Objectives and Purposes

Existing literature has established that interpersonal and academic validating experiences help provide college students with the necessary personal and scholastic skillsets to thrive in higher education (e.g., Coronella, 2018; Ekal et al., 2011). This intrinsic mixed-methods case study explores the extent to which undergraduate students perceived academic and interpersonal validation within a science, technology, engineering, and mathematics (STEM) pipeline program (CMSP) can empower students and influence their attitudes towards their learning environment. Specific research questions are as follows:

1) Is there a significant difference in students' perceptions of validation strategies frequency of implementation by their instructors depending on group (non-CMSP, entering CMSP, 1 year completed CMSP)?
2) Is there a significant difference in students' agreement with validating experiences in school depending on group (non-CMSP, entering CMSP, 1 year completed CMSP)?
3) How do CMSP students (entering and 1 year completed groups) describe their academic and interpersonal validation experiences within their classes, college, and the university?

Theoretical Framework

Validation Theory – Briefly Defined

This study is viewed through the lens of Validation Theory (Rendon, 1994). Validation as a paradigm for "enabling, confirming, and supportive process initiated by in- and out-of-class agents that foster academic and interpersonal development" (Rendon, 1994, p. 44) was birthed out of studies in the 1990s. Terenzini et al. (1994) sought to understand the significance of validating experiences in higher education for historically excluded students and found that validation stimulates successful transition in higher education and sense of belonging. Subsequent studies asserted that validation is made of several components across various settings in post-secondary spaces (e.g., Zhang, 2016; Acevedo-Gil et al., 2015). Particularly, academic in-class and out-of-class validation happen when an educator or mentor actively engages and initiates a relationship with the student. Similarly, interpersonal forms of validation (in-class and out-of-class) occur when students feel accepted and as though their peers/instructors are actively interested in them. As a result, validation is often understood as an essential criterion for a student's development (Rendon, 1994).

Context of the Case

The Department of Homeland Security (DHS) and the National Science Foundation (NSF) administer the CyberCorps Scholarship for Service (SFS) program to recruit and train the next generation of government cybersecurity professionals. These professionals will protect and defend our government's critical information infrastructure. The CyberCorps program provides scholarships for up to three years of support for undergraduate and graduate students. Additionally, CyberCorps students receive stipends during academic terms and professional development (PD) allowance. As of 2021, there are 84 colleges and universities that offer CyberCorps programs. The University serving as the site for this case study runs a CyberCorps program called the CyberCorps Mentoring Scholarship Program (CMSP).

CMSP specifically aims to strengthen the government's workforce by recruiting top talent, emphasizing recruiting women, underrepresented minorities, and veterans. To become a CMSP student, applicants must be a U.S. citizen or lawful permanent resident, enrolled full-time as an on-campus student, enrolled in a cybersecurity major, have a GPA of a least 3.0, be a pre-junior, and obtain an appropriate security clearance. CMSP students participate in weekly cohort meetings, which consist of various activities led by program faculty members. These activities include hands-on cybersecurity training, guest speakers from government agencies, resume writing, job interview practice, goal-setting, and many other activities. CMSP students receive a stipend of $6,250 during academic terms, full-tuition support, and $6,000 in PD funds. This PD allowance can be used for cybersecurity certification training, cybersecurity books, and travel to cybersecurity conferences or SFS hiring fairs.

Because we are explicitly interested in studying the case of CMSP, our case study is considered intrinsic (Stake, 1995). In viewing this intrinsic case study through a validation theory lens, we expect that STEM students who receive financial and academic support from the CMSP pipeline program may perceive their STEM learning environment differently than their peers who are not provided with similar validating supports. Further, validating messages communicated to CMSP students may positively influence students' attitudes toward their ability to persist in a STEM field.

Methods

Data Sources, Sample, & Analysis

Customary in case study research is the use of multiple data sources (Yin, 2003). "Each data source is one piece of the 'puzzle,' with each piece contributing to the researcher's understanding of the whole phenomenon" (Baxter & Jack, 2008, p. 554). In this case study, we employ a concurrent triangulation mixed-method approach where quantitative (survey) and qualitative (interview) data are considered equal in weight and used to provide a holistic picture (Hanson et al., 2005) of this case.

Survey. To answer RQs 1 and 2, undergraduates in the College of Computing and Informatics (CCI) at this university were asked to complete two sections, the *Diverse Learnings Environments* (*DLE*) survey that focus on Academic Validation in the Classroom (7 items) and General Interpersonal Validation (6 items). These 5-point *DLE* survey scales have been validated for use with a wide range of college students (Hurtado et al., 2011). A total of 47 CCI students completed the *DLE,* and their demographics are provided in Table 1. One-way ANOVAs were implemented to look for differences in each overall *DLE* survey section and at the individual item level by CMSP Cohort groups.

