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The Urgency for Innovation: A Case Study on Cybersecurity Education Convergence of High School and Higher Education in Rural Communities

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Abstract

There is urgency for minority serving rural hybrid community colleges for innovation in offering cybersecurity education to local high school students who have no access to these emerging occupations. Focusing on high school women and minorities, this case study uses field experiences to drive an iterative improvement process that enhances the delivery of online pedagogical and learning design in a tri-island county. Beginning in Fall 2016, the project, implements an early college cybersecurity career pathway, targeting the low access of women and minorities at the high schools pursuing higher education cybersecurity programs by: enrolling 84 high school students in an online sequence of college cybersecurity courses over four semesters.

The intent of the case study is to determine how and why things work (including identifying the contextual constraints) within university-high school partnerships aimed at closing the skills gap for women and minorities for cybersecurity jobs while in high school. Our iterative effort has led us to explore deeper issues around innovation in online pedagogies while focusing on the underrepresentation in cybersecurity. This paper serves as an example of an exploratory researcher-practitioners and iterative design specifically within an early college context across educational sectors (e.g., high school and college). The study promotes a better understanding of how to embrace discovery to provide all high school students access to advanced technology educational opportunities like cybersecurity.

Keywords: cybersecurity education, educational innovation, early college, university-high school collaboration, convergence of K-12 and higher education

1. INTRODUCTION

Vital Signs Hawaii (2017) reports that business leaders in Hawaii cannot find the science, technology, engineering and mathematics (STEM) talent they need to stay competitive. STEM fields are growing in Hawaii and is predicted that 2017 and 2027: STEM jobs will grow 8% and Non-STEM jobs will grow 4%. The Hawaii STEM skills shortage starts early. Students' lagging performance in K-12 is a critical reason why.

Cybersecurity Ventures report estimates that there will be 3.5 million unfilled cybersecurity jobs by 2021 which is significantly higher than the 2016 estimates of 2.5 million. According to CyberSeek (2017), which is a project supported

by the National Initiative for Cybersecurity Education (NICE), as of September 2017, there are 350,000 current cybersecurity openings in the U.S. which is up from the 2015 data of 209,000 job openings. This indicates that there is an increasing shortage throughout the United States.

Hawaii must close the gaps in the STEM pipeline. The Hawaii STEM pipeline loses young people at every level of the education system. Low graduation rates from college narrow the pipeline of student who can gain advanced STEM skills. In 2014-2015, approximately 82% students graduated from high school in Hawaii compared to 83% in US. Of the Hawaii 2012-13 high school graduates approximately 47% graduated with 4-year degree program compared to 60% in US. Additionally, approximately 18% of the 2012-2013 high school graduated with a 2-year associate's degree compared to 28% in US. Finally, of the Hawaii 2014-15 graduates, approximately 20% were certificates and degrees in STEM field compared to 26% in US.

Together, females and minorities make up more than half of Hawaii's population, yet they are much less like to earn STEM degrees or become STEM professionals. Closing these gaps can pay big dividends in Hawaii. Low-income and minority children lag behind in Hawaii.

In Hawaii, these gaps limit individual opportunity and economic growth. Yet not enough students get the change to learn rich and challenging content that prepares them for college and careers. Lack of access to better STEM learning opportunities severely limits young people's college and career prospects.

The community college connection to high schools is widely increasing via a number of models that offers early college options (Morest, V. S. and Karp, M. M., 2006; Bragg, D., 2013). In addition, community colleges are central to focusing on this new wave of America's high school women and minorities in these initiatives to improve their labor market prospects (Osterman, P., 2012).

The University of Hawaii Maui College (UHMC) is a rural hybrid community college that offers Bachelors of Applied Science Degrees. UHMC addresses the needs of a diverse student population of approximately 4,200 students in a three-island community with its main campus located on the main island. The two other islands have an estimated population of 154,834 (as of the 2010 U.S. Census). Over 10 percent of the constituent population consists of Native Hawaiian and other Pacific Islanders. The percentage of Native Hawaiian and other Pacific Islanders is much higher in the more remote locations, 26% and 29%, respectively (County Data Book, 2012). High schools in Maui County lack access to basic technological services and certified technically trained teachers to increase the number of women and minority graduates prepared for careers as cybersecurity technicians.

