been used as an investigatory framework by several researchers (Blair, 1997; Killen, Leviton, & Cahill, 1991; Nucci & Turiel, 1993; Smetana, 1989; Tisak & Turiel, 1988; Wainryb, 1991), it suffers from singular reliance on one particular philosophical perspective, namely Kantian morality (Schneewind, 1998). The Kantian model occupies a significant place in the history of moral philosophy, but it does not subsume all approaches to morality.

At least three broad moral philosophies could theoretically be applicable to socioscientific decision-making: deontology, consequentialism, and care-based morality. Deontology, which encompasses Kantian morality, is based on moral rules and principles. This perspective posits that moral dilemmas can be resolved according to preexisting standards to which moral agents adopt. Deontological principles such as beneficence and justice impose duties, on moral agents, that can guide their decision-making and behaviors. In other words, individuals employing deontological reasoning solve moral problems by considering principles relevant to the act of the decision itself irrespective of the potential consequences (Beauchamp, 1982; DeMarco, 1996).

Consequentialism, also referred to as utilitarianism, is frequently contrasted with deontology. Whereas deontological reasoning is based on the degree to which a decision or act upholds principles, consequentialism is based on the projected outcome of a decision. Consequentialist morality is based on calculating the expected consequences of a decision or action. The decision which produces the greatest positive outcome corresponds to the most morally correct option (Beauchamp, 1982; Moore, 1991).

Care-based morality rejects the notion, supported by both deontology and consequentialim, that a single formula exists for solving moral problems. Instead morality is linked to the contexts of individual situations and the people involved, rather than abstract prescriptions or calculations. The care perspective prescribes a far more relational approach, and emotions such as sympathy and empathy contribute significantly to decisions and actions (Noddings, 1984; Tronto, 1987).

This paper is not an attempt to rationalize the adoption of a particular theoretical option or a comprehensive exposition of moral philosophies. The presentation of alternative frameworks merely provides a backdrop for the exploration of the moral aspects of socioscientific decision-making. The focus and approach used for this study are not necessarily inconsistent with any of the described positions. Even if morals are universal and intrinsic to certain situations, an individual decision-maker must still recognize the morality of that situation. If moral decisions stem from consequentialist calculations, then the decision-maker must recognize the context in which the calculations should be made. From the care-based perspective, the individual defines the morality of a situation in terms of his/her experiences. In all three cases, the individual plays a key role in assessing the extent to which morality contributes to decision-making. The process by which individuals assess the morality of a situation has been termed *construal* (Bersoff, 1999; Saltzstein, 1994), and this investigation will focus on how students construe socioscientific issues.

In order for a person to apply deontological principles, calculate moral consequences, or respond to a situation with a care perspective(Hoffman, 2000), s/he must first recognize that the situation involves moral considerations. Construal is the process by which individuals recognize, perceive, and/or interpret particular situations or decisions as moral (Saltzstein, 1994). Construal does not necessarily have to be a conscious process; in fact, it is more likely that a person's immediate reactions, which are informed by emotions, previous experiences, and habits, contribute significantly to construal (Bersoff, 1999). Although experts in bioethics (Evans, 2002; Haker & Beyleveld, 2000; Stock & Campbell, 2000) and science education (Andrew & Robottom, 2001; Pedretti, 1999; Zeidler et al., 2002) may profess the intrinsic morality of socioscientific issues, the ultimate arbiters of morality are the individual decision-makers. In order for moral considerations to contribute to socioscientific decision-making, the individual decision-makers must construe socioscientific issues as moral problems.

Although construal per se, has not been the focus of many investigations involving socioscientific issues (the authors found none), several studies have documented a link between socioscientific decision-making and morality. In a study involving college students, Zeidler and Schafer (1984) analyzed 11 dyadic interactions focused on an environmental dilemma. Trends emerged from the group discussions indicating that the participants incorporated morality in their decision-making. Several student groups concentrated on whether the actions proposed justified the end results. Other students displayed decision-making patterns whereby they integrated personal experiences, affect, and moral reasoning. Fleming (1986a; 1986b) also investigated influences on socioscientific decision-making. He interviewed 38 adolescents (mean age 17.3 years) regarding nuclear power and genetic engineering. The analysis consisted of classifying student reasoning patterns in terms of the knowledge domains they represented (conventional, personal, or moral). The majority of students (70%) employed moral reasoning in the resolution of the issues posed. The propensity for individuals to rely on moral factors for socioscientific decision-making was also confirmed in Bell and Lederman's (in press) work with college professors. Each of the 18 participants responded to four socioscientific issues (fetal tissue implantation; the relationship between diet, exercise, and cancer; global warming; and the link between cigarette smoking and cancer). Eighty-five percent of the responses involved moral, ethical, or value considerations. Global warming was the only issue in which some participants failed to cite morals, ethics, or values. Pedretti (1999) conducted an intervention study with a combined class of fifth and sixth grade students (n=27) as they studied a unit related to mining. In pre-intervention interviews, 22% of the students alluded to moral considerations such as

assessing whether the options were "good" or "bad," but they offered little elaboration. Following the intervention, over half of the students talked about "good," "better," and "right" decisions and justified the use of these terms in a moral context. Transcript excerpts provided in the article revealed that students actively contrasted the notion of rights vs. societal laws, made utilitarian calculations of effects, and applied principles of justice. Pedretti (1999) also suggested that most students adopted one of two environmental ethical perspectives: homocentrism or biocentrism.

The empirical studies just cited provide evidence that decision-makers, representing a variety of ages (fifth graders to adults), do in fact, construe at least some socioscientific issues as moral problems. However, they do not provide a great deal of detail in terms of how or why the construal process proceeds as it does. Three of the studies (Bell & Lederman, in press; Fleming, 1986a; Fleming, 1986b) just confirm that individuals consider moral aspects of socioscientific issues without describing the influences or implications of those considerations. The other reports (Pedretti, 1999; Zeidler & Schafer, 1984) supply descriptions of how moral considerations actually influenced decisions. Science education requires these more detailed descriptions if the field is going to move beyond recommendations for incorporating values and ethics in the science classroom to programs and curricula which actually do (Pedretti & Hodson, 1995; Zeidler, 1984).

