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Investigating Graduate Students' Experiences through Structural Equation Modeling (SEM)

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Abstract: This study used structural equation modeling (SEM) to investigate the role of graduate students' experiences of microaffirmations, microaggressions, financial concerns, and mentor support (exogenous variables) on their perceptions of imposter syndrome, sense of belonging, and access and opportunities (endogenous variables). These success factors were measured using the Graduate Student Support Survey (GSSS), a 7-factor, 28-item survey. The GSSS success factors were mapped onto the basic needs components of self-determination theory: relatedness, competence, and autonomy. The SEM investigated the experiences of students based on a wide range of personal factors: enrollment status (full/part-time), gender, major (STEM/non-STEM), demographic group (race/ethnicity), degree type (M.S./Ph.D.), and family college experience (first/continuing generation). The SEM identified several significant pathways between the latent constructs (e.g., mentor support and sense of belonging) and differences based on demographic characteristics (e.g., STEM, female, and part-time student). Recognizing the impact of these factors on students' well-being can spur relevant university administrators, faculty, and staff to take steps that will create a more inclusive campus climate that better supports graduate student success.

Keywords: self-determination theory; graduate student success; sense of belonging; imposter syndrome; mentor support; structural equation modeling

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1. Introduction

A more diverse workforce will help improve organizational performance by generating creative solutions from alternative perspectives, especially in science, technology, engineering, and mathematics (STEM) fields [1–3]. Diverse representation is a primary concern in STEM programs, especially for the physical sciences, engineering, mathematics, and computer science [4]. Education may have become more accessible in STEM, but there are inequities regarding student success for underrepresented students [5]. Students who attend postsecondary institutions for bachelor's degrees are not representative of the United States (U.S.) population by race, gender, or socioeconomic status (SES), particularly in STEM fields; these differences are further exacerbated in graduate school [6–8]. Understanding factors that inhibit or support an individual's educational journey is a multifaceted issue.

For this study, student success factors were measured using the Graduate Student Success Survey (GSSS; Appendix A, Table A1) by exploring graduate students' experiences at a university in the southeastern U.S. [9]. Survey factors were aligned with self-determination theory constructs to measure students' experiences with mentors along with their perceptions of sense of belonging, imposter syndrome, and opportunities for educational experiences beyond required coursework [9,10]. Gaining a better understanding of students' experiences during graduate school can identify areas where students need additional support. Such modifications can increase students' educational success via higher GPAs, degree attainment, and mental well-being [11–14]. In a cascading effect, successful individuals from traditionally underrepresented groups can act as role models, thereby increasing future students' efficacy to attain a graduate degree [15–17]. Collectively,

these efforts can provide more support while decreasing the barriers graduate students face to make graduate school more accessible and achievable for underrepresented individuals, either by race, gender, or SES.

1.1. Underrepresented Groups

Several groups are commonly underrepresented in graduate school, including first-generation college students, underrepresented minorities, and females in STEM [6,8,18]. These students often encounter additional barriers in graduate school, such as imposter syndrome, a lower sense of belonging, and fewer mentors (e.g., [19–21]). A lack of STEM role models can inhibit these students' pursuit of a STEM degree [16,17]. These groups will be discussed in more detail in the following sections.

1.1.1. First-Generation College Students

Individuals whose parents did not earn a bachelor's degree are considered first-generation college students, and they compose 29% of doctoral recipients in the United States [18,22]. Many of these students earned undergraduate degrees from universities that do not offer doctoral programs, and they lack a more comprehensive understanding of the structure of graduate programs [23]. Most graduate students are continuing-generation college students whose parents hold advanced degrees [18]. These students use their family's collective history and knowledge to inform their graduate school experiences as a cognitive map to assist them in making informed decisions [24,25]. Most first-generation college students are from lower SES backgrounds [26]. Some first-generation college students may be unaware that fellowships or assistantships exist to support graduate education and believe they must finance their graduate education using loans or grants [24].

1.1.2. Underrepresented Minorities and Females

Students of color are more likely to be first-generation college students than continuing-generation college students; 42% of Black and 48% of Hispanic students are first-generation college students, compared to 28% of White students [6]. Black students comprised 6.0% of degrees earned for the life sciences but only 2.3% of those in the physical sciences [27]. Hispanic students accounted for 8.6% of the degrees in life sciences but only 6.9% in the physical sciences. As with underrepresented minorities (URM), female students are disproportionately underrepresented in some STEM fields. In the life sciences, female students accounted for 54.5% of the degrees earned but only 33.6% in the physical sciences [8].

1.1.3. STEM Majors

The retention of women and URMs is affected by dimensions of STEM environments. The lack of encouragement and validation from faculty and the competitive and individualistic nature of STEM disciplines impact the retention of women in STEM [28–30]. Additional limiting factors URM in STEM face relate to the campus racial climate, experiences of tokenization and stereotyping, shortfalls in students' perceived sense of belonging and institutional support, fewer opportunities for research involvement, and issues with the development of students' scientific identity and self-efficacy [15,30–34].

1.2. Campus Climate

Campus climate contributes to academic success for graduate students. For underrepresented students in STEM, microaggressions and mentor support are contributing factors (e.g., [16,17,19]). These aspects can impact students' sense of belonging and create a phenomenon called imposter syndrome (e.g., [20,21,35]), which is described below. Understanding the complex impact these factors may have on a student's well-being can assist faculty and administrators in implementing changes that will shape a campus climate that is more supportive of underrepresented groups.

1.2.1. Sense of Belonging

Sense of belonging reflects how individuals perceive their place and value in a community and their innate desire and motivation to sustain interpersonal relationships [21,35]. A deficit in belonging or feelings of exclusion can lead to negative emotions, such as anxiety, stress, and depression [36,37]. Because graduate students spend most of their time with department members and advisors, their sense of belonging is often tied to faculty more than their peers [38,39]. Consequently, a university's lack of role models and mentors can negatively affect female students' and URM's sense of belonging [40].

1.2.2. Imposter Syndrome

Campus climate can impact graduate students' feelings of competency and stimulate a phenomenon called imposter syndrome (also called imposter phenomenon). Imposter syndrome occurs when individuals attribute their success to luck or others despite their being high-achieving and successful [20]. These individuals often anticipate failure with the next task or assignment, at which point they fear they will be revealed as frauds [20]. Individuals with imposter syndrome struggle to maintain positive self-perceptions of their academic capabilities and success [21]. Byars-Winston and Dahlber found that individuals with this syndrome reported lower self-efficacy and negative perspectives toward attaining their doctorate [15].

Imposter syndrome is inversely related to one's perceived competence. A study by Kamarzarrin et al. of physicians in Iran found that their self-esteem was negatively correlated to imposter syndrome [41]. Those individuals who experienced imposter syndrome could not internalize their achievements; they experienced feelings of lower competence and inadequacy, consistent with imposter syndrome.

In a survey study focused on females in higher education, Vaughn et al. (2020) found that most (95%) of the females attributed their success and failure to their effort and ability, not external factors [42]. Chakraverty found that STEM graduate students, faculty, and those working in the industry were more likely to attribute their success during their Ph.D. program to others (e.g., kindness, connection) or self (e.g., luck or pretense) rather than their ability or hard work, which the authors reported as evidence of imposter syndrome [43]. Chakraverty also found that gender played a role; some female Ph.D. students, particularly those in male-dominated fields, struggled to internalize their achievements.

Lige et al. documented that African-American students with a positive African-American identity and sense of community membership expressed lower levels of imposter syndrome [44]. Rowley et al. [45] described how some students who identify as members of URM racial and ethnic groups hold positive racial identity and self-esteem and may be less susceptible to imposter syndrome.

1.2.3. Mentoring

Mentoring relationships can help all graduate students, especially underrepresented students, navigate graduate school's new cultures and expectations [17]. Research has found that poor student-advisor relationships affect doctoral students' attrition in STEM [46,47]. Female and URM students may have difficulty navigating campus interactions due to the inability to interact with mentors who reflect their gender, race, or other aspects of their identity [19,48,49]. To overcome such obstacles, assigning minority professors to introductory courses could increase the retention of URM in STEM [16].

1.2.4. Microaggressions and Microaffirmations

Racial microaffirmations support racial identities via positive words or actions. In contrast, racial microaggressions represent adverse treatment of racially minoritized individuals based on stereotypes [50–53]. A lack of microaffirmations and the individualistic and competitive nature of STEM disciplines negatively impact the retention of underrepresented students in STEM [54].

Racial microaggressions lead to lower levels of belonging and have been positively associated with psychological distress [55]. In a study with underrepresented minority (URM)

medical students, Chisholm et al. found that microaggressions negatively affected students' learning environments, and few resources addressed the microaggressions [56]. In a focus group study by Nadal et al., microaggressions experienced by fourteen females were pervasive acts that negatively affected their everyday experiences and their mental health [57].

1.2.5. Summary

Diversifying those who seek graduate degrees and careers in STEM disciplines is desirable, yet there are numerous factors that can act to undermine the success of students, particularly those who are URM, first-generation, and female. Campus climate factors include microaggressions, microaffirmations, mentor support, sense of belonging, and imposter syndrome.

1.3. Theoretical Framework

Self-determination theory (SDT) describes what motivates individuals' choices and initiates action and behavioral regulation in various parts of their lives [10,58,59]. In SDT, motivation ranges from *intrinsic* to *extrinsic* to *amotivation*. A sub-theory of SDT is Organismic Integration Theory.

1.3.1. Organismic Integration Theory

Organismic integration theory (OIT) is based on the premise that people integrate their experiences and can be motivated using extrinsic means to complete activities they are not intrinsically motivated to do [60]. Intrinsic motivation is the most autonomous motivation: an individual participates in an activity because of interest and satisfaction gained from engaging in the task [58]. Amotivation is the least autonomous regulation and represents a lack of intention and motivation in the task [10]. Amotivation results from lower competence, viewing the activity as unimportant, or failure to connect one's behavior with the desired outcome [59]. Extrinsic motivation lies between intrinsic motivation and amotivation for its level of autonomy. The individual's motive directs this type of motivation for completing a task by an independent consequence, such as threat, reward, or punishment [61].

