

THE GRADUATE IDENTITY FORMATION THROUGH TEACHING (GIFT)  
PROJECT AS A MITIGATING TOOL FOR IMPOSTER PHENOMENON

by  
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## DEDICATION

This is dedicated to my husband who has supported me throughout this process and has been my partner through all of the ups and downs, my mom who has always advocated for me in my education and instilled in me that I was capable and valued, and to my dad who taught me to value creativity and free thought. Thank you to my sister and to my best friend who were my rock this year. Thank you to all of my teachers in and out of the classroom for pushing me to grow and challenge myself. And last but definitely not least, I dedicate this to myself for all of my hard work.

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## ABSTRACT

This thesis is an exploratory analysis of the impact of the Graduate Identity Formation through Teaching intervention -- an intervention in which Science, Technology, Engineering, and Mathematics graduate students act as subject matter experts through teaching scientific concepts to elementary teacher candidates -- on graduate students and how it may mediate impostor phenomenon. A sense of expertise, community, and belonging were used as proxy measurements for impostor phenomenon. Data from graduate student impact statements in reflection papers and post-semester interviews were analyzed to measure change in impostor phenomenon for each graduate student. As a result of the intervention, graduate students were found to have an increased sense of expertise, community, and belonging, indicating a decrease in symptoms of impostor phenomenon.

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## LIST OF ABBREVIATIONS

5E	Engage, Explore, Explain, Elaborate, Evaluate
BSU	Boise State University
DS	Disciplinary Stewardship
GC	Graduate College
GIFT	Graduate Identity Formation through Teaching
GS	Graduate Student
IP	Imposter Phenomenon
IRB	Institutional Review Board
ME	Mechanical Engineering
MSE	Materials Science and Engineering
NGSS	Next Generation Science Standards
RQ	Research Question
STEM	Science, Technology, Engineering, and Math
TC	Teacher Candidate
TDC	Thesis and Dissertation Coordinator

## CHAPTER ONE: INTRODUCTION

Many fields are losing bright and creative individuals in graduate school due to high attrition rates (Sowell et al., 2008). Some students go through years of undergraduate study, only to enter a graduate program and experience a strong sense of non-belonging, isolation, and mental health issues (Ali & Kohun, 2006; Lipson et al. 2016). Graduate school can be a long, arduous process and an individual's ability to *persevere* through these struggles – not their intelligence or innovation – can determine whether or not they complete their graduate studies and continue on to do meaningful work within the field. Awareness, reflection, and a healthy support system can all facilitate students in bringing to light the struggles they are facing in graduate school as well as enabling the school and faculty to better support students through the process. One factor in particular that has been the subject of study is the concept of imposter phenomenon (IP) -- in which individuals feel a sense of intellectual phoniness -- and the effect that it has on students and faculty (Clance & Imes, 1978).

The purpose of this study was to explore the impact of an intervention – the Graduate Identity Formation through Teaching (GIFT) project – on science, technology, engineering, and mathematics (STEM) graduate students. Specifically, through graduate student impact statements in reflection papers and post-semester interviews this study investigated the research question (RQ) “*In what ways does GIFT help mediate imposter phenomenon?*”. The results of this study may be useful to graduate schools and students alike because it takes an in-depth look at the experiences of the STEM graduate students

enrolled in the intervention and highlights which aspects of the intervention were most valuable for the students in terms of mediating IP. This information can be used to help facilitate STEM graduate students' transition from undergraduate students to graduate students and aid in the formation of a professional identity (Bragg, 1976) in which students have a strong sense of belonging and can envision themselves as an expert in the field.

Particular attention is paid to two aspects of the intervention: the overarching paradigm of disciplinary stewardship (DS) and the course material/reflection aspect. Disciplinary stewardship is the concept of preparing scholars to take care of and improve their discipline through creatively generating new knowledge, critically conserving valuable and useful ideas, and then transforming that knowledge so that it can be shared with others in a meaningful way (Golde & Walker, 2006). Disciplinary stewardship may provide students with an opportunity to be seen as an expert in their field and provide opportunities for community building and interdisciplinary work. Through the reflection process in the course work, students have opportunity to consider aspects of their own experiences.

## CHAPTER TWO: LITERATURE REVIEW

This literature review will focus on three areas - impostor phenomenon (IP), STEM graduate students, and disciplinary stewardship (DS) – and how they intersect. Environmental factors will be explored in how they connect these constructs.

### **Impostor Phenomenon (IP)**

#### IP Description

Researchers have described IP as a function of irrational thinking and an inability of a person to internalize their successes due to negative beliefs they have about themselves: “The standard line is that individuals who experience IP...systematically cognitively err: They under-estimate their own talents by ignoring evidence for those talents -- namely, the evidence of their successes -- and are therefore irrational.” (Slank, 2019, pg. 2). People with IP have the strong belief that they are not as intelligent as others believe them to be and that they have in some way fooled their peers and they do not really belong (Clance & Imes, 1978). This belief that one does not belong can lead to many fears about being discovered as ‘impostors’ and symptoms that include but are not limited to anxiety, depression, and low self-worth, all of which can lead to compounding symptoms and behaviors that include procrastination and the inability, or the belief in the inability, to perform one’s job functions (Clance & Imes, 1978; Parkman, 2016; Slank, 2019). IP has been observed within educational institutions as well as professional organizations (Clance & Imes, 1978; Parkman, 2016). The prevalence within higher

education is a potential threat to retaining people both as students and employees and its causes may be correlated to a culture that exists within the institution (Parkman, 2016).

#### Factors Contributing to or Correlated with IP

Slank (2019) suggests that people with IP actually *do* hold a rational belief that they are not solely responsible for their successes and acknowledge that luck and environmental factors play roles in a person's success. He argues that any one event cannot be isolated as a cause because many events had to occur in order for the effect to be realized, so one can only observe a spectrum of correlations between events and based on that, make a best guess at cause and effect on which to base their next action/assumption. Reflection such as this is a necessity in that it acknowledges the privileges and environmental factors that contribute to successes and failures, allowing people to broaden their perspectives. Therefore, although questioning the role one plays in success has been shown to be correlated to people experiencing IP (Clance & Imes, 1978), reflection on the correlations between events is also a rational necessity in attempting to predict the probability of outcomes. Determination of which events are considered as significant and what that significance is, is filtered through each individual's life experiences and is therefore biased. This suggests there are other variables to consider as one reflects on their successes that may contribute to IP.

Slank (2019) hypothesizes that IP flourishes specifically within the 'culture of genius'. Murphy and Dweck's (2010) research on the culture of genius examined how an organization's lay theory of intelligence impacted people's self-presentation and their judgements of themselves and others. Their work suggests that theories of intelligence are not just individual but also cultural and that the lay theory within an organization has



the power to shape people's cognition, affect, and behaviors. This work presented two theories of intelligence: fixed (entity) and malleable (incremental), in which the former suggests intelligence is a fixed trait that a person has a finite amount of and in which the latter suggests that intelligence is something that can grow and expand. Cultures of genius are spaces (workplace, school, etc.) in which people are viewed as being successful due to innate ability or intelligence which is seen as fixed. Therefore, in these spaces, a person's effort detracts from the role that supposedly fixed traits – such as intelligence or talent – plays in successful outcomes (Murphy & Dweck, 2010). In other words, using this lay theory of intelligence, the harder a person has to work at something, the less intelligent or capable they must be. This culture is perpetuated as people begin to mirror those around them in order to present the values of the organization, not only warping self-perception but also people's perceptions of themselves in comparison to others (Murphy & Dweck, 2010). This involves hiding effort and may result in fear of that effort being discovered and/or the perception that success should be effortless. This cycle can perpetuate as the person works harder and harder to create success, and the harder they try the less successful they feel, creating a highly stressful work environment. This high amount of stress can lead to burnout and people leaving the profession (Allen et al., 2020).

Murphy and Dweck (2010) also explored the possibility that some fields may inherently infer a lay theory of intelligence independent of the culture. For example, they hypothesized that some professions, such as teaching, are predicated on the belief that people can change and learn and as such, an incremental theory of intelligence is inferred independent of the theory of intelligence adopted by individual organizations.

Consequently, this theory may offer explanations as to why some professions and areas of study seem to be more heavily impacted by IP and give cause for reflection on belief systems about different areas of study, and even graduate school itself. In line with the theory that organizational lay theories can influence a person's own affect and behavior, it is possible that exposure to a profession that is inherently growth oriented, such as teaching, could be used as a mechanism to mediate IP by facilitating experiences that allow them to gain new perspectives on theories of intelligence.

### Remedies and Interventions

Murphy and Dweck (2010) showed that people's theory of intelligence can change, which can lead students to experience a change in self-concept of their intelligence as well as a change in the way they judge their peers. If IP flourishes in cultures of genius and is cultivated through the belief system that intelligence/ability is fixed, then it follows that creating cultures that cultivate growth mindset could decrease the incidence of IP. As previously mentioned, Murphy and Dweck (2010) theorize that some professions, such as teaching, are more growth oriented. It could follow that students having experiences with interdisciplinary work in these professions could experience a lessening of symptoms of IP.

Slank (2019) suggests *academic humility* as a way to mitigate IP, which requires individuals to accept shortcomings not as a concession of lower worth but as opportunities for continued and worthwhile improvement – well-aligned with the development of a growth mindset. The development of a growth mindset may also be cultivated through learning about the brain's ability to grow and change through practice through a mechanism called neuroplasticity. Sarrasin et al. (2018) conducted a meta-

analysis on the effects of teaching about neuroplasticity to induce a growth mindset. Their findings indicated that learning about neuroplasticity can support valuing learning for the sake of learning instead of as a method to prove ability to others, perceiving efforts as a facilitator of positive outcomes, and viewing failure or difficulty as an opportunity for growth and mastery. They also found a negative correlation between growth mindset and “motivation variables such as helpless attributions for failure, which imply attributing difficulty to fixed-traits, like low ability” (Sarrasin et al., 2018, pg. 1). This meta-analysis indicates that the brain can learn a new emotional response to struggle and learning through the introduction of the idea that it is possible. These studies collectively support the idea that IP may be mitigated through changing belief systems about performance-based concepts of worth and that the effects of a growth mindset can change attitudes about effort and struggle. Table 1 is adapted from Dweck (2008) and highlights the differences in belief systems associated with fixed and growth mindset. Dweck (2008) asserts that because of these beliefs, people with a growth mindset have a larger sense of agency.