Interviews. To answer RQ 3, CMSP students (entering and 1 year completed cohorts) were asked to participate in online semi-structured interviews using Zoom. All 11 CMSP students participated (16% racial/ethnic historically excluded, 48% women). Interviews sought to understand student perspectives of CMSP program benefits and areas for improvement. More broadly, the interviews aimed to understand how students described validating experiences within the program, and how these experiences may have altered

their view of CMSP and their STEM self-efficacy. Transcriptions were unitized by participant response to allow for the smallest possible unit of analysis while still retaining meaning (Lincoln & Guba, 1985). Open and axial coding were implemented to analyze data to ensure all participant voices were represented (Billups, 2019; Saldaña, 2013). Approximately fifteen open codes were identified that were eventually narrowed down into the axial codes. Axial codes were (a) perceptions of CMSP (i.e., benefits and areas for improvement), (b) academic validation, and (c) interpersonal validation.

Results

RQ1. Validation Strategy Frequency Differences

Across *DLE* frequency items, there was not a significant difference in average scores by cohort group: $F(2, 46)=2.44$, $p=.099$. However, Figure 1 shows practical difference in average scores as CMSP End-of-Year 1 (EOY1) students were averaging in the "often" to "very often" range (4.23) across items. CMSP Entering students averaged in the approaching "often" range (3.83); and Non-CMSP students had an average between "occasionally" and "often" (3.48). Statistically insignificant findings are likely due to small sample sizes in CMSP Cohorts.

Table 2 provides a closer look at each *DLE* frequency item. Two items stood out as least frequently experienced practices regardless of cohort: *Instructors encouraged me to meet with them after or outside of class* (range of 3.39-3.83); *Instructors showed concern about my progress* (range of 2.67-3.60). Items with the greatest frequency of experience across cohorts were: *Instructors encouraged me to ask questions and participate in discussions* (range 3.89-4.60); Instructors could *determine my level of understanding of the course material* (range 3.56-4.60). The pattern of overall scale differences was again noted for individual items. Three items had statistically significant differences by cohort with EOY1 students reporting the greatest frequency followed by Entering and Non-CMSP students ($p<.05$).

RQ2. Validation Experience Agreement Differences

Across *DLE* agreement items, there was a significant difference in average scores by cohort group: $F(2, 46)=7.02$, $p=.001$. Figure 2 shows practical differences in average scores as CMSP EOY1 students averaged approaching "strongly agree" (4.77) across items; CMSP Entering students were right at the "agree" level (4.06); and Non-CMSP students had an average between "neutral" and "agree" (3.47).

DLE agreement item averages by cohort are presented in Table 3. Two items were more challenging for students to endorse across cohorts: *Staff encourages me to get involved in campus activities* (range 3.33-4.40), and *Staff recognize my achievements* (range 3.22-4.60). One item had all three groups reporting an average between nearly "agreeing" to "strongly agreeing" across cohorts: *Faculty believe in my potential to succeed academically* (range 3.78-5.00). The pattern of overall scale differences remained similar for individual items. All but one item in this section had statistically significant differences by cohort with EOY1 CMSP students reporting the greatest frequency followed by Entering CMSP students and Non-CMSP students ($p<.05$, $p<.01$, $p<.001$).

RQ3. CMSP Student Validation Descriptions

This research question explored how CMSP students (entering and 1-year completed groups) describe their validating experiences within their classes, college, and the university. A summary of interview findings by validation area is in Table 4.

In Class Academic Validation

Across cohorts, students expressed they felt academically validated in-class by similar experiences. Students mentioned that they feel validated academically in class through group-based projects to apply knowledge from class. One participant stated that "group work is very valuable" to their academic validation. Two entering CMSP students added that for them, academic validation comes from class discussions and interactions. These are some of the practices that can be easily implemented by faculty in CyberCorps classes to support participants' academic validation further.

Out of Class Academic Validation

EOY1 students identified more experiences that shaped their academic validation related to academic validation outside of the classroom. Entering CMSP students spoke more broadly about experiences that molded their out-of-class academic validation and did not explicitly list activities. However, it is apparent that participation in mentorship and community organization positively influenced out-of-class academic validation in both cohorts.