The call to integrate science and morality is consistent with the growing push to encourage the development of sophisticated epistemologies of science, which includes an appreciation for the social context (including morality) in which science operates, among students (Abd-El-Khalick & Lederman, 2000; American Association for the Advancement of Science, 1990; Driver et al., 2000; Geddis, 1991; Kuhn, 1993; National Research Council, 1996; Siebert & McIntosh, 2001). In order to progress to a position where pedagogy and curriculum help students integrate ideas about scientific issues and their own values and ethics, the community needs an understanding of how individuals naturally construe these issues. The development of this suggested understanding requires an elaboration of the trends explored in previous work (viz., Pedretti, 1999; Zeidler & Schafer, 1984) as well as descriptions of issue construal in other contexts. The present study seeks to address the needs just presented by exploring student construal and resolution of dilemmas related to genetic engineering, which form a subset of socioscientific issues. The study is primarily concerned with the extent to which students construe genetic engineering issues as moral problems and how patterns of construal influence issue resolution. The researchers are also secondarily interested in non-moral patterns (i.e., thinking patterns that are not moral in nature as oppose to immoral or unethical) of decision-making that may emerge from the research context. Specifically, the study addresses the following three research questions:

1. To what extent do students construe genetic engineering issues as moral problems?
2. How do moral considerations influence construal and resolution of genetic engineering issues?
3. What factors (other than moral considerations) influence student decision-making regarding genetic engineering issues?

## Methods

### *Overview*

One approach to discovering how people construe and resolve socioscientific issues is to talk with individuals as they negotiate a series of socioscientific issues. The present study relied on this approach by engaging participants in interviews, and the dialogues focused on human genetic engineering issues. More specifically, the participants and interviewer discussed scenarios concerning gene therapy and cloning. In addition to presenting several scenarios for the participants to consider, the interviewer asked explicit questions regarding participants' feelings and reactions towards the issues and the role of moral or ethical considerations in their decision-making. The results from these interviews were used to construct a profile of how the participants perceived, construed, and resolved genetic engineering dilemmas.

### *Sample*

Socioscientific curricula are appropriate for many levels of science education, including middle school, high school, and college (Chiappetta & Koballa, 2002; Siebert & McIntosh, 2001; Trowbridge, Bybee, & Powell, 2000), and working to reveal patterns of construal and resolution of these issues should be a priority with each of these different groups. It might be the case that individuals from all of these groups share certain decision-making characteristics; however, it is also likely that at least some developmental differences exist among the groups. Describing decision-making in the context of socioscientific issues for each is the first step towards understanding the similarities and differences among groups. The current study seeks to elaborate on the factors which contribute to socioscientific decision-making for college students.

All interviews were conducted with students from a large, public university in the southeastern United States. Volunteers were solicited from undergraduate courses offered within the College of Education. The investigators selected a targeted sample of twenty female and male students. Some moral psychology researchers (Ford & Lowery, 1986; Gilligan, 1982) have noted divergent patterns of moral reasoning in different sexes. Although this study worked under the assumption that males and females do not engage in inherently different forms of moral decision-making (Friedman, Robinson, & Friedman, 1987; Hekman, 1995; Singer, 1999; Tronto, 1987), the sample was constructed so that both male and female voices were represented equally. The first ten females and the first ten males, who volunteered to participate, comprised the sample. Depending on the class in which the volunteers were enrolled, some students received extra credit for participation. Just under half of the sample (9 students) volunteered without the extra credit incentive.

Although gender and willingness to participate were the only factors which contributed to an individual's inclusion in the sample, two other characteristics are noteworthy. Fourteen individuals represented traditional, upper-division college students in terms of age (mean age 21.9 years). The remaining six members of the sample (mean age 39.7) were non-traditional students who had spent their early adult lives pursuing non-academic interests. Given the differences in life experiences of these disparate age groups, their construal and resolution of socioscientific issues may vary. The other notable feature of the sample was the amount of science background each of the participants had experienced. Although college coursework is not the only measure of a person's exposure to science, it does provide one measure of science experience. Fourteen of the participants reported that they had taken two or fewer courses in the natural sciences, and three individuals had completed three or four natural science courses. The remaining three students had completed or were in the process of completing a natural science degree program which involved extensive science coursework. The formal science background

of the participants has been presented because several authors (Fleming, 1986a; Hogan, 2002; Patronis et al., 1999; Tytler, Duggan, & Gott, 2001; Zohar & Nemet, 2002) have suggested that decision-makers' knowledge regarding science content can significantly influence their negotiation of socioscientific issues. Exploring the role of content knowledge in socioscientific decision-making is not an explicit goal of this study. However, to be consistent with the recommendation of providing a "thick description" of participants involved in qualitative research (Lincoln & Guba, 1985), it is important to note available information regarding the participants' relevant backgrounds.

### *Interview Protocol*

The interviews focused on a series of genetic engineering scenarios derived from gene therapy and cloning issues. The investigators chose these particular issues for three primary reasons. First, they are pedagogically appropriate for both high school and college students (Chiappetta & Koballa, 2002; Siebert & McIntosh, 2001; Trowbridge et al., 2000). Second, because the focus of this study was to describe moral construal, issues that were potentially morally derisive were needed. Genetic engineering issues such as cloning and gene therapy are considered by many decision-makers to be morally contentious (Evans, 2002; Haker & Beyleveld, 2000; Stock & Campbell, 2000), and therefore were appropriate for the scope of this study. Finally, the investigators sought issues that might interest potential participants thereby enhancing the quality of the interviews. It was expected that the timeliness of the issues (as gauged by their frequent discussion in the media), compared to completely unfamiliar issues, would contribute to greater participant interest.

One of the investigators conducted semi-structured interviews with individual participants in a private office. The interviews lasted between 30 and 65 minutes and were audiotaped for transcription. Each interview began with a very general description of the study: the interviewer informed the participant that the purpose of the interview was to explore students' ideas and decision-making patterns. The interviewer did not mention the relevance of morality to the study. Participants were then asked to read a handout describing gene therapy as applied to Severe Combined Immune Deficiency (SCID; see Appendix A for the complete handout). After reading the handout, the participants answered a series of questions regarding gene therapy for SCID as well as other scenarios including nearsightedness, eye color, and intelligence (see Appendix B for all of the interview questions). Next, the participants read a second handout (refer to Appendix C for a copy); this reading focused on cloning as a means of overcoming infertility problems. The handout was followed by a series of questions about the appropriateness of cloning in a variety of contexts including reproductive and therapeutic cloning (see Appendix B for an elaboration of each question). Both handouts, presented to the students, were very general and did not capture all of the nuances or controversies associated with human genetic engineering. The researchers were interested in hearing student opinions and thought processes without overwhelming them with details. The students might have offered very different responses to the same basic scenarios had the written prompts contained more information.

