Billy Green **Analyzing the Nature of Science Assignment**
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Recently, I facilitated a panel discussion for a group of youth from St. Louis to discuss "inclusivity as a human right." This panel is in its ninth year and this is the first time one of the youth ask a question about the science behind transgender people medically transitioning. The student asked, "How do those transitioning feel about taking hormone therapy, when long terms effects of the hormone supplements and its effects have not been published or conducted.?" As the panelists began to respond, their answers reveal their fears, confusion, and reluctance to be a part of scientific studies. "… a history of discrimination and exploitation has left many reluctant to trust researchers, …, fearing that some scientists might be seeking a 'cure' to being transgender" (Reardon, 2019, page 447). This prompted me to do my Nature of Science assignment on a new and emerging topic in science; the science of gender transitions. In the article, "Science in Transition," Reardon does an excellent job of presenting this emerging science, it's importance to science, and the limitations of the study presented.

Science is a Human Endeavor

This article is a direct response to how gender acceptability in the public is influencing scientific research. Guy T'Sjoen, the endocrinologist whose research is featured in the article, states he was inspired by a "film" that featured transgender women, and after perusing through the scientific literature could not find anything beyond "surgical techniques" and "psychological reports about the relationship with their mother and father" (Reardon, 2019, page 447). As it states in the NGSS matrix, "science and engineering are influenced by society and society is influenced by science and engineering" (NGSS, 2013, page 7). T'Sgoen, created the European Network for the Investigation of Gender Incongruence (ENIGI) study. This is the "largest study of its kind" with a total of 2600 people who identify as transgender. In addition, the NGSS matrix suggest that "scientists backgrounds, theoretical commitments, and fields of endeavor influence the nature of their findings" (NGSS, 2013, page 7). Interestingly, Reardon talks about this in her article; she presents it as an ethical question. Other researchers who are now getting involved in this field of study might feel pressure just to publish, leading to "getting not-optimal methods and not-optimal science" (Reardon, 2019, page 449). Reardon is reinforcing the Nature of Science here and is respecting that there is a process to achieving scientific evidence and drawing conclusions.

Science is a Way of Knowledge

One of the greatest forms of respect in the science community is the acceptance of the validity of your work by your scientific peers. It is generally understood that science cannot be done in isolation and that the problems of nature are so complex that it requires a team of researchers to address a problem. Reardon in her account of Tsjoen's project ENIGI, shows how his scientific colleagues admire the work he is doing, "Joshua Safer, … , praises T'Sjoen for the scale of its ambition. He's doing this on his own without tons of resources" (Reardon, 2013, page 446). T'Sjoen goal for creating ENIGI was to expand the knowledge of the field of Endocrinology and what is understood about the long term effects of hormone therapy. In the words of T'Sjeon himself: "Everything seems to be very reassuring. But this is short term, and long term we are still collecting data" (Reardon, 2019, page 447). The NGSS matrix states that, "Science is a body of knowledge that represents current understanding of natural systems and the processes

used to refine, elaborate, revise, and extend this knowledge" (NGSS, 2013, page 7). By writing about T'Sjeon work, Reardon illustrates skillfully how Science is "transitioning" because research is constantly presenting new data and provoking new conclusions. Another colleague of T'Sjeon states, "studies such as this not only help transgender youth, but hey can also provide knowledge about human diversity and the spectrum of gender identity, says Johanna Kennedy, a pediatrician" (Reardon, 2019, page 449). Research is about advancing knowledge.

S**cientific Knowledge is Based on Empirical Evidence.**

T'Sjeon runs the 'largest' transgender study in the world, he has over 2600 participants and operates out of four clinics. "The numbers mean that ENIGI researchers can finally draw some significant conclusions about the effects of standard care" (Reardon, 2019, page 447). "Science lines are strengthened by multiple lines of evidence supporting a single conclusion" (NGSS, 2013, page 6). All of us learned very early in the scientific method, that the more trials you do, the more supported your conclusion will be. T'Sjeon understands that in order to draw conclusions that will engage the respect of the scientific community, he has to have a greater sample size, and open up his research. The ENIGI research is being taken on by other scientists globally and collaborating by sharing knowledge. Sven Mueller, a neuroscientist, has taken over 800 brain scans from participants in the ENIGI study. His collaboration with T'Sjeon "…could help to explain why some people are more resilient than others … " (Reardon, 2019, page 448). While highlighting all this great work, I enjoyed the fact that an emphasis was placed on the ethics of the situation and that there was some concern about the misuse of science, "many participants … fearing that some scientist might be seeking a cure to being transgender," or the concern "that, in haste to getting something out there, we wind up getting not-optimal methods and not-optimal science" (Reardon, 2019, page, 447, 449). It is important to follow the rules of science, "science shares common rules of evidence used to evaluate explanations about natural systems" (NGSS, 2013, page 6).

Make Sense of problems and persevere in Solving them

T'Sjeon is quoted in this article stating: " Saying you're not informed about this topic is not really valid any more. It's just that you're lazy" (Reardon, 2019, page 447). T'Sjeon is willing to do the work to discover new knowledge. It is not a "taboo science". He focused in on a blind spot in endocrinology and providing the science community with access points for further research. ENIGI research team is "…analyzing givens, constraints, relationships, and goals. … and always looking for entry points …" for new research (SMP, page 1).

Construct viable arguments and critique the reason of others

This math standard most closely relates to science practice. The nature of science is to use empirical evidence to support and draw conclusions. "They justify their conclusions, communicate them to others, and respond to the arguments of others" (MSP, page 2). Reardon shares multiple perspectives to T'Sjeon work on the ENIGI project. "Safer worries that, in the absence of controlled research studies, physicians are vulnerable to influence from anecdotes and single patient case studies and T'Sjeon cautions "researchers to tread carefully to avoid making things more difficult for a group that is already stigmatized, and putting transgender priorities ahead of questions that are

simply scientifically interesting” (Reardon, 2019, page 449). These constructed arguments add to the quest of seeking new knowledge.

Use appropriate tools strategically

It is important to know the limitations or your study/model. The Standards for Math Practice suggests that proficiency is reached when “they are able to use technological tools to explore and deepen their understanding of concepts” (SMP, page 3). “T’Sjeon acknowledges that the study’s findings won’t be the final word on the safety and efficacy of treatment” (Reardon, 2019, page 449). Other collaborations include the use of data systems for mining the health records of transgender people and the 800 brain scans used to study resilience in collaboration with the Mueller research group.