Chai, Bagchi-Sen, Goel, Rao and Upadhyahya (2006) claim that underrepresentation of minority workforce in the IT industry is one of the reasons for the scarcity of skilled labors in the information security industry. Funded by the National Science Foundation Scholarship for Service National Science Foundation (NSF) Scholarship for Service (SFS) [Award #1516178 (10/15/2015-09/30/2018)] and National Science Foundation Grant [Award #1515256 (9/1/2015-8/31/2018]. This study is designed to increase the number of minorities and women succeeding in college level cybersecurity education and degree programs by offering a Cybersecurity Certificate of Competence as highlighted in Appendix 1.

2. EARLY COLLEGE PROJECT OVERVIEW

Developing Career and Technical Education (CTE) cybersecurity career pathway for high school students is at its infancy in many rural communities. There is a shortage of teachers at the high school who can support their students in being successful in rigorous, academic cybersecurity courses.

This early college project aims to fill this urgency by: (1) offering an online sequence of four cybersecurity college courses to high school students, one every semester, taught by college faculty; (2) orchestrating collaborative recruitment strategies to attract minorities and young women into the field; and (3) embracing a learning-by-doing approach that employs multiple quick tests of change, student and stakeholders surveys, an iterative refinement process to support women and minority high school college students. The university-high school partnership involves the following high schools in Maui County: Maui High School, Lahainaluna High School, King Kekaulike High School and Kamehameha High School-Maui Campus.

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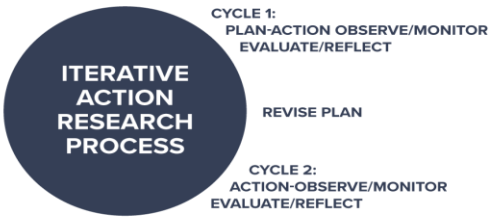
This project offers high school students financial stipends to enroll in a sequence of four college cybersecurity courses and receive a Cybersecurity Certificate of Competence. (See Appendix 1 for course listing and descriptions.) The stipend is used for payment of tuition, fees and course textbooks.

Case Study Design and Implementation

Early college access is complex with multiple causal and mediating factors that govern access for different groups and individuals. Sargut and Mcgrath (2011) state there are three properties that determine the complexity of an environment: (1) *multiplicity* refers to the number of potentially interacting elements; (2) *interdependence*, relates to how connected those elements are; and (3) *diversity*, has to do with the degree of heterogeneity.

This project views the Early College cybersecurity career pathway access and participation as an organic complex system that contains a large number of interactive, interdependent, diverse elements; moreover, the greater the multiplicity, interdependence, and diversity, the greater the complexity. Its essential features may operate in patterned ways but their interactions continually change. Thus, the study uses an iterative action research process for continuous innovation in our access, support services, and teaching pedagogies and learning management systems (See Figure 1).

Figure 1: Iterative Action Research Process



This study aligns with Bryk, Gomez, Grunow and LeMahieu (2016) improvement science theoretical underpinnings. The project also presents a researcher-practitioners and development improvement science design to facilitate learning and innovation throughout the project. The iterative process identifies what the complexities (e.g., multiplicity, interdependence, diversity) and challenges in early college might be, and tracks the impacts on learning, motivation, and other desirable outcomes.

Specifically, one of the major strong points of the program iterative research process is that the project continually evaluated the program to examine its strengths and to also find ways to improve. Some of the program strengths are that it has support from high school counselors and an experienced teaching staff.

One weakness that became evident during interaction with Cohort One was that the students were having difficulty with time on task. Recognizing this was an urgent issue, the Project Recruiter/Retention Coordinator, along with a student mentor were added to the team. According to others on the team, the Project Recruiter/Retention Coordinator "did an excellent job tracking students" and "his role was crucial".

