Supplemental Materials

for

Encouraging Science Communication through Deliberative Pedagogy: A Study of a Gene Editing Deliberation in a Nonmajors Biology Course

Sara A. Mehlretter Drury1,*, Anne Gibson Bost2, Laura M. Wysocki3, and Amanda L. Ingram2

1Wabash College Department of Rhetoric, Crawfordsville, IN 47933, 2Wabash College Department of Biology, Crawfordsville, IN 47933, 3Wabash College Department of Chemistry, Crawfordsville, IN 47933

Table of Contents
(Total pages 6)

Appendix 1: Issue guide

Appendix 2: Facilitation guide

*Corresponding author. Mailing address: Wabash College Department of Rhetoric, PO Box 352, Crawfordsville, IN 47933. Phone: 765-361-6393. E-mail: drurys@wabash.edu. Received: 2 October 2017, Accepted: 12 December 2017, Published: 30 March 2018.
Appendix 1: Issue guide

Should gene editing technology be used in humans?
This deliberation today is an opportunity to collaboratively consider the different perspectives on gene editing. Our conversation will consider the different approaches, actions, and concerns surrounding genetically modifying humans.

<table>
<thead>
<tr>
<th>Option One: Human Enhancement</th>
<th>Option Two: Human Therapeutic Use</th>
<th>Option Three: Ban Human Gene Editing for all purposes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Few / no restrictions on using gene editing technologies to improve humans</td>
<td>gene editing technologies restricted to curing or treating human diseases</td>
<td></td>
</tr>
<tr>
<td>Imagine that ...</td>
<td>Imagine that ...</td>
<td>Imagine that ...</td>
</tr>
<tr>
<td>Joan has dyslexia, and while she benefitted from great teachers and support systems in school and ultimately learned to read well, she’s nervous about having children because she knows the trait has a genetic basis. She recently had her genome sequenced and learned that a small mutation in the gene DYX1C1 is probably responsible for her learning disorder. Joan’s doctor has told her that gene editing techniques could be used to modify this gene in embryos to ensure that her children learn to read just as easily as other children who have been more fortunate in the “genetic lottery”. Should gene editing technology be available for this type of human enhancement?</td>
<td>Bob is 25 years old and has cystic fibrosis. His disease has responded well to treatments, so he’s still pretty healthy and recently got married. Bob and his wife, Elena, are anxious to start a family while Bob is still healthy, but a genetic test shows that Elena is a carrier for cystic fibrosis. The genetic counselor tells Bob and Elena that gene therapy could be used on their embryos to correct the single nucleotide mutation in the CFTR gene, allowing their children and subsequent generations to live free of this disease. Would you support the use of gene editing technology in this situation?</td>
<td>You are reading the morning paper and see that a new technology has developed that has the power to alter human DNA segments. The news is featured heavily throughout the month with many interest groups weighing in on the possibilities. Families seeking quick remedies to diseases, many of which already have treatments, and companies looking to sell this technology have had the strongest voices. Many people seem to be looking at exaggerated possible benefits that the media portrays without reflecting on the risks or ethical dilemmas. Children “manufactured” by their parents are some of the victims people do not seem to think about. The risk is overlooked by the excessive optimism and ignorance of the general public. No one has seemed to think that all of this power and choice will lead to “trending genes” and drastic gene changes that may produce unintended consequences. Is this the world you would wish to see?</td>
</tr>
</tbody>
</table>
## Should gene editing technology be used in humans?

<table>
<thead>
<tr>
<th>Option One: Human Enhancement</th>
<th>Option Two: Human Therapeutic Use</th>
<th>Option Three: Ban Human Gene Editing</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Benefits:</strong></td>
<td><strong>Benefits:</strong></td>
<td><strong>Benefits:</strong></td>
</tr>
<tr>
<td>✓ Allows for not only the elimination of genetic diseases, but can also allow for positive changes in non-essential traits</td>
<td>✓ Improves the health of individuals and their progeny; effectively improving the health of the population, lowering health care costs</td>
<td>✓ Eliminate risks associated with altering the human germ line</td>
</tr>
<tr>
<td>✓ Parents can choose the features of their children</td>
<td>✓ Maintain individually among people while receiving the most ethical benefits from gene editing technology</td>
<td>✓ By not providing further research into this technology, abuse will never be possible (i.e. extreme mutations, loss of progeny freedoms)</td>
</tr>
<tr>
<td>✓ Could create evolutionarily advanced humans that have the best features without playing “the genetic lottery”</td>
<td>✓ Prevent potential abuses of the technology such as extreme germ line mutations, black markets for unregulated use, and social classes that would form with mainstream enhancement use</td>
<td>✓ We could always revisit the ban, but this approach prioritizes limiting potential problems.</td>
</tr>
<tr>
<td>✓ Children beneficiaries from this technology will have increased opportunities</td>
<td><strong>Concerns:</strong></td>
<td><strong>Concerns:</strong></td>
</tr>
<tr>
<td><strong>Concerns:</strong></td>
<td>✓ The creation of a thin and fragile line between what is therapeutic vs. enhancement</td>
<td>✓ The total ban of genetic engineering technologies could destroy any opportunities to efficiently cure diseases</td>
</tr>
<tr>
<td>✓ It may be costly to perfect, produce, and regulate.</td>
<td>✓ Opportunities to create a stronger human race are lost because of a debatable ethical line</td>
<td>✓ We’ll lose opportunities to use new technologies to study human growth and development in the laboratory</td>
</tr>
<tr>
<td>✓ The choices of parents would affect their progeny without consent from the future generations</td>
<td>✓ Any possible dangers of using gene editing technology for enhancement might also apply to therapeutic applications</td>
<td>✓ Banning a current technology based on a “slippery slope” argument prevents progress from being made due to fear of future possibilities</td>
</tr>
<tr>
<td>✓ Choices in genes may lead to lower biodiversity and would be subject to “popular trends” in gene selection</td>
<td>✓ Communities, such as the deaf, that see deafness as a difference and not a disability would either lose their culture or subject their children to fewer opportunities</td>
<td>✓ We have an ethical requirement to relieve human suffering in any way we can, even through “unnatural” means</td>
</tr>
<tr>
<td>✓ Allowing certain enhancements may create a slippery slope into eugenics, socioeconomic stratification, and discrimination.</td>
<td><strong>Possible Actions:</strong></td>
<td><strong>Possible Actions:</strong></td>
</tr>
<tr>
<td><strong>Possible Actions:</strong></td>
<td>✓ Convene experts in gene editing technologies and bioethics to construct guidelines for appropriate use of new technologies.</td>
<td>✓ Lobby your local and federal representatives to completely ban research and clinical trials having to do with human genetic engineering</td>
</tr>
<tr>
<td>✓ Allow for and fund further research into human genetic engineering technologies such as CRISPR, ZFN, and TALEN</td>
<td>✓ Allow carefully selected research institutions to experiment with human embryos to further basic understandings in human development and disease control.</td>
<td>✓ Refuse to support any institutions that promote such engineering practices and educate the public on the ethical and medical danger of human genetic engineering</td>
</tr>
<tr>
<td>✓ Provide possible public policy design guidelines for human germline modification</td>
<td>✓ Improve existing regulations that allow for gene therapy to include editing DNA and help remove unnecessary stigma of genetic engineering</td>
<td></td>
</tr>
</tbody>
</table>
Appendix 2: Facilitation guide

