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Improving Belonging and Connectedness in the Cybersecurity Workforce: From College to the Profession

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Abstract

This article explores the results of a project aimed at supporting community college students in their academic pursuit of an Associate of Applied Science (AAS) degree in Cybersecurity through mentorship, collaboration, skill preparation, and other activities and touch points to increase students' sense of belonging and connectedness in the cybersecurity profession. The goal of the project was focused on developing diverse, educated, and skilled cybersecurity personnel for employment within local industry and government to help curtail the current regional cybersecurity workforce gap that is emblematic of the lack of qualified cybersecurity personnel that presently exists nationwide. Emphasis throughout the project was placed on community building so that students felt a part of the cybersecurity community. A project community survey was distributed to students as both a pre-test when they began the project in Year 1 at the start of their cybersecurity coursework, and again as a post-test at the conclusion of Year 2 when they finished their cybersecurity program. Two project cohorts were employed, and the survey questionnaire measured students' sense of connectedness and level of learning within the project environment. The results showed a marked increase in both constructs from the pre- to post-survey indicating that students felt a greater sense of community as they moved through the project and experienced increased learning through their cybersecurity program. The study concluded that increased feelings of connectedness to the project activities through authentic shared learning experiences promoted belonging and provided social and academic supports to help project students be successful in their cybersecurity academic program and going forward in the in-demand cybersecurity vocation throughout their professional careers.

Keywords

cybersecurity, belonging, community, connectedness, diversity, education, learning

Cover Page Footnote

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***Abstract* —This article explores the results of a project aimed at supporting community college students in their academic pursuit of an Associate of Applied Science (AAS) degree in Cybersecurity through mentorship, collaboration, skill preparation, and other activities and touch points to increase students' sense of belonging and connectedness in the cybersecurity profession. The goal of the project was focused on developing diverse, educated, and skilled cybersecurity personnel for employment within local industry and government to help curtail the current regional cybersecurity workforce gap that is emblematic of the lack of qualified cybersecurity personnel that presently exists nationwide. Emphasis throughout the project was placed on community building so that students felt a part of the cybersecurity community. A project community survey was distributed to students as both a pre-test when they began the project in Year 1 at the start of their cybersecurity coursework, and again as a post-test at the conclusion of Year 2 when they finished their cybersecurity program. Two project cohorts were employed, and the survey questionnaire measured students' sense of connectedness and level of learning within the project environment. The results showed a marked increase in both constructs from the pre- to post-survey indicating that students felt a greater sense of community as they moved through the project and experienced increased learning through their cybersecurity program. The study concluded that increased feelings of connectedness to the project activities through authentic shared learning experiences promoted belonging and provided social and academic supports to help project students be successful in their cybersecurity academic program and going forward in the in-demand cybersecurity vocation throughout their professional careers.**

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I. Introduction

A worldwide cybersecurity workforce shortage presently exists for qualified cyber professionals. It is expected that the cybersecurity shortage will remain as the current workforce is not keeping pace with demand [1]. Today, there are approximately 4.7 million cybersecurity professionals in the cybersecurity workforce and even so, the shortage of skilled cybersecurity workers endures [2]. According to the 2022 (ISC)^2 Cybersecurity Workforce Study, there is presently a global shortage of 3.4 million cybersecurity professionals with more than 700,000 unfilled positions in the United States [3]. This is amplified in the first-ever "State of the Federal Cyber Workforce Report" that details the chronic workforce challenges faced by federal agencies as they strive to minimize the cyber workforce gap through a coordinated, interagency approach [4].

Given that this cybersecurity workforce shortage is so pervasive in both industry and government, this project was designed to serve as a regional effort to strengthen cybersecurity workforce needs in both government and industry. This project aimed to solve this deficit and meet critical workforce development demands for trained cybersecurity personnel.

II. Project Overview

A. Project Focus

This project worked with two student cohorts enrolled in the Cybersecurity Associate of Applied Science (AAS) program at a two-year community college with three campuses located south of Washington, DC. The focus of the project was to support cybersecurity students in their academic progress and respective program concentrations by implementing a variety of curricular and co-curricular activities in the cybersecurity discipline to improve retention, student academic success, and degree attainment, with particular emphasis on underserved students.

Project activities were multi-faceted. On the programmatic front there were curriculum updates that included a new concentration in Information Assurance. In addition, faculty were supported with training and new and/or updated certifications. There was alumni engagement and industry and government stakeholder involvement to allow for continuous feedback and real-world input. A Cybersecurity Advisory Council of industry leaders ensured a responsive and adaptive approach to the cybersecurity curriculum. This collaboration shaped the project's strategies for program development, aligning with industry requirements, and fostering continual enhancement for impactful cybersecurity education.