Other hurdles for Cohort One concerned technology. There were multiple firewalls that the students had to navigate and they had to learn to navigate the learning support platform of the UHMC. For underrepresented high school students, the additional support such as that provided by Project Recruiter/Retention Coordinator is extremely important. The Project Recruiter/Retention Coordinator along with high school teachers and the mentor helped them navigate the learning support platform. For many of these underrepresented students, the only feasible way to offer these cybersecurity classes is online. Yet, online classes create additional barriers for these same underrepresented students such as navigating the technology and lack of time management skills. The Project Recruiter/Retention Coordinator, along with their high school teachers, were able to help students deal with the technology issues and to keep them on task.

Another example is the first cohort had more Filipinos than Native Hawaiians/Polynesians. In order to increase the number of Native Hawaiians/Polynesians, the project recruited from the Arts and Communications pathway. This was both innovative and essential to success of diversifying the program since this pathway had a higher concentration of Native Hawaiians/Polynesians. Recruiting from Arts and Communication pathway also increased the number of female students in the program since females are more heavily concentrated in the Arts and Communication pathway.

In addition, the project used their social network to recruit at an Open House through a senior high school counselor. Parents also attended this Open House at two private schools with a high concentration of Native Hawaiians. The combination of these two changes led to a major increase in the number of Native Hawaiians/Polynesians in Cohort Two.

Another change from the first cohort to the second was to recruit students earlier in their academic career. By the time that students are seniors it is challenging to change their college and career aspirations.

The project also learned some practical issues concerning Early Admit programs. The project learned that there were some misunderstandings about how Early Admit programs work. For example, the Principal Investigators thought that they would initiate enrollment in the Early Admit program. In reality, since the students are under 18, high school principals initiate the enrollment into the program. This makes the relationship between the high school principals and the project Principal Investigators even more crucial for success of the project.

Admissions processes at universities and community colleges need to be reviewed to make sure that they do not unreasonably provide obstacles for Early Admit students taking online classes. For example, the normal Health Clearance is not necessary for online Early Admit students and can create an unnecessary, prohibitive burden for these students. Overall, it was important for all the constituents from high school teachers, high school principals, high school counselors, project Principal Investigators/staff, college teachers and college administrators to develop an effective professional relationship and willingness to revise or allow exceptions to existing policies when necessary for the project to be successful.

3. ANALYSIS – FIRST YEAR EVALUATION

Demographics of Cohort One and Cohort Two

The First Cohort of students in Spring 2016 contained 41 students and in Summer 2016 Cohort Two consisted of 43 new students. Thus, during Year One of the grant 84 students have already participated in the project. This surpasses the expectation for the entire two years of the grant. For both cohorts, females outnumbered males.

An innovative strategy to reach Native Hawaiians/Part-Hawaiians was also used by this project. In addition to traditional STEM recruitment, they recruited students from the Arts and Communication pathway. This project has a higher concentration of Native Hawaiians/Part-Hawaiians and served as a successful, innovative way to recruit students into cybersecurity. Thus, from Cohort One and Cohort Two the percentage of Native Hawaiians/Part-Hawaiians increased from 7% to 19%.

From Cohort Two, the project was able to collect additional, valuable survey data. Thirty students completed the survey. From this survey, we were able to discern what excited them about being an Early Admit Student.

Students were allowed to select more than one option from a checklist that also allowed them to select *Other* and to fill in an open-ended answer. The most popular answer was *New Classes* with 86.67% of the students selecting this option. The second most popular response was *Friends Enrolling* with 43.33% selecting this option. *New Teachers and Other* tied for third most popular response with 16.67% selecting each of these options.

When asked to rank order their plans for after graduation, it was evident that most planned on attending college. Neither work nor the military was any of the students' first choice. Work was the second choice for 6.67% of the students. The number one choice for the majority of the students (58.62%) was to study on the Mainland US or abroad. The second most popular choice was study in the Pacific, which was selected as the number one choice by 23.33% of the students. University of Hawaii Maui College being selected as the number one choice by 20.69% of the students followed this.