### *Analysis*

The qualitative analysis of interview transcripts was consistent with inductive data analysis described by Lincoln and Guba (1985) and the constant comparative method described by Glaser and Strauss (1967). The two authors independently reviewed 20% of the transcripts.

This review consisted of reading through the transcripts a number of times, taking notes on student thought patterns and emergent trends. Although the authors adopted slightly different approaches to their initial analyses (i.e, one began by examining patterns displayed by individuals across multiple scenarios and the other looked for patterns within a particular scenario across multiple individuals), both documented the same kinds of patterns. The initial taxonomies that each built were similar but not identical; however, after a period of consultation, the investigators developed a modified taxonomy consistent with both interpretations. The remaining transcripts were analyzed by the first author. Any patterns, which had not emerged in the sub-sample examined by both investigators, were checked by the second author. In preparing the final report, only those categories which were demonstrated by a minimum of four participants have been included (unless otherwise noted). The qualitative taxonomy that is presented in this report describes the patterns that emerged from the interview transcripts, but it should be noted that the researchers, who formalized the taxonomy have been influenced by the literature in moral philosophy and psychology.

In the results that follow, the authors will attempt to build a case for their interpretation of the data by providing a thick description of the emergent taxonomy, which includes student quotes taken directly from the interview transcripts. To help give context to student comments, the questions to which they are responding are frequently included. In the interest of space, some of these interviewer questions have been paraphrased. It is important to note that some students demonstrated distinct forms of reasoning while responding to various scenarios; therefore, while individual statements were classified in mutually exclusive categories, a single individual could have made statements representative of multiple categories.

## Results and Discussion

The students sampled expressed a variety of opinions regarding the socioscientific issues they confronted during the interviews. Despite the fact that all of the scenarios to which students responded stemmed from genetic engineering issues, they elicited a wide range of judgments and decision-making patterns as evidenced by the varying degrees to which the respondents supported the uses of genetic technologies. Whereas eighteen of the participants approved of the use of gene therapy for combating diseases like SCID, only one of the participants supported the use of cloning for the purpose of recreating successful people. The number of participants who supported or opposed particular genetic engineering applications was relatively insignificant as compared to the patterns that emerged from the rationales offered in support of these decisions. The figures are presented here to support the contention that the issues discussed were controversial enough to study construal and moral decision-making.

The next few sections discuss how students construed the dilemmas they considered. In most cases, students construed the issues as moral problems and demonstrated decision-making patterns consistent with moral construal. The emergent moral-based patterns of decision-making included moral reasoning, moral emotion-based choice, and moral intuitionism. An overview of the taxonomy that emerged regarding construal is presented in Figure 1. Descriptions and data which support taxonomic formation are provided in the sections that follow.

[Insert Figure 1 here.]

### *Non-Moral Construal*

The first research question addressed the extent to which students construe socioscientific issues as moral problems. *All* of the participants considered at least *some* of the scenarios moral

problems; however, a minority of the sample construed some scenarios as non-moral. For the purposes of this paper, the term non-moral will be used in a metaethical context; that is, the term assesses whether a problem resides in the moral domain. Non-moral does not imply a normative assessment and therefore, is not synonymous with immoral (Beauchamp, 1982). Three individuals construed cloning as a non-moral issue. All three displayed reasoning patterns consistent with moral construal in the context of gene therapy dilemmas, but they expressed different interpretations regarding cloning. The following quotations were made in response to questions about whether cloning was a moral issue.

- Participant 4 (P4): I don't think it's a moral issue...That's just me. That's just not how I was brought up with my family or my religion or anything.
- P7: The reasons for me to say that I would not do them [cloning applications] are not moral or religious. They are just the way I see myself. If I knew more about it, I may see some morals, but at this point I don't.
- P19: I don't see any moral issue when it comes to that [cloning]. On the gene therapy, I mean right away I thought it had moral issues but not so much with cloning. I'm not sure why.

These explicit comments denying the morality of cloning were supported in terms of how the participants rationalized their positions on each of the cloning scenarios. They suggested that cloning was an issue of personal choice and relied on practical considerations like the availability of resources as opposed to moral or ethical guidelines. Interestingly, some participants who did construe gene therapy and cloning issues as moral problems (n=4) integrated the idea of personal choice in their decision-making. These individuals suggested that genetic engineering scenarios were moral, but the ultimate arbiter of that morality should be individual decision-makers. The following excerpts provide examples of this pattern.

- I: Should parents be permitted to use gene therapy to predetermine the eye color of their children?
  P10: Everyone has to live with themselves. If they believe they are right in doing it, so be it. Personally, I would not mess with stuff that has been set already. It's not broken, why fix it? I don't know, I like a little surprise in life.
- I: What is your opinion in terms of the rights of a parent in terms of gene therapy?
  P3: You want to let someone have the right to choose. You know, it's their child and they can do what they think is right. I mean I think it's more interesting and more how things work to see how your child does turn out. I don't think I would ever fool around with anything going on with the pregnancy.
  I: But would you be opposed to someone else doing that?
  P3: No. I would not be opposed to it.

### *Moral Construal*

As mentioned previously, all participants considered at least some of the genetic engineering scenarios to be moral problems. Students expressed this idea explicitly as demonstrated in the excerpts below.

- Interviewer(I): When thinking about gene therapy, do you think that there are any moral principles or ethical guidelines that apply to these decisions?
  P13: I do not think that it is moral [to employ gene therapy]. I do not think it is a good thing to be creating these genes just to change the way individuals are. I

think there should be morals behind it but it really depends on peoples' own opinions. Overall, I definitely think there should be morals behind it because it is not right.

- I: Should gene therapy be used to eliminate SCID?
  P17: I think ethically definitely. I think it should be done. With the example of SCID, we have a disease that is killing. I think ethically, if this gene is found and we can replace it, I think ethically we have to replace it, and we need to do so as equally and equitably as we can.
- I: Should a mother be permitted to take cells from her dying infant to use for cloning another child?
  P20: That is a quick fix to replace something that you have lost. There is a grieving process that you have to go through and I do not think that it is morally right to turn back time basically—to ignore something that happened.