Extrinsic motivation can be classified on a continuum from low to high self-regulation [61]). Beginning on the low end of the continuum, *external* regulation (very low self-regulation) involves behaviors influenced by external factors (i.e., reward, threat, or punishment) [58]. Individuals complete these tasks based on the consequences they will receive and do not connect their task completion to personal goals [62]. *Introjected* regulation (moderately low self-regulation) is distinguished by an individual partially internalizing external regulation controlled by self-imposed feelings [60]. In these instances, the rewards or punishments connected to the goal, such as shame or guilt, are administered by the individual [62]. In *identified* regulation (moderate self-regulation), individuals express a greater choice in their participation by identifying the activity as necessary to personal goals and consciously valuing a behavioral goal as personally necessary [60,61]. With this more internalized form of regulation, individuals pursue a goal because they understand the value of the goal but do not personally value the goal [62]. *Integrated* regulation (high self-regulation) occurs when the extrinsic form of motivation is congruent with personally endorsed values, goals, and needs [60]. In the most complete internalization, individuals personally value the goal and view it as important [62]. Individuals do not inherently find the goal fun or interesting, but it is valued and autonomously motivating [62].

1.3.2. Basic Needs Theory

Satisfying an individual's basic needs—*autonomy*, *competence*, and *relatedness*—is essential in internalizing a task's value, motivation to complete the task, and the desire for achievement related to the task [59,63]. *Autonomy* is the realization of free choice to engage in a task. In school, it is achieved when students feel their teacher is interested in their perspective, encourages exploration, and provides student choice [63]. It can be described as the innate need for self-direction and self-endorsement instead of feeling

controlled, coerced, or constrained [64]. Higher levels of *autonomy* are seen when students feel their opinions are valued and they have a choice in their education [65]. *Competence* is self-efficacy for a task or the degree to which an individual believes they can accomplish a goal [59,66]. Lastly, *relatedness* is the need to establish close emotional bonds and secure attachments with others [67]. Teacher and parent relationships affect *relatedness* via emotional availability, attention, and time [68]. Feelings of *relatedness* are most critical to individuals in adverse situations, where few others are perceived as similar [69].

1.3.3. Summary

Self-determination theory (SDT) focuses on what motivates individuals' choices and actions, ranging from *intrinsic* to *extrinsic* to *amotivation*. Basic needs theory explains that individuals are motivated to satisfy their basic needs: *autonomy*, *competence*, and *relatedness.* Meeting these needs helps to internalize the value of a task and their motivation to complete it and achieve more in relation to the task.

1.4. Existing Survey Measures

Prior work on college success has focused on undergraduate models, whereas graduate student studies focused on attracting the best and/or underrepresented students [70–72]. Girves and Wemmerus developed a model to predict progress toward attaining a master's or doctoral degree [73]. They used the following aspects as predictors: department and student characteristics, financial support, student perceptions of faculty, program involvement, department satisfaction, and alienation. There were differences based on degree type. Overall, factors related to academic integration, departmental characteristics, and students' relationship with faculty were important, but social integration did not predict degree progress. Student characteristics were influential for master's students, while the type of financial support was important for doctoral students. Thus, it is essential to identify differences by degree and student group when considering support strategies [73].

1.5. Graduate Student Success Survey

Several studies on graduate students' experiences have investigated one or more factors, such as sense of belonging and imposter syndrome [74–77]. In order to create a more comprehensive measure, the Graduate Students Success Survey (GSSS) was developed and validated by the authors [9]. The goal of the GSSS was to identify factors that support or inhibit graduate student success by including several related subscales (e.g., sense of belonging, mentor support, imposter syndrome). The survey was administered to a broad group of graduate students, with the hoped that differences in the experiences of subgroups (e.g., URM, females) could be identified. Latent constructs on the survey are related to a sub-theory of SDT, organismic integration theory. This theory describes how internal and external factors influence individuals' intrinsic motivation [64]. Individuals' perceptions of imposter syndrome, access and opportunity, and sense of belonging are linked theoretically to competence (inversely related to imposter syndrome), autonomy (access and opportunity), and relatedness (sense of belonging), aspects of basic needs theory [64].

Basic psychological needs contribute to positive life outcomes and are essential for the health and well-being of an individual [59]. Contexts that undermine these needs, such as microaggressions and financial concerns, negatively impact students' wellness, can exacerbate perceptions of imposter syndrome, and decrease one's sense of belonging [59]. In contrast, positive mentor relationships and microaffirmations can act to enhance an individual's basic needs [64]. Students' well-being, perceptions of themselves, and positive academic outcomes are influenced by the presence or absence of these factors [78].

1.5.1. Linking the Latent Variables to Basic Needs Theory

The first author connected the sense of belonging theoretically as a measure of the SDT construct *relatedness* and the desire to be emotionally connected to and interpersonally involved in warm, caring, and responsive relationships [10]. (See Figure 1 for all constructs

and relationships.) She also linked the SDT construct of *competence* theoretically as an inverse measurement of students' imposter syndrome. Individuals with higher levels of imposter syndrome would correspond with lower levels of *competence* [41,79]. *Autonomy*, the third SDT construct, was theoretically linked by the first author to the survey subscale, access and opportunity. Many aspects of graduate school are scripted regarding which courses students must take and the required program milestones. The opportunities reflected in the access and opportunity subscale represent a graduate student's choices in the direction or self-governance of their education.

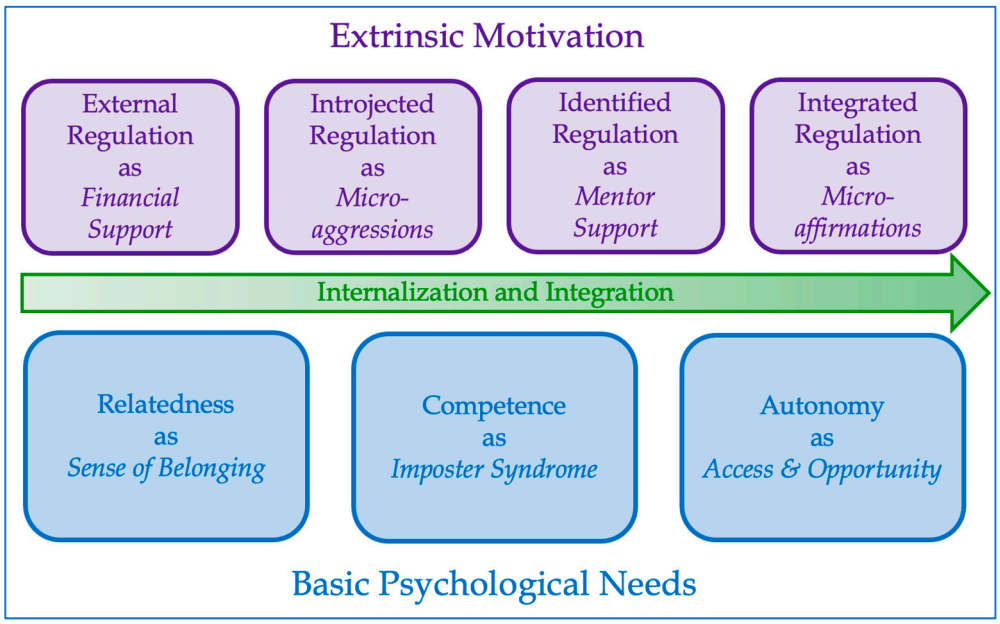

Figure 1. Graduate student success survey constructs aligned with self-determination theory (adapted from [80,81]).

1.5.2. Latent Variables Linked to Organismic Integration Theory

The authors predict that the remaining latent variables will act as forms of extrinsic motivation, as seen in the top row of Figure 1. The microaffirmations subscale can be considered an *integrated* regulation because it influences how a student perceives oneself. The mentor subscale can be considered a form of *identified* regulation because feedback on the work the student completes relates to their personal goals of conducting research, writing papers, and other activities associated with graduate work. Microaggressions may be viewed as a form of *introjected* regulation connected with feelings of shame or guilt. Financial support can be considered an extrinsic motivator, specifically as an *external* regulator. Lastly, financial aspects related to graduate school, such as tuition and student fees, can be seen as not self-determined and potentially viewed as a demand. The financial support students receive via scholarships, assistantships, and fellowships provides motivation to persist in graduate school. A schematic of the proposed model for this study using SDT is represented in Figure 1. In Figure 1, GSSS survey constructs (in italics) are aligned with SDT types of regulation (from external to integrated regulation) and basic psychological needs (relatedness, competence, and autonomy).

1.5.3. Summary

The Graduate Student Success Survey (GSSS) was previously developed and validated by the authors to create a more comprehensive measure of factors that support graduate student success or inhibit it. For this study, each factor in the GSSS was theoretically connected to constructs of basic psychological needs (BPN). Related concepts are: relatedness (BPN) and sense of belonging (GSSS); competence (BPN) and imposter syndrome (GSSS); autonomy

(BPN) and access and opportunity (GSSS); and financial support, microaggressions, mentor support, and microaffirmations (GSSS) along a continuum of extrinsic motivators (BPN).

1.6. Research Design

The purpose of this study was to understand the relationship between the latent constructs (i.e., financial support, microaggressions, microaffirmations, mentor support, sense of belonging, and imposter syndrome) of the GSSS using the lens of SDT to gain a more holistic understanding of graduate students' experiences. This project sought to better understand the experiences of *all* students, with a goal to include and ideally be able to understand the experiences of underrepresented groups, such as females in STEM, URM, and first-generation students. This study focused on forms of extrinsic motivation for graduate students (e.g., financial support, mentor support, and microaggressions), as these are areas that can be addressed by the university. This research aims to provide insight as to how students can be better supported, with the ultimate goal to increase students' academic success and support a more diverse and inclusive campus community in graduate school. In order to examine the relationships among multiple variables in the data set, structural equation modeling (SEM) was used as the primary technique for statistical analyses for this study, combining three statistical techniques: multiple regression, path analysis, and factor analysis.

