

Advancing doctoral student professional development through a strengths-based cohort program

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Abstract

Purpose – Strengths-based professional development has been associated with positive outcomes in academia and in the organizational workplace. Students pursuing their doctoral degrees in the biomedical sciences in the US are often on graduate assistantships, where they experience an academic component to their training integrated with an employee-like existence. The individual who serves as their academic and research advisor is often their supervisor, who pays their stipend. The traditional training structure poses unique challenges and may be accompanied by stress, burnout and imposter phenomenon. The purpose of this study is to utilize a strengths-based approach to equip students with essential personal and professional skills that build self-awareness and self-confidence further preparing them for their future in the scientific workforce.

Design/methodology/approach – The authors developed and implemented a novel strengths-based professional development cohort program for doctoral students in the biomedical sciences at a research-intensive (R1) institution. The program was designed to create a supportive and inclusive space for participants ($n = 18$) to explore their identity as a student and scientists and to develop and leverage their talents for more effective and strategic use. Program outcomes were evaluated through a mixed methods case study design using a post-program Likert-based survey ($n = 10$ participants) and participant interviews ($n = 13$). Explanatory sequential design was used in the interpretation of the findings.

Findings – The results show that the program had a positive impact on students' perceptions of themselves as scientists, as well as on their self-efficacy, self-confidence and interpersonal interactions in the research setting.

Practical implications – This strengths-based professional development program demonstrates immense potential as a model to equip students with self-awareness and a new foundation of essential skills needed to supplement their technical and scientific training for their future careers in the team-based workplace.

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Originality/value – This study demonstrates how professional development programming can complement scientific training by equipping students with self-awareness and other lifelong skills to navigate feelings of imposter phenomenon and interpersonal relationships in the team-based workplace.

Keyword STEM

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Introduction

Scientists pursuing doctoral education are often at the forefront of cutting-edge research. Yet, the pressure of meeting the milestones within their academic program, the work and productivity expectations of their mentors and supervisors and achieving a healthy integration of their training with the rest of their lives can be daunting. In the area of biomedical sciences graduate education in the US, the student experience includes some aspects similar to their undergraduate (UG) experience, such as coursework, but a large amount of time is spent in a laboratory setting, where they have an employee-like existence as an individual and as part of a research team. Through this apprenticeship-type training model, graduate students often interface daily with a supervisor, their primary advisor/mentor, who may not have been trained in management and leadership. This primary advisor/mentor is also often called the Principal Investigator (PI) based on their role in leading the laboratory. Students face unique challenges and stressors during this time with new pressures and demands, the expectation of increased responsibility and accountability and navigating school, work and life. They can easily become overwhelmed, setting the stage for burnout, lower academic productivity and diminished well-being (Hyun *et al.*, 2006). Traditional aspects of STEM doctoral training, such as student-supervisor relationships, original scientific findings and a written dissertation, have remained steady over the last hundred years, yet the scientific landscape and the career goals and aspirations of graduates have evolved (Hancock and Walsh, 2016). Some have proposed that traditional graduate training environments themselves have inherent structures, processes or lack thereof, that can set the stage for stress, burnout and mental health problems. Some examples are long work hours (Ferreira, 2003), insufficient work-life balance (Fuhrmann *et al.*, 2011), strained relationships with advisors (Hyun *et al.*, 2006) and financial stress (Furr *et al.*, 2001). A study by the Council of Graduate Schools in the US and Canada reported that by year five of graduate school, 11.8%–33% of life sciences graduate students left their programs without completion (Nagy *et al.*, 2019).

Numerous studies have also shown that graduate students are experiencing higher levels of stress, burnout, substance use and mental health problems than the general population (Levecque *et al.*, 2017; Hish *et al.*, 2019). Graduate students were shown to be more than six times as likely to experience depression and anxiety compared to the general population (Evans *et al.*, 2018). A survey of 3,500 graduate students at 12 public institutions in 2020 reported that 67% of respondents scored low on well-being factors, 32% had symptoms of post-traumatic stress disorder, 35% had moderate or higher levels of depression and 33% had moderate or higher levels of anxiety (Ogilvie *et al.*, 2020). Additional stressors noted by students in the study were uncertainty about their future careers and economic and food insecurity. Reports have shown that when students struggle with personal challenges and mental health, this may impact productivity and research quality with financial implications and an adverse impact on the pipeline to the research workforce (Levecque *et al.*, 2017; Nagy *et al.*, 2019).

Experiencing imposter phenomenon (IP), common in graduate school, has also been shown to put one at risk for mental health issues (Sonnak and Towell, 2001; Henning *et al.*, 1998) and to negatively impact self-esteem (Sonnak and Towell, 2001) and one's overall sense of belonging (Ivie, 2009; Brian *et al.*, 2017). A study of STEM graduate students and postdoctoral trainees found that those with IP tended to overestimate others' abilities while underestimating their own

(Parkman, 2016). Research self-efficacy (Jööstl *et al.*, 2012) has a negative association with IP which may hinder scholarly productivity (Wester *et al.*, 2020). Self-efficacy is transformed over time through experiences and challenges. Positive student experiences that built both confidence and competence were shown to lead to the promotion of self-efficacy traits through a concept analysis of 23 articles focusing on self-efficacy development in graduate students (Muñoz, 2021). Interestingly, individuals with high research self-efficacy may, in some cases, benefit from a moderate level of IP, as it has also been shown to motivate individuals to work harder and produce more (Lane, 2015). Self-efficacy influences an individual's persistence to overcome challenges, and as we examine this from the perspective of graduate education this persistence extends to retention in the graduate program and the scientific workforce. Findings from an extensive qualitative study by Chakraverty led them to posit that early intervention, through conversations, support systems and professional development, may foster belonging among graduate students and help them understand and develop skills to overcome IP (Chakraverty, 2019). Graduate students have found strong social connections to faculty and peers to insulate them from commonly faced challenges (Schlemper, 2011). Mentoring can have a strong impact on one's sense of belonging and one's view of their potential to be successful as a researcher (Ivie, 2009) and participation in professional development and informal activities along with active engagement within programs can provide avenues for community building among peers (Rizzolo *et al.*, 2016; Golde, 2000). A study by Schreiner demonstrated that students who were connected to others and engaged in their academics, along with believing they were making a difference and had a positive outlook, were achieving better academic outcomes and, overall, more success compared with peers of similar backgrounds (demographics did not impact this) (Schreiner, 2010). Schreiner defined what it means to be a thriving student based on this and other studies. She notes that along with being academically successful, they "experience a sense of community and a level of psychological well-being that contributes to their persistence to graduation and allows them to gain maximum benefit from being in college." She identified thriving as a distinct construct made up of five distinct elements, all traits amenable to change over time, leaving opportunities for designing interventions to promote thriving and student success.