Students were asked to rank order the following items as to what would increase their interest in Cybersecurity: (1) more information about what the job might entail, (2) access to more relevant classes to see if I would be good at it, (3) reassurance that I would earn a good living, (4) opportunity to speak to current professionals about the pros and cons, (5) if my friends thought it would be a cool career, (6) if my parents thought it would be a good career, and (7) nothing.

The choice that was ranked number one the most frequently was more information about

what the job might entail. This option was selected first by 36.67% of the participants.

The second most frequently selected response was access to more relevant classes to see if the student would be good at it. This option was selected first by 33.33% of the participants.

The third most frequent response was reassurance that I would earn a good living. No participant selected either my friends thought it was a cool career or my parents thought it was a good career as his or her number one choice.

For the second most important reason, access to more relevant classes to see if I would be good at it was the most frequently selected response at 36.67% followed by more information about what the job might entail at 33.33% and opportunity to speak to current professionals about the pros and cons at 20.69%.

For the open-ended response, the most frequent response provided by students was that a teacher recommended that they take the course. This was the response provided by 35.7% of the students. When combined with counselor recommendation when reported by 7.1% of the students, we have a clear indication that one of the successes of the project, is based upon the relationships that have been built with teachers and counselors at the schools.

The next most common response was that they would receive college credit. This indicates that the students do plan on going to college and are very interested in their future. Another important finding was that 21.4% of the students took the course because it is free. Cost is going to be a major factor for underrepresented students and it is important to find ways for them to be able to have an affordable route to careers in fields like cybersecurity. Another 17.9% of the students took the course because friends recommended it. The success of students in Cohort One influenced students in Cohort Two.

Cohort Two was asked in two different ways why they took the class. First they were asked whether they agreed with certain statements as to why they took the class. Secondly, they were able to write in an open-ended answer as to why they took the class.

When asked if they agreed with the statement, "I took this class to see what Cybersecurity is all about," 82.1% either agreed or strongly agreed. For the statement, "I took this course to see where Cybersecurity is applicable," 71.4% either agreed or strongly agreed. The lowest agreement was with "I took this course to understand the Cybersecurity issues in business" with half of the students either agreeing or strongly agreeing.

4. ANALYSIS – SECOND YEAR EVALUATION

Cybersecurity Early Admit Cohort One Withdrawal Report

A total of nine students withdrew from Cohort One. In consultation with project PIs, the project evaluator developed a survey to understand why students withdrew from the courses and to see what if any impact the courses had upon students who withdrew. The survey for students withdrawing had a 100% response rate.

Of the students who withdrew, 77.78% were female and 22.22% were male. There are slightly more females in this cohort than in the number who successfully completed the project (68%). The majority of students withdrawing were Filipino with 66.67% of the withdrawing students. In addition, 11.11% were Japanese, 11.11% were White, and 11.11% were multiple ethnicities. Again, Filipinos were slightly higher in the withdrawal cohort at (66.67%) compared to 59% successfully completing the project. In both of these cases, the small sample of those withdrawing means that the difference of one student can make a larger difference in the percentages.

One of the most surprising answers was to the question, "What grade did you expect in the class if you did not withdraw?" Over half (55.56%) said that they expected an A, 22.22% expected a B, 11.11% expected a C, and 11.11% expected a D. None of the students expected to receive an F in the course.

Prior to taking the course, 33.33% reported no experience with programming, 44.44% reported beginning level, and 22.22% reported intermediate level. None reported advanced level of programming. Similarly, 22.22% reported no prior knowledge of cybersecurity, 22.22% reported slight prior knowledge, and 55.56% reported moderate prior knowledge of cybersecurity. None reported that they were somewhat or very knowledgeable about cybersecurity before the course. Prior to the class, 22.22% reported no interest in cybersecurity, 22.22% reported a slight interest in cybersecurity, 11.11% reported a moderate level of interest in cybersecurity, 33.33%

reported they were somewhat interested in cybersecurity, and 11.11% reported they were very interested in cybersecurity.

Students who withdrew from the course, overwhelmingly reported being more aware of career opportunities in cybersecurity (88.89%) and more knowledgeable about what is involved in cyber careers (87.55%). Over half (55.56%) reported that they are interested in taking courses in cyber security in the future. All reported that they plan on attending college.