1.6.1. Research Questions

In the SEM model, the survey constructs functioned as latent variables, including microaggressions, sense of belonging, microaffirmations, mentor support, imposter syndrome, and access and opportunity. Demographic characteristics acted as controls for the SEM model, including race, gender, international status, first-generation status for a bachelor's degree, first-generation status for a graduate degree, part-time status, and year in graduate school. The research questions that guided this study are as follows:

1. What predictive SEM model can be developed to explain the relationship between sense of belonging, imposter syndrome, mentor support, microaggressions, microaffirmations, financial support, and access to academic experiences with the control variables?
2. Are there differences between graduate students' experiences with the measured support and success factors based on demographic characteristics?
3. Are there differences between graduate students' experiences with the measured support and success factors based on their enrollment in STEM or non-STEM degree programs?

1.6.2. Hypotheses

Hypothesis 1a. *Utilizing SDT, the latent variables, microaggressions, microaffirmation, mentor support, and financial support will have significant direct effects (exogenous variables) on sense of belonging, imposter syndrome, and access and opportunity (endogenous variables). Positive support for graduate students, in the form of more microaffirmations, mentor relationships, and financial support, along with fewer microaggressions, will result in greater perceived success for students, as measured by a greater sense of belonging, less imposter syndrome, and more access and opportunity.*

Hypothesis 1b. *Race, gender, international status, first-generation status for a bachelor's degree, first-generation status for a graduate degree, part-time status, STEM degree, and year in graduate school will act as control variables with significant effects on endogenous and exogenous variables.*

Hypothesis 2. *First-generation college students, URM, and non-male students will have more negative experiences with the measured success factors, regarding more microaggressions, fewer microaffirmations, lower sense of belonging, and a greater sense of imposter syndrome.*

Hypothesis 3. *There will be more negative factors for STEM degree programs than non-STEM degree programs. These negative perceptions will include more microaggressions, fewer microaffirmations, a lower sense of belonging, and a greater sense of imposter syndrome.*

2. Materials and Methods

2.1. Survey Development

Previously validated instruments were located and considered for use during the initial face validity process of the GSSS. The O'Meara et al. graduate students' sense of belonging survey provided insights for items relating to the sense of belonging, whereas the 2000 National Doctoral Program guided the development of items with mentor relationships [82,83]. The Clance IP Scale was referenced to assist in item development for the imposter phenomenon [84]. The Racial Microaggressions Scales and the Racial and Ethnic Microaggressions Scale gave insight into the wording of the original GSSS's race and gender microaggression items [76,85]. The Estrada et al. survey for undergraduate persistence in science career pathways informed the development of items in the GSSS's microaffirmation scale [74]. Various items for the previously mentioned validated surveys were selected and modified to accommodate the needs of the current study. Other items were created based on areas of concern from the literature and suggestions from fellow faculty members, including financial support and advisor relationships [86].

The survey development used a wide range of experts (diversity, equity, and inclusion university committee members, graduate students, graduate faculty, psychometrics, dean of the graduate school, and staff) for multiple rounds of survey iterations. After all changes were made, the survey had 10 demographic questions and 51 questions developed by the authors.

2.2. Survey Distribution

The GSSS (see Appendix A, Table A1 for items) was developed and shared with graduate students who attended an R1 university in the southeastern U.S. [9]. The university enrolled approximately 36,000 students, with 5400 graduate students. The overall graduate student population comprised slightly fewer females (48.4%), 24% of the students identified as a racial/ethnic minority, and 31% were international students. Fifty percent of the faculty members at the university were female, and 79.4% identified as White. The university in the study is part of a state-wide system, has a strong STEM focus, and each of the colleges has distinct cultures and ways of operating, led by fairly independent deans. Given the differences, program areas were solicited, although no students' names were visible to the researchers, to protect the anonymity of the participants.

All survey items were evaluated with a 5-point Likert scale, with 1 representing *strongly disagree* and 5 representing *strongly agree*. After approval was obtained from the university institutional review board (IRB; #23581), invitations to participate in the survey were emailed to 4,044 graduate students in early December, with the assistance of the university's research administration office. Students who graduated in December were not invited to take the survey to avoid confusion with an important exit survey given by the university. Due to the focus of the survey items, those programs without a thesis or dissertation requirement did not receive an invitation to participate. The survey was administered via Qualtrics https://www.qualtrics.com/login/ (accessed on 8 December 2020).

Of the 696 surveys started, 537 were determined to be >90% complete and were used in further analyses. Eight items in the final model had missing responses, ranging from 1 to 3 missed data observations. With the final model including 27 items, this tabulates to 0.09% missing data, an acceptable value since missing values of less than 5% are of little concern [87]. Over half of the survey participants identified as White (57.7%), and 14.2% identified as Asian. Most participants were female (56.4%) and U.S. citizens (78%). The majority of the graduate students who participated in the survey attended graduate school full-time (92.6%) in doctoral programs (79.7%) and were mainly enrolled in STEM disciplines (70.4%). Only 22.9% of the students were first-generation bachelor's students, but 51.4% were first-generation graduate students. Table 1 compares the descriptive statistics for the university graduate student population and the survey participants. Most categories are similar in composition, with the exception of part-time status and degree programs. Survey participants were more likely to be full-time students and Ph.D. than the university profile.

Table 1. Descriptive statistics of survey participants and the university graduate population.

	GSSS Participant	University Graduate Population
URM	15.5%	24%
Female	56.4%	48%
International	22%	31%
Part-time	7.4%	37%
Ph.D.	79.7%	36%

2.3. Survey Validation and Reliability

The authors worked on the validation and reliability of the GSSS [9]. Half of the sample was designated for exploratory factor analysis (EFA), whereas the remaining half was utilized for confirmatory factor analysis (CFA). The software package Statistical Package for the Social Sciences (SPSS) version 27 (2020) was used for EFA to validate the instrument.

A detailed description of the validation of the GSSS survey is in Collier and Blanchard [9]. The original EFA model had 5 factors and 32 items. Due to a poor model fit with CFA, the model was restored to 7 factors, which restored the originally intended categories of Sense of Belonging, Mentor Relationships, and Microaffirmations [88,89]. Additional modifications were made to improve the model fit until an acceptable model was found, with 7 factors and 28 items [90]. The survey operated better and conformed more closely to constructs in the literature (e.g., [21,54,91]). Previously published surveys focused on the experiences of graduate students tended to focus on one factor and, therefore, did not represent the complexity of underrepresented students' challenges experienced in graduate school (e.g., [76,83,84]). Reverse-coded items created a problem with the validation, as has been discussed [92]. Individuals are more likely to misinterpret reverse-coded items and, consequently, answer them incorrectly. This can lead to the data misrepresenting the views of participants. Furthermore, reverse-coded items have a tendency to load on the same scale in factor analysis [93]. This anomaly (i.e., participants may have been confused by the negative wording or misunderstood the item) causes reverse-coded items to be removed in survey validation, as they were with the GSSS. Unfortunately, this resulted in removing all the microaggression questions related to race, making the survey unable to capture these concerns expressed by URM students. However, the range of factors in the GSSS provides a more holistic depiction of students' experiences, mentor relationships, sense of belonging, financial aspects, and imposter syndrome (e.g., [20,21]).

As displayed in Table 2, significant bivariate correlations were present between all the latent variables except imposter syndrome, for which none existed. Correlation values between 0.90–1.00 are described as very strong, whereas values between 0.70–0.89 are considered to be strong [94]. Correlations between 0.49–0.60 are designated as moderate, and those with values between 0.10–0.39 are depicted as weak. Values below 0.10 are determined to be negligible. Microaffirmations had strong, positive correlations with both sense of belonging (0.840) and mentor (0.741), while the remaining correlations were smaller, <0.500. Sense of belonging had a strong correlation with mentor support (0.827) and a moderate correlation with access and opportunity (0.599). Mentor Support had a strong correlation with access and opportunity (0.663), as well. The remaining correlations were significant but smaller, mostly moderate or weak. These correlations indicate that students who experienced more microaffirmations had a great sense of belonging and reported more positive mentor relationships. Individuals with a greater sense of belonging experienced stronger mentor relationships and more access and opportunity. Lastly, greater mentor relationships correlated with greater access and opportunity. The Correlation Table for the observable variables is located in Appendix A, Table A2.

Table 2. Bivariate correlations of latent variables.

Variable	Micro-Affirmations	Sense of Belonging	Mentor	Financial	Access & Opportunity	Imposter Syndrome	Micro-Aggressions
Microaffirmations	1						
Sense of Belonging	0.840 *	1					
Mentor Support	0.741 *	0.827 *	1				
Financial Support	0.349 *	0.350 *	0.190 *	1			
Access & Opportunity	0.485 *	0.599 *	0.663 *	0.266 *	1		
Imposter Syndrome	0.069	0.085	0.064	0.047	−0.157	1	
Microaggression	0.310 *	0.219 *	0.154 *	0.238 *	0.137 *	0.212 *	1

Note: * denotes $p < 0.05$.

Descriptive statistics and internal consistency measures are displayed in Table 3 for the items of each scale. The alpha coefficients ranged from 0.890 to 0.729. Moderate normality thresholds are presented as +/− 2.0 and +/− 7.0 for skewness and kurtosis, respectively [95]. As presented in Table 3, the data for the survey items falls into the acceptable range for both parameters of skewness and kurtosis. Values above $\alpha > 0.7$ are considered reliable; however, the alpha value is dependent on the number of items [96]. The effect size is assessed with r^2, with values of 0.01 reflecting on a small effect, 0.09 on a medium effect, and 0.25 on a large effect [97]. As evident by the values in Table 3, the items have a large effect size for the latent variable.

Table 3. Descriptive statistics and internal consistency for each measure.