Strengths-based approaches to professional development

Scholars have investigated thriving together with strengths-based approaches in higher education to identify a robust, holistic model of student success (Kinzie, 2012). The strengths-based philosophy of developing "confident, efficacious, lifelong learners whose work is infused with a sense of purpose" (Lopez and Louis, 2009) complements the existing technical and developmental training that graduate students receive. Both the concepts of thriving and strengths-based approaches are rooted in positive psychology, where an individual's natural talents are identified, cultivated and leveraged to promote robust performance and meaningful lives (Seligman, 2002). They are also related to the concept of flourishing (Keyes, 2002), which refers to emotional well-being, resiliency to meet challenges and active and productive engagement with others and the social world. As part of the Recommendations section of the ASHE Higher Education Report, Kuh *et al.* (2007) note that "Institutions that focus on student success, subscribe to a talent development philosophy and create a student-centered culture are better positioned to help their students attain their educational objectives." They go on to recommend an asset-based talent development philosophy as it relates to teaching and learning (Kuh *et al.*, 2007).

Strengths-based programming in higher education has proven to influence self-awareness, academic self-efficacy, confidence and engagement (Soria and Stubblefield, 2014) and to increase the ability to develop leadership skills and to work more effectively in teams and groups (Soria *et al.*, 2015). The latter is associated with an increased appreciation for the strengths of others (Soria and Stubblefield, 2015b). Additional studies have shown that students

who use their strengths regularly report greater optimism (Soria and Stubblefield, 2015a) and greater subjective mental and physical well-being (Proctor *et al.*, 2011). Studies of strengths-based programming and application have demonstrated important outcomes in adult employees in the professional setting which parallel reported student outcomes. Examples include higher productivity, employee retention and performance (Clifton and Harter, 2003; Connelly, 2002; Harter *et al.*, 2002), increases in psychological measures of hope, subjective well-being and confidence (Clifton and Harter, 2003; Park *et al.*, 2004) and higher levels of self-efficacy and workplace performance (Govindji and Linley, 2007; Linley *et al.*, 2009). Moreover, inviting people to use their strengths regularly in new and different ways has been shown to increase happiness with decreases in depression, sustained over a six-month period (Hannush, 2005). A study of strengths-based interactions of students who participated in strengths-based development in curricular and co-curricular leadership demonstrated more impact in the social and psychological thriving (social connectedness, diverse citizenship, positive perspective) domains as compared to academic (engaged learning and academic determination) thriving domains (Soria *et al.*, 2019).

Assessing strengths

Multiple avenues exist to determine one's talents or strengths. Clifton and Nelson (1992) posited that people naturally gravitate toward activities that enable the use of their talents and that they will be satisfied and energized while engaging in those activities that come most naturally to them. They go on to note that one can determine when they are using their most natural talents (strengths) because these activities are ones they rapidly learn, perform at their best and effectively achieve and accomplish tasks. Linley (2008) defines a psychological strength as "a pre-existing capacity for a particular way of behaving, thinking, or feeling that is authentic and energizing to the user, and enables optimal functioning, development and performance" (Linley, 2008).

Beyond observation, there are multiple standardized and validated inventories to assess one's talents and strengths, such as the Values in Action (VIA) Survey of Character Strengths (Christopher and Martin, 2004) and the CliftonStrengths (CS) assessment (Clifton and Anderson, 2001; Clifton and Nelson, 1992). In this study, we use CS for its extensive use within academic and organizational workplace settings (Clifton and Harter, 2003) worldwide.

The CS assessment is based on five decades of research involving interviews with successful individuals considered top performers in their fields worldwide. The thirty-four most prevalent talent themes that emerged (Buckingham, 2001) serve as the foundation for the development of the assessment, which has been subjected to psychometric examination for reliability and validity (Asplund *et al.*, 2014; Harter *et al.*, 2002). It consists of 177 different self-assessment items where participants are presented with sets of self-descriptor statements and must select the one that most aligns with how they think, feel or behave. Assessment output includes a sequenced list of 34 talent themes in an order unique to each person. When participants review their assessment results, the top five talent themes represent the areas of most significant potential, known as signature themes or dominant themes. The approach to professional development within this model is based upon the concept that with knowledge, skill and practice, one can transform natural talents (ways in which you most naturally think, feel and behave) into strengths (consistent, near-perfect performance). A common misconception about strengths-based approaches is that the idea of weaknesses is ignored (Dugan, 2017). With the full report (34 talent themes), participants learn about their supporting (middle) and lesser themes (lower ranking) which ensures that a comprehensive picture is available, and they can learn to understand how they can also manage or develop those areas that do not come as natural to them.

Much of the research using CS has been conducted and released by Gallup as proprietary reports that do not go through the typical external peer-review process, leaving scholars apprehensive of the numerous beneficial outcomes reported (Dugan, 2017). Thus, there is a need for more independent researchers to conduct studies in this area and publish their outcomes.