When asked an open-ended question about why they withdrew from the class, 77.78% reported issues related to time. These included their lack of time management and/or too many activities. One of the other two students reported that they dropped the class because it was not related to their career interests and the other reported that they would not have dropped the class if they had known that there was going to be an additional class. When asked what would have helped them be more successful in the class, again many of the answers related to time management. For example, one student suggested that there should be due dates throughout the course. A couple of students did express communication concerns such as better prompts and better communication between the students and teacher. Overall, even with the students who withdrew from the project, the course had a positive impact with students gaining insight into careers in cybersecurity.

Cybersecurity Early Admit Cohort Two-Withdrawal Report

A special survey was administered to the students who had withdrawn from the Early Admit Project Cohort Two to ascertain how to improve the project. Sixteen students completed this survey. Of the students who withdrew from the project, 81% were female and 19% were male. The majority of the students who withdrew from the project was either Filipino or classified themselves as multiple ethnicities. It is important to note that none of the white students withdrew from the project.

Similar to the finding from the withdrawals from Cohort One, the majority of students who withdrew from Cohort Two expected to receive a good grade from the class with 53% of the students reported that they expected to receive a 4.0 in the project and another 33% reported that they expected to receive a 3.1-3.9 in the project. None of the students expected to receive a 0 to 1.0 in the project.

The majority of the students who withdrew from the course reported that they had either no programming experience (37%) or were a beginner (50%) while 13% reported that they had intermediate level experience and none reported that they were advanced in programming. Similarly, most reported limited knowledge of cybersecurity before the project with 38% reporting no knowledge of cybersecurity and 44% reporting slight knowledge of cybersecurity, 6% reporting moderate knowledge, 12% somewhat knowledgeable of none reporting that they were vey knowledgeable about cybersecurity prior to the course.

Half of the students who withdrew were very interested or somewhat interested in cybersecurity before the course. The students who withdrew from the project overwhelmingly reported that the project had made an impact on them. All of the students reported that from participating in this project that they were more aware of career opportunities in cybersecurity and 88% reported that they were interested in future classes in cybersecurity. All of the students were reported that they intended to attend college.

When students were asked an opened ended question about why they withdrew or dropped the class, the most common response from 73% of the students related to competing activities, competing classes such as AP classes, or time management. One student reported that there was miscommunication with their school so that they did not know whether they were in the course or not and another student reported computer compatibility issues.

When asked an open ended question in regard to what would help them be more successful, over half of the students (53%) responded with responses related to time management or having more time. The second most frequent response was more or better communication with the teacher. This was the response of one third of the respondents. One respondent said that easier assess would be helpful and one respondent said they would have been more successful if they were more interested.

5. YEAR 2 PROJECT RESULTS – LEARNING MANAGEMENT SYSTEM

Description of LMS

Higher education institutions have strived to improve instructional techniques and methodologies to enhance the learning

experience for students. By offering distance learning/online classes higher education has made learning accessible to larger student populations (Chawdhry, et.al. 2011). As of Fall 2014, approximately 5.8 million students enroll in at least one online course according to a study by Babson Survey Research Group and the Online Learning Consortium (2015).

Early college students at the University of Hawaii Maui College, currently use the Learning Management System (LMS) Sakai that was originated from within higher education to address the needs of the academic environment. Sakai provides tools to assist with delivering online classes comparable to those offered in traditional on-ground classes. Institutions can customize the features of Sakai to best fit the needs of their students and curriculum. Core tools that assist with the online delivery include discussion capabilities, announcements, messaging and email, dropbox, gradebook, and group features for chat and collaborating on projects (Sakai, 2017).

In addition to using Sakai, early college students use TestOut as a supplement to the LMS. TestOut is an outside LMS that provides online labs for academic institutions. Students are able to have hands-on experience to labs in a simulated environment of LabSim (TestOut, 2017). Universities are often faced with lack of resources especially when it comes to building computer labs that meet the changing needs of information technology. By using LabSim, students watch videos dealing with the class being studied such as Introduction to Security and Introduction to Networking where they can learn the techniques and skills used in the field. After watching the videos, students are required to complete labs based upon the lessons learned in the virtual environment. Students are given virtual computers and networks to practice their skills.