	Item	*N*	Mean	*SD*	Skewness	Kurtosis	r^2	Alpha
Microaffirmations	Scale	—	—	—	—	—	—	0.890
	q24	537	3.89	0.825	0.000	0.000	0.80	—
	q23	537	3.92	0.784	0.000	0.000	0.77	—
	q22	537	4.10	0.862	0.000	0.000	0.61	—
	q25	537	4.22	0.855	0.000	0.000	0.55	—
Sense of Belonging	Scale	—	—	—	—	—	—	0.803
	q33	537	3.45	1.105	0.000	0.016	0.69	—
	q35	537	3.93	0.956	0.000	0.000	0.50	—
	q36	537	3.11	1.172	0.150	0.000	0.51	—
	q34	537	3.88	0.946	0.000	0.004	0.35	—
Mentor Support	Scale	—	—	—	—	—	—	0.756
	q48	537	3.69	0.983	0.000	0.134	0.56	—
	q46	537	3.54	1.080	0.000	0.189	0.57	—
	q47	536	3.91	0.949	0.000	0.002	0.40	—
Financial Support	Scale	—	—	—	—	—	—	0.810
	q41	535	3.44	1.115	0.000	0.205	0.55	—
	q40	537	2.69	1.371	0.096	0.000	0.46	—
	q39	535	2.83	1.274	0.546	0.000	0.43	—
	q42	537	3.33	1.408	0.000	0.000	0.39	—
	q44	537	3.22	1.242	0.024	0.000	0.38	—
	q43	537	3.18	1.318	0.089	0.000	0.33	—
Access & Opportunity	Scale	—	—	—	—	—	—	0.729
	q56	536	4.01	0.974	0.000	0.000	0.46	—
	q52	537	3.77	1.000	0.000	0.194	0.40	—
	q54	537	3.08	1.134	0.093	0.000	0.40	—
	q53	537	3.28	1.009	0.000	0.016	0.33	—
	q38	537	3.74	1.197	0.000	0.364	0.23	—
Imposter Syndrome	Scale	—	—	—	—	—	—	0.834
	q30	537	2.23	1.148	0.000	0.251	0.62	—
	q28	537	2.52	1.275	0.000	0.000	0.64	—
	q39	537	2.34	1.155	0.000	0.185	0.63	—
Microaggressions	Scale	—	—	—	—	—	—	0.768
	q19	537	3.36	1.172	.029	0.000	0.91	—
	q18	537	2.73	1.150	0.000	0.000	0.42	—

Note: standardized model.

After EFA and CFA, the survey comprised seven factors and 28 items. The factors or subscales included microaffirmations, sense of belonging, mentor support, financial support, access and opportunities (for research and academic writing), imposter syndrome, and microaggressions. (Figure 2; See Collier & Blanchard, 2023, for a detailed report of validation and reliability [9]).

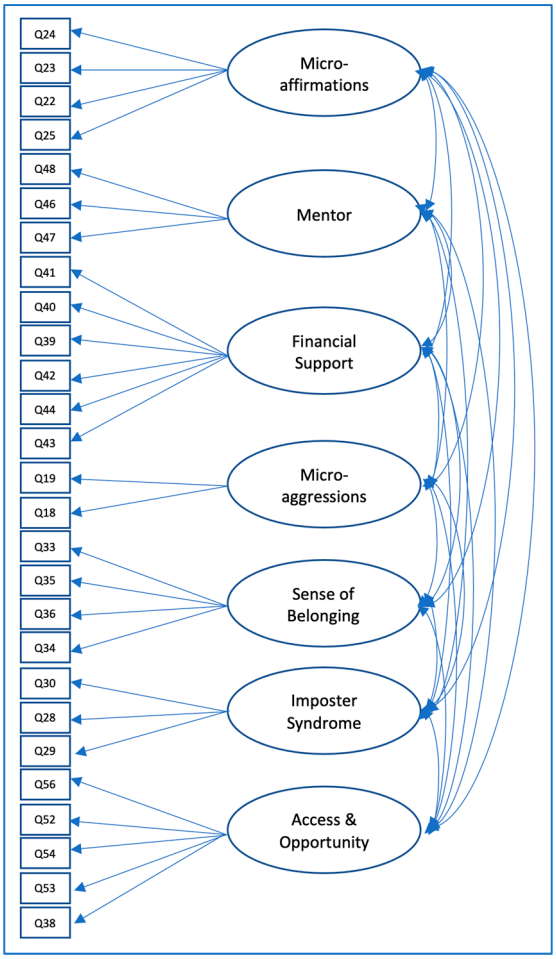

Figure 2. CFA Model for Graduate Student Survey.

Chi-square (χ^2) was used to test the model fit, which is often criticized for being overly sensitive to model misspecification in large samples [98]. In addition to the χ^2 value, the following fit indices were used to assess the fit of the model: (1) the Comparative Fit Index (CFI), (2) the Standardized Root Mean Square Residual (SRMR), and (3) the Root Mean Square Error of Approximation (RMSEA) [90,99,100]. Based on current recommendations, values > 0.90 are considered acceptable for CFI, and values less than 0.05 and 0.08 represent excellent and acceptable model fit for SRMR and RMSEA, respectively [90,101]. The fit indices for the CFA were acceptable (Table 4).

Table 4. Fit indices from validation and reliability tests.

Sample	Model	χ^2	CFI	RMSE	SRMR
CFA	7-factor, 29 items	(df = 356, N = 271) = 701.954, $p < 0.005$	0.894	0.060 *	0.0639 *
CFA	7-factor, 28 items	(df = 329, N = 271) = 620.919, $p < 0.005$	0.907 *	0.057 *	0.0583 *
EFA	7-factor, 28 items	(df = 329, N = 271) = 620.081, $p < 0.005$	0.911 *	0.058 *	N/A

Note: * acceptable value; *df* is abbreviated for degrees of freedom.

The seven subscales range between two and six items. The microaffirmations subscale is composed of four items related to an individual's perceptions of how their work

and ideas are valued, the respect they receive, and the encouragement they are given. The microaggressions subscale is composed of two items asking if an individual's opinion is overlooked due to gender and if others make assumptions about their abilities due to gender. The mentor support subscale includes three items asking about a student's relationship with faculty at the university to support their growth as a graduate student. The financial support subscale consists of six items that reflect a student's concern about the cost of graduate school, available financial support, and debt resulting from graduate school. The access and opportunity scale comprises five items that inquire into students' opportunities to write papers and grants, participate in conferences, receive assistantships, and participate in extension activities beyond their program. The sense of belonging subscale is composed of five items concerning a graduate student's sense of *relatedness*. Lastly, the imposter syndrome subscale comprises three items concerning an individual's perceptions of *competence* as a graduate student.

2.4. Structural Equation Modeling Analysis

Stata Version 16 was used to construct a model with direct pathways for this hypothesized model (Figure 3). Appendix A, Figure A1 displays the hypothesized model with all control variables.

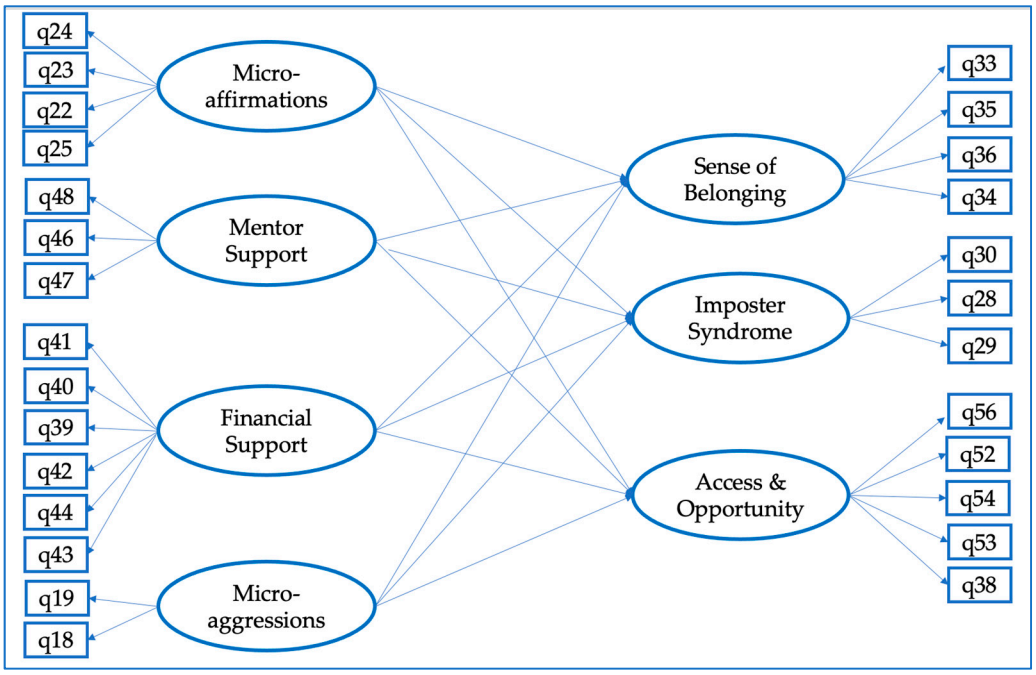

Figure 3. Hypothesized SEM Model.

3. Results

3.1. SEM Model

3.1.1. Determination of Paths between Exogenous and Endogenous Variables

In constructing the SEM, a model was run for the previously established CFA with the validation and reliability analysis (Model 1, Table 5) [9]. Direct pathways were created between the exogenous variables (i.e., microaffirmations, mentor support, financial support, and microaggressions) and the endogenous variables (i.e., sense of belonging, imposter syndrome, and access and opportunity). The model maintained acceptable fit measures from this analysis, except for the χ^2 (Model 2, Table 5). However, a larger sample size often inhibits obtaining an acceptable fit for χ^2 [98]. The analyses showed that not all direct paths had a significant effect. Several significant effects were found in the initial SEM model: microaffirmations with sense of belonging, mentor support with sense of belonging and access and opportunity, financial support with sense of belonging and access and opportunity, and microaggressions with sense of belonging (Model 2, Table 5).

Table 5. Fitness indices for SEM models.