Salient concepts under out-of-class academic validation are professional experiences, organizations, and mentorship. Four out of six participants interviewed indicated that they had been validated academically through co-ops and part-time jobs. Both cohorts spoke highly of their experiences with student clubs and organizations as a source of academic validation outside-of-class. Further, three students mentioned the importance of mentorship and interactions with people experienced in the field; these include advisors in and outside academia, TAs and guest speakers from the industry.

In-Class Interpersonal Validation

In-class interpersonal validation was also similar across cohorts; however, EOY1 students pointed to specific experiences and events that support their in-class validation. Entering CMSP students noted that guest speakers and interactions with the staff (instructors) created a sense of in-class interpersonal validation. EOY1 students expanded upon this notion and shared that the type of guest speakers matters — they noted that representation mattered, which was critical to feeling interpersonal validation in the classroom. These students also discussed explicit experiences that developed their in-class interpersonal validation. Dissemination of resources by instructors, such as internships and how to navigate higher education, was mentioned. Both groups discussed the importance of relationships in shaping in-class interpersonal validation. These two cohorts demonstrate similar forms of validation that manifest before starting the CMSP program and continue to blossom.

Out of Class Interpersonal Validation

Interpersonal validation outside of the classroom manifested similarly across the two cohorts. Both groups identified community as the primary source of interpersonal validation out-of-class. Students referenced outside organizations as a source for community, such as sororities, fraternities, and extracurricular clubs such as Cyber Dragons: Cybersecurity Club. Students also noted the importance of family for out-of-class interpersonal validation.

Scholarly Significance

This mixed-methods intrinsic case study illustrates how validation in STEM can positively influence undergraduates' perceptions of their learning environment and ability to persist in STEM, which is aligned with validation research (Rendon, 1994; Terenzini et al., 1994). Further, this study demonstrates that greater exposure to strategies and mentoring intentionally designed with Validation Theory in mind increased student perceptions and desire to persist in a STEM field. Until recently, most Validation Theory studies have used qualitative methods alone (Hurtado et al., 2011). Our study adds to the body of literature by providing a case study using both quantitative and qualitative data sources. Findings from this study suggest that Validation Theory has a place in STEM education and can help to improve student sense of belonging. Additionally, this study holds important implications for instructional and mentoring strategy best practices to cultivate inclusive and equitable learning spaces in STEM in higher education environments.

Table 1. ***Survey Participant Demographics***

Demographic Variable	% (*f*)
Gender	
Male	46.8% (22)
Female	48.9% (23)
Not Reported	4.3% (2)
Race/Ethnicity	
Asian	12.8% (6)
Asian/White	4.3% (2)
Biracial	2.1% (1)
Black/African American	6.4% (3)
Hispanic/Latino	4.3% (2)
White	68.1% (32)
Not Reported	2.1% (1)
Year in CCI	
Freshman	10.6% (5)
Sophomore	10.6% (5)
Pre-Junior	23.4% (11)
Junior	31.9% (15)
Senior	23.4% (11)
CMSP Cohort Groups	
Non-CMSP	76.6% (36)
Entering CMSP	12.8% (6)
1 Year Completed CMSP	10.6% (5)