**Table 1 Fixed vs. Growth Mindset. Revised table adapted from Dweck (2008)**

	FIXED MINDSET	GROWTH MINDSET
<b>CHALLENGES</b>	are to be avoided	can be embraced
<b>OBSTACLES</b>	make me want to give up	teach me to persist in the face of setbacks
<b>EFFORT</b>	is fruitless	is the path to mastery
<b>CRITICISM</b>	is bad so I ignore it	is a great way to learn
<b>SUCCESS OF OTHERS</b>	is threatening to my self-image	is inspirational and an opportunity to learn

Clance and Imes (1978) suggested a multi-modal approach to mitigate IP which was partially based in Gestalt psychology in which the person experiencing IP participates in a type of role play. The individual who does not believe they are intelligent acts out being intelligent. Frequently participants were able to connect with a part of themselves that imagined them to be intelligent and identify the negative feelings that inhibited them from realizing that self-image. Through taking on this role many of the participants were also able to identify belief systems they had about success (i.e., stereotypes such as successful women are ‘unfeminine’ or ‘bossy’). Clance and Imes also used group therapy as an approach in which participants would share their imposter feelings and experiences and face the reality that people they view as accomplished and successful have this common experience, leading them to question their belief systems.

Finally, purposeful reflection has been shown to be useful in supporting reframing thoughts. Hussein’s (2018) study found that writing in a reflective journal promotes a growth mindset, sheds light on students’ inner thoughts, and enhances students’ understanding of their own thoughts. Dweck (2015) suggests the reframing of perceptions from fixed mindset to growth mindset by rephrasing thoughts about ability, skill, and struggle. For example, adding the word ‘yet’ when referencing a skill that is lacking allows for the possibility of growth, changing the statement from ‘I can’t do that’ to ‘I can’t do that yet’. Dweck (2015) also brings awareness that struggle in learning or the feeling of something being hard is the feeling of the brain growing. The awareness of a person’s own perception of an experience and self-talk is facilitated through reflection. Additionally, Bernard et al. (2002) found a negative association between

conscientiousness and IP, lending support to the notion that reflective journals could help mitigate IP.

Additionally, it is possible that reflective journaling on material that is related to IP, such as growth mindset, emotional aspects of learning, stereotype threat, neuroplasticity, etc. may also have potential to mitigate IP through exposure to and/or higher order thinking about these concepts as well as increased self-awareness about the negative impacts of limiting beliefs on their life.

### **STEM Graduate Students and Imposter Phenomenon**

#### STEM Graduate Students

According to the National Science Foundation (NSF) (NSF, 2019), in 2017, 206,000 people earned their master's in science and engineering (approximately 41% men and 59% women) and 46,000 earned their doctorate in science and engineering (approximately 50% men and 50% women). In one study, it was found that over the span of 10 years, doctoral students in the mathematics and physical sciences fields had a 36.9% cumulative attrition rate and doctoral students in engineering fields had an approximately 26% cumulative attrition rate (Sowell et al., 2008). The high attrition rate of graduate programs has been attributed, in part, to the feelings of isolation that graduate students experience (Ali & Kohun, 2006). Lipson et al. (2016) suggested that the nature of STEM courses may differ from courses in other disciplines in that they often employ practices to 'weed' people out, discourage collaborative learning, and encourage competition. These practices may help explain the high attrition rates in STEM graduate students. Additionally, as a result of these practices, STEM graduate students may be

more likely to experience feelings of isolation as they collaborate less and compare themselves more, decreasing a sense of community.

In the same sense that Murphy and Dweck (2010) theorized that some professions and fields of study are inclined to be more growth mindset oriented, it follows that some may have a tendency towards being more fixed. Reid and Ferguson (2014) asserted that engineering student success can be predicted by affective characteristics such as their mindset on their intelligence and self-perception of leadership ability (rather than cognitive skills/intelligence), supporting that mindset can impact student success. Recent studies show that engineering students typically experience a shift in the direction of a fixed mindset after their first year in their programs (Flanigan et al., 2017) highlighting that there may aspects of undergraduate STEM programs that are having an effect on students' mindsets, such as a lack of open-ended problems (Reid & Ferguson, 2014), something that is more present in graduate studies. Limeri et al. (2020) found that students' experiences with struggle heavily impacted their mindset and that when they repeatedly failed to overcome struggle they trended toward believing their intelligence was fixed, emphasizing the importance of critical reflection of how institutions, cultures, and students pursuing difficult goals define failure. Not only does the student's mindset impact their success but Muenks et al. (2014) found that students' perception of their teacher's beliefs about their ability to change and learn also affected student success. Students who perceived their professor's mindset as fixed were less likely to feel a sense of belonging, and more likely to have feelings of impostorism. It follows that, professors who believe intelligence is fixed (or are perceived to believe this) are more likely to have students who experience psychological vulnerability, and this vulnerability can result in

less motivation and a lower belief in one's own competence (Muenks et al., 2014).

Similarly, Murphy and Thomas (2008) found that computer science students with a fixed mindset were more likely to experience helplessness and lower self-esteem.

In a study including over 64,000 participants Lipson et al. (2016) found that 26% of master's students and 26.7% of doctoral students met the criteria for at least one mental health problem. Although other fields, such as social work, had a higher prevalence of mental health issues, students in engineering were far less likely to seek help than their peers with only 20.23% of master's students and 27.73% of doctoral students seeking help compared to 43.34% and 45.67%, respectively, of criteria-meeting people in social work. Natural sciences students sought help at a higher rate than engineering students with 41.23% and 31.14%, respectively, of criteria-meeting students seeking help.

#### Imposter Phenomenon and Graduate Students

Many STEM graduate students transition directly from undergraduate to graduate studies, with little to no experience in the field acting as a professional or an expert. In graduate school, students are surrounded by more experienced professors who are accepted as experts in their fields. Students are in the process of transitioning from an inexperienced student to an expert and peer. Although they are inexperienced relative to many of their expert peers, many of these students, particularly those in technology and engineering, have surpassed the minimum requirements to work in industry once they have obtained a bachelor's degree and/or licensure. For example, the National Council for Examiners for Engineers and Surveyors Fundamentals of Engineering exam is administered to many engineering students and graduates to ensure they meet a certain

standard and skill set required for success in the field. Despite this expertise, many STEM graduate students experience IP and have a hard time viewing themselves as experts (Chakraverty, 2019). Chakraverty (2019) found that out of 165 respondents to an open-ended survey, 120 graduate students could bring to mind instances in which they felt like a fraud during their graduate career. While some STEM students experienced imposter feelings earlier in their lives, 90 of the 120 students started to experience it as they began their PhD. Chakraverty (2019) also found that 46 of these 120 participants attributed their success to someone else. 24 of the 120 participants credited their success to their identity (in this instance, gender or race/ethnicity) and that they were only chosen for their program, award, or recognition in order to bring diversity.

Chakraverty (2020) found through the analysis of interviews with STEM PhD students ( $n = 90$ ) that imposter feelings were related to “progress and public recognition, comparing oneself to others, developing skills (public speaking and scientific writing), application of knowledge, and asking for help” (p. 169). They also suggested the possibility that graduate students might not be equipped to cope with the contrasting elements of academia, inasmuch as scientific research involves entering the unknown without knowing the end result, but it exists at large within the productivity driven paradigm that is academia.

IP has been linked to an increase in ‘downshifting’ in STEM professionals (Collett et al., 2013) in which an individual moves “away from an initially coveted research-intensive career... toward a less research-intensive, non-tenure track, or teaching positions” (Tao & Gloria, 2019). Within the STEM fields in particular, graduate students who experience a higher level of impostorism were also found to have “bleaker



outlook toward finishing a STEM-related PhD program, lower [self-efficacy], and negative perceptions of the doctoral environment” (Tao & Gloria, 2019). Allen et al. (2020) found a positive correlation between high stress levels, moderate to severe anxiety symptoms, and moderate to severe depressive symptoms to increased levels of burnout. Since these symptoms are also associated with IP, IP could therefore lead to higher rates of burnout in graduate students.

### **Disciplinary Stewardship**

Related to the idea of *normal* perfectionist’s desire to contribute to the interests of others, DS may also be considered a mitigating factor for IP. Golde & Walker (2006) proposed the “purpose of doctoral education, taken broadly is to educate and prepare those whom we can entrust the vigor, quality, and integrity of the field” and that in order to do this, scholars must be taught to be stewards of the discipline in which they “creatively generate new knowledge, critically conserve valuable and useful ideas, and responsibly transform those understandings through writing, teaching, and application” (p. 5). Golde & Walker (2006) also assert that a discipline shapes academic departments while simultaneously being shaped by them and that the departments are shaped by the culture, climate, and practices that the department members perpetuate. It can therefore be hypothesized that the graduate college may be an effective place to integrate disciplinary stewardship into a discipline.

As a disciplinary expert, sharing knowledge with the community in a way that is meaningful can build trust between the community and the discipline about the importance of a field of study/work, and can inspire future professionals (Golde & Walker, 2006). Golde & Walker (2006) assert that over time disciplines, schools, and

professionals have changed and that it is important for graduate education to change as well in order for it to serve a meaningful purpose. Further, as disciplines have changed, so have the expectations of the professionals within them. Interdisciplinary work, which can be facilitated through disciplinary stewardship, provides useful opportunities for professionals to expand their skill set (Golde & Walker, 2006). For example, a teacher who works with a STEM expert may gain a deeper understanding of the material, which gets passed along to their students. Vice versa, a STEM expert may improve in sharing and communicating their knowledge to others by working with an expert in teaching. In this interaction both participants act as a steward to their discipline. In doing so they are transforming their disciplinary knowledge into something that they can meaningfully share across disciplines. This interdisciplinary aspect of stewardship improves the disciplines through the exchange of knowledge about the cultures and practices of other disciplines that are effective (Golde & Walker, 2006). The changing and expansion of these disciplines into more flexible and interdisciplinary fields may improve the workplace in many facets, one of them being creating a more inclusive space for those who desire a career outside of more established routes (e.g., academia, labs, etc.), which could offer individuals a more authentic and meaningful experience within their field.