#	Model	χ^2	CFI	RMSEA	SRMR
1	CFA	(df = 303, N = 534) = 735.767, $p < 0.005$	0.928 *	0.052 *	0.047 *
2	SEM with all paths	(df = 306, N = 534) = 740.23, $p < 0.005$	0.928 *	0.052 *	0.047 *
3	SEM with sig. paths	(df = 312, N = 534) = 742.52, $p < 0.005$	0.929 *	0.051 *	0.047 *
4	SEM all paths and all control variables	(df = 652, N = 534) = 1692.80, $p < 0.005$	0.843	0.055 *	0.086 *
5	SEM with all paths and sig. control variables	(df = 664, N = 534) = 1706.74, $p < 0.005$	0.843	0.054 *	0.097 *
6	SEM with sig. paths and sig. control variables	(df = 669, N = 534) = 1707.43, $p < 0.005$	0.844	0.054 *	0.097
7	SEM with sig. paths, sig. control variables, and cov.	(df = 540, N = 534) = 1189.38, $p < 0.005$	0.901 *	0.047 *	0.062 *

Note: * denotes an acceptable fit; sig. is abbreviated for significant; cov. is abbreviated for covariance; *df* is abbreviated for degrees of freedom.

The SEM model was run again but only included the significant direct paths. The model produced acceptable fits for the indices, except for χ^2 (Model 3, Table 5). For the next iteration of SEM, all the control variables from the study were added to all the endogenous and exogenous variables (Model 4, Table 5). For the race and gender question, the participants typed in their preferred wording, and responses were grouped using similar categories (e.g., African American and Black, White and Caucasian). There were ten race categories after responses were grouped: African, African American/Black, Asian, Hispanic/Latino, Middle Eastern, Multiracial, Native American, Turkish, White/Caucasian, and No Response. White graduate students were used as the base group for race because it was the largest group that participated in the survey. These students were compared to the race groups of Black, Asian, Latino/a, Multiracial, Native American, and Middle Eastern. Additional control variables included STEM majors, female and nonbinary students (with male students as the base group), first-generation bachelor's students, first-generation graduate students, international students, part-time students (with full-time students as the comparative group), and Ph.D. students (with master's students as a base group). Lastly, the year in graduate school was used as a control variable, with first-year students as the base group to be compared to 2nd-year, 3rd-year, 4th-year, and 5th-year and beyond.

A poor fit was indicated with CFI when using *all the paths with all control variables* (Model 4, Table 5). The decision was made to remove control variables that were not significant to improve model fit. For the next iteration of the SEM analysis, control variables were used only where the previous model indicated a significant relationship with a *p*-value of 0.100 or less, *all paths and sig. control variables* (Model 5, Table 5). This model had a slightly improved CFI value but a lower fit for SRMR. For the next iteration, only paths that were significant were maintained in the model to improve the fit indices. For Model 6, an analysis was completed with significant paths between exogenous and endogenous variables and significant control variables, *sig. path and sig. control variables* (Table 5). The fit indices between this model were similar to the indices for the model with all the paths. The decision was made to use the model with only the significant direct paths for the remainder of the analysis.

3.1.2. Addition of Covariances to Improve Model Fit

Referencing the regression coefficients, several control variables were no longer significant, $p > 0.100$, and, consequently, were removed from the model. This modification provided a better fit but was not acceptable. The model fit was improved with the addition of covariances based on modification indices to improve the fit (Figure 4). Covariances, or the degree to which two items behave similarly, were added individually, beginning with the highest modification incidence value and those that fit best with the theory of the latent constructs. Covariances were added between microaffirmations and mentor, between microaffirmations and financial support, and between q35 and q36.

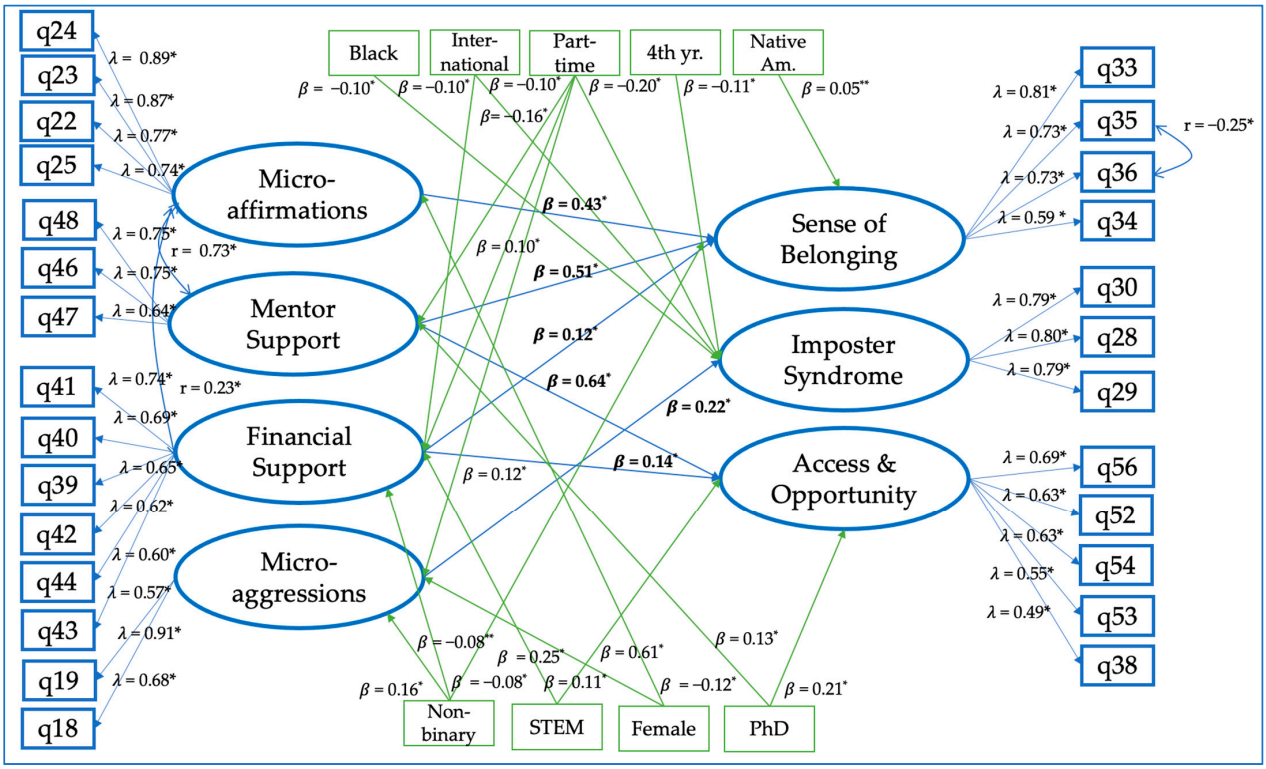

Figure 4. Significant paths with significant control variables and added covariances. In the diagram, λ = standardized factor loading; r = correlation coefficients, β = standardized path coefficients for control variables [beta not bold], and **β** = standardized path coefficients for latent variables [beta bold]. * denotes $p < 0.05$, ** denotes $p < 0.10$.

After accounting for the variance explained using sense of belonging, the covariance between q35 and q36 may indicate that other factors influenced the items beyond the scope of the survey. Covariances between microaffirmations and mentor support, in addition to microaffirmations and financial support, corroborate the interdependence of the latent constructs of the survey with graduate students' well-being. These covariances are logical relationships: higher values of mentor support will likely correlate with higher values of microaffirmations and financial support since mentors are likely a source for both microaffirmations for students and financial support [28,29,102–104].

The model was checked for relationships that were no longer significant between control and latent variables, with $p > 0.100$, and subsequently removed after adding each covariance. No covariances were added between error variance, and they were not included in the model (Figure 4). Adding these covariances and removing nonsignificant control variables produced a model with a good fit for all fitness indices except for $\chi 2$ (Model 7, Table 5).

3.1.3. Satorra-Bentler χ^2 Test for Model Fit

Satorra-Bentler χ^2 is a test that measures improved model fit based on differences in the χ^2 values of two models, and it was calculated to compare the SEM models (Table 6). For the first comparison, the SEM model with all direct paths and no control variables was compared to the model utilizing only significant paths and no control variables (Model 1). No significant difference was observed between the χ^2 values for these models. For the remaining comparison, control variables were included (Models 2–4). The SEM model with all direct paths and all control variables was used as the baseline model. It was compared to a model with all paths and only significant control variables (Model 2) and a model with only significant direct paths and only significant control variables (Model 3). For both comparisons, no significant differences were found between the χ^2 values. The last comparison was for the SEM model with only significant direct paths, only significant

control variables, and three covariances (Model 4). This comparison revealed a significant difference between the χ^2 values, indicating an improved model.

Table 6. Satorra-Bentler χ^2 model comparison.

Model	Baseline Model	Constrained Model	Satorra-Bentler Scaled χ^2	*df*	*p*-Value
1	SEM—all paths	SEM—sig. paths	2.29	6	0.891
2	SEM—all paths & all control variables	SEM—all paths & sig. control variables	13.94	12	0.305
3	SEM—all paths & all control variables	SEM—sig. paths & sig. control variables	14.63	17	0.662
4	SEM—all paths & all control variables	SEM—sig. paths, sig. control variables, and cov.	503.41 *	112	<0.005

Note: * denotes a significant value of $p < 0.05$; sig. is abbreviated for significant; cov. is abbreviated for covariance; *df* is abbreviated for degrees of freedom and represents the differences between the models.

3.1.4. Final SEM Model

The final model partially supported Hypothesis 1, with some significant direct pathways existing between the exogenous variables (ExoV) and endogenous variables (EndV) (Table 7). Significant relationships existed between sense of belonging (EndV), and microaffirmations, mentor support, and financial support (ExoV) (Figure 4, Table 7). Significant relationships were also found between access and opportunity (EndV) and mentor support and financial support (ExoV). Imposter syndrome (EndV) had one significant relationship with microaggressions (ExoV). Of the various control variables applied to the model, significant relationships were found among all the latent variables but to a lesser degree than expected (Figure 4, Table 8).

Table 7. Regression coefficients for direct paths.