Strengths-based cohort program

There is a significant gap within the strengths-focused literature on outcomes of strength-based approaches within STEM graduate student (PhD) populations. Given the multitude of challenges that graduate students face and the prevalence of mental health and wellness concerns, we believe that an expanded model of student success, one that considers aspects beyond academic performance, such as engagement, purpose and persistence (Kuh *et al.*, 2007; Schreiner, 2010) must also be considered in the context of STEM doctoral education.

A pilot study with biomedical sciences doctoral students who participated in a two-part strengths-based professional development experience found a positive influence on student self-awareness, self-confidence and science identity (Ferguson and Lockman, 2024). We implemented a similar yet expanded program providing multiple touchpoints so that students can revisit the conversation around their natural talents and strengths within the context of their doctoral training on a regular basis. The overarching goal of this expanded program was to promote the incorporation and integration of strengths-based approaches in support of the development of lifelong skills that will be an asset to doctoral students during their training and into their careers in the scientific workforce. The UK “Concordat to Support the Career Development of Researchers” (2019) designated professional and career development as critical and necessary to enable researchers to achieve their potential and to achieve success in a variety of careers (academic and non-academic) (Concordant Strategy Group, 2019). With more doctoral students choosing non-academic career paths, it has become essential for students to enhance their personal effectiveness skills while in graduate school (Vitae, 2015).

The semester-long strengths-based cohort program presented here aims to provide tools for building personal effectiveness (self-management, personal qualities, professional and career development) (Vitae, 2011), reducing social isolation and promoting healthy self-awareness in doctoral health and biomedical sciences students.

The program design was based on a similar cohort model successfully implemented with women leaders across campus (Lockman *et al.*, 2023; Swan Dagen *et al.*, 2022). Reflective work prior to each session and post-session engagement and reinforcement are cornerstones of the model. Individual session objectives for this program focus on coaching students to take advantage of (capitalize on) their talents to enhance their academic and research performance, navigate individual and group dynamics in research teams and develop self-awareness, confidence and scientific identity. Through this study, we sought to understand how this strengths-based cohort program impacted students’ identity and self-efficacy as individuals and scientists.

Research Questions:

- RQ1. *How did participants perceive their confidence in their abilities as scientists after program completion?*
- RQ2. *How did participants perceive their confidence in their abilities to accomplish the tasks and goals required to successfully complete their doctoral studies after program completion?*

RQ3. *How have participants incorporated the knowledge gained from the program into interactions with others and in their daily lives?*

Methods

Intervention

Health and biomedical sciences PhD students in Year 3 or above who had previously participated in introductory strengths-based sessions ($n = 63$) were eligible and invited to participate in the strengths-based cohort program. All were full-time students who had taken the CS assessment within the last year and participated in workshops offered by the same facilitator. All had access to the report, including their Top 5 dominant talent themes. Those who enrolled in the cohort program ($n = 18$) received their fully sequenced report of 34 talent themes (CS 34) before the program began. An initial 90 min virtual workshop assisted participants in analyzing their reports and gaining a better understanding of their dominant talent themes beyond the top five.

The workshop consisted of the following topics:

- (1) Interpret and analyze your CS 34 report.
- (2) Share and evaluate the theme frequencies of the cohort.
- (3) Review and revise the brand statement from the prior session (prerequisite).
- (4) Strategies to develop your talents into strengths.
- (5) Applying your talents to immediate tasks and goals.

After the workshop, participants were divided into two groups of nine students who met virtually (zoom) monthly for four months with the same facilitator. Each monthly session focused on the application of strengths knowledge in different contexts. Participants completed preparatory work prior to and reflective work after each session so that the sessions were interactive with rich discussion. The curriculum for the monthly sessions is shown in Figure 1. Topics were selected to ensure a solid foundation in understanding a strengths-based approach, and application sessions targeted skills and activities aligned with the needs of students in the latter years of their doctoral studies. A research team member observed the sessions, collecting observational data through field notes. The other member of the research team designed and facilitated the sessions.

Study design

To assess the program's impact, a mixed-methods case study approach was used, using in-depth data collection from multiple sources of information (Creswell and Poth, 2018). An explanatory sequential design was used in that the qualitative methods were used to explain



Source: Created by author

Figure 1. Curriculum of the strengths-based cohort program

the quantitative results (Creswell, 2015). We first conducted and analyzed survey data and followed with participant interviews to further understand and expand upon the participant perspective found in the survey data. All aspects of this study (ethics and regulatory) were reviewed and approved by the WVU Office of Human Research Protections and the Institutional Review Board (2203535116).

Participant survey

An anonymous Likert-based (1 – strongly disagree; 5 – strongly agree) survey (*Supplemental Figure*) housed and managed within the web-based Research Electronic Data Capture (REDCap) system was distributed to program participants ($n = 18$) within one month of the completion of the program. Gender or race/ethnicity were not asked due to the limited diversity in the participant pool to maintain anonymity. The quantitative portions of the survey contained 12 items focused on the research questions and seven items focused on program design and delivery. The survey also included four free response questions for program evaluation and sharing general insights about their development over the four months. Questions focusing on strengths knowledge and application were adopted from Stebleton *et al.* (2012). Questions related to STEM identity (Robinson *et al.*, 2019a; McDonald *et al.*, 2019), belonging (Sandrone, 2022; Johnson, 2012) and self-efficacy (Bandura, 1977; Syed *et al.*, 2019) were adopted from validated tools or conceived through close review of the literature. The survey items were analyzed using IBM SPSS Statistics (Version 28) and presented as descriptive statistics. The free-response survey items were analyzed using NVivo 12 and coded along the same methodology outlined further in the participant interview section.

