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BIOENGINEERING FOR KIDS: A GRAPHIC NOVEL TO EDUCATE AND INSPIRE

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Author

Solkowitz, Samantha

Publication Date

2024-07-24

BIOENGINEERING FOR KIDS: A GRAPHIC NOVEL TO EDUCATE AND INSPIRE

By

Samantha Solkowitz

A capstone project submitted for Graduation with University Honors

May 09, 2024

University Honors

University of California, Riverside

Dr. Linlin Zhao
Department of Chemistry

Dr. Richard Cardullo, Howard H Hays Jr. Chair
University Honors

ABSTRACT

Outside of academia, there is a negative stigma around genetic engineering. In the media, it is often used as a point of conflict (i.e a genetically engineered virus that causes a zombie apocalypse, or the creation of inhuman “super soldiers”). Outside of the entertainment industry, there is rhetoric against genetic engineering, specifically in the use of “GMO.” Many people will not buy a product that is labeled as a GMO, even when the genetic modification may improve it for consumption (i.e Golden rice is more nutritious than its organic counterpart because it is genetically modified to contain vitamin A precursor beta-carotene). There is very little positive representation for genetic engineering in the media. This project seeks to increase positive exposure of children (ages 12-15) to genetic engineering via a narrative and informational webtoon.

ACKNOWLEDGMENTS

I extend gratitude to my faculty mentor, Dr. Linlin Zhao, who guided me in the process of developing a proper plot that was suitable for children ages 12-15. Additionally he verified that the scientific explanations were correct and appropriate for the intended audience.

I also extend gratitude to my proofreaders: Annika Martinez, Sarah Rash, Jose Garcia, Max Sussman, Joel Solkowitz, Daniel Solkowitz, Bunlam Solkowitz, Adele Solkowitz, Sharon Solkowitz, Rosemary Presburger.

A special thanks to Joel Solkowitz, who can be a harsh critic that tells the truth when you really need one.

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CREATIVE PROCESS

Inspiration and Background

As the bell rings for 4th period, I hurriedly scoop the mess on my desk into my backpack. My math homework tears at the corners and my notebooks jut out at odd angles, but these things are secondary to the excitement and anticipation I feel. 4th period is *Medical Interventions*; I can't wait to pull up a stool next to Mrs. Richter's desk and discuss the latest paper that everyone in the field of genetic engineering is talking about.

As the daughter of a highschool chemistry teacher and a student who loved medical science deeply, I never had an aversion to the advancement of science. I saw genetic engineering as an opportunity, and a hubris of human talent and grit. When He Jiankui claimed that he had used *CRISPR* to edit the genome of twins, making them immune to HIV, I saw it as a success for the field and for all of humanity. I was excited about the possibility of erasing disease entirely. It was only when He Jiankui was subsequently arrested that I came to realize that I may have been living in an echo chamber of my own. I believed that genetic engineering was for the benefit of human health, and I believed that I shared the sentiments of the majority. I did not consider that He Jiankui may have had ill intent with his experiment, or that the technology could be used to *harm*. I did not consider, as well, that this belief was the general consensus of the public.

Regardless, I was confident in my own values and opinions; I chose to pursue my passion in bioengineering. It was this decision that made even more apparent the disparity between myself, my fellow bioengineers, and the general public. At family reunions, I was frequently asked if I was creating an army of super soldiers or if I knew the people who engineered the COVID virus. When discussing my major, the topic of "designer babies" came up before the use of monoclonal antibodies in the COVID vaccine. My aunt warned against the dangers of GMOs

or eating foods with ingredients that you can't pronounce as I was handed *Elote* made from the very same "GMO" corn she had warned me about.

I came to the realization that there was actually a stigma around bioengineering. Especially in regards to genetic engineering. I started to notice it everywhere in daily life. People would prefer to pay a premium for non-GMO products, stating that GMOs were dangerous or unhealthy without scientific facts to support their claim. As I sat down to watch one of my favorite films, *Jurassic Park*, I couldn't help but notice that the entire conflict of the movie was caused directly by the use of genetic engineering to revive the dinosaurs. Upon further reflection, genetic engineering (or in general, genetic modification) is often used as a source of conflict in popular media (such as in *GATTACA* or *Raiders of the lost ark*) (Gibbons, 2021).

Then the question is: *why* is there such a stigma around genetic engineering? In 2016, the Pew Research Center conducted a survey to gauge public opinion surrounding the use of gene editing to reduce the risk of serious disease in babies. This was a hypothetical question to assess the public attitude towards genetic engineering in general. It was found that 49% of Americans were enthusiastic about the idea, while 68% were worried (Funk, 2016). Furthermore, 57% of the participants who were already familiar with genetic engineering responded that they would want to use the technology for their child, while only 37% of participants who were *not* familiar agreed. This suggests that someone is more likely to use genetic engineering if they are already familiar with the concept. Therefore, a contributing factor to the stigma around bioengineering is a knowledge gap between the science and the people that it is meant to benefit. There is a tendency to fear the unknown, and genetic engineering still falls within the realm of the "unknown."