Moral construal was also evident implicitly in the patterns of thought and feeling expressed as students worked to resolve individual scenarios. In other words, the arguments offered in response to the different scenarios (for example, whether gene therapy should be available to parents to alter eye color) revealed a tendency towards moral construal. The exploration of these patterns attended to the second research question which addressed how moral considerations influence construal and resolution of socioscientific issues.

Students displayed three broad categories of moral decision-making throughout the interviews: 1) moral reasoning, 2) moral emotion-based choice, and 3) moral intuitionism. The moral reasoning category, in turn, subsumed two distinct patterns that emerged from the discussions. a) Many students employed a form of consequentialism; that is, they based their decisions on an assessment of the consequences of the application of gene therapy or cloning. b) The other pattern of reasoning was based on the application of moral principles or prescripts, consistent with a deontological approach to morality. (Refer to Figure 1 for a schematic overview of the emergent taxonomic organization.)

*Moral Reasoning: Consequences*

Students demonstrating consequentialism justified their positions in terms of expected outcomes. They made utilitarian analyses of the benefits and detriments of particular genetic engineering applications. In response to gene therapy scenarios, a primary consequence that students considered was effect on the health of individuals. Students supported the use of gene therapy to improve the health of individuals (as in the SCID scenario) in contrast to gene therapy for convenience or cosmetic reasons (as in the nearsightedness and eye color scenarios). The other consequences considered were applied to contexts of both gene therapy and cloning. The erosion of diversity was a concern for some students. The idea that gene therapy and cloning would restrict individuality and overall diversity led some students to oppose these technologies. Others opposed genetic engineering because of its potential to contribute to social stratification. Just as racial, socioeconomic, and religious classifications tend to divide a society, gene therapy and cloning may also segregate a population by creating classes of "genetic haves" and "genetic have nots." Another consequence applied to both applications involved "slippery slope" arguments (Boss, 2002). Students expressed concern that permitting the application of technology in one acceptable context would lead to the use of that technology in unacceptable contexts. For example, a student might initially support gene therapy for combating disease, but ultimately oppose it because employing gene therapy for disease might lead to its use for altering cosmetic characteristics. In an attempt to limit slippery slope consequences, some students

suggested that a line of demarcation must be drawn between what is and is not acceptable. In discussing gene therapy, participant 20 expresses this sentiment, "I think there needs to be a line because without a line you're making everyone the same. You're defining what a person should be, and by going that route, you're making everyone to a certain set of guidelines." Another consequence considered in response to gene therapy and cloning scenarios was the betterment of society. Particular applications were supported if they had the potential to improve society overall. Finally, students analyzed the effects of genetic engineering on human population. They opposed genetic engineering because of its potential to exacerbate the problem of overpopulation.

In support of the taxonomy of consequentialist moral reasoning, Table 1 provides examples of reasoning patterns taken directly from interview transcripts as well as the number of of individuals who demonstrated each category. Although it is not necessary or customary to substantiate qualitative taxonomies with quantitative measures (Lincoln & Guba, 1985), the numbers have been included for the benefit of readers who might be interested. However, the inclusion of these figures does not suggest that these results are equivalently generalizable. The aim of qualitative inquiry is transferability rather than generalizability: the degree to which these findings apply to other contexts can only be determined by the researcher or practitioner charged with the application. The emergence of patterns among individuals is far more significant than the actual number of individuals who displayed them.

Table 1. Patterns of consequentialist moral reasoning. (The number under each category represents the number of the individuals who employed this pattern of reasoning.)

| Consequence | Exemplar |
|---|---|
| Health Improvements (16) | I: Why do you support gene therapy for SCID and not eye color?<br>P12: One is an area where you're helping poor health or helping disorders that may spread, things that can be harmful to children or other people and one that should be fixed for the well-being of the child. But when it comes to just cosmetic..., I'm not in favor of it.<br><br>I: Should gene therapy be used to combat SCID?<br>P14: I think it is good because it is a help to people. I don't think you should go making whole humans using genes. There is kind of like a bad side, I guess, but as long as it is helping people. From what I read there, it is targeting disease, so sure, I think it is good. |
| Diversity (8) | I: Should gene therapy be used to alter intelligence?<br>P7: [No, because] it is a fear of mine that all kids would be the same, like the diversity in our culture is something that makes it what it is. And when we have these things available to people, maybe all kids would be at the same level which is probably not healthy.<br><br>I: Should gene therapy be used to alter intelligence?<br>P8: I don't think so because it is like creating one type of person. Eventually, everyone—like when Hitler was trying to create a certain type of person. I just feel like you are opening a bag of worms basically. |

Continued on next Page

Table 1 continued.

| | |
|---|---|
| Social Stratification (4) | I: Should cloning be a reproductive option for infertile couples?<br>P15: No...Maybe in the future, instead of economic stratification we would have genetic stratification...I just do not trust the end social results and the uses of this. That is my main ethical argument against cloning.<br><br>I: Should parents be able to use gene therapy to alter eye color?<br>P17: If we allow people to choose then it becomes an issue of those who can afford to choose or those who are educated to the choice. These people would be in a different class than those individuals who cannot afford it or may not have the knowledge of it. You're drawing another social line in addition to the ones we already have. |
| Slippery Slope (14) | I: Should parents be able to use gene therapy to correct nearsightedness?<br>P1: I think if scientists start with this and change something like nearsightedness, that it's going to be their hair color and eye color next. To me, it just seems like it's going further and further.<br><br>I: Should cloning be a reproductive option for infertile couples?<br>P5: I think once you start cloning human beings, it could get so out of hand. Where would it end? Everybody wants this color hair, this color eyes etc...It could cause total chaos in actually in the population. |
| Societal Betterment (4) | I: Should gene therapy be used to alter intelligence?<br>P3: It would be nice if everyone were more intelligent. It would make our world more productive and our country more productive. I don't see any harm in making someone smarter to make your life easier, to make them more intelligent.<br><br>I: Should gene therapy be used to correct nearsightedness?<br>P12: I think so. It will only lead to progress. Unfortunately, some things [side effects] happen, but I think humanity is ready for improvement and is ready for progress. |
| Overpopulation (5) | I: Should gene therapy be used to combat SCID?<br>P13: Overall it is not an excellent idea because if you cure all of these diseases then no one is going to die. To an extent, you're going to have overpopulation. People are supposed to die and if we just keep on coming up with things to keep people alive, then we are going to incredibly overpopulate the earth. As if it is not bad enough as it is.<br><br>I: Do you have any initial reactions or feelings regarding gene therapy?<br>P20: I think that gene therapy is something that needs to be investigated but not necessarily used because people have these diseases as a part of population control. |