Although TestOut provides a way for students to have hands-on experience in a virtual environment, it still has a downside. Ethics in regard to cheating is an area of concern. The digital landscape has caused a paradigm shift of protocols when it comes to test taking, or in the realm of TestOut, virtual labs (Douglas, et.al 2015). Academic institutions all over the world are using TestOut. With that being said, it should not be a surprise to find out that there are YouTube videos on almost every lab in TestOut. Students can follow along with the YouTube videos while working on the virtual labs and have all of the answers within minutes. Additionally, due to the nature of how TestOut is set up by a second party provider, students can easily get the answers within the interactive demos by merely starting the demo and clicking "done" in the right hand corner of TestOut. By clicking "done" TestOut shows step-by-step every answer to the lab. Students can then take screenshots or pictures with their mobile devices that can then be used to answer the questions when they start the lab again. The need for ethics in distance learning education is critical to a student's success that is why it is important to invest in tools that minimize student cheating.

An improvement to students using both Sakai and TestOut would be to follow the standards set by Accreditation Board for Engineering and Technology (ABET) which is the accrediting body for engineer and technology degrees. ABET standards require group projects that simulate real-world experience in both on-ground and online courses in information technology. Students should still use TestOut to gain an understanding of how the technology works but the labs should be weighted at a lower percentage to the points that can be earned in the class, allowing the majority of points to be awarded to group projects where students must demonstrate the understanding of the tools, concepts and lessons.

Student Feedback on the LMS

The University of Hawaii Maui College (UHMC) Early Admit Project funded by an extramural grant overall has been a very successful project. However, one of the obstacles for the successful implementation of the project has been the issue related to the Learning Management System used. The high school students found it difficult to access the project. In addition, there were compatibility issues between Test Out and Laulima, the Learning Management System used by UP. This created additional issues for the students and potentially may have increased the number of student withdrawals. Students from the first two cohorts who withdrew from the project were administered a survey. This allowed the project to identify problems to address for improvement. From both cohorts the number one reason that students withdrew was related to time management issues (such as balancing AP classes, extracurricular activities, or simply procrastination). However, another issue students addressed as a reason for their withdrawing from the project was related to the Learning Management System.

From the first cohort of students who withdrew from the class one reported, "The way we did the work was time consuming because it would load slowly at times". Another student from this Cohort commented on the vague prompts from the system. Two students felt that there should have been more due dates throughout the course.

The second cohort of students who withdrew from the class reported similar issues. When students who withdrew from the class were asked why they withdrew, the majority of the students responded with issues related to time management. However, one student reported that they were confused as to whether they were enrolled in the class and another student reported compatibility issues with the Learning Management System. Another student reported, "Maybe the project could explain more and sometimes it was slightly confusing". An additional student stated that they would have been more successful in the class if, "More time and an easy way to get in the files". A student reported that their computer was not compatible with the system.

Even students who successfully completed the class reported that there were compatibility issues with the system and their computers. One student said that no matter what they did, "some keys just didn't work no matter what I tried".

Advisory Board - Student Support and CyberPatriots

At the end of first year, a recommendation of the Advisory Board was to make sure that there is not a misunderstanding on how students are recruited into the project or the definition of the purpose of the Cybersecurity Early Admit project. Currently, no high schools give credit for the courses.

Additionally, Board members said that students should be encouraged to participate in cybersecurity competitions. They also said that it was very important that help, such as that provided by the Coordinator and Recruiter, and peer mentoring (UP undergraduate student) increase as students enter into networking classes. It was suggested that the project look at ways to expand to middle schools.

One point that was brought up at the Advisory Board meeting was that there is often a six-year break between when minorities graduate high school and when they enter the UP Cybersecurity Project. This grant may provide important insights into strategies to close this gap. Overall the Advisory Board was unanimously impressed with the project and the project's outreach.