There are several aspects of disciplinary stewardship that lend themselves well to mitigating IP. Bragg (1976) defines professional identity as the end product of professional socialization into a field in which the individual has internalized the values and norms of a group into their self-image. Disciplinary stewardship can reinforce the professional identities of graduate students through various modalities. It provides them an opportunity to be recognized by others as a subject matter expert, and it facilitates

opportunities to do interdisciplinary work and work in their communities. This can cultivate both a sense of expertise and belonging, possibly mitigating symptoms of IP for these students, while simultaneously benefitting the discipline as a whole. Given the opportunity to act as an expert through disciplinary stewardship, graduate students may experience some benefits similar to what Clance & Imes (1978) described in their proposed approach based in Gestalt psychology as they step into the role of expert for the purposes of the intervention. This may offer a unique opportunity for students to embody the role of expert outside of the culture of genius. Interdisciplinary work in fields that are predicated on growth mindset, such as teaching or social work, may allow for critical reflection of any limiting beliefs about being an expert. Disciplinary stewardship can also be an opportunity for community building and interdisciplinary work that may increase an individual's sense of belonging in their field, as they experience others seeing them as an expert. It also provides new context for the meaning of their work, within their own communities, in contrast to more typical classroom and lab settings. Disciplinary stewardship is mutually beneficial for all involved, providing opportunity for meaningful interdisciplinary work.

## CHAPTER THREE: METHODS

This chapter will include a description of the intervention as well as the setting for the intervention which includes campus and student demographics. Additionally, it includes the methods in which data was collected and analyzed.

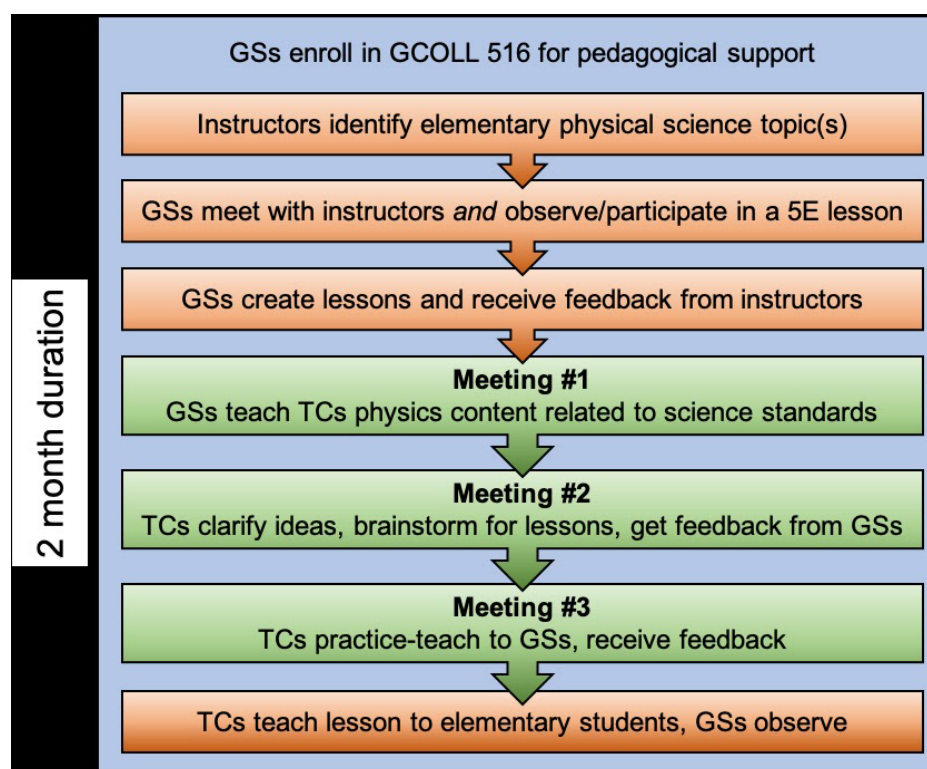
### **Intervention**

The GIFT intervention entailed two main components. The first was enrollment in the one credit GCOLL 516 course, “Explorations of Pedagogy”, at Boise State University (BSU) that consisted of eight class meetings throughout the semester as well as some activities outside of class, which include a workshop on 5E lesson planning, and periodic reflection papers. The second was working with teacher candidates (TCs) to build a lesson teaching science content related to *Next Generation Science Standards* (NGSS; NGSS Lead States, 2013). The teacher candidates then turned this content into a mini lesson for elementary school students which they delivered to students at a local Title I elementary school. Not all students enrolled in GCOLL 516 participated in GIFT and these non-GIFT students were therefore excluded from the study. In order to avoid confusion, participating students will be referred to as GIFT participants instead of GCOLL 516 participants. GIFT participants were paired with undergraduate elementary TCs from BSU enrolled in a science methods course.

#### Work with Teacher Candidates

GIFT participants were assigned reading about the 5E method (engage, explore, explain, elaborate, and evaluate) (Bybee, 2014) for creating a lesson plan. Participants

then met with faculty members of the GIFT team to review the necessary information about content and the NGSS. Once the participants completed this they were assigned to develop and teach an adult-level lesson on science content that was consistent with the NGSS standards selected for the TCs by the instructor. Subsequently, the TCs were assigned to prepare and deliver a 5E lesson plan for a local elementary school utilizing the content knowledge from their GIFT counterpart. GIFT participants then had the opportunity to observe the lesson delivery to the elementary school students and the impact of their collaboration with the teacher candidates. Due to COVID-19 restrictions, the graduate students in this iteration of GIFT were not able to observe the delivery. However, in previous iterations students attended the lesson delivery and in subsequent iterations students were provided an online alternative. Figure 1 shows the general timeline of the intervention activities between the GIFT participants and TCs.



**Figure 1 Intervention Flow Chart**

### GCOLL 516 Assignments

Throughout the semester GIFT participants wrote reflection papers, hereafter referred to as GIFT reflection assignments. Three reflections were on reading material from the GCOLL course and their experiences implementing what they learned into their practices working with the teacher candidates. These GIFT reflection assignment topics can be found in Table 1. Additional media were provided before each class meeting related to learning processes, potential barriers, mindset, etc. and the participants were assigned a short reflection paper prior to each meeting. These reflection assignment topics can be found in Table 2. The media students were assigned throughout the course as well as grading criteria can be found in Appendix A. At the end of the semester participants wrote an end of semester reflection, hereby referred to as the end of semester reflection. The assignment and grading criteria can be found in Appendix B.

**Table 2** Periodic GIFT reflection assignment topics. Abbreviations: Next Generation Science Standards (NGSS).

Reflection 1	NGSS exploration (reading) 5E workshop 5E reading
Reflection 2	Write a lesson plan Teach your lesson Lesson plan feedback
Reflection 3	Watch your team teach Family science event Disciplinary stewardship reading/video

**Table 3** Biweekly GIFT reflection assignment topics.

Meeting 1	Growth mindset and wise feedback
Meeting 2	Novice to expert transition
Meeting 3	Flipped classes
Meeting 4	Stereotype threat and who gets to graduate
Meeting 5	Decoding academia
Meeting 6	Alternative grading frameworks
Meeting 7	Teaching with technology

## Setting

The GIFT intervention took place face-to-face at BSU, beginning in the Spring of 2019 until COVID-19 restrictions were set in place on March 13, 2020, following which students and faculty continued the class online via Zoom meetings. BSU has approximately 3,000 graduate students, 60% of whom are part time (“Boise State Facts & Figures”, 2021). The students in the school identify as White (73%), Hispanic/Latino (13%), two or more races (5%), Black/African American (2%), Asian (2%), nonresident/international (1%), American Indian/Alaska Native (<1%), Native Hawaiian/Pacific Islander (<1%) (“Boise State Facts & Figures”, 2021).

## Participants

In total there have been 29 participants in the GIFT intervention over the span of the project (Spring 2019-Spring 2021). Only the data from one semester is included in this analysis, as it is an exploratory study for the purpose of a thesis paper. The semester featured in this thesis is the Spring 2020 semester as it was the most recent iteration of the intervention at the start of this analysis. Participants from Spring 2020 were seven STEM graduate students from BSU who hailed from physics, materials science, and mechanical engineering programs. GIFT research was subject to an Institutional Review Board (IRB) and protecting the identities of students is extremely important. Therefore, students were assigned an identifier in order to protect their identities. Table 3 contains a description of each graduate student’s demographic information and gives further insight into each student’s intersectional identities. Of the seven participants one identified as female and six identified as male, four (57.1%) identified as White, one (14.3%) identified as Asian, one (14.3%) identified as Black/African American, and one (14.3%)

identified as two or more races/ethnicities. One of these students also identified as a first-generation college student.

## **Methods**

### Data Collection

Data were collected via a pre- and post-semester survey which contained both qualitative and quantitative data, post-semester interviews which were recorded and transcribed, and reflection papers written throughout the semester. For the purpose of this analysis the pre- and post-semester surveys were used to collect information about participant demographics but were not further analyzed. See Appendix C for the survey. The semi-structured interviews were conducted by one of the GIFT faculty team members and were approximately 10-25 minutes



Table 4 GIFT participant demographics.