*Moral Reasoning: Principles*

In addition to consequential moral reasoning, students also relied on moral principles or prescripts to guide their decision-making. Although students did not necessarily articulate formal principles such as justice and duty (Beauchamp, 1982; DeMarco, 1996), they did use a series of moral guidelines. Their reasoning was deontological in the sense that decisions were based on moral standards independent of the consequences. Four principles emerged as significant contributers to moral reasoning: two applied specifically to therapeutic cloning, and the others affected multiple scenarios of both gene therapy and cloning. In response to the therapeutic cloning dilemma, several students objected to the technology because of the status of an embryo. They believed that an embryo was a human life; therefore, therapeutic cloning which involves sacrificing embryos violates a principle against taking human life. Some students were also concerned about using human embryos as a means to an end. They suggested that using embryos as resources or tools was immoral. All but one of the students cited concerns about using genetic technologies in at least one of the interview contexts because these

applications alter natural progress. Many students equated genetic engineering with "playing God," and this typically was not a desirable assertion. Another principle employed, related to the idea of preserving natural order, implied that parents did not have the right to genetically alter or clone their children. Table 2 presents the patterns of principle-based reasoning and exemplars extracted from the interview transcripts.

Table 2. Patterns of principle-based moral reasoning. (The numbers under each category represent the number of individuals who employed this pattern of reasoning.)

| Principle | Exemplar |
|---|---|
| Taking Human Life (6) | I: Should therapeutic cloning be pursued?<br>P5: Initially, I was going to say yes because I see all those benefits that you listed and many, many more; but when you said that the embryo cannot be re-implanted, then I disagree. Merely because I've always been taught that an embryo is still a human being regardless of whether it is six weeks or six months or whatever.<br><br>I: Should therapeutic cloning be pursued?<br>P8: The fact that you are sacrificing an embryo makes my answer no...It does not matter what stage the embryo is at...I see those [embryos and children] as equal things. |
| Means to an End (4) | I: Should therapeutic cloning be pursued?<br>P6: No...Because I think here you have created a human being for spare parts, and I do not think that is right...The fact that you create and put all this research into creating this embryo and take what you want and then throw away the rest, I find that hard to swallow.<br><br>I: Should therapeutic cloning be pursued?<br>P13: Basically, you're creating a human being to take their parts to help someone else. I don't think you should create anything just to use for parts. I mean, granted, it would be great to help science and help people with diseases and stuff, but that should not be the way to do it. |
| Disrupting Natural Order (19) | I: Should cloning be a reproductive option for infertile couples?<br>P3: Cloning is messing with things that we are not supposed to mess with. We all got along just fine before cloning...I think that everything happens for a reason and things will work themselves out with that kind of stuff.<br><br>I: Earlier you mentioned that your religious ideas influenced your decision-making. Can you describe how?<br>P11: I just think that God created people so maybe we should just leave the world as it is. You do not want to mess with the natural flow of things. Sometimes it is better if you don't. |
| Parental Rights (6) | I: Should parents be able to use gene therapy to change eye color?<br>P12: [No.] The child may not have wanted it that way. If anything, they should wait until the child gets old enough to make that decision for themselves. I don't think that the parents can make that decision for them.<br><br>I: Should parents be able to use gene therapy to change eye color?<br>S13: I don't think it's necessary...I don't think parents have a right to choose that. |

*Moral Emotion-Based Choice*

Students did not always base their judgments on rational deliberations of consequences or principles. In some instances, the students were influenced by the emotions they felt towards the interview scenarios or the characters described in the scenarios. Almost half of the sample (9 participants) shared information indicating that emotions had significantly contributed to their consideration of the issues. The application of emotions was more frequent in the cloning scenarios, particularly in the scenarios that involved reproductive cloning. Students empathized with the hypothetical couple who could not have children and the mother who wanted to clone her dying child. The following quotes, offered in response to the scenario involving a mother who wants to clone her dying child, provide support for the influence of empathy.

- P3: I would not want to deny this woman because she has no one else—she just lost a child...When I think about these things, I put myself in that situation. If this happens to me, how would I want to go on?...I think she should because it's going to make her happy and make her life better. Since this traumatic event happened, she should do it if it's going to make her happy.
- P12: When people are suffering, only they know what they are feeling...We have an attachment to life. People choose not to let go and I don't think we should tell them no, you do have to let go. I think it is rather arbitrary, somewhat unfair...That is kind of harsh. If she would like to, and we can, I say why not.

Although these excerpts reveal cases in which emotions directed the resolution of the dilemma, some students seemed to integrate emotional influences with other decision-making factors. In these cases, students felt empathy towards the scenarios' characters but also relied on other factors such as assessment of consequences or principles in the articulation of a final position. Consider the following exemplars which were also made in response to the scenario just cited.

- P13: I just don't think that [cloning] is right. I feel terrible for the mother. If I was in the situation, I would feel terrible too, but I would never turn to cloning to get another child.
- P19: I feel sorry for the woman for losing a child and her husband, but that is not going to alter my decision.

*Moral Intuition*

The final category of consideration which confirmed moral construal was moral intuition. Individuals displaying this pattern responded to scenarios as if they instinctively knew a moral resolution to the problem. The students did not support these resolutions with an analysis of consequences, principles, emotions, or any other discernible factors; they simply perceived a particular genetic engineering application as morally right or wrong. Fourteen individuals expressed an intuitive analysis of at least one scenario, and all of these responses opposed the application of the genetic technology in question. The following quotations provide examples of the intuitionism demonstrated in this investigation.

- I: Do you have an opinion on cloning?
  P6: It is not right!
  I: Why is it not right?
  P6: I don't know why it is not right...Some of these things just can't be supported academically or intelligently. You just have to go with your feelings about the issue.

- I: What are your initial feelings or immediate reactions to cloning?
  P20: I'm totally against recreating another human that is identical to one that is already here.
  I: Are you opposed to cloning because of a specific reason or is it the case that you just know this is wrong?
  P20: Well, I see it as wrong, but I can say it [a specific reason to oppose cloning]. I just do not see—it just does not make sense. (Long pause.) I just don't see—I guess it is just a whole broad spectrum that I just don't think we should do.