Exogenous Variable	Endogenous Variable	Regression Coefficient	*SD*	*p*-Value
Microaffirmations	Sense of Belonging	0.425 *	0.057	0.000
Mentor Support	Sense of Belonging	0.514 *	0.057	0.000
Financial Support	Sense of Belonging	0.117 *	0.037	0.001
Mentor Support	Access and Opportunity	0.637 *	0.038	0.000
Financial Support	Access and Opportunity	0.139 *	0.049	0.004
Microaggressions	Imposter Syndrome	0.222 *	0.049	0.000

Note: * denotes a significant value of $p < 0.05$; items in red represent inhibitory relationships; standardized model.

Table 8. Regression coefficients for control variables on latent variables.

		Regression Coefficient	*SD*	*p*-Value
Microaffirmations	Female	−0.114 *	0.034	0.000
Sense of Belonging	Native American	0.053 **	0.029	0.070
Sense of Belonging	Nonbinary	−0.097 *	0.030	0.001
Mentor Support	Part-time	−0.090 *	0.038	0.017
Mentor Support	Ph.D. Student	0.129 *	0.037	0.001
Financial Support	STEM Major	0.246 *	0.045	0.000
Financial Support	International student	−0.095 *	0.045	0.036
Financial Support	Nonbinary	−0.076 **	0.045	0.090
Financial Support	Part-time Student	0.098 *	0.046	0.034

Table 8. *Cont.*

		Regression Coefficient	*SD*	*p*-Value
Access and Opportunity	STEM Major	0.107 *	0.043	0.013
Access and Opportunity	Ph.D. Student	0.210 *	0.041	0.000
Imposter Syndrome	Black	−0.100 *	0.049	0.027
Imposter Syndrome	International student	−0.162 *	0.046	0.000
Imposter Syndrome	Part-time student	−0.200 *	0.045	0.000
Imposter Syndrome	4th-year student	−0.113 *	0.045	0.012
Microaggressions	Nonbinary	0.117 *	0.038	0.002
Microaggressions	Female	0.614 *	0.033	0.000
Microaggressions	Part-time Student	0.117 *	0.038	0.002

Note: * denotes a significant value of $p < 0.05$; ** denotes a significant value of $p < 0.10$; items in red represent inhibitory relationships; standardized model.

3.2. Regression Coefficients for Direct Paths in SEM Model

In the original analysis of the survey items, microaggression, and imposter syndrome subscales were composed of reverse-coded items. To assist with easier interpretation, these items were re-coded, and higher scores for these items indicate a greater perception of those factors.

Effect of Measured Support and Success Factors for Underrepresented Groups

Hypothesis 2 predicted there would be more negative effects with measured support and success factors (e.g., microaggressions, microaffirmations, sense of belonging, and imposter syndrome) with underrepresented groups, such as non-male, URM, and first-generation college students. These relationships were present for some of the control variables, whereas others were not; therefore, the results partially supported Hypothesis 2 (Table 8). *P* values less than 0.05, and values less than 0.10 were used to identify which relationships were significant in the regression analysis.

Female students perceived fewer microaffirmations, and female and nonbinary students perceived more microaggressions than male students. This relationship supported the hypothesis that female and nonbinary students would experience more microaggressions than males. Nonbinary individuals perceived less financial support and a lower sense of belonging than male students, supporting Hypothesis 2. For race, many control variables did not significantly affect the latent variables, as predicted. Findings for two subgroups did not support Hypothesis 2. Native American students conveyed a greater perception of sense of belonging compared to White individuals, indicating a more supportive environment for this subgroup. Black students had a lower perception of imposter syndrome than White students (Table 8).

Numerous findings were consistent with Hypothesis 2. International students perceived less financial support but reported lower rates of perceived imposter syndrome than U.S. students. Part-time students revealed barriers they faced: a lower perception of mentor support and more microaggressions than full-time students. Full-time students reported a greater perception of imposter syndrome and less financial support than part-time students. Master's students reported lower scores for access, opportunities, and mentor support than Ph.D. students. Compared to 1st-year students, 4th-year students had a lower perception of imposter syndrome. STEM majors had higher mean scores than non-STEM majors for access, opportunity, and financial support (Table 8).

3.3. Effect on Success Factors for STEM Students

To further investigate the differences between STEM and non-STEM students, interaction terms were created with STEM majors for female students, nonbinary individuals, first-generation bachelor's students, and first-generation graduate students. An initial analysis was conducted with interaction terms between STEM and four racial subgroups, Black, Latino/a, Native American, and Multiracial, with White as the comparative group. However, no significant relationships were found between those terms. Therefore, an

additional interaction term was created for STEM and URM students, including Black, Latino/a, Native American, and Multiracial students. For the SEM analysis, previously used control variables were removed, and the STEM interaction terms were applied to all the latent variables. The model produced an acceptable fit with the following indices: CFI = 0.918, SRMR = 0.066, and RMSEA = 0.047 [99,101]. The $\chi 2$ value was not acceptable, at $\chi 2 = (432, N = 537) = 945.353$, $p < 0.005$, though it is most likely attributed to the larger sample size [98].

Supports for STEM-Interaction Terms

As seen in Table 9, several interaction terms produced relationships, revealing that various STEM subgroups encountered more barriers during graduate school, supporting Hypothesis 3. STEM-nonbinary individuals indicated a lower sense of belonging, and STEM-female and STEM-nonbinary students revealed a greater perception of imposter syndrome and more microaggressions than other students. However, other relationships revealed additional support for STEM subgroups, in contrast with Hypothesis 3. STEM-URM had a greater perception of sense of belonging and access and opportunity, whereas STEM-first-generation students perceived a greater sense of belonging, fewer microaggressions, and greater financial support. STEM-female students also conveyed greater financial support.

Table 9. Significant regression coefficients for STEM interaction terms on latent variables.

		Regression Coefficient	*SD*	*p*-Value
Sense of Belonging	STEM-URM	0.053 **	0.029	0.069
	STEM-1st Gen. Grad.	0.061 *	0.032	0.030
	STEM-Nonbinary	−0.137 *	0.035	0.085
Financial Support	STEM-Female	0.127 *	0.049	0.008
	STEM-1st Gen. Grad.	0.100 *	0.049	0.040
Access & Opportunity	STEM-URM	0.103 *	0.042	0.015
Imposter Syndrome	STEM-Female	0.123 *	0.052	0.019
	STEM-Nonbinary	0.114 *	0.046	0.013
Microaggressions	STEM-Female	0.496 *	0.040	0.000
	STEM-Nonbinary	0.087 *	0.044	0.045
	STEM-1st Gen. Grad.	−0.205 *	0.044	0.000

Note: * significant at $p < 0.05$; items in red represent inhibitory relationships; ** denotes a significant value of $p < 0.10$; standardized model.

3.4. Limitations

This study represents the responses from students at one research university in one year in which students experienced virtual learning during the COVID-19 pandemic. The additional stresses of the COVID-19 pandemic and attending graduate school virtually could have influenced students' responses to be different than if the study had occurred at a different time. The responses represent approximately 13% of the graduate students invited to participate and, therefore, reflect a subset of students at the university. The results of this study were analyzed with constructs from the theoretical framework, self-determination theory. Utilizing another framework with a different group of students at a different non-COVID-19 period may have led to different findings.

4. Discussion

This study sought to better understand graduate students' experiences via the GSSS. Structural equation modeling provided a mechanism to determine the interconnections between the survey's latent constructs (i.e., microaffirmations, sense of belonging, mentor relationships, imposter syndrome, access and opportunities, microaggressions, and financial support) in conjunction with self-determination theory constructs [9]. The SEM model investigated survey results based on students' personal characteristics (i.e., enrollment status, gender, major, race and ethnicity, degree type, and first-generation status). SEM provided a better understanding of the role these factors have on students' experiences.

The study's structural equation modeling analysis of the Graduate Student Support Survey data found that microaffirmations, microaggressions, mentor support, and financial support impacted the experiences of graduate students. These constructs resonated with the basic psychological needs essential for an individual's health and well-being, contributing to positive life outcomes and the success and support of graduate students [9,59]. Contexts that thwart these needs, such as microaggressions and less financial support, were documented in the SEM for particular groups.

4.1. Connecting the Findings to Self-Determination Theory Constructs

4.1.1. Relatedness

Sense of belonging had a positive relationship with microaffirmations, mentor support, and financial support (Table 7), suggesting in SDT terms that students had a greater sense of *relatedness*. Previous research has revealed a positive relationship between faculty-student engagement and positive outcomes for undergraduate students, such as degree attainment [13,105]. Similar to the current study, prior work has shown that access to mentors and role models can reduce inhibiting factors, especially for underrepresented students at the undergraduate, graduate, and faculty levels (e.g., [12,54,106,107]).

4.1.2. Competence

Imposter syndrome, inversely related to *competence* in this study's theoretical framework, had a positive relationship with microaggressions, indicating that students who encountered more microaggressions also conveyed greater concerns with imposter syndrome (Table 7). Resonating with this assertion, Kamarzarin et al. identified a negative correlation between self-esteem and the imposter phenomenon among physicians in Iran [41]. Similarly, Nadal et al. shared that lower self-esteem was predicted by racial microaggression in undergraduate students [108]. The relationship found in the current study, the positive correlation between microaggressions and imposter syndrome, highlights an area that needs additional support; previous research with undergraduates has indicated that higher levels of perceived *competence* can help maintain interest in higher education [109].

4.1.3. Autonomy

For this study, the theoretical construct of *autonomy* was represented through opportunities students were provided outside of coursework on the access and opportunities subscale. The analysis found a positive relationship between access and opportunity and mentor support. Students who had more positive relationships with their mentors perceived more opportunities for academic writing and research and attending conferences. For this study, these opportunities beyond the degree requirements reflected students' perceptions of *autonomy* or choice in their educational future. Resonant with these findings, Hébert shared that opportunities to complete research with faculty allowed undergraduate students to experience immersion in learning while engaging in authentic problem-solving, which increased students' self-confidence and self-awareness [110].