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To support cybersecurity students enrolled in the project, activities were numerous and varied over the course of the four-year project that included two cohort groups. There were annual "Night of Cybersecurity" career awareness events for current and prospective students where local employers discussed cybersecurity career opportunities. Multiple field trips occurred throughout the project – both virtual and in-person - to expose students to cybersecurity regional opportunities. Capture the Flag competitions occurred yearly with student participation and a summer Boot Camp was offered to assist students in preparing for CompTIA Security+ Certification. Open Labs were developed at each of the college's three campuses where cybersecurity students had access to technology resources as well as an opportunity for part-time employment as student lab assistants to help build their resumes.

B. Project Goal

For this project, the role of project connectedness as it relates to the academic learning environment at a two-year community college was examined. This research was pursued to ensure engagement within and throughout the project by creating high academic expectations with sustained and continued student supports for authentic learning and student belonging.

Throughout the project, students were engaged with a Cybersecurity AAS curriculum rich in industry-specific skills and knowledge. In addition, this project was able to provide necessary academic and curricular supports, as well as encourage positive and engaged student-to-student and student-to-faculty relationships. In coordinating a variety of activities and opportunities for students throughout their time in the Cybersecurity AAS program, the hypothesis was that higher levels of student connectedness and a sense of belonging would occur.

As prior research has shown, when students believe that their academic institution supports and believes in them and their learning, they feel connected to the academic program as well as believe in their own capabilities and achievement [5] [6]. Thus, throughout this project, the premise was to engage students in their own learning, as well as encourage interactions and community-building with their peers, faculty, the college community, and with industry cybersecurity professionals. In so doing, students felt a part of their educational endeavor, cared about their learning, and actively participated in extracurricular activities to strengthen their connections and network with outside business and governmental partners as well as the internal college community.

By keeping students connected and involved in the cybersecurity field while in college and preparing academically, this project aimed to build professional networks, both educative and within the workplace itself that students could rely on and build upon throughout their professional careers [7]. The goal was to show that by cultivating a strong sense of membership in the cybersecurity profession among participating project students in both cohort groups that students would feel as though they belonged and were a part of the cybersecurity profession resulting in greater tenure and advancement within the industry.

III. METHODOLOGY

The focus on designing the quantitative research component of this project was to measure the level of community and connectedness with a diverse group of students focused on technology-oriented careers in cybersecurity.

This research study evaluated community and student connectedness from two cohort groups of students to discern their sense of belonging and feelings of overall support while participating in the project and pursuing an AAS degree in Cybersecurity. Pre- and post-survey questionnaires were administered to all participating students in both project cohorts to assess their level of belonging and specifically the degree of connectedness and learning they experienced while in the project.

This quantitative assessment was used to determine if students felt a greater sense of belonging to the cybersecurity profession that they could then carry over from their academic preparation and studies to the workforce and their cybersecurity professional careers long-term.

A. Project Participants

The participants for this study were selected based on a competitive application process. Students were required to enroll full-time at the community college (at least 12 credits) and declare cybersecurity as their major. They also completed an application along with an essay where they discussed their background and how they believed they would benefit from participating in the project based on their cybersecurity interests.

Priority was given to diverse applicants with regards to age, ethnicity, gender, Veteran status, socioeconomic status, and/or disability. The goal was to identify students who were underrepresented in cyber careers and who may have been traditionally underserved in higher education.

The project was initially promoted to the first cohort group of students at a "Night of Cybersecurity" in-person event at the college. Twenty students applied for this first cohort and of those students, 13 were selected to participate. The following year, the "Night of Cybersecurity" event was held virtually due to the Covid-19 pandemic. Twelve students applied to the second cohort and eight students were selected.

Total demographic data of participants from the pre-survey is shown below in Table I. While there were a total of 21 students admitted into the project from both cohorts, 20 students agreed to voluntarily complete the pre-survey questionnaire - 13 from Year 1 and 7 from Year 2.

TABLE I. PARTICIPANT DEMOGRAPHICS

Demographic Data	**Total Participants**		
	Sub-categories	***N=20***	***%***
Age	18-24	12	60
	25-34	3	15
	35-44	4	20
	45-54	1	5
Gender	Male	11	55
	Female	8	40
	Did not state	1	5
Ethnicity	White	11	55
	African American	6	30

Demographic Data	Total Participants		
	Sub-categories	*N=20*	*%*
	Multi-racial/Other	3	15
Classes Completed	0-2	11	55
	3-5	2	10
	6-10	1	5
	11-15	3	15
	>15	3	15
Working	Full-time	5	25
	Part-time	5	25
	Not working	10	50

B. Survey Instrument

The Classroom Community Scale (CCS) created by [8] - and renamed the "Project Community Scale" for purposes of this study - was distributed to the two groups of project students - Cohort 1 and Cohort 2 - as both a pre- and post-survey to evaluate students' sense of community and connectedness while participating in the project.