Participant interviews

Interviews with participants were conducted to capture more detail about the student experience and their perceptions of the program. We used a constructivist approach, as the nature of this research assumes that the reality being observed is socially constructed and that we, as researchers, are interpreting the phenomenon with that awareness (Merriam and Tisdell, 2015). All students who completed the strengths-based cohort program were invited to participate. Interview questions were developed to explore student understanding of their strengths and application of the strengths-based approach in their graduate student experience. Prior research on strengths-based programs and self-awareness, survey results and field notes collected during program sessions were used to inform the interview questions and process. The qualitative results from the survey were used to guide probing questions that emerged in the semi-structured design of the interviews. The collected field notes were used to orient the interviewer to the common discussions, topic areas and themes during program sessions. Interview questions were pilot tested for clarity. Twelve interviews were conducted in person, and one was conducted virtually at the participant's request. The minimum interview length was 9 min, and the maximum was 19 min, with an average length of 14 min. Interviews were recorded using a secure device, anonymized and transcribed. Interview participants were randomly assigned pseudonyms upon initiating transcript and data analysis, and all read a consent form and provided informed consent prior to the interview process.

Qualitative analysis was conducted by applying First Cycle codes through In Vivo coding (Saldaña, 2016) grounded in the literature on self-awareness, identity development, self-efficacy and a sense of community. Following the completion of this initial coding stage, the Second Cycle method was used to demonstrate patterns and categorize the codes into themes (Saldaña, 2016). The two researchers discussed the thematic analysis to reach a consensus on

categorizing codes. Additionally, the triangulation of the data collected through field notes, survey data and interviews was reviewed to ensure the accurate formation of identified themes. NVivo 12 was used to manage the data analysis.

Reflexivity

The researchers considered their positionality and relationship with the data throughout the process. One research team member is a trained strengths coach who designed and facilitated the strengths-based cohort program. This individual is a faculty member and administrator who oversees graduate programs at our institution, and most students knew this person before the program. None of the students were currently enrolled in courses taught by the instructor at the time, and the invitation to participate in the program was sent by e-mail with no additional incentives or disincentives. We are uncertain whether the position of this research team member would positively or negatively impact participation. The other research team member participated in strengths training and conducted all data collection and analysis. This individual works closely with student organizations and graduate students, especially in the early years of their doctoral program. We considered our different educational and experiential backgrounds throughout the research process with a critical approach to prevent any expectations or biases from guiding the analysis. Students in their third year and beyond were invited to participate to ensure participants had completed their coursework and several programmatic milestones. The curriculum was meant to aid students in developing their talents and to leverage this newfound information as they embark on their career searches, therefore, being more stage-appropriate for third year and beyond. This also allowed some distance between the researchers and the participating students since their involvement is more frequent in the student's earlier years.

Results

There were 63 students who were initially invited to participate in the strengths-based cohort program with a target enrollment number of 15–20, which was achieved ($n = 18$). All participants joined together for the workshop, and then for all following sessions, they met with their small group of nine students monthly. The post-program survey was administered within one month of program completion and had a total of ten respondents, providing a 56% response rate. Four months after program completion, participants were invited to participate in post-program interviews. Thirteen students engaged in interviews, providing a 76% participation rate. The overall PhD enrollment at the health sciences center at which this program took place is distributed across thirteen PhD programs with a total enrollment of 215. The average time-to-degree is 5.4 years. The total population consists of 144 (67%) female students and 71 (33%) male students. Of the 18 enrolled program participants, 11% ($n = 2$) identified as men and 89% ($n = 16$) identified as women. A demographic overview of the interview participants alongside the overall cohort participants can be found in [Table 1](#). Gender/sex was not asked on the post-program survey, thus the data is not provided.

Results from the analysis of both methods of inquiry are organized thematically based on the three prominent themes that emerged in the analysis:

- (1) Identity;
- (2) Interpersonal interactions; and
- (3) Capitalizing on strengths.

Table 1. Demographic overview of cohort and interview participants

Demographic characteristic	Cohort (<i>n</i> = 18)	Interviews (<i>n</i> = 13)
<i>Year in program</i>		
3	7	5
4	4	4
5	5	3
6	2	1
<i>Race</i>		
Asian	4	4
Black or African American	1	1
White	13	8
<i>Gender identity</i>		
Woman	16	12
Man	2	1
<i>Citizenship status</i>		
US citizen	12	7
Non-Immigrant	5	5
Permanent resident	1	1

Source: Created by author

All interview responses are reported under pseudonyms randomly assigned to each participant. An overview of all survey responses is included in [Table 2](#). Responses are shown as frequency, not percentages.

Theme 1: identity

Through interviews and survey responses, all participants noted how the program impacted their development of or understanding of their identity. The sub-themes that emerged in this area included self-awareness, science/student identity and self-confidence.

When considering their professional identity, 90% (*n* = 9) of survey participants agreed or strongly agreed that they believed they have natural talents and skills that make them strong research team members after completing the program. One survey participant neither disagreed nor agreed with this (neutral). Additionally, 70% (*n* = 7) of survey participants agreed or strongly agreed that they believe they have natural talents and skills that make them good scientists after completing the program. Three survey participants neither disagreed nor agreed with this (neutral).

All interview participants shared reflections on how the programming influenced their understanding of their identity as scientists. Participants discussed their individual strengths and how they use them to accomplish tasks in their laboratory environment or professional activities. One survey respondent shared:

Graduate students are trained to be independent and often receive less guidance and feedback on their work. Knowing your strengths can increase self-awareness and confidence by helping you to be aware of what you bring to the table.

Olivia's awareness of her talents and how they intersect with her preferences in a working environment guided her understanding of how to optimize her efforts. She shared:

My top strength is deliberative. I spend a lot of time planning out experiments and need a lot of time to think and process things, which is very different from everyone else in my lab.