GS Identifier	Sex	Race/ Ethnicity	First Gen College Student	Under- graduate Major	Graduate Major	Graduate Program Type	Intended Graduation	Future Career Plans	Previous Graduate Degrees
GS1	M	White	No	Physics	MSE	PhD	2022	Government Agency	None
GS2	M	Two or more White	No	Chemical Engineering Math/Physics	MSE	Masters	2023	Industry/ Corporation	None
GS3	M	White	No	Math/Physics	Math/ Physics	Masters	OTHER	Undecided	None
GS4	M	White	No	ME	ME	Masters	2021	Undecided	None
GS5	M	Black/ African American	No	Biomolecular Sciences	MSE	PhD	2023	Academia	MS, Chemistry
GS6	F	Asian	No	Chemistry	Chemistry	Masters	2021	Industry/ Corporation	None
GS7	M	White	No	ME	MSE	PhD	2024	Government Agency	None
<b>Abbreviations: Mechanical Engineer (ME), Materials Science and Engineering (MSE), Male (M), Female (F), Master of Science (MS).</b>									

long with roughly 15 questions. Generally, the participants were asked to reflect on their experiences working as a disciplinary expert with the TCs. See Appendix D for interview questions. GIFT reflection assignments were collected prior to each class meeting. The end of semester reflection was collected at the end of the semester. For the purpose of this study only the interviews, end of semester reflections, and the reflection papers shown in Table 3 were coded, as those were the ones that related directly to the participants work with the teacher candidates. There are multiple semesters of data, however due to the scope of this project, only one semester of data was analyzed. The semester chosen to be analyzed was the most recent iteration of the GIFT intervention.

#### Data Analysis

Lacking a sense of expertise and belonging were used as a proxy for IP. The qualitative responses to surveys, reflections, and interviews were coded into two main categories which are summarized by students feeling and increased sense of belonging, purpose, and community responsibility as well as students feeling an increased sense of expertise. These two main categories were made of various other subcategories shown in the Table 4.

**Table 5 Data Analysis Categories.**

<b>Category</b>	<b>Code</b>	<b>Definition</b>	<b>Positive Affect Example Quote</b>
GIFT may mitigate imposter phenomenon by cultivating a sense of belonging, purpose, and sense of community.	Purpose	The reason for which something is done or created	“I decided to learn chemistry because I actually wanted to make the world a better place.”
	Sense of community	Feelings of interdependence.	“I hope to play a more active role in my research group by mentoring undergraduates and being someone other students can come to with questions about research or classes.”
	Belonging	Feeling like a part of something	“I feel like I really didn't know how to be involved in the field and I feel like with GIFT I was able to communicate with others about my work.”
GIFT may mitigate imposter phenomenon by facilitating an increased sense of expertise in participants	Possession of expert knowledge	Having a deeper understanding than the typical person on a particular topic	“It has given me the confidence to view myself as someone who has expert knowledge on topics in my field.”
	Communicating and sharing knowledge	The ability to share and translate useful information to others	“I have knowledge to provide to others and through the tools and information gained, I feel as though I can more effectively communicate my research and ideas to others.”

Potential instances of the student experiencing a shift in their sense of expertise and belonging were coded into the applicable categories. Instances of negative affect (anxiety, self-doubt, non-belonging, etc.) and instances of positive affect (confidence, acceptance, excitement, etc.) were used to code for an increase or decrease in the proxies

and impostorism. Any transformational experiences, such as working with teacher candidates and taking on the role of expert were noted.

## CHAPTER FOUR: FINDINGS

This chapter will detail the findings from the GIFT participants' interviews and reflections in response to the research question “*In what ways does the GIFT intervention mediate imposter phenomenon?*”. The first section provides evidence of impact on students’ sense of belonging. The second section provides evidence of impact on students’ sense of expertise.

### **Finding One: GIFT may mitigate imposter phenomenon by cultivating a sense of belonging, purpose, and sense of community.**

This section presents findings related to the intersection of the intervention and social interests for the students by focusing on their sense of belonging, purpose, and responsibility to others. There is overlap between the constructs and not a clear distinction where one ends and the other begins; however, they fall under the umbrella of the concept of social interests, presented by Ashby and Kottman (1996), which is a key factor of disciplinary stewardship. This section also presents findings related to the intersection of the graduate students’ sense of belonging, culture of genius and social interest.

#### Purpose

By working through GIFT, participants expressed that they now had deeper purposes for pursuing graduate education. GS6 stated “I think my role is to share my

knowledge with the world, either through what I'm doing or... through teaching. I decided to learn chemistry because I actually wanted to make the world a better place, but I'm nowhere near there. I thought that was my role.” In this statement the graduate student indicates they feel a sense of disconnect from their purpose in their graduate studies. The student speaks of wanting to make the world a better place in the past tense and states, “I thought that was my role”. They do so after stating that they are nowhere near making the world a better place. This may indicate that their current studies do not inspire a feeling of connection to their purpose. It may be related that GS6 also stated,

I felt like my discipline is all about research and finding new things. But now I feel that I don't have to just do research. It doesn't have to be in the lab all the time. I can also share with other things that are related to my discipline as well.

Additionally, in the end of semester reflection while writing about the broader applications of GIFT, GS6 gave the impactful statement that they, “have come to the revelation that beyond contributing research and work to our disciplinary communities, graduate students can (and are responsible to) share and communicate their knowledge to others”. All of this may indicate that GS6 experienced disconnection from their purpose in some manner and that GIFT inspired feelings of connection to that purpose through sharing knowledge while working with the teacher candidate.

Other participants also indicated a deeper purpose, akin to improving the world, as motivation for their pursuit of higher education. All six of the participants stated that they felt they had a larger responsibility to the world, and many stated it was part of their

reason for pursuing education. After the GIFT intervention all of the students indicated they also felt a responsibility as disciplinary stewards to the community. GS7 shared,

I just wanted to thank you for reminding me and the other students in GCOLL, the duty we have as graduate students to serve our public. I think in our daily grind of study and research that we tend to forget the overall, big-picture impact that our niche area of study has on the public. Listening to the [TED talk on...] and reading the paper by Golde and Walker, I feel like I am extremely lucky to be in an environment that has fostered my growth as a ‘steward of the discipline’.

In this statement the graduate student speaks about how lucky they feel to be a participant in the GIFT intervention and to receive the guidance and support provided. Similarly to GS6, their statement also indicates a disconnect from their deeper purpose in their studies, and GIFT supported a feeling of reconnection to a larger purpose and responsibility through disciplinary stewardship.

### Sense of Community

Students in this study stated that GIFT provided an opportunity to be involved in the community. GS3 felt that students can become isolated from the broader context of their work stating, “you become blind and just waste away in your research lab cutting yourself off of everything else that is happening around you” and that,

having a view that spans outside of the scope of what you are doing, and you can incorporate some of the work that you are doing, that in turn helps integrate you to become a part of something that you would have otherwise not been a part of.

GS3 also saw value in, “developing critical thinking as well as a moral compass that is community-centric” and highlighted the possible impact on people’s work when they become isolated from their communities in that,

those that get too involved with their work in the higher level of education and in research and maybe partially based on what their background is in, tend to become isolated from what is happening within the community... [and] aren’t attuned with what is happening around them; they almost feel like they become part of the cold machine they are working on which is their work.

The participants found that sharing their knowledge with their community brought more meaning to their work, that they were a part of something, and provided a moral value. In other words, GIFT provided value in the sense that they enjoyed it and they felt they were being of service.

Through GIFT, students were given the opportunity to work with members of their community and have an impact beyond their labs. Due to COVID-19, these students were not able to observe their impact on the elementary students directly, but they were able to observe the impact on the TCs as they gained a deeper understanding of scientific concepts. Graduate students were able to have a first-hand experience in teaching, perhaps highlighting the value of preserving, expanding, and sharing knowledge for the sole purpose of passing it onto others. In this way GIFT took them outside of their labs and their usual surroundings in which their goals may be geared more toward scientific progress. It connected them more directly to the people who will be impacted by it,



whether it be from impacts scientific advancements or through their own acquisition of knowledge and our shared human experience of learning and teaching.

Throughout the intervention students embraced the idea of being a disciplinary steward in their own classrooms and in their larger communities. They acted as stewards not only by sharing content knowledge with the TCs, but also by improving their own discipline by sharing what they learned from GIFT with their academic community, integrating useful techniques that improve learning in the labs they taught. Students improved their teaching by utilizing the concepts discussed in their GCOLL course such as Universal Design for Learning and the 5E Framework (Bybee, 2014; Rose, 2000) in their professional practices and classrooms. This demonstrates a sense of community as students were not required to integrate this into their classrooms but did it of their own initiative out of a sense of leadership and community responsibility to their peers and discipline. For example, GS1 stated,

[Because of my experience with GIFT] I hope to play a more active role in my research group by mentoring undergraduates and being someone other students can come to with questions about research or classes. Furthermore, I can leverage knowledge gained in GIFT to mentor new students and help them to feel more engaged with the community than I felt when I first started.

As can be seen here, this student felt more connected to other students and developed a desire to mentor them. This may indicate participants felt more qualified to try new creative approaches in their teaching and positions of leadership with their peers

which requires a sense of expertise and confidence. Furthermore, students felt inspired to share their knowledge with the larger community, with GS5 stating,

I would like to be a part of community outreach and come up with a number of simple topics and experiments in the Treasure Valley during my matriculation at Boise State University. This will allow me to make a small difference in young people and hopefully may inspire others to do their part to benefit their community with whatever skills they possess.

### Belonging

When asked how the GIFT intervention affected their sense of belonging, some students specifically mentioned disciplinary stewardship. As disciplinary stewards, the participants participated in the sharing and conservation of knowledge within their local communities, highlighting the link between a sense of community and a sense of belonging. GS1 responded to the question stating,

I think it kind of made me realize that as PhD students and future PhD holders, we have... reason to give back to the community and share our knowledge and stuff. You know, especially when it comes to teaching people.

When asked this same question GS6 responded,

I feel like I really didn't know how to be involved in the field and I feel like with GIFT I was able to communicate with others about my work. I mean, like just what I know and my knowledge. I feel like that's one way that I felt like I got more involved with the community.