This survey instrument measures a sense of community and belongingness in the learning environment. This environment was applied to the project community as the survey is recommended for use with populations such as online communities, commuter schools, and community colleges [9].

The survey instrument yields an overall project community score as well as scores related to connectedness and learning [10]. It has been tested previously for both validity and reliability showing Cronbach's coefficient for the overall survey instrument at 0.93 and reliability coefficients for the two subscales – social community and learning community – at 0.92 and 0.87 respectively [11]. In addition, a Flesch-Kincaid grade level score of 6.60 indicated that the survey instrument could be used by a wide range of student populations [12].

The 20-question survey instrument utilizes a Likert-type scale whereby students self-report on a 5-point scale whether they strongly agree, agree, are neutral, disagree, or strongly disagree. The 20-questions focus on student feelings related explicitly to caring, support, connectedness, community, opportunities for learning, and desire to learn about cybersecurity. For example, "I feel that students in this project care about each other" or "I trust others in this project".

Two subscales – connectedness and learning – are contained within the survey instrument and each comprise 10 items. Of the 20 questions, 10 questions focus on connectedness and 10 questions center on learning. Half of the questions are positively worded, e.g., *I feel connected to others in this project* and are coded from strongly agree (5) to strongly disagree (1) on the Likert-scale and half are negatively worded, e.g., *I feel that my educational needs are not being met* and are reversed scored from strongly disagree (5) to strongly agree (1) to reduce response bias.

A higher score indicates a greater sense of community for the positively worded items (1, 2, 3, 6, 7, 11, 13, 15, 16, and 19) and a lower score is more favorable for community for the negatively worded items (4, 5, 8, 9, 10, 12, 14, 17, 18, and 20).

Connectedness items are contained in the odd-numbered questions and these measure the sense of interpersonal integration with the project while learning items are in the even-numbered questions and they measure the degree of pedagogical support the student perceives within the project [13].

Five demographic questions were included in the survey questionnaire to look at variables that might cause the results to differ, e.g., students age, gender, ethnicity, classes completed, and employment status.

C. Data Analysis

Both the pre- and post-survey results were analyzed from both student cohorts to determine if the project resulted in students feeling a part of the social and learning community formed through this project. The data was analyzed using Excel, SPSS, and an online t-test calculator [14]. Data analysis was conducted using descriptive statistics, a paired t-test, and a one-way analysis of variance (ANOVA).

To analyze the data, the initial coding and scale process was completed according to scale directions [15], namely that the test instrument items shown in Table II were coded as follows:

- For items 1, 2, 3, 6, 7, 11, 13, 15, 16, and 19, the weights equated according to the following scale for the positively worded questions: Strongly Agree = 5, Agree = 4, Neutral = 3, Disagree = 2, and Strongly Disagree = 1
- For items 4, 5, 8, 9, 10, 12, 14, 17, 18, and 20, the weights equated according to the following scale for the negatively worded questions: Strongly Agree = 1, Agree = 2, Neutral = 3, Disagree = 4, and Strongly Disagree = 5

The mean weights of all 20 items were averaged to obtain the overall project community mean and then the project community mean subscale scores for connectedness and learning were calculated as follows:

- Connectedness (social community) by averaging the mean weights of odd items in the survey questionnaire - 1, 3, 5, 7, 9, 11, 13, 15, 17, and 19
- Learning (learning community) by averaging the mean weights of even items in the survey questionnaire - 2, 4, 6, 8, 10, 12, 14, 16, 18, and 20

TABLE II. PROJECT COMMUNITY SCALE ITEMS

Item	Project Community Scale	
	Subscale	*Question*
1	Connectedness	I feel that students in this project care about each other
2	Learning	I feel that I am encouraged to ask questions
3	Connectedness	I feel connected to others in this project
4	Learning	I feel that it is hard to get help when I have a question
5	Connectedness	I do not feel a spirit of community
6	Learning	I feel that I receive timely feedback
7	Connectedness	I feel that this project is like family
8	Learning	I feel uneasy exploring gaps in my understanding

Item	Project Community Scale	
	Subscale	*Question*
9	Connectedness	I feel isolated in this project
10	Learning	I feel reluctant to speak openly
11	Connectedness	I trust others in this project
12	Learning	I feel that this project results in only modest learning
13	Connectedness	I feel that I can rely on others in this project
14	Learning	I feel that other students do not help me learn
15	Connectedness	I feel that members of this project depend on me
16	Learning	I feel that I am given ample opportunities to learn
17	Connectedness	I feel uncertain about others in this project
18	Learning	I feel that my educational goals are not being met
19	Connectedness	I feel confident that others will support me
20	Learning	I feel that this project does not promote a desire to learn

Note: Grey rows indicate items which are negatively worded and reversed scored with the reverse Likert-scale, e.g., *strongly disagree* (5) to *strongly agree* (1)

IV. Findings and Results

This section reviews the findings and results obtained through descriptive statistics showing the mean scores per question, a t-test analysis, and a one-way analysis of variance (ANOVA).