Table 2. Survey responses (data presented as frequency of responses)

Survey question	Strongly disagree	Disagree	Neither disagree nor agree	Agree	Strongly agree
There was a sense of community among the program participants	0	1	1	6	2
I felt a sense of belonging within the program	0	0	2	3	5
I believe that a strengths-based approach can be used to help me navigate interpersonal conflicts or challenges	0	0	1	4	5
I can accurately assess my abilities	0	0	0	6	4
I can use my strengths in the laboratory or research setting	0	0	1	3	6
I can use my strengths in the classroom setting	0	0	0	5	5
I believe that a strengths-based approach can be used to help me achieve the goals I set for myself	0	0	0	5	5
I am confident in my ability to develop a plan to target my strengths at specific tasks and goals	0	0	0	5	5
I have natural talents and skills that make me a good scientist	0	0	3	1	6
I have natural talents and skills that make me a strong member of my research team	0	0	1	2	7
I am confident that applying my strengths will help me learn more effectively in the laboratory	0	0	2	4	4
Having an understanding of my strengths has helped me to manage my responses to challenges and setbacks in my professional life	0	0	0	7	3

Source: Created by author

During the interviews, five participants shared their perspectives on the role of scientists and how they perceive themselves as scientists. Amelia shared:

I think the common thought in the field is you have to be very competitive, *and strategic thinking should be high. But what I saw in mine (strengths) was more relationship building and some execution. There is not one box that scientists should fit in.*

When asked how her strengths knowledge impacted the way she saw herself as a scientist, Riley shared that her communication talents along with several interpersonal talents have led her to explore how these interact with her identity and role as a scientist:

It validated some of my feelings in the sense that I don't think a traditional 'in the lab by myself' type of job would make me happy [...] I feel more confident to look for something that I enjoy doing more because I also have the skills to back it up, she shared.

For Amelia and Riley, this demonstrated their perception of deviating from the perceived norm and confidence in their abilities:

The interactive model of the program provides the opportunity for students to learn about the strengths of others in the cohort. Savannah expressed this as she reflected:

There's such a broad spectrum of how many people are scientists, but we're all very different and unique. We're all still doing this and [...] I guess seeing all the interpersonal stuff I have on mine (report), I thought maybe being in science was the wrong choice. But everybody is so unique that it actually – it made me feel better with where I'm at.

Through recognition of peers' unique and diverse abilities, Savannah observed confidence in her abilities.

After completing the cohort program, 100% ($n = 10$) of survey participants agreed or strongly agreed that they believe they can accurately assess their abilities. One survey respondent noted that awareness of their abilities influenced their confidence development by saying, “The program helped me to feel more confidence in myself and to embrace my own strengths, my presence, and the impact I have on others.”

During the interviews, eight participants expressed how the program positively impacted their confidence. These discussions highlighted themes of increased self-confidence and self-efficacy as the participants described their perceived ability to accomplish their tasks or goals.

When asked to explain how understanding her strengths influenced the way she perceived herself, Lindsey shared, “It's given me more confidence in my leadership abilities [...] and allowed me to embrace how I interact with others that can benefit both the work environment and the individuals.” When expressing how her knowledge of strengths influenced her as a graduate student, Megan shared:

It really has given me a lot more self-confidence in my abilities. I think that translates to a lot of things like graduate student life in general and my life in the lab. It makes me a lot more confident in my presenting skills since a lot of my strengths were communication and leadership-based.

Similarly, Dylan summarized her takeaway from the program as “Sometimes in grad school your self-esteem goes down, but then just knowing your strength and what you're bringing to the table helps a lot.” Lindsey, Megan and Dylan shared unique perspectives of how knowledge of their strengths shaped their understanding of their identity and abilities. This awareness was noted alongside comments of confidence.

Emma and Theresa shared stories of encountering challenges in their lab environment that impacted their confidence and motivation. Emma used her strengths knowledge to navigate the challenge by using her learning talents as motivators. Theresa explained the intentional use of her competitive and adaptable talents to maintain motivation and propel her toward resiliency.

When reflecting on their development of self-confidence, two interview participants specifically noted their experiences with IP. Kayla explained that some of the feelings she experiences are based on her perception of struggling with data analysis. She noted that she now navigates these feelings by identifying how she can better collaborate with the members of her lab, leveraging the concept of complementary partnerships from the program. Charles noted, “It was definitely a confidence booster to say you're good at these things, you do have strengths, and it gets rid of, I think, some of the imposter syndrome.” While Kayla navigated these feelings of IP with a strategic approach, Charles combats those feelings through recognition of his own abilities.

Theme 2: interpersonal interactions

Participants found the program useful in providing them with tools to navigate interpersonal relationships and interactions. Several noted this was a motivator for their participation in the

program. Lindsey chose to learn about her talents, explaining that the programming was “a good opportunity for self-reflection that could benefit how I interact with my colleagues, my PI, my lab mates, and in my personal life as well.”

After completing the cohort program, 90% ($n = 9$) of survey participants agreed or strongly agreed that they believed a strengths-based approach could help them navigate interpersonal conflicts or challenges. One survey participant neither disagreed nor agreed (neutral). All interview participants described how the program influenced their interpersonal skills or their understanding of interactions with others. These influences were demonstrated through discussions of teamwork, collaborations and personal interactions.

During the interviews, 11 participants referenced teamwork or working with others – describing how awareness of others’ talents, skills or needs can help them navigate conflicts or strategize to be a more productive team. Amelia shared her perspective on how understanding and respecting the differences of others positively impacts how she interacts, explaining:

Sometimes it’s difficult to comprehend that the other person might think differently than you do [...] So understanding the differences in how everybody acts, reacts, comprehends, and what their strengths are helps you better understand where they’re coming from.

Similarly, Lindsey expressed how understanding strengths can help navigate conflicts with lab group members. She explained:

We all have a unique set of strengths and being able to, if you’re having difficulties with a co-worker or colleague, reflect and think about what strengths they have versus what strengths you have and how you can use them together to form a collaborative unit.

During the interview, Kayla shared that her strengths contrasted with those of her lab colleagues, explaining that her strengths trend toward interpersonal skills while her colleagues are more analytical. Kayla explained, “At first, I was like, ‘I don’t work like them,’ but now I can see how we work differently and how we can come together to collaborate on things.” This demonstrates an intersection of Kayla’s recognition of her ability, confidence in her skills and a strategic approach to teamwork. Lindsey shared similar experiences of reflecting upon the differences between herself and her colleagues. She shared:

I am harmonious in how I work with other people in that I tend to avoid conflict. And rather than seeing that as a problem, because of the strengths workshop I think I have really focused on the positives of that strength which are – I’m trying to find common ground. I’m trying to keep the peace and keep those around me feeling confident in what they’re doing.