In the last excerpt, Participant 20 seems to think that his position would be strengthened by providing a specific rationale, but he never offers (in this selection or the remaining transcript) that rationale. It appears more likely that Participant 20 and other participants oppose certain types of genetic engineering because use of these technologies feels intuitively wrong.

*Decision-Making Influences*

One of the advantages of qualitative inquiry is the potential to reveal and study unexpected results. The third research question was included in order for the focus of the study to remain sensitive to unhypothesized factors affecting socioscientific decision-making. Five significant patterns emerged from the analysis. 1) Several students explicitly mentioned religion as an important decision-making factor. 2) Students frequently related the scenarios to their own personal experiences. For instance, while responding to the scenario involving gene therapy for the correction of nearsightedness, students with vision problems often used their experiences to inform their decisions. Similarly, some participants talked about acquaintances or relatives encountering fertility problems in response to the reproductive cloning scenario. 3) Students revealed a tendency to articulate a particular position, but suggested that their position would change if the situation involved themselves or family members. 4) Many students reported that they would benefit from more information regarding genetics and gene therapy. They suggested that ignorance about issues significantly hampered their ability to make informed decisions. 5) The final influence was derived from popular culture. Students relied on information and predictions provided in literature, movies, and the media. Table 3 supplies student quotations that support the formation of these five categories.

Table 3. Decision-making influences. (The numbers below each category represent the number of the individuals who employed this pattern of reasoning.)

| Influence | Exemplar |
|---|---|
| Religion (11) | I: What factors contributed to your decisions regarding genetic engineering?<br>P5: Medical benefit, medical risks, emotions, faith.<br>I: How does faith influence these decisions?<br>P5: I would say that a majority of people in the world have a belief in a god. Most people are not atheists. So, I think the majority would weigh their beliefs in making decisions.<br><br>I: What are your initial reactions to cloning?<br>S8: I do not believe in cloning as far as people go...probably because of my upbringing. I was raised Catholic and I have been around religion all my life...I'm not really a strict Bible reader, but I know that we as people do not need to be playing the act of God. |
| Personal Experience (12) | I: Should gene therapy be used to correct nearsightedness?<br>P3: Well, I'm nearsighted and it's annoying. I want lasik surgery so bad, so I would totally do it.<br><br>I: Do you support the use of therapeutic cloning?<br>P16: I don't know because I have a mother who has kidney failure. If this would have helped in earlier stages in her life, I would have been all for it. |
| Family Bias (7) | I: Should gene therapy be used to combat SCID?<br>P2: I think that's kind of God's call...Now if it were my family...I would think about it differently. As a person that I feel bonded to, I would be more apt to say do more, do whatever you can.<br><br>I: What are your initial feelings regarding gene therapy?<br>P20: I think gene therapy is something that needs to be investigated but not used...I'm sure I would feel differently if this were dealing with someone that I loved. |
| Need More Information (9) | I: What are you initial feelings regarding cloning?<br>P9: If I had more data, if I know more about it...I don't understand the whole cloning portion.<br><br>I: What are you initial feelings regarding gene therapy?<br>P16: I don't know a lot of science. I don't know what all you could do with it, but as far as diseases, as long as it is going to help people. Why not help them? |
| Pop Culture (5) | I: What are your feelings regarding cloning?<br>P14: I don't think you should be able to do it...When it comes to humans, that is when you can get into possibly living forever. I don't know if you ever saw the movie *Sixth Day*—what they did was clone people and insert their brain, so down the road you never know what can happen.<br><br>I: What are your feelings regarding cloning?<br>P15: It's like *Brave New World* or something. I am not ready for it. I just do not know that we are ready in our philosophical, spiritual, moral, ethical development to proceed along with things like this. |

### *Sub-groups within the Sample*

This investigation did not specifically test for variations in the reasoning patterns of different sub-groups within the sample. Therefore, the following comments are not offered as generalizable conclusions but rather, as descriptive trends found in this sample. In the methods section, three classes of sub-groups within the sample were described: differences in gender, age, and content background. No observable differences emerged as a function of any of these groups. Both male and female students displayed examples of all of the taxonomic categories described in this report. Likewise, no systematic differences emerged between the reasoning patterns displayed by students of traditional college ages and older students or between students with limited and extensive formal, science backgrounds.

## Conclusions and Implications

The primary focus of this investigation was an exploration of socioscientific issue construal and resolution in the context of genetic engineering. The study specifically sought to address how individual decision-makers interpreted and negotiated the moral dimensions of gene therapy and cloning. Whereas the results presented support earlier conclusions which suggest that moral factors are important influences on decision-making regarding genetic engineering issues (Bell & Lederman, in press; Fleming, 1986a; Fleming, 1986b), the present investigation also provides an expanded description of how individuals perceive and apply moral factors in the resolution of gene therapy and cloning issues.

Some of the patterns that emerged from this study have also been identified as important aspects of decision-making in other socioscientific contexts. For instance, Pedretti (1999) cites the analysis of consequences among 5th and 6th graders considering an environmental issue. These students also relied on basic principles related to fairness and justice. Although the subjects in the current study are significantly older than Pedretti's participants, the college students also made analyses of consequences and principles. Given the divergent decision-making contexts and the differences in maturity levels, it is not surprising that the actual consequences and principles used by students in the two studies are quite different. The dominant forms of (cognitive-based) reasoning that students in the present study employed were: 1) consequentialist moral reasoning -- students resolved problems in terms of issues such as health outcomes, "slippery slope" concerns, and diversity; and 2) moral reasoning based on principles (or prescripts) -- students appealed to principles such as natural law or order, the sanctity of human life, and parental rights.

In their study of college student decision-making regarding environmental issues, Zeidler and Schafer (1984) suggested that affect served as an important influence. The present study confirms this result and expands the discussion of how factors related to affect such as emotion and intuition contributes to the consideration of socioscientific issues. Specifically, students did not confine their decision-making of socioscientific issues related to genetic engineering to rational deliberation of consequences and principles of justice. Students consistently evoked emotive considerations and consciously used related affective factors in arriving at moral decisions. It should be noted that the authors do not equate the influence of emotion with "non-rational" factors. To the contrary, many students showed evidence of metacognitive strategies as they evaluated the dissonance they faced in cases where their empathy of others was in conflict with their stated positions or principles. How actions were construed in this case as good or valuable derived from valuing empathy and not solely on the will or desires of the student whose initial position may be contrary to others. Reasoning understood in this manner constitutes a form of value-centered practical rationality (Milligan, 1980; Keefer, 1996; Keefer and Olson, 1995; Raz, 1998).