This participant also stated, “Through the teaching experience that I had with GIFT, I felt that I can be a source of knowledge and I can engage with the community by sharing my work and my knowledge with others”. These participants were given opportunities to express their expertise and communicate with others in their communities and it fostered a sense of belonging.

Although this sense of belonging is likely not fostered exclusively through disciplinary stewardship and GIFT, there is an indication that it increased in participants throughout the intervention. Non-belonging is a key symptom of IP. Therefore, it appears that for some participants, disciplinary stewardship may have decreased symptoms of IP. The participants mentioned a desire to improve the world and be of service to others through their work and yet some spoke as if they were disconnected from that purpose. Some participants also expressed that they were unsure of how they belonged in their discipline at the start of the intervention. Throughout the course of working with the TCs the participants related a sense of belonging to their work as disciplinary stewards. Therefore, it is possible that disciplinary stewardship increases feelings of belonging in students through reconnecting them to their purpose.

**Finding Two: GIFT may mitigate imposter phenomenon by facilitating an increased sense of expertise in participants**

Possession of Expert Knowledge

Graduate students are expected to hold a certain degree of expertise. It follows that a student’s sense of expertise may have an impact on their sense of belonging in their discipline and their feelings of authenticity about their position. When asked in an

interview if they identified as an expert, 5 out of 6 participants indicated that they felt like more of an expert after participating in the GIFT intervention while one was unsure.

Many of the participants did not initially feel comfortable with the term expert being used to describe them. Most participants originally experienced feelings of nervousness, self-doubt, not being equipped for the responsibility, and questioning where they belong in their discipline. For example, GS7 shared,

I didn't feel like I was the expert at the time. But in hindsight... I felt like looking back into the experience, I definitely was the expert. Mainly because they kept asking me questions that I read about so I guess in that sense, I was the expert because I have that added information prior.

Similarly, GS1 stated

Some other insights I had about teaching was how nervous I was before and at the beginning of the lesson. Over time, however, I began to get more comfortable once I realized that I was in fact the 'expert' on the topic and knew how to go about teaching the students since I had prepared pretty extensively,

and, "it has given me the confidence to view myself as someone who has expert knowledge on topics in my field".

Symptoms such as self-doubts, non-belonging and inadequacy have all been linked to IP, and the data shows a decrease in these symptoms due to the impactful experiences in the GIFT intervention. Possibly the most impactful aspect for these participants' increases in their sense of expertise was taking on the role of expert and

being acknowledged as having expert knowledge by the TCs through the process of asking questions and sharing knowledge. Participants also gained perspective on their own expertise by working with people who had less expertise in the area. GS4 stated,

I graduated with a degree in mechanical engineering and I'm doing graduate school. If you consider that in the grand scope of things, you have a lot of expertise that maybe not every person has. And so, I would say that you're an expert in your specific area. And so, use that expertise to help people who don't have the same knowledge base in that specific area. And so, in that case, it does make sense. Now, if you're trying to teach the same things to maybe some professors, it might not be the same, you know, it's all relative.

One participant also noted that they had never participated in a class that was so focused on effectively sharing and communicating information and some students stated that this was their main motivation for taking the class. Although they prepared adequately, preparation alone was not sufficient for them to realize their expertise. The participants indicated that *sharing* the knowledge with others was an integral piece.

#### Communicating and Sharing Knowledge

Communicating knowledge and information to others is part of the role of an expert and a foundational professional skill. A strong professional identity implies that a person believes they are who they say they are professionally and that they have a sense of belonging through that identity. This can be developed through people being seen as a professional by others. In order to facilitate this, it is important for students to feel comfortable and practiced in their scientific communication skills in order to connect

with their peers, future stakeholders, and communities outside of academia. Some participants lacked confidence and practice in communication, which if not addressed can lead to anxiety and a belief that they are not able to perform what they have expressed is an integral part of their job function -- one key trait of those experiencing IP. Some students joined the GIFT intervention *specifically* for the purpose of improving upon this integral skill, while also expressing feelings of apprehension about communication and that it was a weakness prior to the intervention. GS4 stated,

I think it's really important for people in science to be able to communicate with others, what they're doing and why it's important. I think sometimes there's a big disconnect between...the public and...some research and... why is that important...and what's the purpose.

When asked why they signed up for the GIFT intervention GS1 stated,

The main driving factor was my desire to enhance my scientific communication skills, especially when communicating to people that might not have a background in science. I have a strong belief that being able to communicate research and other basic scientific concepts to people is going to be important forever in my career. And I wasn't very comfortable with that going into GIFT. So, I was hoping that GIFT would hopefully help that in some way or another.

This participant also stated, "I have knowledge to provide to others and through the tools and information gained, I feel as though I can more effectively communicate my research and ideas to others" and that

It has given me the confidence to view myself as someone who has expert knowledge on topics in my field. By teaching my lesson plan, I realized that I can effectively teach others and communicate my knowledge to them. Going forward, I now have the goal of being the best possible teacher and mentor I can be to others by utilizing my experience with GIFT.

Due to the intervention, students felt more comfortable communicating their knowledge as GIFT provided opportunities for them to practice. Having confidence communicating with peers in a professional environment may also improve their sense of belonging. GS4 shared that, "GIFT made me a more effective communicator because when I present information, I think more about how my subjects are arranged. My experience from GIFT will be used in my professional community". For GS1 this was particularly impactful as they stated, "a major part of my self-identity is being someone always willing and able to help others. My participation in GCOLL 516 and GIFT has provided me with the knowledge and tools to be an effective teacher to others in my field" and that they had plans to "play a more active role in my research group by mentoring undergraduates and being someone other students can come to with questions about research or classes". This student was able to improve upon a skill they stated was a large part of their identity in their field indicating this was an identity affirming experience for them professionally speaking. It follows that this may increase participants' belief that they are who they say they are, which may mitigate symptoms of IP.

In summary, these students indicated that communicating their knowledge to others was an essential part of their responsibilities as a professional. They expressed

confidence in their disciplinary knowledge in their respective areas of study yet felt they had a lot of room for growth in their ability to communicate it to others. Overall, they felt a sense of improvement in that area, with some expressing that there was still room to improve.



## CHAPTER FIVE: DISCUSSION

The purpose of this study was to explore in what ways the GIFT intervention mediated IP for participants by using the proxies belonging, community, and expertise in place of IP. The implications of findings from this study will expand the current research by focusing on which experiences were most transformational for students and why. The findings indicate that it is very likely students had an overall increase in their sense of belonging and expertise, indicating a decrease in symptoms of IP. This section consists of three assertions: 1) Symptoms of IP were reduced when graduate students felt an increased sense of belonging through feeling connection to a purpose; 2) Participants experienced a decrease in symptoms of IP as they practiced taking on the identity of expert in an environment that facilitated a growth mindset, in contrast to the culture of genius, and; 3) GIFT provided an opportunity to practice communicating, interacting, and facilitating in expert-like ways, which as a result decreased symptoms of IP.

**Assertion 1: Symptoms of IP were reduced when graduate students felt an increased sense of belonging through feeling connection to a purpose.**

Results from the study showed an increase in the proxy ‘sense of belonging’ amongst participants, indicating that the intervention may have been effective in mitigating IP. Participants spoke about pursuing graduate education as a way of improving the world and helping others. However, they felt disconnected from that purpose sometimes even referring to it in the past tense indicating that something

throughout their time in their studies had changed the way they view their work. When asked about their sense of belonging one participant stated that they were unsure of how to become involved in their discipline and community. However, after learning about disciplinary stewardship and working with the teacher candidates they stated they felt it was important to continue working toward bettering their community indicating they felt reconnected to their initial purpose. Participants related to the idea of becoming isolated from their communities and connected their sense of belonging and disciplinary stewardship.

This is significant because success and achievements will have many ups and downs based on factors that are outside of the students' control. Success in their courses and research positions are frequently measured by the ability to produce results, whether that be a grade, a grant, or new knowledge. This is a necessity for progress and upholding standards; however, it seems that productivity alone is not enough for these students. Productivity and results will naturally ebb and flow as part of the learning process and as students' progress their milestones may become more difficult to achieve. Students who have a sense of belonging to their discipline and society that is rooted in disciplinary stewardship and service to their communities may not experience the same feelings of non-belonging when their successes ebb and flow, therefore decreasing overall symptoms of IP.

**Assertion 2: Participants experienced a decrease in symptoms of IP as they worked with people within the field of education.**

Participants related that their sense of belonging was linked to their sense of expertise after participating in the intervention and yet at the beginning of the intervention the participants were uncomfortable with the term ‘expert’. The belief that they were experts generally increased throughout the intervention with the main reason stated being, working with the TCs (i.e., disciplinary stewardship). The participants were able to see that relative to people *outside of* their discipline they were in fact the expert, which might indicate there was some type of cognitive distortion around what it means to be an expert. This experience gave them a broader context for their own expertise as they are more frequently working with people who are equally or more experienced in the field.

The graduate students’ work with the TCs as subject matter experts mirrors the Gestalt Psychological approach suggested by Clance and Imes (1978) in which people experiencing IP work through their negative beliefs through role play in a safe space. Although participants in the intervention were not in therapy and were not role playing, there are parallels between the two. Therapy is designed to be a safe space for growth and challenging limiting beliefs, and in theory, so are educational spaces. Although the students were not role playing as an expert, they were taking on the role in a space geared toward facilitating growth and learning. Murphy and Dweck (2010) proposed some professions might implicitly foster a culture of genius through the nature of the work and if they are predominantly results oriented. It follows that professions in which growth and learning is an inherent aspect of success – such as teaching – may implicitly foster a

growth mindset for some. The GIFT intervention also took place through GCOLL 516, which is a one-credit, low-stakes course that was more aligned to an education/growth mindset philosophy rather than a STEM/fixed mindset philosophy. As the students transitioned to the role of expert in their field, they may not have felt comfortable to take on that role in their usual environments, especially if they are operating within a culture of genius, out of a fear of failure. However, exposure to the role of expert through disciplinary stewardship may result in participants feeling safer to try on a new role. Through this identity-affirming experience the students felt an increased sense of expertise as they were perceived by the teacher candidates to be in possession of expert knowledge which could mitigate feelings of non-belonging decreasing symptoms of IP. This is in alignment with Bragg's (1976) definition of professional identity.