Recognition of their unique strengths supported Kayla and Lindsey in resolving conflicts and encouraging effective collaboration with teammates.

In his reflections on his experiences with members of his lab, Charles shared a perspective of the challenges that can occur when the members do not know each other well. He explained:

I feel like we did not ever break the ice, really get to know each other in terms of what makes us thrive and what doesn’t make us thrive. And that can really impact the lab environment if you don’t really understand people that are around you.

This suggests that for some students, a lack of awareness of each other’s interests and abilities can have a negative impact on their experience in that environment. Demonstrating a different perspective, Amelia shared that her lab group members had previously participated in strengths-based programming. Reflecting on how this shared language impacted their lab group, she said:

It was nice to know what each of our strengths is and why we react the way we do as a group [...] I think that kind of solidified what we already knew and also how to approach each other and how to get the best of each other.

These findings indicate that team-building activities, including but not limited to strengths-based programming, can influence the group's environment and nature of camaraderie. Riley described how an understanding of each member of the team influences the workplace environment by sharing:

It's just good to be aware of what makes you tick and how you best operate and communicate with other people that you work with. Then they know how to work with you best and how to be successful all around.

During the interviews, seven participants described how their interactions with their dissertation mentor were influenced by their awareness of strengths. Kayla explained that her mentor had participated in strengths-based programming and was familiar with the concept, so their one-on-one meetings sometimes had conversations about strengths. She provided an example describing how she and her mentor would review her strengths, breaking down, "These are things that motivate me [...] and these are things I work well with, and these are things I don't." The cohort program helped Kayla cultivate and use a common language to communicate her needs to her mentor.

Developing a knowledge of her strengths helped Olivia navigate challenges with her mentor. She explained:

I think it's helped a lot with my PI, getting him to understand where I'm coming from because, there's always the pressure of 'I need more data'." And, for me, expressing to him that the way I work is that I need time to plan [...] I think it's helped to get that understanding with my PI.

Charles expressed that he wished the strengths programming had occurred earlier in his graduate studies, including having his mentor be aware of the language of talent. He said, "I feel like if she [mentor] would have known that earlier it may have saved us some learning curves with each other [...]" Both Olivia and Charles highlight the importance of understanding their needs and being able to communicate those needs with their mentor, allowing the possibility of alignment of expectations between the pair.

Similarly, Riley also shared how strengths knowledge could have helped her navigate a challenge earlier in graduate school. She experienced an issue in receiving the type of feedback she needed from her mentor, but at the time did not know the type of feedback she needed or how to express that. Riley said, "Had I known that about myself back then and discussed that with my mentor [...] it might have kind of given them that little push to be cognizant of that." Riley further shared, "Having that little bit of awareness of what I need as a student has helped my mentor and my relationship because we can give that back and forth." Riley further demonstrates the need to align expectations between the mentor and the mentee and how this alignment can influence the mentoring relationship.

Theme 3: capitalizing on strengths

Program participants conveyed positive perceptions of their ability to achieve their goals and apply their skills through a strengths-based approach. After completing the cohort program, 90% ($n = 9$) of survey participants agreed or strongly agreed that they could use their strengths in the laboratory or research setting. One survey participant neither disagreed nor agreed (neutral) with this. Additionally, 80% ($n = 8$) of survey participants were confident (agreed or strongly agreed) that applying their strengths would help them learn more effectively in the laboratory. Two survey participants neither disagreed nor agreed (neutral)

with this. A survey participant provided an example: “I understand more about what I need to be successful and even ways to use my weaknesses as a strength or leverage other strengths to navigate weak areas.”

The results highlighted how a strengths-based approach can influence a student’s perception of their ability to accomplish goals. After completing the cohort program, 100% ($n = 10$) of survey participants agreed or strongly agreed that they believe a strengths-based approach can help them achieve the goals they set for themselves, and 100% ($n = 10$) of survey participants were confident (agreed or strongly agreed) that they can target their strengths at specific tasks or goals.

During the interviews, nine participants described strategies for using their strengths. Strategies included a focus on career preparation and communicating their strengths or needs. Six of these nine interview participants emphasized that the strengths-based programming provided them with tools to support their career preparation. For students at the earlier stages of graduate training, there was a focus on how reflecting on one’s strengths can help them explore potential pathways for future careers. Olivia stated:

It’s helpful to know about your strengths because those are things that can help you decide what to do with future careers [...] how you could possibly apply this to a future career.

Dylan noted that after exploring job postings and opportunities, one can identify some strengths they feel they need to develop to become a desirable job candidate.

A few interview participants also reflected on the programming benefitting their interview skill development, which was of particular interest to them as they were approaching the end of their program. When reflecting on these activities, Megan shared, “I’ve got really good information on how to frame my strengths in an interview.” Similarly, Theresa explained that her strengths knowledge provided her with language to communicate her skills in an interview. She said, “I got words for things I’ve always been doing.” Theresa noted that this helped her in a job interview when she was asked to share a time in which she encountered a difficult situation. She was able to answer the question and share how she navigated that situation by leveraging her strengths. Riley specified that she used the interview skills developed in the sessions during an interview with her future (now current) employer.

Charles shared how learning about his Strengths helped him discover more about himself to enhance his career preparation. He reflected, “In terms of a career that I am going to be good at in the future. I might not be the [...] most strategic thinker but I am a better leader. So maybe it’s more of a leadership role.” Charles shared how an earlier introduction to the strengths language could have benefited him. Charles explained:

I actually wish I had done this earlier because I think it would be important information to try to home in on to develop your scientific career, because if you know that your strengths are in certain categories you can capitalize on them progressively throughout.