The literature in moral psychology has detailed the significance of emotions in moral decision-making (for reviews see Eisenberg, 2000; Hoffman, 2000), but the role of emotions in general and empathy in particular have not been explored extensively in research regarding socioscientific issues. The results presented in this study document the effects of empathy on decision-making in the context of genetic engineering issues.

### *Implications for Science Education*

Recent calls for improving scientific literacy have suggested socioscientific issues as a vehicle for promoting an appreciation of the complex interactions of science and society

including moral and ethical influences (on the practice of science) and ramifications (resulting from science) (Driver, Leach, Milar, & Scot, 1996; Geddis, 1991; Zeidler et al., 2002). This study supports the notion that exploration of socioscientific issues encourages students to confront the moral aspects of science. The results suggest that student (at least college student) decision-making regarding socioscientific issues (in this case, genetic engineering dilemmas) is largely determined by moral considerations. Therefore, it is our recommendation that science curricula should not only incorporate socioscientific issues; it should explicitly attend to (and not deny or overlook) the moral aspects of these issues. Recent work on socioscientific issues has suggested that students' understanding of the Nature of Science (NOS) (Sadler et al., 2002; Zeidler et al., 2002) and evaluation of evidence (Kolstø, 2001; Korpan et al., 1997; Tytler et al., 2001) are central to the negotiation of these issues. While we do not deny the significance of NOS considerations and the ability to evaluate evidence, we suggest that moral and ethical considerations are also important. If moral aspects of socioscientific issues are primary determinants of student decision-making, then treatments of these issues without addressing moral and ethical aspects severely limit the productivity of the exercises and encourage the tendency for students to isolate school science from their everyday experiences (Sadler et al., 2002; Zeidler et al., 2002).

The results of this study provide some direction in terms of how the morality and ethics of socioscientific issues, particularly those dealing with genetic technologies, can be handled in science classrooms. Students were frequently interested in the moral consequences of genetic engineering; therefore, teachers and curriculum designers might focus on these areas in the presentation of issues. Students also applied principles in their decision-making. Teachers might encourage the discussion of principles and could introduce philosophically important positions such as utilitarianism and deontology. We are not recommending that teachers tell students how to negotiate the morality of socioscientific decisions, but by providing a forum for the exploration of consequences, principles, emotions, and intuitions, teachers will be empowering their students to resolve difficult issues on their own.

### *Implications for Future Research*

This study directs attention to a variety of areas that deserve exploration in the field of science education. Socioscientific issue construal and resolution require investigation using other contexts and scenarios as well as with different age groups. How context dependent reasoning is regarding socioscientific issues and whether or not developmental differences affect decision-making remain open questions. Another area of potential research involves how moral considerations are integrated in overall patterns of informal reasoning and argumentation. Informal reasoning and argumentation have become significant aspects of classroom science (Driver et al., 2000; Jiménez-Aleixandre et al., 2000; Kuhn, 1993; Zohar & Nemet, 2002); the position of moral consideration in this framework is an important area of inquiry. The final implication for future studies emerges directly from the student interviews. Many students cited a lack of knowledge regarding the issues they were asked to discuss. This yields a question regarding the relationship between content knowledge and socioscientific decision-making. Although it is sensible to intuitively assume that increased understanding of concepts related to an issue will contribute to improved decision-making (Patronis et al., 1999; Zohar & Nemet, 2002), research in other fields have not revealed significant links (Kuhn, 1991; Means & Voss, 1996; Perkins & Salomon, 1989). This too, remains an open area for future research.

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## Appendix A: Gene Therapy Prompt

**Gene therapy**

Human development is influenced by a person's genetics and environment (i.e. nature and nurture). Some human characteristics are determined almost entirely by genes. For instance, eye color is determined almost exclusively by genes (there are actually several genes that contribute to the color of a person's eyes). On the other hand, height is a trait that is influenced significantly by both a person's heredity (genes) and nutrition (environment). In addition to traits like eye color and height, some diseases can be controlled by a person's genetics (or an interaction between genetics and the environment). Gene therapy has been proposed as a means of stopping genetic diseases. In theory, gene therapy would work by replacing disease-causing genes with healthy-operating genes in human embryos. The person that would develop from the "genetically engineered embryo" would not carry the disease because the disease-causing genes had been replaced.

Severe combined immune deficiency (SCID) has been proposed as a disease to be targeted by gene therapy. SCID is a disease caused by a single gene that affects a person's immune system. SCID patients cannot fight-off common infections such as chicken pox, the common cold, and the flu. Whereas the immune systems of most children enable them to get well following a bout with the flu or chicken pox, SCID patients frequently die after being exposed to these common diseases. Children with SCID must live in isolation from others, unable to go to school or play with other children because of the danger of contracting infectious diseases; most do not live into adulthood. Some medical researchers suggest that embryos carrying the SCID gene should undergo gene therapy. In other words, doctors would replace the SCID gene in the embryo with a gene that does not cause SCID.

## Appendix B: Interview Questions

1. When you hear something about gene therapy, or as in this case, read about gene therapy, do you have an immediate reaction or initial feelings regarding this issue?

2. Should gene therapy be used to stop the development of SCID? Please explain your response and provide justification for your answer.

3. What do you think about gene therapy in other conditions? If nearsightedness could be linked to a single gene that could be targeted by gene therapy, should doctors screen for this condition and correct it by means of gene therapy? Please explain your response and provide justification for your answer.

4. Should future parents be permitted to use gene therapy to manipulate genetic traits of their choosing? For instance, if it were possible, should parents have the right to predetermine the eye color of their children by means of gene therapy? Please explain your response and provide justification for your answer.

5. A person's intelligence is controlled by a variety of factors, but if a gene were found to contribute to intelligence, should science explore ways to develop this gene for gene therapy with the intention of improving the intelligence of future offspring? Please explain your response and provide justification for your answer.

6. Do you think that decisions regarding gene therapy should involve moral principles, ethical guidelines or values? If so, please describe those principles, guidelines or values and how they influence the gene therapy debate.