A. Descriptive Statistics

Descriptive statistics allowed for comparison based on measures of spread and averages so that the numerical data could be interpreted and analyzed [16]. Mean scores for all participants were calculated along the two main dimensions of connectedness and learning for both the pre-test and the post-test. The mean score captured the measure of central tendency and the mathematical average of the responses for each question.

Interpretation of the mean results depends on whether the questions were worded positively or negatively. For positively worded questions (1, 2, 3, 6, 7, 11, 13, 15, 16, and 19), the mean range for the Likert scale is:

	Mean Range
5 – Strongly Agree (SA)	4.21 – 5.00
4 – Agree (A)	3.41 – 4.20
3 – Neutral (N)	2.61 – 3.40
2 – Disagree (D)	1.81 – 2.60
1 – Strongly Disagree (SD)	1.00 – 1.80

For negatively worded questions (4, 5, 8, 9, 10, 12, 14, 17, 18, and 20), the mean range for the Likert scale is:

	Mean Range
5 – Strongly Disagree (SD)	4.21 – 5.00
4 – Disagree (D)	3.41 – 4.20
3 – Neutral (N)	2.61 – 3.40
2 – Agree (A)	1.81 – 2.60
1 – Strongly Agree (SA)	1.00 – 1.80

The following tables summarize the data obtained from the survey questionnaire to illustrate summary results and better understand data attributes through analysis of mean comparisons. The interpretation of the mean scores for each question grouped by respective subscales – community and learning – is shown in Tables III and IV.

TABLE III. Connectedness Mean Interpretation

Item	Connectedness		
	Question	*Mean Score Pre to Post Tests*	*Interpreted*
1	I feel that students in this project care about each other	3.90 to 4.44	A to SA
3	I feel connected to others in this project	3.65 to 4.33	A to SA
5	I do not feel a spirit of community	3.65 to 4.56	D to SD
7	I feel that this project is like family	3.50 to 3.89	A to A
9	I feel isolated in this project	3.70 to 4.45	D to SD
11	I trust others in this project	3.65 to 4.45	A to SA
13	I feel that I can rely on others in this project	3.80 to 4.56	A to SA
15	I feel that members of this project depend on me	3.30 to 2.89	N to N
17	I feel uncertain about others in this project	3.60 to 4.67	D to SD
19	I feel confident that others will support me	4.30 to 4.67	SA to SA

TABLE IV. Learning Mean Interpretation

Item	Learning		
	Question	*Mean Score Pre to Post Tests*	*Interpreted*
2	I feel that I am encouraged to ask questions	4.15 to 4.67	A to SA
4	I feel it is hard to get help when I have a question	4.05 to 4.44	D to SD
6	I feel that I receive timely feedback	4.00 to 4.67	A to SA
8	I feel uneasy exploring gaps in my understanding	3.60 to 4.33	D to SD
10	I feel reluctant to speak openly	3.45 to 4.11	D to D
12	I feel this project results in only modest learning	3.45 to 3.44	D to D
14	I feel that other students do not help me learn	3.55 to 4.44	D to SD
16	I feel that I am given ample opportunities to learn	4.20 to 4.33	A to SA
18	I feel that my educational goals are not being met	4.10 to 4.44	D to SD
20	I feel that this project does not support a desire to learn	4.35 to 4.56	SD to SD

Note: Grey rows indicate items which are negatively worded and reversed scored with the reverse Likert-scale, e.g., *strongly disagree* (5) to *strongly agree* (1)

There were two prompts – one under *connectedness* and one under *learning* – where the scores dipped instead of increasing from the pre- to the post-survey:

- Question 12 (learning): *I feel this project results in only modest learning.* Here the response was negligible, but it is notable that students in both cohorts disagreed with this question in the pre-survey (mean = 3.45) and again disagreed in the post-survey, but slightly less (mean = 3.44) with a minor difference of 0.01.
- Question 15 (connectedness): *I feel that members of this project depend on me.* Here the response remained "neutral", but the mean score decreased by nearly 0.5 points out of a possible 5.00. This was also the only question that had a neutral response out of all 20 questions.

For the other 18 survey questions, whether positively or negatively worded, the mean increased from the pre-survey to the post-survey and a comparison of results shows that participants in both cohorts and along both the learning and connectedness constructs felt more positively (agree to strongly agree) or less negatively (disagree to strongly disagree) in the post-surveys at the project conclusion.