Figure 1. ***DLE Frequency Items Average by Cohort***

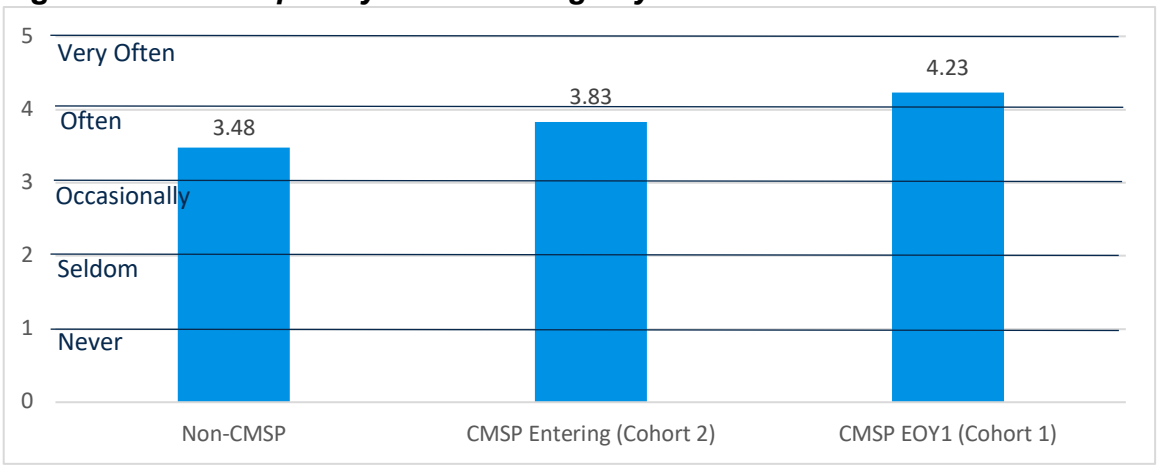

Table 2. ***One-Way ANOVA Table for DLE Frequency Items by Cohort***

DLE Frequency Items	Average Scores			*F*-statistic
	Non-CMSP	Entering (Cohort 2)	EOY1 (Cohort 1)	
Instructors were able to determine my level of understanding of the course material	3.56	4.17	4.60	4.28*
Instructors provided me with feedback that helped me judge my progress	3.58	4.00	4.00	0.83
I feel like my contributions were valued in class	3.50	3.83	4.60	3.47*
Instructors encouraged me to meet with them after or outside of class	3.39	3.83	3.80	0.59
Instructors encouraged me to ask questions and participate in discussions	3.89	4.50	4.60	2.50
Instructors showed concern about my progress	3.11	2.67	3.60	0.82
Faculty empower me to learn here	3.33	3.89	4.40	3.49*

Note. *p<.05

Figure 2. ***DLE Agreement Items Average by Cohort***

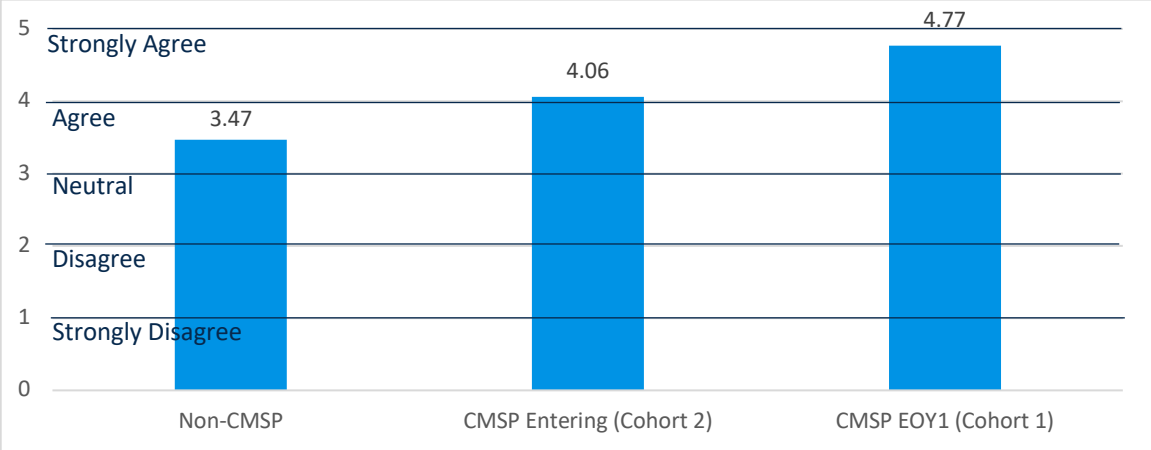

Table 3. ***One-Way ANOVA Table for DLE Agreement Items by Cohort***

DLE Agreement Items	Average Scores			*F*-statistic
	Non-CMSP	Entering (Cohort 2)	EOY1 (Cohort 1)	
Faculty empower me to learn here	3.58	4.00	4.60	3.43*
At least one staff member has taken an interest in my development	3.36	4.67	5.00	8.06***
Faculty believe in my potential to succeed academically	3.78	4.00	5.00	4.79*
Staff encourage me to get involved in campus activities	3.33	3.33	4.40	2.21
Staff recognize my achievements	3.22	3.67	4.60	3.79*

Interview Areas of Inquiry	CMSP End of Year 1 (Cohort 1)	CMSP Entering (Cohort 2)
Validation		
In Class Academic Validation	1) Positive rapport with professors 2) Hands-on activities	1) Group-based projects & class discussions 2) Growth opportunity: More applied application of knowledge
Out of Class Academic Validation	1) Award nomination 2) Attending out-of-class academic activities 3) Getting support from others 4) Assuming peer mentoring roles	1) Personal experiences 2) Organizations 3) Mentorship
In Class Interpersonal Validation	1) Guest speakers 2) Staff Interactions	1) Resources 2) Representation 3) Relationships
Out of Class Interpersonal Validation	1) Engagement with university organizations 2) Staff interactions	1) Community (e.g., outside organizations)

At least one faculty member has taken an interest in my development	3.56	4.67	5.00	7.51**

Note. *p<.05; **p<.01; ***p<.00

Table 4. ***Interview Summary***

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