**Assertion 3: GIFT provided an opportunity to practice communicating, interacting, and facilitating in expert-like ways, which as a result decreased symptoms of IP.**

As noted by one of the participants, for some this was the first course they took in which these students explored the role of expert beyond subject mastery, such as communicating their expertise. Participants agreed that communicating their knowledge was an integral part of being effective and successful in their role as a professional and yet many of the students' primary reasons for signing up for the intervention was that they felt they were significantly lacking in that area. The statements from the students indicated that sharing the knowledge was an impactful experience for them. The students have had ample experiences in acquiring knowledge and yet sharing the knowledge from the position of expert was not something they felt practiced in. Sharing and translating knowledge to others is often the role of an expert and it is worth considering whether or

not graduate colleges amply prepare students for this role. Coursework offers extensive practice in the domains of sciences for STEM students and yet the majority of students in the study indicated they felt they were less than equipped to communicate the information. GIFT offered an opportunity for practice in an essential aspect of expertise which is communicating in their disciplinary area. During the intervention the students acquired confidence to act with appropriate authority in their area. This connection between communication and feelings of expertise may be connected to some of the concepts presented by Ashby and Kottman (1996) and the participants sense of belonging and connection with their purpose. Communication is in essence about community. Beyond feeling connected to others, communication with the teacher candidates also presented opportunity to have their professional identity (Bragg, 1976) affirmed by others.

Furthermore, it is worth noting that many students seemed to lack an understanding of what the term 'expert' meant for them personally and seemed to only define the term as a comparative measure, the magnitude of which can be determined by milestones and accolades when the reality of being an expert also includes struggle and perseverance and is not a binary. It is useful to have some relative idea of where you are on the spectrum of expertise, but if a person's expertise is growing and improving and evolving, they may experience more struggle than success at many points of their career. This aspect of growth which requires often being in the state of 'becoming an expert' is often dismissed and hidden in a culture of genius (Slank, 2019). Many of the participants had a skewed perception of expertise which might be mitigated through more open and honest conversations about what it means to be an expert and the struggles people

experience. An increased sense of community within the discipline may also prove successful.

Beyond the students' perceptions of themselves, students' expertise grew in other ways as they embodied expert behavior by taking key lessons from the material presented in the intervention and utilized it in their own classroom and learning. The students were presented with ample information on ways to improve learning and teaching in the classrooms. These topics varied from expert learning and teaching to growth mindset, to Universal Design for Learning and 5E framework and so on. Participants referenced this material while writing their reflections mentioning how it has impacted their own learning and how they have used it in their labs they teach to improve student learning. This resulted in students taking on roles of co-creators and leaders in their discipline as they practiced disciplinary stewardship in their own labs they taught, by improving their own teaching methods with what they learned from the teacher candidates and in GCOLL.

### **Implications and Future research**

An interesting implication of this research and intervention is that there are both individual and environmental factors that come into play when considering IP in graduate STEM students. Likely addressing one without addressing the other will not fully address what is going on. This highlights the need for both personal awareness as well as community effort. Individuals vary and therefore approaches must vary as well. A key implication of this is that mentors, advisors, and other leaders need to have strong relationships with their mentees and peers in order to really know where they might be

struggling in order to address it head on. This is highlighted by the benefits of having some kind of safe space for students to experience growth and in order to do that there has to be a strong sense of community trust that leaders are invested in the people and the process as much as the results.

This approach for cultivating spaces that allow students to take on the role of expert that affirm their identity can be continually expanded through many iterations to create more spaces that value diversity. In order to serve diverse students, there must be diverse approaches. There is no ‘one way’ and multiple pathways to success are required in order to increase students’ sense of belonging. Key aspects of GIFT that can be expanded upon and implemented are the focus on disciplinary stewardship, a connection to social interest, reflection journaling, and community building. Beyond a GIFT-like intervention, this could mean normalizing struggle and effort and bringing awareness to the ways people may be participating in a culture of genius.

Additionally, many of the participants in this study felt uncomfortable with the term ‘expert’ and uncomfortable with their ability to communicate their expertise. After their work as a subject matter expert with the TCs, students’ sense of expertise increased which may imply that communication is a part of students practicing their expertise. This may also imply that students need more opportunities to practice communicating their expertise outside of cultures of genius.

The participants were placed in the role of expert for the intervention and beyond that, many took what they learned and integrated it into their own communities through their teaching positions in the labs and their own study practices. Perhaps this could be

translated to future research mentorship programs between advisors, graduate students, upperclassmen, and freshman. When people are able to express their struggle in a supportive environment, they are less likely to repress it and become isolated. It could allow them to work through struggles as they come and teach them a very necessary skill of being a professional and expert. Not only would this benefit the less experienced students, but it is an opportunity for practice in a leadership role that has lower stakes for the more experienced students. This is professional development for all involved and it mirrors the type of community effort and collaboration that many companies try to cultivate. It could also take the form of student led study groups in which students practice taking on the role of expert with their peers. Interdisciplinary work is a great opportunity for students to feel connected to the broader impacts of their work and it allows students to diversify their profession and enrich disciplines.

The GIFT participants spoke about feeling a sense of purpose through interacting with their communities through disciplinary stewardship and interdisciplinary work. STEM students may not spend an adequate amount of time connecting their work to their purpose, as this is not always obvious from a lab setting. Working with other disciplines to observe a larger impact on communities may be a successful route for these types of connections.

In future research it would be beneficial to have a measure of students' imposter feelings by using the Clance IP scale. The participants could take the quiz pre and post intervention to measure any changes throughout. This data could be compared to the data from the proxies and add validity to the current proxies. Furthermore, researchers could ask questions more specifically pertaining to the culture of genius to inquire if it is



something students are experiencing and if it is related to feelings of impostorism. Changing the culture in classrooms in something professors can control so it is worth investigating further.

### **Conclusion**

In conclusion, the GIFT intervention has potential to mitigate IP through increasing participants' sense of belonging, sense of purpose, and feelings of expertise. The participants expressed a sense of purpose beyond academic achievement that was rooted in responsibility to better their communities. Through these experiences, students were reminded that their impact reached beyond the lab and the classroom and that they were connected to their communities. This sense of connection positively impacted their belonging. The participants identified more heavily as an expert by the end of the intervention. They were assigned the role of expert in their field as they participated in interdisciplinary work with the teacher candidates. This provided an opportunity to practice being an expert in an environment that brought new knowledge and perspective. Being seen as an expert by others can be identity affirming for both them and the teacher candidates as they share disciplinary knowledge with each other.

There were quite a few limitations to this study. Only one semester of data was analyzed due to this being an exploratory study; mitigation of IP was not an original objective for GIFT but appeared worthy of purposeful investigation due to anecdotal conversations with GSs. Additionally, the semester of focus was the most recent semester at the time and had therefore undergone the most iterations of the feedback cycle to improve the experience; however, it also took place during the onset of COVID-19 in the

US which limited the students' interactions with the TCs and they were not able to observe the impact of their work when the TCs taught their lessons. If future research is done in this area through the GIFT intervention it may be useful to include a survey geared toward measuring IP. It would also be useful to ask questions in order to gauge participants' experience of the culture in the graduate school and maybe more generally college or school altogether. Additionally, questions regarding mindset could be very useful.

Despite the limitations of this study, students clearly spoke about an increase in feelings of expertise as a result of participating in GIFT. Furthermore, their introduction to the concept of disciplinary stewardship and their interdisciplinary work with teacher candidates reconnected participants to their purpose for pursuing a graduate career, which many stated was to improve the world and give back to their communities. STEM fields are often viewed as separate from the humanities, when in reality the STEM field is made up of individuals who are inseparable from their humanity. Interdisciplinary work with a focus on disciplinary stewardship, such as the work in GIFT, may present many opportunities to improve retention and help decrease symptoms of IP in graduate students.

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## APPENDIX A

## GIFT/GCOLL Reflection Media and Grading Criteria

GIFT Pedagogy exploration reflection #1

GCOLL 516 Fall 2020

Due Sunday, September 20 by 11:59 PM

### ACTIVITIES INCLUDED

[NGSS exploration](#)

[5E workshop](#)

[5E reading](#)

### CRITERIA

Your work will be evaluated on the basis of the following criteria (“meets standard” performance is described):

- **NGSS reflection:** Describes your overall thoughts on the NGSS. Reflects on the comprehensiveness of the Practices and their place in the standards. Reflects on the comprehensiveness of the way that the Nature of Science is defined and its place in the standards. Describe insights you had when exploring some of the standards in more depth.
- **Main takeaways for 5E workshop:** Clearly summarizes the 3-4 main takeaways from each activity. Main takeaways are focused on what you learned about how to engage students or enhance student learning.
- **Main takeaways for 5E reading:** Clearly summarizes the 3-4 main takeaways from each activity. Main takeaways are focused on what you learned about how to engage students or enhance student learning.
- **Connections:** Makes connections among the activities. Compares / contrasts what was seen/heard/read. Integrates different activities as part of the reflection. Identifies ways that the activities reinforce (or contradict) one another.
- **Implementation:** Identifies at least two specific ideas for implementation. Justifies how each would clear how each would enhance student learning.