The five largest gains – listed in order by highest gain – from the pre- to post-survey found under the *connectedness* subscale included:

- Question 17: *I feel uncertain about others in this project.* Students had a difference of over one point on the 5-point scale moving from disagree (3.60) to strongly disagree (4.67) at the conclusion of the project.
- Question 5: *I do not feel a spirit of community* went from disagree (3.65) in the pre-survey to strongly disagree (4.56) in the post-survey. This was a difference of nearly a full point on the scale.
- Question 11: *I trust others in this project* went from agree (3.65) at the start of the project to strongly agree (4.45) at its conclusion or a 0.80 increase.
- Question 13: *I feel that I can rely on others in this project* advanced from agree (3.80) to strongly agree (4.56), a difference of slightly over three-quarters of a point.
- Question 9: *I feel isolated in this project.* Students disagreed (3.70) at the beginning of the project and then strongly disagreed (4.45) with this statement at its conclusion.

The five largest gains – listed in order by highest gain – from the pre- to post-survey found under the *learning* subscale included:

- Question 14: *I feel that other students do not help me learn* grew from disagree (3.55) to strongly disagree (4.44) at the end of the project by almost a full point on the 5-point Likert scale.
- Question 8: *I feel uneasy exploring gaps in my understanding* went from disagree (3.60) to strongly disagree (4.33) indicating a difference of nearly three-quarters of a point.
- Question 6: *I feel that I receive timely feedback* showed a 4.00 mean (agree) in the pre-survey followed with a strongly agree (4.67) result in the post-test.
- Question 10: *I feel reluctant to speak openly* remained a disagree and the degree to which students disagreed with this statement rose by a little more than half a point on the 5-point scale (0.66).
- Question 2: *I feel that I am encouraged to ask questions* went from agree (4.15) to strongly agree (4.67) at the conclusion of the project.

Descriptive statistics were used to obtain the overall sense of project community as well as connectedness and learning. Numerically, both cohorts saw their total mean scores increase from the pre-survey at the start of the project to the post-survey at the conclusion of the students' Cybersecurity AAS degree program in terms of overall community, and along the two constructs of connectedness and learning. Table V compares the average scores obtained from the pre-test to the post-test:

TABLE V. COMPARISON OF MEAN SCORES

Average Mean Scores		
	Pre-test	***Post-test***
Overall Community	3.80	4.32
Connectedness Construct	3.71	4.30
Learning Construct	3.89	4.34

B. t-test

A paired t-test was conducted to determine whether student connectedness and learning were impacted and increased over the course of their participation in the project. The paired t-test is a statistical test that compares the means of two groups – pre-test and post-test scores – and provides as output a p-value that ranges between 0 and 1 [17]. A value that is close to 0 indicates that the data observed between the two groups is statistically significant in that the process or treatment that was conducted had a deliberate effect on the population and the changes in the data did not occur due to chance [18].

The t-test was run to determine any significant differences between the participants mean scores of the pre-survey and post-survey in both project cohorts. The paired t-test results showed a two tailed p-value of 0.0001 which indicates that there was a positive and significant change across students' feelings of belonging as it related to connectedness as well as learning.

This two-tailed p-value indicates that students experienced increased learning and project connectedness throughout their cybersecurity studies at the community college and that the project was highly effective in increasing students' sense of belonging and community.

C. ANOVA

An analysis of variance (ANOVA) was used to compare variances across the means of different groups. A one-way analysis of variance was conducted to determine if a statistically

significant difference existed between the means of three or more independent (unrelated) groups, namely the five demographic questions posed to project participants at the beginning of the survey questionnaire as related to age, ethnicity, gender, courses completed, and work status.

To be statistically significant, the p-value needed to be 0.05 or smaller. Those that were greater than 0.05 were likely due to chance and not due to the influence of one variable, e.g., age, gender, ethnicity, classes completed, or employment status on the two variables of learning and connectedness [19].

1) Connectedness Subscale

a) Gender

With regards to connectedness and gender, there was no statistical significance shown in questions 1, 3, 5, 7, 9, 11, 13, 15, 17, and 19. All p-values were larger than 0.05 and therefore likely due to chance and not statistically significant.

b) Age

With regards to connectedness and age, a statistically significant relationship was shown between the age of students in the following questions:

- Question 1: *I feel that students in this project care about each other* (p = 0.017)
- Question 9: *I feel isolated in this project* (p = 0.017)
- Question 11: *I trust others in this project* (p = 0.010)
- Question 13: *I feel that I can rely on others in this project* (p = 0.005)
- Question 17: *I feel uncertain about others in this project* (p = 0.029)
- Question 19: *I feel confident that others will support me* (p = 0.029)

c) Ethnicity

In terms of connectedness and ethnicity, there was no relationship shown for any of the odd-numbered questions and all p-values were greater than 0.05 indicating a lack of statistical significance as it relates to ethnicity.

d) Classes Completed

A statistically significant relationship existed for the following questions as it related to the number of classes completed and students' sense of connectedness:

- Question 1: *I feel that students in this project care about each other* (p = 0.020)
- Question 9: *I feel isolated in this project* (p = 0.020)
- Question 11: *I trust others in this project* (p = 0.004)
- Question 13: *I feel that I can rely on others in this project* (p = 0.004)
- Question 17: *I feel uncertain about others in this project* (p = 0.022)
- Question 19: *I feel confident that others will support me* (p = 0.022)

Notably, these are the same questions as shown above with regards to age and connectedness as well.

e) Employment Status

With regards to connectedness and employment status, no statistical significance was shown as p-values per odd-numbered questions were all greater than 0.05.