I do not fear genetic engineering because I have grown up with it. My parents, teachers, and peers were enthusiastic about it. It is my passion and my field of study. However, there are many children who will not have this experience. The science behind the technology is often not accessible to them. Not because it is expensive or unavailable, but because the format in which it is provided is difficult to digest for someone who is not accustomed to reading scientific language or does not have knowledge of certain topics. Currently, there is very little positive (or even neutral) representation for genetic engineering in popular media. My goal is to create an introduction to genetic engineering that will ease youth into the topic via a narrative format that will erase some of the misconceptions or fear of the unknown surrounding the field, and inspire them to further pursue the knowledge.

Story Creation

The first objective was to define the list of topics to be covered. Bioengineering is a large and diverse field. Although the focus of the project was narrowed down to specifically “genetic engineering” due to the fact that this topic causes the most anxiety and fear among the general public (as opposed to other subsets of bioengineering like medical devices, which are more commonly accepted as aids in human health), there was still a large variety of genetic engineering techniques and news of interest. The initial list of topics included the Human Genome Project, Dolly the sheep, CRISPR-cas9, Cell engineering, and TALEN and ZFNs. After consulting with my faculty mentor, Dr. Zhao, it was decided that this range of topics may be too intensive for an introduction to genetic engineering. Therefore, the list was narrowed down to the most notable advancements in genetic engineering: Dolly the sheep (somatic nuclear transfer) and CRISPR-cas9 gene editing. These advancements both changed the trajectory of the field and were so influential that most of the general public were aware of their existence, as opposed to

other topics like TALENs and ZFNs which are more notable to bioengineers but widely unknown by anyone outside of the field. The length of the webtoon was also discussed. For the purpose of this project, a webtoon that could be read in one sitting was the most appropriate format because the target audience (children ages 12-15) may not be engaged in longer works. If the webtoon can be read in one sitting, the reader can gain a general understanding of the topics discussed and decide to pursue a deeper understanding. They may also be more inclined to read a shorter work, which is less of a time commitment, as opposed to a longer work. Therefore, it was decided that the webtoon would consist of 5 chapters broken down as the introduction (character and world background, as well as story exposition), an introduction to practical applications of genetic engineering and the argument surrounding them, explanation behind the mechanism and practical use for CRISPR-cas9, explanation behind the mechanism and practical use for somatic nuclear transfer, and an open ended conclusion to leave a possibility for the expansion of the story to include more topics as well as an inspirational atmosphere to the reader.

Researching Narrative Techniques

As a bioengineering student, I was already familiar with CRISPR-cas9 and the concept of somatic nuclear transfer. Most of the research was on the topic of narrative storytelling, current portrayals of genetic engineering, and public opinion. Additionally, I devoted much time to learning how to use Clip Studio Paint, how to draw well enough to convey the story (which took a lot of practice), and how to create a webtoon. I had believed these things to be secondary to the scientific research, but soon found that they consumed more time and effort than I had anticipated. A lot of nuance is involved when creating a story that is both informative and enjoyable. For webtoons specifically, the balance between art and text is significant, and I learned how to integrate text as a character itself.

My initial drafts were episodic, meaning that each chapter was a self contained story. The overall premise was that humanity had gone extinct due to the effects of a nuclear winter. The sentient AI was then a guardian of the library with no one to guide, until Zara was born of dust and light by a miracle. Then, each episode would consist of Zara learning a new topic in genetic engineering as she explored the library. While this version accurately described the mechanisms of the techniques, there was no application. It was not engaging because it was not narrative. Instead, it was more akin to an informational pamphlet. It was also considered too dark for the target audience because there was no chance for the revival of humanity. After receiving this feedback from Dr. Zhao, I turned to other resources to learn about narrative storytelling. The most notable of these was *Spilling Ink, a Young Writer's Handbook* by Anne Mazer and Ellen Potter. The book described mental exercises and thought experiments to aid in crafting an engaging story with realistic characters, plot devices, and narrative flow.