Gene Editing Technology Facilitation Guide

Created by Wesley Virt, Alex Wimber, Isaac Empson, Amanda Ingram, and Sara Drury

Introduction

In today’s society we are told that the way to be the best is to be athletic, smart, and physically attractive. While some people have genes that allow them to fulfill this role, others do not. Other people have errors in their genomic code that cause mental or physical disabilities, genetic disorders, or other undesirable traits. But what if we could change all of that? What if through gene editing we could change the grandma with Alzimers, or the kid in class who is ridden with an extra chromosome? Even still what if we could enhance humans to become the best they could be? Would this be an ethical dilemma?

For this deliberation, we are going to address these questions by presenting three options on how to view new gene editing technologies like CRISPR. The three options that we will be considering today ask if CRISPR should be allowed for human enhancement, human therapeutic use, or be completely banned.

There are a few guidelines that I would like to lay out that will make this deliberation successful. First, we want everyone to participate and join in the discussion. Second, no one should be discouraged from participating. That being said no single person in the group should dominate the conversation. Third, be mindful of the other members of your group and allow them to voice their opinions. Finally, you should never belittle or be disrespectful to any of the members of your group for an opinion that they express.

With that being said are there any questions about our deliberation?

Introduction to the topic

Before getting into the discussion, I want to have us review some key considerations, based on what you’ve learned in your class.

- What are the pros/cons of the zinc finger nuclease, TALEN, and CRISPR methods of editing genes, compared to older gene therapy technologies?
- How do the newer gene editing technologies utilize the “normal” DNA repair capacities of human cells?
- What can go wrong during gene therapy or gene editing?

(5 minutes)

(Transition discussion to option one)
Option One: Human Enhancement
“Option one states that we should use technologies like CRISPR to allow for human enhancement. This could range from a variety of options ranging from parents choosing features of their children to enhancing certain traits of the individual.”

✔ What are some initial thoughts to this option? (3 minutes)
✔ Which case study do you think relates to this option and why? (2 minutes)
✔ Who would benefit from this option and whom do you think would suffer? (2 minutes)
✔ What are the ethical concerns surrounding human enhancement? (humans as gods) (3 minutes)
✔ What would humans be like forty years down the road if we allows for technologies like CRISPR in all age groups? (2 minutes)

Option Two: Therapeutic Use
“Option two states that we should use technologies like CRISPR to allow for therapeutic use of gene editing technologies restricted to curing or treating diseases. This would allow for the elimination of a specific gene to be passed on from parents to children. Thus, eliminating it from future progeny as a whole.”

✔ Was there an initial gut reaction to this option? (3 minutes)
✔ What diseases/infections should gene editing be used towards? (2 minutes)
✔ What is the difference between therapeutic and enhancement? (2 minutes)
✔ If you could ensure a healthy future for your child would you take advantage of gene editing? (3 minutes)
✔ What would the human populous be like forty years down the road if we allowed for technologies like CRISPR? (2 minutes)

Option Three: Ban Gene Editing for all purposes
“Option three states that we should ban all Gene Editing should be banned. It would be banned with the general public being aware of the technologies, but not fully educated on the potential outcomes of Gene Editing.”

✔ Can you think of any examples where we should have banned scientific progress? (3 minutes)
✔ How important is worldwide collaboration on the issue of banning Gene Editing? (2 minutes)
✔ From an ethical viewpoint, what issues would arise from banning Gene Editing? (2 minutes)
✔ What ways should we educate the general population about gene editing? (3 minutes)
✔ When would be the “ideal” time to pursue Gene Editing from a societal standpoint? (2 minutes)
As we conclude our discussion today, I’m curious if any of you would bring experiences or knowledge from your academic major or minor into this discussion. Are there other unresolved questions we should think about?
  - (i.e. religion, political science, economics, language (how it would affect indigenous people), rhetoric (change of dialogue among people), arts)

As you think about gene editing, how do you think our society should proceed?

(5 minutes)

Are there any other remarks that people would like to express before I summarize what we have talked about today?

Summarize all of the main points that were said about the different options. Thank them for participating in this deliberation (2-3 minutes)