2) Learning Subscale

a) Gender

In terms of gender and learning for the even numbered questions, only Question 18: *I feel that my educational goals are not being met* was found to be statistically significant (p = 0.027).

b) Age

Regarding age and learning, the following questions reported a p-value less than 0.05 and therefore a statistically significant relationship between age and learning occurred with the following questions:

- Question 2: *I feel that I am encouraged to ask questions* (p = 0.029)
- Question 4: *I feel that it is hard to get help when I have a question* (p = 0.010)
- Question 14: *I feel that other students do not help me learn* (p = 0.017)
- Question 20: *I feel that this project does not promote a desire to learn* (p = 0.005)

c) Ethnicity

No relationship was shown between ethnicity and learning with all p-values greater than 0.05.

d) Classes Completed

A statistically significant relationship was shown between classes completed with regards to the following questions:

- Question 2: *I feel that I am encouraged to ask questions* (p = 0.022)
- Question 4: *I feel that it is hard to get help when I have a question* (p = 0.004)
- Question 8: *I feel uneasy exposing gaps in my understanding* (p = 0.034)
- Question 14: *I feel that other students do not help me learn* (p = 0.020)
- Question 20: *I feel that this project does not promote a desire to learn* (p = 0.004)

e) Employment Status

No relationship was shown between employment status and learning.

V. Discussion

The purpose of this research study was to determine the level of belonging students felt while participating in the project cohort over the two years they were enrolled in their degree program at the community college. The theoretical framework

for this study, as established by Reference [20], is rooted in the sense of community theory which comprises four elements aimed at fostering a feeling of affiliation.

1) Students must feel they belong to the project;
2) Participation within the project is influential;
3) Through participation, students' needs and wants are achieved; and
4) Students develop an emotional connection which in turn positively impacts the learning experiences of the group.

These four elements – membership, influence, integration and need fulfillment, and shared emotional connection – provide the sense of community that develops when all are present and working together in coordination [21].

When applied to the project's objectives and outcomes:

- The goal was to create a sense of membership and belonging within the academic community, specifically the Cybersecurity AAS program. This goal was achieved through an updated curriculum that included current industry-specific skills and timely knowledge.
- Project students received sustained support from cybersecurity faculty creating high academic expectations as well as peers empowering active engagement in their own learning.
- The project focus was on meeting students' academic and curriculum needs, providing necessary supports, and fostering relationships between students, faculty, and industry partners. This comprehensive integration and fulfillment of needs contributed to the academic experience within the project.
- Opportunities provided for students to establish positive and involved relationships with their peers, cybersecurity faculty, and industry experts fostered the development of a shared emotional and educational connection. Through the integration of community building activities and interactions, even during the pandemic when remote learning was predominant throughout the college, students were still able to cultivate a sense of connection and shared identity within the cybersecurity field.

By integrating the sense of community theory into cybersecurity education, there is renewed emphasis on the importance of membership, influence, integration of needs, and shared emotional connection. This collective emphasis enhances the overall educational experience and fosters the professional growth of students enrolled in the Cybersecurity AAS program.

A. Further Research

The study conducted a one-way ANOVA to examine the differences in project community among cybersecurity students based on various demographic factors. The results showed differences in project community based on age and number of classes completed along both subscales – learning and connectedness. However, no significant differences were reported as they related to gender, ethnicity, or work status. Reference [22] likewise showed no difference in classroom community by ethnicity in his study over twenty years ago.

The implications of these findings suggest that cybersecurity faculty and other college staff working with cybersecurity students should consider the influence of a student's age and academic progress, especially regarding the number of classes completed, and the impact this has on the level of connectedness and active involvement in learning experiences.

Students who experience a low sense of community may feel isolated, emphasizing the criticality of effective retention and program completion support needed from within the college, as well as other programs such as advising, mentoring, and counseling. This research highlights the significance of addressing age-related and academic progression variables to enhance students' academic connectedness.

Further research is needed to explore the impact of age and academic program progression on a student's sense of community and academic connectedness so that students at the community college perceive that the institution is committed to their learning and individual well-being, fostering a supportive environment where they feel valued and included.

Educational institutions can develop more targeted approaches to assist community college students, ensuring they feel cared for in their learning and integrated within the academic community. In so doing, the institution will promote an inclusive learning environment that fosters student resilience and overall well-being.