Graduate students with more financial support revealed higher rates of *autonomy* based on responses to access and opportunity items (Table 7). This relationship may be attributed to the benefit of financial support through assistantships and other financial supports. For instance, many graduate students who are on assistantships also receive travel support to present their research at regional, state, national, and even international conferences, which would go beyond the base support of an assistantship. However, students who are not funded on assistantships or whose departments have less funding may need help with tuition, which would lead to experiencing more significant financial concerns. Prior studies have found that undergraduate students negate the effects of tuition costs by attending school part-time or maintaining additional employment [111,112]. Students who attend part-time or work additional hours often have fewer opportunities to participate in other education opportunities [112,113]. Fewer opportunities to participate in research activities could potentially lower their sense of *autonomy*.

4.1.4. Summary

The findings of the study were considered in light of the corresponding constructs in self-determination theory: *relatedness*, *competence*, and *autonomy*. Sense of belonging, or *relatedness*, had a positive relationship with microaffirmations, mentor support, and financial support. Imposter syndrome, which is inversely related to *competence,* was positively correlated with microaggressions. That is, students who encountered more microaggressions also expressed greater concerns about imposter syndrome. The access and opportunities graduate students were afforded, beyond coursework, reflected their *autonomy*. There was a positive relationship between access and opportunity (autonomy) and mentor support, as well as financial support.

4.2. Variance between Subgroups

4.2.1. Gender, Race, and Ethnicity

Lower rates of microaffirmations, more microaggressions in female students, and lower rates of sense of belonging in nonbinary individuals were found in the current study; these areas may need additional support on campus to create an inclusive climate. Similar to prior findings with female graduate students in physics and astronomy, the female students expressed higher rates of microaggressions than male students [114].

In the current study, Native American students revealed a greater sense of belonging, and African American students felt less imposter syndrome (Table 8). Consistent with the current study's finding, Lige et al. found that African-American undergraduate students perceived lower levels of imposter syndrome when they held positive attitudes toward their African-American identity [44]. In contrast to these findings, prior studies have documented that URM undergraduate students experienced a sense of otherness based on their race, ethnicity, first-generation status, and socioeconomic status [115,116].

4.2.2. International Students

U.S. citizens experienced more imposter syndrome, whereas international students had more financial concerns (Table 8). Similar to the findings of this SEM study, Nguyen conveyed that international graduate students often struggle with financial concerns [117]. The SEM findings also resonated with those of Curtin et al., who reported that international graduate students experienced a greater sense of belonging than domestic students [38]. A narrative study by Collier and Blanchard found that international graduate students experienced a low sense of belonging, struggled with financial issues, perceived low mentor support, and lacked access and opportunities in their programs [47].

4.2.3. Ph.D. and Master's Students

In the current study, master's students communicated fewer opportunities for research and writing and less mentor support (Table 8). Lower scores for access and opportunity for master's students might be attributed to the design of their program. These findings are consistent with Ren and Hagedorn's findings of unique educational expectations for master's and doctoral students, which predicted differences in work habits and academic performance [118]. The authors found that doctoral students were expected to work independently, whereas master's students were socialized as team players.

4.2.4. Part-Time Students

Part-time students expressed fewer financial concerns and perceived less imposter syndrome than full-time students but experienced more microaggressions and less mentor support. It is likely that part-time students have additional employment, which may lessen financial concerns, consistent with what was found by Collier and Blanchard [47]. However, opportunities to interact with mentors and peers are less frequent if they attend classes at night and have lower participation rates in social events outside of the required coursework (Table 8).

Similar results were reported by Oswalt and Riddock, who found that the biggest sources of financial stress for graduate students were issues that were less likely to impact part-time students (e.g., healthcare costs, needing a larger graduate assistantship stipend,

and university fees) [119]. In addition to financial concerns, Oswalt and Riddock reported that full-time students indicated more feelings associated with the imposter phenomenon and less optimism toward completing their program. In interviews with graduate students, the Authors found that the part-time students felt a lower sense of belonging and struggled less with finances, but the mentor support was variable [47]. In this study, those findings depended upon which of the student groups were investigated. Consistent with the current study's findings, Yusuf et al. found that part-time graduate students had a better work–life balance than full-time students [120].

4.2.5. STEM Majors

In the analyses, several areas of concern were identified with STEM students. STEM-nonbinary students expressed a lower sense of belonging, whereas STEM-female and STEM-nonbinary students conveyed more concerns with imposter syndrome and microaggressions (Table 9). These findings are consistent with prior research, in which female undergraduate and graduate students have been found to have more concerns with the imposter phenomenon and a lower sense of belonging [20,121,122].

The survey also identified areas in which STEM students conveyed greater support than other students. STEM students, STEM-female, and STEM-first-generation students communicated greater financial support, whereas STEM-URM indicated a higher score for access and opportunities. STEM-first-generation graduate students revealed fewer experiences with microaggressions, and both STEM-URM and STEM-first-generation graduate students expressed a greater sense of belonging than other students (Table 9).

The SEM analysis indicates higher levels of *autonomy* for STEM students through positive responses to their financial support and *relatedness* through their stronger sense of belonging. These findings resonate with prior studies showing that individuals who are employed in STEM careers have a level of security and opportunity, which also alleviates the health and economic disadvantages they may have faced [2,123,124].

4.2.6. First-Generation College Students

In the current study, there were few significant differences between first-generation and continuing-generation college students. STEM first-generation graduate students perceived more financial support, a greater sense of belonging, and fewer microaggressions than other graduate students. A narrative study by Collier and Blanchard revealed that finances were the biggest struggle for first-generation graduate students, but they reported stronger mentor and peer support and a stronger sense of belonging [47]. In contrast to the current study, Gardner and Holley affirmed that first-generation doctoral students expressed feelings related to a low sense of belonging and imposter phenomenon [125]. Additionally, conflicting with the current study's results, Roksa et al. found that first-generation Ph.D. students in biology published fewer articles than continuing-generation Ph.D. students in their second year, reflecting less access and opportunities for academic writing research [126]. Ellis et al. shared that first-generation undergraduate students at a Predominantly White Institution (PWI) experienced microaggressions from peers (i.e., inferior intelligence and lack of academic preparation) [127].

4.3. Future Research

To better understand graduate students' experiences, a second iteration of the GSSS could include students across additional areas of the U.S. [81]. Ideally, this could increase the number of students in URM and gender groups. Interviews with graduate students could provide greater insight into their experiences, understand areas the survey did not address, clarify areas that were unclear from the SEM quantitative results, and add more depth to understanding the nuances of their experiences (e.g., [47]). A study on improving GSSS factors using interventions could measure whether these steps increased academic success (higher GPAs, degree attainment, and mental well-being) for graduate students [11–14].

5. Conclusions

The purpose of this study was to better understand the experiences of graduate students. Structural equation modeling was used to reveal connections between the GSSS graduate student success factors (i.e., microaffirmations, sense of belonging, mentor relationships, imposter syndrome, access and opportunities, microaggressions, and financial support) and self-determination theory constructs [9]. The SEM model provided a vehicle to investigate the experiences of students based on a wide range of personal factors. These included enrollment status (full or part-time), gender, major (STEM/non-STEM), demographic group (race/ethnicity), degree type (M.S./Ph.D.), and family college experience (first/continuing generation). In doing so, it was possible to better understand the role of these factors on students' experiences. Results from the current study highlight the impact mentor support and peer relationships (through microaggressions and microaffirmations) can have on an individual's perceptions of *relatedness*, *competence*, and *autonomy*. In addition, external stress, as with financial concerns, can thwart fulfilling a student's basic needs and negatively impact their well-being.

The study's results indicate that graduate students were significantly impacted by microaffirmations, microaggressions, mentor support, and financial support. The ways that they were impacted had a lot to do with who they were, how they attended school, and their context. In an analysis of demographic characteristics, female and nonbinary individuals conveyed results representing additional barriers (e.g., lower rates of microaffirmations and more microaggressions). In contrast, Native American and African American students' responses represented more support (e.g., greater sense of belonging and less imposter syndrome). The SEM analysis also identified other concerns for various groups (e.g., part-time and international students). However, many groups created from STEM interaction terms showed greater support than students in non-STEM programs (e.g., financial support, access and opportunity).

5.1. Recommendations for University Programs

Graduate students' experiences are very much influenced by who they are. The findings of this survey suggest that students' personal factors alter their experiences and needs. Therefore, the findings of the study lead to a number of recommendations to better support students.

Faculty ought to be made aware of how students' needs differ based on such things as their status (e.g., enrollment level, international status, gender, and race/ethnicity). Faculty need professional development opportunities to better understand the critical role they play in supporting graduate students and to help them develop as mentors. Similar programs also ought to be geared toward graduate students so that more advanced students are better prepared to serve as mentors to more junior students.

Programs could develop cohorts to support students or encourage those at an informal level. In addition, financial planning and counseling that provides clear information about students' financial obligations and available support should be provided. A focus on increasing the availability and level of student funding ought to be a priority.

Graduate student professional development opportunities (e.g., research, writing, conference presentations) ought to be provided, with a focus on making sure that those who are less likely to have access (e.g., part-time students, those underrepresented in programs) are sought out. In addition, providing workshops or seminars on issues that greatly impact students' experiences, such as imposter syndrome, microaggressions, and sense of belonging, could help students realize that their experiences are shared by others and learn how to better navigate those experiences. Workshops on career development at every stage of graduate school could help students know what opportunities exist and how to gain access to them. These opportunities ought to be encouraged and supported by faculty members.

5.2. Recommendations for Future Research

It is hoped that other researchers will follow up on this study by seeking out different settings to administer the survey so that we can learn more about graduate students' experiences at (1) Hispanic-serving institutions (HSI), (2) Historically Black College and Universities (HBCUs), (3) Women's colleges, and (4) Public universities that have higher percentages of first-generation students.

In addition, mixed methods and qualitative studies (e.g., Collier and Blanchard [47]) focused on graduate students could provide additional insight into how to better support and motivate graduate students' success.

This research provides empirical support for the differing needs of graduate students based on their majors, demographic, and socio-cultural backgrounds. Understanding the impacts of these factors—particularly for those students who are negatively affected—can alert university administrators, advisors, and mentors to students' needs. It is hoped that this research will provide insight that will lead those in graduate education to better support and facilitate graduate students' academic and personal growth and enhance an inclusive climate for all graduate students.