**GIFT Pedagogy exploration reflection #2**  
**GCOLL 516 Fall 2020**  
**Due Sunday, November 1 by 11:59 PM**

**ACTIVITIES INCLUDED**

[Write a lesson plan](#)

[Teach your lesson](#)

[Lesson plan feedback](#)

**CRITERIA**

Your work will be evaluated on the basis of the following criteria (“meets standard” performance is described):

- **Lesson plan:**
  - Describes what were the easiest and/or most natural parts of making the lesson plan.
  - Identifies the most difficult parts of creating the lesson plan.
  - Explains how you used the formative assessment information in planning the lesson.
  - Shares insights about the process of developing a lesson plan.
- **Teach your lesson:**
  - Identifies and describes what worked well when you taught your lesson to your team.
  - Describes what things could have been improved about the lesson you taught to your team.
  - Clearly describes the experience of using the 5E instructional model. Focuses on how the 5E model serves to enhance student learning.
  - Thoughtfully describes other insights about teaching as a result of these activities.
- **Providing feedback on your team’s lesson plan:**
  - Describes how well the team appeared to grasp the content taught at the previous meeting.
  - Describes any misconceptions which needed to be corrected. Explains how the original lesson either perpetuated or dispelled misconceptions.
  - Describes the experience of providing feedback to your team. Explains the ways ideas from the reading on feedback were implemented.
- **Connections:** Makes connections among the activities. Compares / contrasts what was seen/heard/read. Integrates different activities as part of the reflection. Identifies ways that the activities reinforce (or contradict) one another.
- **Implementation:** Identifies at least two specific ideas for implementation. Justifies how each would clear how each would enhance student learning.

**GIFT Pedagogy exploration reflection #3**  
**GCOLL 516 Fall 2020**  
**Due Sunday, December 6 by 11:59 PM**

**ACTIVITIES INCLUDED**

[Watch your team teach](#)

[Family science event](#)

[Disciplinary stewardship reading/video](#)

**CRITERIA**

Your work will be evaluated on the basis of the following criteria (“meets standard” performance is described):

- **Watch your team teach their lesson:**
  - Summarizes things that the team did well in teaching their lesson.
  - Describes how the concept could have been taught differently so that the team was better positioned to develop their own lesson.
  - Describes how the lesson might impact K-8 interest/excitement about science.
- **Family science event**
  - Describes something you learned about teaching or learning from observing the event.
  - Identifies what skills the ED-CIFS team members brought to bear during the event that you hadn’t considered before.
  - Explains what the experience taught you about the role of classroom teachers and/or content area experts in K-8 education.
  - Identifies other insights from having observed the event.
- **Disciplinary stewardship reading/video:** Clearly summarizes the 3-4 main takeaways. Main takeaways are focused on what you found to be most important from this activity.
- **Connections:** Makes connections between the activities you have completed for this paper to other activities you’ve done as part of GCOLL 516. Looks for ways that the activities/content reinforce or contradict each other.
- **Implementation:** Identifies at least two specific ideas for implementation. Justifies how each would clear how each would enhance student learning.

## GCOLL Reflection Media and Grading Criteria

### Media

#### **Meeting 1 (1/27/20)**

##### **Topic: Growth mindset and wise feedback**

- Watch [The Power of Believing you Can Improve](#)
- Read [Wise critiques help students succeed](#) (this one is pretty short)
- Read [Struggle Means Learning](#)
- Read [Growth Mindset Misconceptions](#)

#### **Meeting 2 (2/10/20)**

##### **Topic: Novice to expert transition**

As you engage in each activity below, try to do so through the lens of your own experience as a learner:

- Read [Prior knowledge as an unexpected obstacle to learning](#)
- Read [How experts differ from novices](#) (and, as needed, explore links therein)
- Read this summary of [How people learn](#)
- Review Chapter 2, “Key Findings” from [How People Learn](#), National Academies Press (focus on the findings... no need to read the details unless you want to)

#### **Meeting 3 (2/24/20)**

##### **Topic: Flipped classes**

- Watch [Let's use video to reinvent education](#)
- Read [Vanderbilt's guide to flipping the class](#)
- Watch [Eric Mazur using interactive teaching](#) (pay attention to what (1) the instructor and (2) the students are doing)

#### **Meeting 4 (3/9/20)**

##### **Topic: Stereotype threat and who gets to graduate**

- Read [Stereotype threat widens the achievement gap](#)
- Watch [Stereotype threat](#) (video)
- Read [Who Gets to Graduate?](#) (reading)

#### **Meeting 5 (3/30/20)**

##### **Topic: Decoding academia**

- Watch [this video](#) about a freshman’s first finals experience
- Read [‘Why Do We Have So Many Freaking Acronyms?!’](#)
- Read one of the following (or both, if you have time):
  - [College Students: How To Make Office Hours Less Scary](#)
  - [We Must Help First-Generation Students Master Academe’s ‘Hidden Curriculum’](#)

**Meeting 6 (4/13/20)****Topic: Alternative grading frameworks**

- Read [Why I don't grade](#) and [How to ungrade](#) (a bit of a misnomer) OR listen to [How to ungrade](#)
- Read [New ways to grade more effectively](#) and review this [implementation of specifications grading](#)
- Read about [using grading contracts](#) (and look at the different models in this longer essay on [three approaches to contract grading](#))

**Meeting 7 (4/27/20)****Topic: Teaching with technology**

- Read [26 critical thinking tools aligned with Bloom's taxonomy](#)
- Read [Integrating technology with Bloom's taxonomy](#)
- Review these [Digital tools for different types of doing](#)
- Consider these [Ideas of apps to use in learning](#)
- From these resources, pick two technologies for teaching/learning that are new to you, look into what they are and how they could be used (summarizing these can count as two of your takeaways for your class preparation paper!).

Grading Criteria**Class preparation reflection**

GCOLL 516 Spring 2020

**Due before each scheduled cohort meeting****Purpose**

This assignment asks you to reflect on [the readings you've done or videos you've watched](#) in preparation for our cohort meeting discussions in order to clarify what you've taken away from the reading and/or video. You will consider your main takeaways as well as how you plan to integrate what you took away from the reading/video in your own teaching.

This assignment will help you practice the following **skills**:

- Identifying the aspects of the reading/video which most impacted you
- Planning for how to apply the findings of the reading/video to your own future teaching

This assignment will help you gain the following **knowledge**:

- How learning works and how we can support our students in what they do

**Task**

After you have engaged with the readings, videos, and/or podcasts, and in the format of your choosing (more below):

1. Identify three main takeaways that particularly stood out to you in your reading, viewing, or listening. Briefly describe why each of these resonated with you.
2. Describe one specific idea for how to apply the ideas from the reading, video, and/or podcast in your future teaching.
3. Identify one outstanding question you have about which you'd like to learn more (connected to the topic of the week). Briefly describe why you are interested in learning more about this question.

You can choose how you would like to share your findings and reflections. You might opt for:

- A written reflection (~1-2 pages long), ideally submitted as a google doc
- An audio essay (<5 minutes long, e.g., using [audacity](#) or similar)
- A video essay (<5 minutes, e.g., using the media submission tool in canvas)
- A [concept map](#) (either hand-drawn or using a program like google slides)
- A [sketchnote](#) (1 page)
- Other representation that we've agreed on

**Submitting your work**

Submit your reflection through the assignment on Blackboard.

**Tips for success**

- This is meant to be a short reflection, so don't allow yourself to go on and on!
- As you're reading or watching though, look for things that really resonate with you from the article or video. In your reflection, tell me about why they stood out to you.
- For the idea of how to apply the content, be as specific as possible. Consider how what you've read or seen could be applied in your own discipline.
- Remember to explain why the question you have posed is of interest to you.

**Evaluation**

Your work will be evaluated on the basis of the following criteria (see full rubric in Canvas):

- **Main takeaways:** You have identified three main takeaways from the reading or video. These ideas have personal significance and their importance to you is explained.
- **Applying the findings:** You have described one idea for how to apply the findings from the reading/video in your future teaching. These ideas are specific and go beyond those presented in the reading/video.

- **Questions you have:** You have identified one outstanding question connected to the topic of the week. These are thoughtful questions worthy of further consideration. A brief description is included for why those questions are of particular interest to you.

## APPENDIX B

## End of Semester Reflection Assignment and Grading Criteria

### GIFT End-of-semester reflection

**GCOLL 516 Fall 2020**

**Due Sunday, December 13 by 11:59 PM**

### PURPOSE

This assignment will help you reflect on what you've learned over the course of the semester about teaching and learning.

This assignment will help you practice the following **skills**:

- Make connections between different parts of the course
- Plan for your future teaching/communicating content to non-science audiences
- Analyze the biggest take-always from all that you experienced.

This assignment will help you gain the following **knowledge**:

- How the observations, workshops, and readings you did are interconnected and support one another

### TASK

As a research team, we are very interested in your GIFT experience. Please share your thoughts about your experience and your personal growth with us by reflecting on the following prompts (in what will likely take 3-5 pages):

1. In about one paragraph for each, identify three things you did this semester (from among the activities you completed as part of GCOLL 516 and GIFT) that most stood out to you. Describe why each stood out to you and what you learned from each (either about yourself or about teaching and learning).
2. Describe at least three specific **ideas** you would like to **implement in your future teaching** which have arisen over the course of the semester. Note that this may be inside or outside of a classroom, as teaching can happen in industry and governmental organizations as well as in academia. Describe **WHY** you have selected these three ideas and the benefit they will have for your students/audience. Note: Many of your assignments have asked you for ideas. This is a chance to think about what your highest priorities might be in terms of what you want to implement in the future.
3. Discuss your **evolution as a teacher** (in the broadest sense of the word - think about being one who shares knowledge). Explain the major ways in which your approach to teaching and learning has changed as a result of GCOLL 516. Describe the ways in which you have grown this semester as a teacher and what you still need to be a confident teacher.
4. Review the “Framework for Professional Identity” at the bottom of this document. Discuss how the skills/knowledge you have obtained this semester might impact your **professional identity** (e.g., your sense of self in your field) in line with the framework you have reviewed and your experience with GIFT. Identify specific components that could prove useful to you.



5. Review the “Framework for Disciplinary Stewardship” at the bottom of this document. Consider how your involvement with GIFT helped shape your view of who you are as a **member of your disciplinary community** (in line with the framework you have reviewed). In other words, do you feel like a part of the community of scholars in your discipline? How has your participation in GIFT affected how you feel? Where do you see opportunities to further integrate with your disciplinary community?