B. Study Implications

This quantitative research study provides support to the current body of literature regarding community of learners to help improve social connectedness and belonging [23] [24]. The results of this research show a positive relationship between students' sense of community and their level of learning support in the Cybersecurity AAS program at this community college.

Whether termed the Classroom Community Scale (CCS) as developed by [25] or the Project Community Scale, the survey questionnaire provided a helpful resource to discern student belonging and learning connections as related to this project. Students had a connectedness with their peers and the college, as well as a newfound connectedness to the cybersecurity community that will enable them to continue to be successful in this technical and professional field as their careers unfold.

Sample anonymous student feedback included:

- "Really enjoyed connecting with others in the program and in the cybersecurity community. Loved the hands-on opportunities to learn."
- "The support of the professors, the opportunities and the resources that were offered throughout the project, and the structure of the program allowed me to successfully complete the Cybersecurity AAS program."
- "I really appreciated the flexibility of the schedule. Although progressing at a slower pace than my peers, this has allowed me to effectively manage my coursework alongside my work commitments to cover expenses. I really liked the social gathering and events every semester, providing opportunities for students and

faculty to interact. The availability of tutoring services and open lab sessions have been valuable in my learning. The staff and faculty were friendly and easy to communicate with."

The significance of this project was three-fold in that project leadership was able to:

- Work with industry partners to enhance the cybersecurity curriculum at the community college;
- Implement real-world cybersecurity enrichment activities for students to enhance the community college experience and increase student satisfaction within the cybersecurity academic program and improve retention; and
- Contribute to the growing body of empirical knowledge about community college students' experiences in the cybersecurity discipline.

C. Limitations

There were several limitations that existed in this study. They included the Covid-19 pandemic, the transitory nature of the community college student, student recruitment during in-person college closure, and the need to increase interest among diverse students and those who are underrepresented in the cybersecurity field.

1) Addressing the Pandemic

The major limitation which impacted this project was the Covid-19 pandemic which occurred soon after the project commenced. An in-person Night of Cybersecurity career awareness event was held in early March 2020 with high student and in-person community participation, along with an industry guest speaker presentation. This successful in-person event to promote both project participation and the Cybersecurity AAS program at the community college was the last in-person event as the college shut down its in-person activities as the world began to move through the global pandemic.

Even with the move to remote learning and online gatherings, the project leadership team, along with cybersecurity faculty, continued to keep up momentum using technology, online resources, and personal outreach to students. During the first year of student cohort recruitment, we saw our highest level of interest because we were able to promote the project to students in-person rather than during the second year of cohort recruitment when events were predominately remote.

The Covid-19 pandemic was significant for this community college because students either were not as aware of the project as they may have been through in-person classes or college gatherings, and because activities and events for students accepted into the project became largely remote for the two years following.

The impact of the Covid-19 pandemic was significant nationwide as well. While 2.6 million students started college nationwide in fall 2019, over 25% or nearly 700,000 did not return in 2020, and this was even more pronounced for community college students where the percentage was closer to 30% of students leaving their educational institution at some point during the 2019-2020 academic year and not returning the following year [26].

2) Reducing Attrition

Along these same lines, a related limitation was that there was some attrition of students who were accepted into the project in Cohorts 1 and 2. This was due to some students changing their major and leaving the Cybersecurity AAS program, withdrawing from the college, moving to part-time status, or simply ceasing to communicate within their project cohort. The lack of in-person outreach during the pandemic may have precipitated some of this attrition.

Methods employed to address attrition included early engagement and project orientation for admitted students, implementation of a mentorship program for project students to be paired up with experienced cybersecurity faculty, bi-monthly group check-ins to foster transparent and open communication, track student progress, and address any concerns or issues, as well as offering college support resources for students who were struggling academically or having personal challenges. The goal was to provide students an involved community of learners promote retention and successful program completion.

3) Improving Project Recruitment

With regards to project recruitment, particularly with the second cohort at the height of the pandemic closures, project leadership struggled to recruit students. Now that the worst of the pandemic appears to be behind us, any future efforts to stimulate student interest, along with targeted promotions and assistance from the college's marketing department should be met with substantial renewed student interest given the return to in-person gatherings at social events and in classrooms.

At the same time, recent data shows that the pandemic has had a major impact on college and university enrollments with declines of about 7% from fall 2019 enrollments before the global pandemic hit [27]. Thus, recruitment of students will continue to be a challenge unless enrollment trends reverse.

Approaches used in project recruitment, which should be continued, included campus events such as the Night of Cybersecurity along with personalized outreach conducted by faculty and Cybersecurity Advisory members and local cybersecurity businesses aiming to retain students for internships or employment. Additionally, engagement with local high schools and offering technology support for in-coming project students were also used. Overall, whether through inclusive campus activities or fostering community partnerships with local stakeholders, a focused outreach to prospective students within the community can help improve recruitment.