This further demonstrates the interview participant’s perspective of the programming on their professional development, specifically in the identification of career pathways.

Discussion

This study evaluated the impact of a strengths-based professional development program on graduate students’ science identity, self-efficacy and ability to leverage their strengths strategically. The data suggest that this program positively impacted student science identity, self-efficacy, self-confidence and interpersonal interactions in the research setting. Study participants successfully translated knowledge from the program into action, positively influencing career preparation and interpersonal interactions, among other areas. The three

factors shown to be important in converting recognition of one's strengths into capitalizing on strengths are social support, experiencing success and reinforcing strengths (Bowers and Lopez, 2010). This program was designed to take place over four months and in small groups to enable these factors. Additionally, numerous students shared how reinforcement occurred from lab mates, mentors and colleagues who had previously participated in a strengths-based program.

Judge and Hurst (2008) demonstrated that one's self-confidence impacts academic and professional success and can even extend to overall well-being, a critical element of concern for graduate students in training (Judge and Hurst, 2008). Studies have shown that experiencing failures, obstacles or setbacks in research, such as failed experiments or rejected manuscripts, are some of the most reported aspects of research that worsen graduate student's depression (Gin *et al.*, 2021). Hutchinson and colleagues report that teaching strategies to young people that develop and enhance character strengths and resilience may be a valuable tool for improving psychological well-being (Hutchinson *et al.*, 2010).

A psychologically safe environment to promote community and a sense of camaraderie were intentional elements within our program design. Topics known to nurture the development of resilience skills and known factors to protect against worsening depression (Gin *et al.*, 2021) in graduate students were intentionally built into the curriculum. Students gained an understanding of how different strategies are effective for various individuals based on their unique motivators, demotivators and talents in general. For instance, helping students understand how to break larger goals and tasks into smaller ones to provide "small wins and a sense of accomplishment was emphasized for individuals with certain talents. Other strategies involved understanding the need for more or less structure based on the individual's talent themes. Students also gained an understanding of how they can use strengths-based approaches to build more positive and effective relationships with their mentors and peers based on the characteristics of each party involved, an important outcome considering the amount of time scientists in training spend with their mentors and peers over multiple years.

Science identity

Professional development has been shown to have an important influence on the formation of professional identity in scientific fields, especially in minoritized students (Garcia, 2022). Based upon the expectancy-value theory (Eccles, 1983), students who highly value science as a part of their identity are more likely to persist in challenging science tasks and continue to choose science as a field of study. Noticing decreases in a student's science identity over time may indicate or coincide with lessened engagement in the training process and potentially less motivation to continue in the pursuit of science (Robinson *et al.*, 2019b). Facilitating the development of a robust professional identity for PhD scientists should be considered in a more flexible way compared with the traditional (discipline-focused) model to prepare future scientists to have the capacity to manage the demands of today's contemporary researchers in the workforce (Hancock and Walsh, 2016).

While we did not directly measure science identity upon students entering their graduate program, we used this intervention to highlight the diversity of talents among successful scientists and the importance of traits not typically associated with successful scientists when we consider the traditional stereotypes. The program helped participants understand that they might not all lead with strong strategic thinking themes, like being naturally analytical. Still, the presence of other talents can be critical to conducting the work necessary to succeed in science and to move the field forward. The outcomes of this program demonstrate a positive impact on the way participants see themselves as scientists, the way they view the role of a scientist and in helping them overcome feelings of IP. Prior studies with a similar student

population showed that students participating in a two-part strengths-based professional development program significantly increased their belief that they have natural talents and skills that make them a good scientist and a strong member of their research team (Ferguson and Lockman, 2024). While this current study's survey data is not pre-post program data, and the number of participants is much less in this study, we explored the same two questions. The results concur that over 90% of participants in both studies believed they have natural talents and skills that make them strong members of their research team after participating in a strengths-based program. Interestingly, only 70% of participants in this study (compared to 96% in the previous study) noted that they believe they have the natural talents and skills to be good scientists after completing the respective strengths-based programs. This differential in response to these two questions in this study reinforces the student's understanding of the value of teams in science. While they may not perceive that they have all the skills they need to be an independent scientist implementing all aspects of research alone, they understand that they bring great value to the scientific process and when partnering with individuals of complementary skills, they can be successful. This concept was conveyed by students in interviews. Students gained a greater appreciation for the diversity of talents needed in scientific research. When comparing themselves to their colleagues and mentors, they noted increased self-acceptance and appreciation for themselves as they are. We believe this mindset shift will be important as they transition into the career search and job interview process, as career uncertainty has been shown to be a major source of stress impacting students' well-being (Walsh and Juniper, 2009).

Strengths and students' future careers

Research by Vitae (2011) found that almost half of doctoral graduates left academic research within three years of attaining their PhD, and three-quarters of this group left academia to participate in scientific research through other avenues or professional roles (Vitae, 2011). The current job market requires doctoral scientists to be prepared for multiple career avenues in different research sectors. While in doctoral training, the current focus on disciplinary research with a minor allocation of time for transferable skills training (Hancock and Walsh, 2016) is unlikely to provide the best career preparation for students in this professional climate.

Strengths-based professional development has translated to improved workplace performance in a variety of settings. Our results show that this program's participants successfully used a strengths-based approach to navigate group dynamics within their research teams and through interpersonal interactions. Some examples include but are not limited to, enhanced communication with mentors and colleagues and the ability to set and align expectations more clearly. Participant interviews also provided insight into the increased confidence students gained as they embarked on their career search by having a language they did not have previously to speak about themselves in a positive way. Some also mentioned the usefulness of the strengths framework in analyzing job descriptions and identifying good fits for them. The multiple skills gained will prepare participants for professional interviews during the job search and will carry into their future careers and relationships as lifelong abilities whether they choose a path within the academy, industry or other sectors.