6. Many argue that graduate education should support students in considering how their disciplinary knowledge can solve real-world problems and serve a purpose larger than their career trajectory. Describe the ways GIFT has allowed you to **consider the broader applications of your field** and future profession.

### Submitting your work

Submit your reflection, ideally as a Google doc (which makes for easier commenting), through the assignment on Blackboard with the file name “LastName end-of-semester reflection”.

### Tips for success

You’ve done so many different activities all semester long. This is a chance to look for the points of overlap or to consider how one thing you’ve seen, read, or heard about connects to another. Look hard for those points of connection! You’ve also been asked to come up with lots of ideas for how to implement things in your future teaching. This is your chance to review your many ideas and to pick out a few that you think would have the biggest impact going forward.

### CRITERIA

Your work will be evaluated on the basis of the following criteria (“meets standard” performance is described):

- **Stand out activities:** You have identified three things you did this semester that most stood out to you. You described why each stood out to you and what you learned from each (either about yourself or about teaching and learning).
- **Ideas to implement:** You have described at least three specific ideas for how to apply what you learned in your future teaching (in or out of a classroom). Your reasons for choosing each one are clearly described. You have identified the potential benefits of each for your students/audience.
- **Evolution as a teacher:** You have explained your evolution as a teacher and the ways in which your approach to teaching and learning have shifted as a result of GCOLL 516. You have identified ways that you have grown as a teacher and what you would still need to feel confident as a teacher.
- **Professional identity:** You have discussed how the skills/knowledge you have obtained this semester might impact your professional identity. Your reflection identifies specific components of GIFT that could prove useful to you.
- **Disciplinary community:** You have considered how your involvement with GIFT helped shape your view of who you are as a member of your

disciplinary community. You have addressed to what extent you feel like a part of the community of scholars in your discipline and how your participation in GIFT affected how you feel. You identified opportunities to further integrate with your disciplinary community.

- **Broader applications:** You have described the ways GIFT has allowed you to consider the broader applications of your field and future profession.
- **Presentation:** Your reflection is written professionally and errors of mechanics and syntax do not detract from its reading.

### **FRAMEWORK FOR PROFESSIONAL IDENTITY (from Carlone & Johnson)**

- **Competences** → Student has and can articulate:
  - Foundational knowledge/skills within discipline/profession
  - Appreciation for discipline and role it plays in society/societal issues
- **Performances** → Student:
  - Can communicate to or perform for others the competences above
  - Demonstrates a commitment to the discipline/profession
- **Recognition** → Student:
  - Acknowledges own competence/knowledge in discipline/profession
  - Sees oneself as a member of their disciplinary/professional community
  - Is seen by others part of the disciplinary/professional community
  - Is seen by others as having the competences of and being able to perform as a part of the disciplinary/professional community

### **FRAMEWORK FOR DISCIPLINARY STEWARDSHIP (from Golde)**

- **Generation** → Students should be able to:
  - Work successfully across disciplines
- **Conservation** → Students should be able to:
  - Understand the role that a discipline is meant to play in society at large
- **Transformation** → Students should be able to:
  - Communicate about one's discipline across disciplinary boundaries
  - Apply disciplinary knowledge in service of the collective good and to meet others' needs

*Note: both frameworks are broader than what is described here; these are simply the parts we believe we are getting at with GIFT.*

## APPENDIX C

## Pre/Post Semester Survey

### Pre-Semester Survey Questions

*Please describe how active you have been in the following science-related activities. We are interested in science-related activities that occurred OUTSIDE of your regular coursework. Please consider both your undergraduate and graduate experiences.*

*1=never; 2=once; 3=a few times; 4=many times*

- I have volunteered with K-12 students to do science/engineering activities.
- I have informally taught or tutored others about science/engineering.
- I have used my science/engineering knowledge to solve a problem for someone else.
- I have used my science/engineering knowledge to help someone make a thoughtful decision.

*As student, you may have had a range of different people play the role of mentor: faculty members, program staff, graduate students, peers. A mentor is anyone more experienced than you who has given you individual support related to your development as a science or engineering student. Please think back to the mentoring you received, including people who were not formally designated as "mentors." Describe the extent to which your mentor(s) provided you with the following opportunities. 1=not at all; 2=to a small extent; 3=to some extent; 4=to a large extent; 5=to a very large extent*

- Helped you overcome insecurities about your abilities as a science or engineering student, if you had any.
- Gave you challenging assignments that presented opportunities to learn new skills.

- Encouraged you to work with others outside your field.
- Encouraged you to consider community and societal needs that could be met by your field/research.
- Helped you meet other people in your field both inside and outside of the university.
- Helped you figure out for yourself how to understand and explain your research results.
- Helped you figure out for yourself how to explain your research results to others.
- Taught you specific research or analysis skills.
- Viewed you as a colleague and member of your disciplinary community.

*This section assesses your confidence in your abilities to function as a scientist or engineer. Indicate the extent to which you are confident you can successfully complete the following tasks. 1=not at all confident; 2=to a small extent; 3=to some extent; 4=to a large extent; 5=absolutely confident*

- Appropriately use tools and skills necessary in your field.
- Understand and can explain big concepts in your field.
- Identify the 'giants' in your field and summarize their contributions.
  - Identify unique and meaningful questions/problems to investigate in your field.
  - Conduct research that meets the standards of credible work in your field.
  - Articulate the core values and ethical responsibilities of your field.
  - Communicate big ideas in your field to those outside of your field.

- Identify ways in which your field can contribute to society.
- Articulate the accepted behaviors, attitudes, and norms in your field (in terms of philosophies, approaches, research, etc.).

*The following questions ask how you think about yourself and your personal identity. We want to understand how much you think that being a scientist/engineer is part of who you are. 1=strongly disagree; 2=somewhat disagree; 3=neutral; 4=somewhat agree; 5=strongly agree*

- In general, being a scientist/engineer is an important part of my self-image.
- I have a strong sense of belonging to the community of scientists/engineers.
- Being a scientist/engineer is an important reflection of who I am.
- I believe I have the knowledge and skills to be a valuable part of the science/engineering community.
- Others whose opinions I value view me as a scientist/engineer.
- I am a scientist/engineer.
- I intend to work in a job related to science/engineering.
- I feel committed to my science/engineering field.
- I believe I can integrate 'who I am' as a person with 'what I do' in my science/engineering field.
- I expect a career in this field will be very satisfying.
- Others in my field view me as a competent member of our community.
-

*Open ended question:*

- What informed the career choice you indicated above? In other words, what led you to pursue this career?

Post-Semester Survey Questions

*Open ended questions:*

- Have your career plans changed this semester? Please explain.
- Have your interactions with/attitudes towards your advisor/mentor changed over the course of this semester? Please explain.
- Have your interactions with/attitudes towards your classmates/colleagues changed over the course of this semester? Please explain.
- In what ways, if any, has GIFT impacted your vision of who you will be as a STEM professional?
- How many hours TOTAL did you spend working on GIFT-related activities (including meetings in Dr. Wenner's class but excluding non-GIFT GCOLL 516 coursework).
- How much did you find GCOLL 516 impacting your instruction to and interactions with the teacher candidates in GIFT? (1=not at all; 2= eh, a little; 3= a lot!)
- Please explain your rating above regarding the GCOLL course.
- What did you most enjoy about working with the teacher candidates?
- In what ways has working with GIFT impacted your attitude towards teaching and/or (science) education?

- Would you recommend future STEM graduate students take part in GIFT?  
Why or why not?

*ALSO ON PRE-SURVEY: This section assesses your confidence in your abilities to function as a scientist or engineer. Indicate the extent to which you are confident you can successfully complete the following tasks. 1=not at all confident; 2=to a small extent; 3=to some extent; 4=to a large extent; 5=absolutely confident*

- Appropriately use tools and skills necessary in your field
- Understand and can explain big concepts in your field.
- Identify the 'giants' in your field and summarize their contributions.
- Identify unique and meaningful questions/problems to investigate in your field.
- Conduct research that meets the standards of credible work in your field.
- Conduct research that meets the standards of credible work in your field.
- Communicate big ideas in your field to those outside of your field.
- Identify ways in which your field can contribute to society.
- Articulate the accepted behaviors, attitudes, and norms in your field (in terms of philosophies, approaches, research, etc.)

*ALSO ON PRE-SURVEY: The following questions ask how you think about yourself and your personal identity. We want to understand how much you think that being a scientist/engineer is part of who you are. 1=strongly disagree; 2=somewhat disagree; 3=neutral; 4=somewhat agree; 5=strongly agree*

- In general, being a scientist/engineer is an important part of my self-image.



- I have a strong sense of belonging to the community of scientists/engineers.
- Being a scientist/engineer is an important reflection of who I am.
- I believe I have the knowledge and skills to be a valuable part of the science/engineering community.
- Others whose opinions I value view me as a scientist/engineer.
- I am a scientist/engineer.
- I intend to work in a job related to science/engineering.
- I feel committed to my science/engineering field.
- I believe I can integrate 'who I am' as a person with 'what I do' in my science/engineering field.
- I expect a career in this field will be very satisfying.
- Others in my field view me as a competent member of our community.

APPENDIX D

## Interview Questions

\*Note this was a *semi-structured* interview and therefore interviews varied.

1. Why did you choose to participate in GIFT?
2. What was it like to collaborate and communicate with the teacher candidates?
3. Did it feel like there was a communication gap?
4. Did you feel you could communicate across disciplines?
5. Did you get to use any of your research base in developing your lesson plan or was it more in line with using your basic scientific knowledge?
6. Which content standards were you teaching?
7. We refer to graduate students as disciplinary experts. How do you feel about that term?
8. Did GIFT at all impact your sense of community or belonging?
9. Did GIFT change the way you view your discipline?
10. Did you share the experiences you're having in GIFT with other colleagues in your department?
11. Do you see GIFT impacting your future career path?
12. Has GIFT impacted at all your identity as a scientist or engineer?
13. What do you believe your role is as a scientist or engineer?
14. How did COVID-19 restrictions impact your experience this semester?
15. Would you recommend GIFT to other graduate students?