4) Greater Outreach to Diverse and Underserved Students

The final limitation was observed in cohort participants. While project leadership sought to recruit diverse students, in terms of applicants who were qualified and accepted into the project, over 50% of students in both cohorts were traditional-aged, male, and white. Given that this project was intended to support underrepresented and underserved students at the community college, continued efforts need to be made in this area.

It is important to mitigate bias to establish a fair and inclusive approach to attract diverse and underserved students to the Cybersecurity AAS program and the cybersecurity field. Specific strategies for addressing bias include:

- Establish predetermined criteria for evaluating applicants to diminish subjectivity and guarantee consistent assessment of all candidates based on relevant factors.
- Ensure diversity within the selection committee to incorporate a variety of perspectives to reduce bias and promote a more equitable evaluation process.
- Provide training for project leadership and student recruitment personnel to increase awareness of unconscious bias, along with regular audits of the recruitment and selection procedures.

Project leadership must think innovatively about alternative recruitment strategies to expand reach and accessibility for diverse and underserved students. For example, in addition to organizing inclusive campus gatherings to promote community awareness, tailoring outreach efforts towards non-traditional students with inclusive language in promotional materials through customized and inclusive language to appeal to a diverse audience. Thus, bringing about increased interest, representation, and ultimately participation in the cybersecurity profession.

Within this project, both project cohorts showed higher diversity in terms of gender and ethnicity than the current national average of cybersecurity workers. There were approximately 40% of project participants who identified as female and about 45% African American and other multi-racial students in both project cohorts. Nationally in the cybersecurity workforce, women make up merely an estimated 24% of workers and minority representation is only about 26% [28].

VI. Future Directions

This project offers valuable insights to inform educational policies and pedagogical practices for cybersecurity in higher education. Some ways in which the project findings can contribute to enhancing Cybersecurity AAS programs in the community college include:

- Promoting active learning and student engagement through hands-on projects, participation in cybersecurity competitions, and attendance at industry events.
- Supporting on-going professional development for faculty to foster a sense of community and positive student-faculty relationships.
- Strengthening industry connections through collaborative partnerships and joint projects and updating and aligning curriculum to meet industry needs and industry standards.
- Continuing to tailor outreach efforts through community partnerships, social media campaigns, and engagement with local high schools.
- Monitoring and enhancing student retention rates by improving student support services such as advising, mentorship, and counseling.
- Benchmarking the Cybersecurity AAS program with similar programs at other institutions and with the National Centers of Academic Excellence in Cybersecurity to ensure alignment with industry standards and an innovative curriculum to offer students for a cybersecurity career.

These future directions align with the project's underlying principle that when students establish a connection with their academic institution, have confidence in their abilities, and feel a sense of belonging, they are more likely to engage actively in their learning and exhibit greater commitment to their chosen profession.

This sense of membership and connection to the cybersecurity field at the start of their academic journey has long term payoffs in terms of building professional networks so that students can achieve greater tenure and advancement in their careers. Ultimately, this will lead to greater representation and participation within the industry as diverse and underserved students transition into professional cybersecurity careers.

VII. Conclusion

This research study on project community examined the degree of connectedness and belonging students experienced along with evaluating learning within the context of community while students were part of a project cohort and enrolled in the Cybersecurity AAS program at a community college located south of Washington, DC.

The results of this research study revealed that students in each project cohort and over a two-year period from the pre-test to the post-test had increased levels of connection and learning because of their involvement in the project. In addition, there was a relationship between student age and number of courses completed that also aligned to level of connectedness and learning experienced within the project.

This is significant because while the population size was small, the students were of different ages, genders, ethnicities, academic starting points, and employment status, yet all benefitted from the project interactions with faculty and students, as well as the project opportunities and activities that took place over the two-year period in addition to their regular cybersecurity courses and program requirements.

The findings of this study contribute to a growing body of knowledge on the importance of students feeling a sense of connectedness in their college program, vocation, and ultimately their profession which can translate into students having long-term sustainable and enjoyable careers in cybersecurity as well as other in-demand fields.

Furthermore, the findings allow educators and college leadership in workforce development programs to consider the importance of creating a sense of community and cohesion with students that can translate into students' feeling a sense of belonging and improved confidence and self-worth.

This is especially noteworthy in today's current environment of student mental health concerns amid the post-pandemic era. The construct of social connectedness refers to

feelings of affiliation and reflects feelings of meaningful connection with others interpersonally [29]. It is a key determinant of student mental health and well-being [30]. Going forward, it is incumbent upon educational institutions to connect students to the college and construct interventions for students who may exhibit low levels of connectedness to combat mental health issues and promote student wellness in a supportive and welcoming academic culture.

The advancement of study in this area of student belonging and creating communities of engagement provides higher education and those within the growing cybersecurity profession with more evidence on the importance of promoting connection and belonging to support student diversity, well-being, academic success, and professional development in the field.

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