Challenges in using strengths

Students conveyed in interviews that the act of implementing strengths-based approaches also presented challenges, such as an overall lack of awareness by others and the unwillingness of other individuals to learn or support them using this strategy. In terms of lack of awareness, participants were referring to the strengths-based language and specifically what each of the 34 strengths meant apart from how an individual might interpret

it. For instance, certain CS talent themes do not easily define themselves to someone unfamiliar with the CS language and, in fact, may be misinterpreted, which can be a barrier to strengths use.

Communicating needs related to strengths can be challenging when the other party does not have experience in understanding this framework. One of the core principles of CS is that “themes are not labels,” and sometimes, when one takes the language at face value, a negative connotation can be associated, which can cause harm. We work to counteract this by equipping the student with everyday language to describe their talents so that they can converse with anyone about these concepts, not just those familiar with this language and framework. Additionally, mentors or colleagues, especially those in highly technical and quantitative scientific fields, may not be receptive to the tool or take it seriously if the student is not equipped to share the research that has contributed to the development of the framework.

Finally, from an educator and researcher perspective, the use of the CS assessment to measure talent is associated with a cost per participant. Many institutions and programs choose to work with the signature themes Top 5 report for cost purposes. The use of the CS 34 report, as in this study, is associated with an increased expense. There are other ways that educators can approach talent measurement to meet the same goals described in this study. The work of Linley describes how strengths spotting can be used to identify one’s strengths through observation of multiple factors (Linley, 2008; Linley, 2012). The introduction of this paper includes additional information about talent identification without an assessment tool. These techniques can easily be applied to assist students in developing the skills targeted within this study.

Critiques of positive psychology and strengths-based approaches

Positive psychology has its roots in Western ideals and beliefs and, if not considered carefully and within an appropriate context, can imply that there are certain personality characteristics associated with being a mentally healthy individual (Miller, 2008). In the context of CS, the diversity of individuals’ behaviors and characteristics is highlighted to emphasize that there is no perfect combination of talent themes; rather, the key concept is understanding one’s dominant talents and learning to use them most effectively. This approach tends to be identity-neutral and may not consider how certain talent themes may be received or understood by others based on an individual’s identity (Dugan, 2017). Tapia-Fuselier and Irwin posit that having a universal or identity-neutral approach may promote ignoring the role of race and how it can shape reality for an individual (Tapia-Fuselier, 2019). Additionally, understanding the role of privilege and social status in achieving goals and opportunities is critical, and this may be understated in a strengths-based approach that emphasizes the effective utilization of certain attributes as a key factor (Miller, 2008). Some argue that the field privileges and classifies “particular ways of being and functioning as strengths,” upholding neoliberal discourse (McDonald and O’Callaghan, 2008).

Critics reference the lack of independent, empirical studies from independent researchers and scholars are apprehensive about the numerous beneficial outcomes that Gallup researchers have attributed to strengths-based approaches. They raise the question of the unique influence of strengths, considering the multitude of other factors at play and the importance of the context, which is often not addressed or reported (Dugan, 2017). The external body of research continues to grow, yet Gallup continues to be a dominant force in publishing reports and outcomes in this field. We note that care must be taken to consider these concerns when developing and designing strengths-based professional development programs. The training approach of instructors and the curriculum used is critical. Facilitators and educators must examine their own identities and privilege, or lack thereof and consider their own journeys and biases. Curricula must

be designed and delivered with identity and inclusion in mind and in a way that promotes critical thinking to avoid centering whiteness and marginalizing other groups. These issues are fully reviewed with accompanying recommendations and examples by Tapia–Fuselier and Irwin. While our own study was extremely limited in racial diversity as a result of the organization population, we have seen similar concepts emerge related to gender identity within our programs with graduate students and women leaders.

Strengths and limitations

This study provides insight for understanding how intentional strengths-based professional development can be effectively used to impact graduate students within STEM fields. This study is strengthened by a mixed-methods case study design, the triangulation of the data with three distinct data sources, and an intentional approach to considering reflexivity. This program is implemented by an experienced strengths coach with decades of experience in STEM education and who also has experience with the model in other contexts. We are limited in that the population of students who enrolled in this program is going to represent a subset of students who prioritize professional development and have the support of their mentors to participate in voluntary programming. Additionally, these students had prior experience with strengths-based workshops, a prerequisite to enrolling in the program. Therefore, we know this model was appealing to them. With the small sample size, it is possible that only those who had positive experiences in the cohort program or who felt they benefited from the program chose to participate in the survey or interview. This may explain why there were few negative responses in the interviews or the survey. Finally, the population of students in the cohort program itself was primarily woman-identifying, with only a few men. With that, the overall generalizability is limited. We did not design this study with a focus on women in STEM, but moving forward, this will be an important consideration in our programming. Implementing this program with a larger student population with more diversity will enhance the generalizability to other institutions and disciplines within STEM fields. We look to grow this program to encompass a larger, more diverse group of STEM doctoral students and to complement the student perspective with that of the mentor to understand their observations after students participate in the program. Finally, we are interested in incorporating other measurements such as resiliency, participant mindset and self-efficacy upon entering and leaving the program when we have a larger number of participants.

Conclusion

Professional and career development leaders in graduate education can play a key role in providing programming to guide students in strengthening their self-confidence, self-efficacy and self-awareness. The returns go far beyond students' self-actualization and can translate into real and tangible changes in skills and behaviors critical to building a successful future professional. We advocate for continued investment in supportive programs that build community and nurture a student's scientific growth while creating an environment for students to explore their self-awareness and professional identity. This strengths-based professional development program demonstrates immense potential as a model to equip STEM students with self-awareness and a new foundation of essential skills needed to supplement their technical and scientific training for their future careers in the team-based workplace. Supplementing traditional technical and developmental training models with an asset-based approach can change a student's experience and their view of themselves translating into essential lifelong skills that support them in not only surviving but thriving in their graduate training and beyond.

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Supplementary material

The supplementary material for this article can be found online.

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