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Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The datasets generated and analyzed during the current study are not publicly available due to the potential to compromise the individuals' privacy but are available from the corresponding author upon reasonable request.

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Appendix A

Table A1. Graduate Student Success Survey.

Micro-affirmations	Q24: My work is valued in my program. Q23: People in my program value my ideas. Q22: I am treated with respect in my program. Q25: I am encouraged to complete my degree.
Sense of Belonging	Q33: I feel a sense of belonging in my program. Q35: I have received academic support from faculty members in my program. Q36R: I feel isolated in my program [83]. Q34: I have received academic support from graduate students in my program. Q32: I feel my advisor cares about my well-being.

Table A1. *Cont.*

Mentor Relationships	Q48: I receive helpful feedback on my research from the faculty in my program. Q46: I have relationships with the faculty in my program that support my academic progress. Q47: My own goals and research interests are incorporated into my master's/doctoral research.
Financial Support	Q41: Insufficient financial support from the Graduate Student Support Plan (GSSP) has slowed my progress toward a degree. Q40R: I worry about having financial support during the summer months. Q39: I receive enough financial support from the Graduate Student Support Plan (GSSP) to maintain an acceptable standard of living. Q42R: I am concerned about the amount of debt I have taken on for graduate studies. Q44R: I am concerned about affording the technology I need to support my graduate work. Q43: I am unsure of whether I will have financial support next year.
Access & Opportunity	Q56: I have opportunities to write academic papers for publication. Q52: I have opportunities to participate in conferences. Q54: I have opportunities to help write grant proposals. Q53: I have opportunities to engage in extension activities beyond my program. Q38: I have had opportunities to receive assistantships for research.
Imposter Syndrome	Q30: I often compare myself to those around me and think they may be more intelligent than I am. Q28: I am afraid people may find out that I am not as capable as they think I am. Q29: I am often afraid that I may fail at a new assignment or undertaking even though I generally do well at what I attempt [84].
Micro-aggressions	Q19: My opinions are overlooked in group discussions because of my gender. Q18: Other people make assumptions about my abilities because of my gender.

Note: Items with an R represent reverse-coded items in item analysis.

Table A2. Bivariate Correlations between Observable Variables.

	q24	q23	q25	q33	q35	q36	q34	q48	q46	q47	q41	q40
q24	1											
q23	0.801	1										
q22	0.665	0.703										
q25	0.672	0.618	1									
q33	0.643	0.607	0.540	1								
q35	0.548	0.534	0.519	0.518	1							
q36	0.518	0.490	0.423	0.656	0.425	1						
q34	0.397	0.386	0.326	0.493	0.499	0.451	1					
q48	0.502	0.442	0.463	0.468	0.517	0.375	0.279	1				
q46	0.515	0.501	0.471	0.551	0.584	0.441	0.357	0.557	1			
q47	0.395	0.394	0.372	0.401	0.403	0.328	0.268	0.542	0.435	1		
q41	0.270	0.229	0.244	0.242	0.206	0.266	0.249	0.112	0.101	0.084	1	
q40	0.215	0.162	0.168	0.106	0.132	0.141	0.119	0.060	0.066	0.063	0.475	1
q39	0.194	0.176	0.145	0.188	0.143	0.155	0.111	0.070	0.047	0.053	0.546	0.457
q42	0.124	0.132	0.113	0.113	0.120	0.111	0.141	0.051	0.031	0.070	0.451	0.407
q44	0.157	0.170	0.136	0.132	0.178	0.133	0.159	0.118	0.089	0.127	0.470	0.383
q43	0.281	0.230	0.307	0.232	0.236	0.201	0.204	0.177	0.218	0.162	0.377	0.506
q56	0.308	0.292	0.345	0.314	0.326	0.276	0.234	0.429	0.309	0.314	0.055	0.069
q52	0.235	0.234	0.304	0.307	0.219	0.226	0.207	0.301	0.271	0.317	0.051	0.094
q54	0.249	0.251	0.301	0.315	0.288	0.272	0.147	0.296	0.271	0.273	0.087	0.163
q53	0.247	0.235	0.295	0.346	0.288	0.313	0.259	0.260	0.303	0.276	0.171	0.134
q38	0.217	0.192	0.191	0.181	0.215	0.220	0.132	0.256	0.201	0.204	0.081	0.157
q30	0.058	0.107	−0.005	0.055	−0.021	0.156	0.023	0.010	0.072	0.048	0.030	0.085
q28	0.036	0.010	−0.003	0.026	−0.062	0.108	−0.060	−0.016	0.041	0.015	−0.035	0.012
q29	0.089	0.075	0.078	0.077	0.015	0.172	0.056	0.058	0.063	0.032	0.109	0.064
q19	0.230	0.277	0.192	0.131	0.177	0.223	0.077	0.161	0.082	0.077	0.172	0.111
q18	0.135	0.156	0.113	0.088	0.130	0.176	0.072	0.075	−0.011	0.056	0.116	0.094

	q39	q42	q44	q43	q56	q52	q54	q53	q38	q30	q28	q29	q19	q18

Table A2. *Cont.*

q39	1													
q42	0.431	1												
q44	0.364	0.428	1											
q43	0.265	0.356	0.392	1										
q56	0.085	0.110	0.081	0.152	1									
q52	0.066	0.067	0.081	0.173	0.451	1								
q54	0.125	0.102	0.049	0.210	0.441	0.349	1							
q53	0.088	0.091	0.140	0.194	0.305	0.412	0.422	1						
q38	0.251	0.115	0.050	0.171	0.354	0.319	0.311	0.208	1					
q30	−0.020	−0.015	0.069	0.009	0.026	−0.001	−0.048	−0.020	−0.047	1				
q28	−0.052	−0.049	0.012	−0.007	−0.069	0.016	−0.043	−0.017	−0.119	0.630	1			
q29	−0.001	0.026	0.111	0.096	0.060	0.066	0.033	0.018	−0.048	0.624	0.631	1		
q19	0.182	0.165	0.191	0.049	0.181	0.071	0.017	0.037	0.063	0.140	0.150	0.194	1	
q18	0.118	0.111	0.147	0.015	0.122	0.031	0.020	0.053	0.015	0.144	0.130	0.139	0.620	1

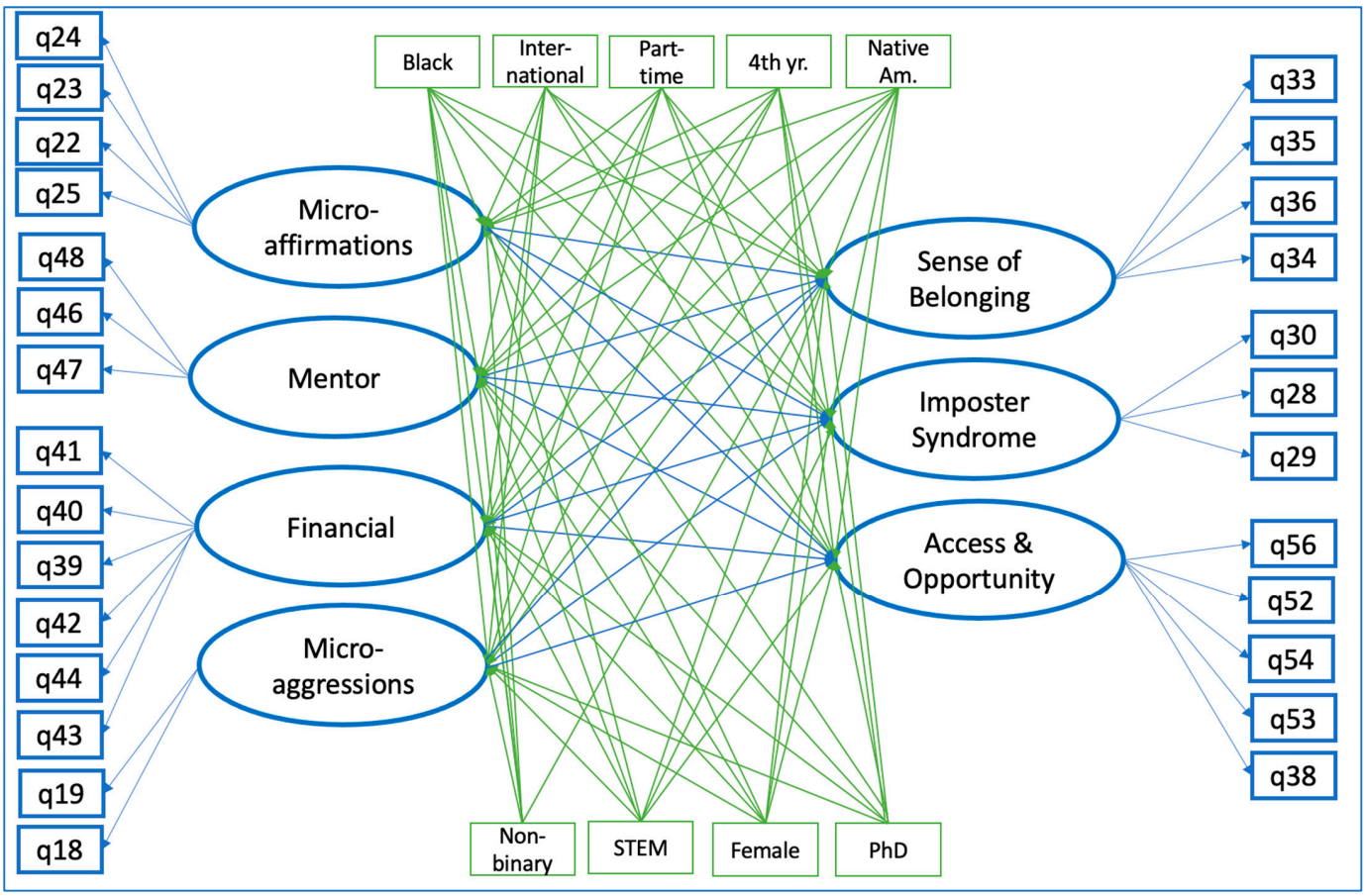

Figure A1. Hypothesized SEM Model.

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