7. When you hear something about cloning, or as in this case, read about cloning, do you have an immediate reaction or initial feelings regarding this issue?

8. Imagine that you know a couple that cannot have children. You know that they desperately desire to have children, and think that they would make wonderful parents. Should your friends try cloning in order to have their own baby? Would you recommend and/or support cloning as an option? Please explain your response and provide justification for your answer.

9. Imagine a situation in which a young couple with a newborn child (their only child) are involved in a terrible car accident. The husband dies at the scene of the crash and the baby is mortally wounded and will undoubtedly die within days. The distraught wife wants a child fathered by her deceased husband. Should she be permitted to take cells from her dying baby to use for cloning another child? Please explain your response and provide justification for your answer.

10. Should society attempt to clone its most successful individuals? Consider a very successful person with great intelligence, fabulous artistic skills, and impressive physical abilities. Should society try to clone this individual? Please explain your response and provide justification for your answer.

11. So far, we have been talking about reproductive cloning. Therapeutic cloning is another procedure that some people advocate. In therapeutic cloning, a donor's genetic material would be put into an egg cell and stimulated to grow. The resulting embryo would be implanted into a woman for a short amount of time and then removed. Stem cells that could be used to generate transplant tissue such as kidney cells for patients with kidney disease, nerve cells for spinal cord injuries, and cardiac cells for people suffering from heart disease. Do you think that therapeutic cloning should be pursued?

12. Can you think of any principles or rules (ethical, religious or otherwise) that might apply to human cloning? If so, describe the principles or rules and how they inform the cloning debate.

13. Why do you think human genetic engineering (including cloning and gene therapy) is such a contentious issue?

## Appendix C: Cloning Prompt

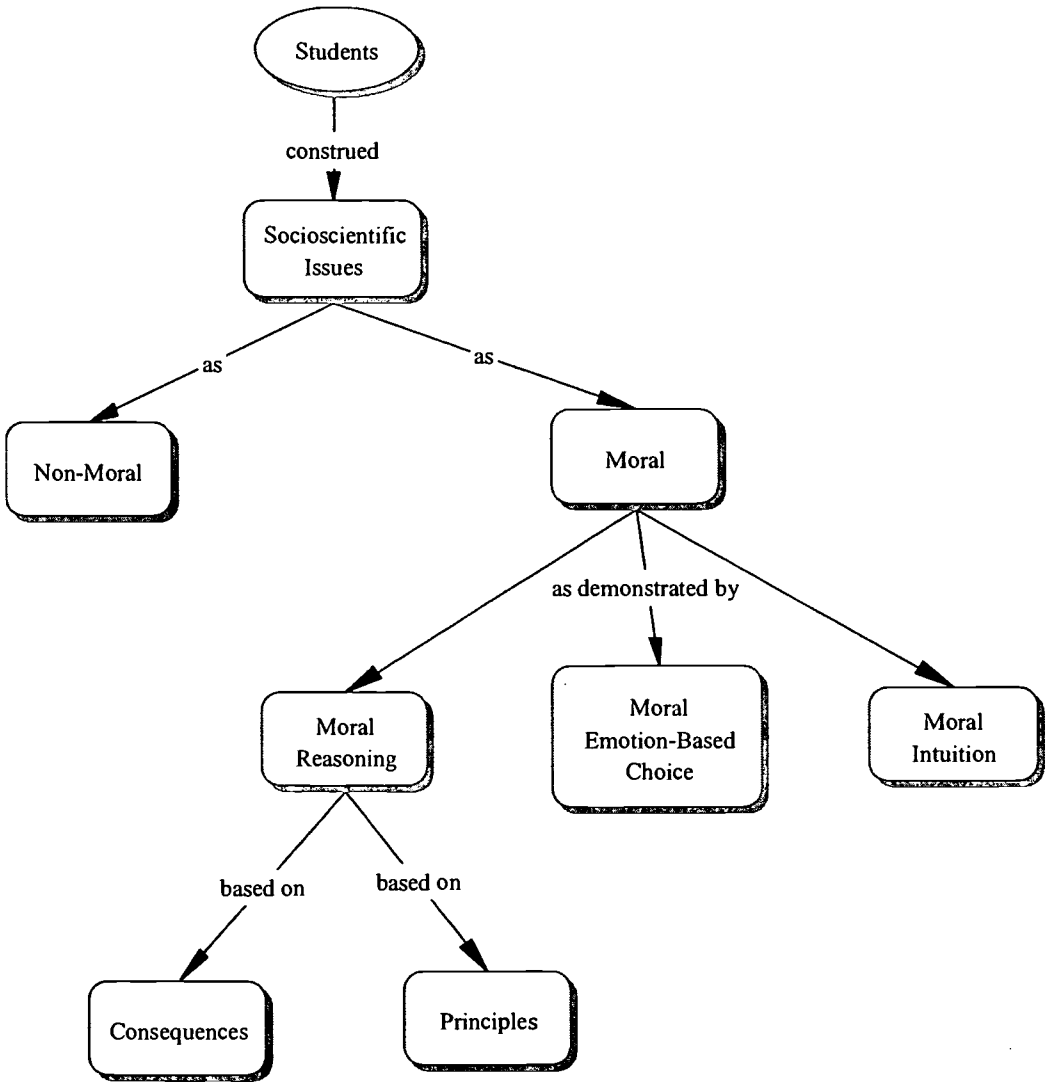
**Cloning**

The process of cloning is designed to produce an organism genetically identical to another organism. In the normal process of mammalian reproduction, genetic material from an egg and sperm combine during fertilization to produce a new genetic makeup. The new genetic combination of the offspring is distinct from both parents. The fertilized cell will eventually develop into a new offspring. In cloning, the genetic material of an unfertilized egg cell is removed and a complete set of genetic material (from a donor) is inserted into the egg cell. This cell, carrying a copy of another organism's genetic material, will eventually develop into a new offspring. The cloned offspring will be genetically identical to the donor organism.

The above paragraph describes how cloning should work in theory. In actual practice, cloning is difficult to successfully complete. However, scientists have cloned several animals including sheep, cows, and monkeys. The technology to successfully clone humans has not been developed, but research groups are currently working to overcome these problems.

While some people oppose cloning outright, others suggest that cloning could be a useful reproductive technology. It has been proposed as a possible strategy for couples who want children but are infertile.

Figure 1. Overview of student construal and resolution patterns.



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