The novel suggested creating characters first, and allowing them to create the story. In other words, develop characters that seem real (with personality, goals, fears, aspirations) and the story will progress naturally. I kept the two characters from the original draft, with added development. The sentient AI was now more of a motherly figure. By being created to guide humans, as opposed to simply guarding their knowledge after their demise, she had formed a bond with and a love for them. When humanity eventually leaves the planet, a conflict arises within her. This gives her a motivation to help the last two humans when they arrive in the library, and helps to drive the story forward. This also gives a significance to the birth of Zara, who gives the sentient AI a sense of purpose after the fall of humanity. Zara's nature ultimately stayed the same: she was a curious child with a hunger for knowledge. However, the new context allows her to put that knowledge to use, and she eventually desires to live as humanity once did.

This serves to add an inspirational message to the reader: that anyone can achieve their goal with the proper work. Two new characters were added: Asha and Hugo. Asha, whose name means “hope,” is the first person to decide to stay behind on Earth. She is enthusiastic about genetic engineering and the potential it has to reduce the toxic conditions on Earth. Hugo, whose name means “mind” or “intellect,” is inspired by her hope and decides to help her in her endeavor. Hugo is more critical of genetic engineering and of Zara. The two are meant to represent two sides of the debate around genetic engineering, while still working towards the same goal. After these characters were created, it followed naturally that they would use genetic engineering to make the Earth habitable for them. In the final draft there is an overarching story across 5 chapters, with cliffhangers at the end of each chapter to motivate the reader to continue.

Synopsis

In the far future, Earth has become uninhabitable for humanity. The soil is poisoned, and the weather is harsh. Most of humanity has left Earth in search of another, Earth-like planet. However two friends, Asha and Hugo, are not so quick to give up on their home. They’ve heard rumors of *The Last Library*, a place where all of humanity’s greatest achievements and knowledge have been stored. When the two finally find the library, they are greeted by Zara, a girl made of dust and light, and her sentient AI guardian. With the AI’s vast knowledge of previous human technology, Zara’s ability to manipulate matter, and Asha and Hugo’s desire to save their home, the 4 explore bioengineering topics and use them to create better living conditions for themselves and future generations.

Future Directions

The finished work can be considered a “pilot.” It is an introduction to both the story, and the genetic engineering topics covered. However, there is potential for an expansion. The 5 chapters could be expanded to include more character development and provide more opportunity for conflicts and resolutions. In this way, the scientific content may be more seamlessly woven into the narrative aspect so that the audience is not even aware that they are learning. This may be significant because subtleness is often more impactful than boldness. Such as is the case with genetic engineering in films. The audience subconsciously builds an argument against genetic engineering because the film does not explicitly say “this is bad.” Instead, it is shown in the way that genetic engineering causes conflict. This work has the potential to take the same approach. By showing how genetic engineering can be used to resolve conflicts instead of stating it overtly, the audience may be more inclined to build an argument for genetic engineering.

Additionally, the work could be expanded to include Zara’s journey. Audience interaction could be incorporated so that topics that are of most interest are covered within the episodes. This inspiration comes from my process in the first drafts. A major difficulty I faced was deciding what topics should be covered. As I was writing the draft in the summer of 2023, there were major developments in CRISPR-cas9 technology. The first human trials and the first FDA approved CRISPR-cas9 therapies were released. It felt as if there was a new development everyday. I realized that this would also be an issue in bridging the gap between the field and the general public: the average person may not be informed on new developments and will feel overwhelmed. Therefore, a webtoon that addresses new developments as they happen would be beneficial.

Conclusion

As a bioengineering student, and not an artist or a creative writer, this creative project was out of my comfort zone. However, it provided me ample opportunity to put myself in the position of my audience. It allowed me to examine my own beliefs, and to recognize that they are a result of my environment. What I believe is not necessarily correct, but it is at least founded on both sides of the argument. As I researched public opinion, I found myself doubting my own beliefs in the use of genetic engineering. I came to understand how the notion could be terrifying. It is true that if used for ill intent, such as in biowarfare, genetic engineering could be a great danger. A major aspect of individuals who oppose genetic engineering is religion. As found by Cary Funk et al, highly religious Americans were against genetic editing and stated that it was a disrespect to god's will. I recognize that trying to change the opinion of someone who cites religion as their reason for arguing against genetic engineering is very difficult. It may not even be appropriate, as all individuals have a right to religion and their own beliefs. Despite the ethical turmoil I experienced, I remain optimistic in the use of genetic engineering because I believe that the goal of genetic engineers is to improve human health. This belief is the result of my own exploration of both sides of the argument, and exposure to both positive and negative forms of media. My goal is to provide a form of positive exposure for the topic to balance the effects of the negative exposure prevalent in popular media. I do not necessarily want to argue for genetic engineering. Instead, I want my audience to be well informed and have the ability to cultivate their own belief, just as I was able to do for myself over the course of this project.

Link to the Creative Work

The webtoon, *The Final Chapter*, can be read [Here](#)

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