During Second Year, the project entered five (5) teams in the National CyberPatriots Competition. Two teams made it to Round 2 Regionals Gold Division CyberPatriots Competition. One of the teams won second place in the Regionals. CyberPatriots Cyber camps have also been scheduled for this summer targeting middle school students by statewide coordinators.

Early Admit Stakeholders Survey

Thirteen stakeholders in the University of Hawaii Maui College (UHMC) Early Admit Project were surveyed about their experience and the experience of their students with the project. These stakeholders worked with the project in various capacities. They included high school teachers, high school counselors, mentor for schools (business/industry), grant recruiter and ICS instructor for UP.

These stakeholders had various levels of prior knowledge about cybersecurity before participating in this project. With the most frequent responses being very knowledgeable or moderate level of knowledge with approximately 31% of respondents selecting each of these options. Most participants were either very interested (42%) or somewhat interested (33%) in cybersecurity before the project commenced.

Overall, the Stakeholders reported that the project has been a success. Of the stakeholders 92% reported that from participating in this project, they were more aware of career opportunities in cyber security. Similarly, 92% reported that from participating in this project, they were more interested in helping students enter a career in a cyber security field. Of the participants, 82% reported that they were more prepared to help students take cyber security classes in the future. Likewise, 83% felt that this opportunity would help their students be more successful in the future; that they feel more confident in their students taking college classes in the future, and that they were interested in learning more about cyber security. An overwhelming 92% of the participants felt that they were more knowledgeable about cyber security careers. Most importantly, 92% agreed that they planned on recommending the Early Admit Project to their students. It is important to note here that the one person who disagreed with this statement was a college teacher so

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therefore the Early Admit project would not be relevant for their students.

The Stakeholders made the following recommendations to improve the project. When asked an open-ended question in regard to what could be done to improve the project, 38% of the participants responded that the project should be expanded. Similarly, 38% of the respondents want more focus on the relationship building for the students. For one participant that meant to build relationships with mentors for the students while for another it meant to have an onsite meeting with the students at the beginning of the project. One quarter of the participants wanted additional services and materials such as licenses for Windows Server. Similarly, one quarter 25% felt that the participants were high school students and that therefore they may need special consideration. Overall, the Stakeholders were extremely positive about the value of the project and its contribution.

6. SUMMARY AND LIMITATIONS

One of the biggest challenges for the high school students was time management. A major obstacle in the transition from high school to college is the change from a teacher-directed to a student-directed environment; rarely does a college instructor monitor students' progress (Dembo and Seli, 2013). In college, students are expected to manage their own learning (Bembenutty, 2011). Additionally, high school teachers spend considerable time attempting to motivate students to learn, whereas college instructors generally expect students to be self-motivated. An online course format intensifies the culture shock and difficulties for high school students' first early college experience.

Another important functioning set of skills in early college online course dynamics to overcome its contextual constraints are: (1) learning how to navigate the learning management system, and (2) sending and receiving messages effectively between students and faculty. Help seeking is essential prerequisites among online learning strategies because students may feel that it implies they are incapable of completing the academic tasks without assistance, which can be threatening to self-worth. As a result, many college students fail to seek needed help, considering it embarrassing, an admission of defeat, and something to be avoided whenever possible (Karabenick & Dembo, 2011).

We are learning how to innovate promising cybersecurity educational pedagogies and support methodologies for early college high school students via an informative iterative process. Our iterative process has led us to explore deeper issues in innovation and the essential role of stakeholders across educational sectors.

Since the data features continually evolve via recent changes over 12 weeks, further feedback and reflection should be done to refine its improvements. Transferability refers to the extent that these findings can be applied to other populations, contexts, or individuals (Lincoln & Guba, 1985). A number of factors impact the application of these results to other groups, demographics and sample size. It is entirely possible that the results would be different if the research were conducted in another city or state, or if the research utilized a cross sample of locations within the United States. Sample size is another limitation of this study. Because of the resources and time, the number of participants was limited. Thus, consideration should be used when applying these results to studies of other cybersecurity early college project overall.

7. FUTURE IMPLICATIONS

The development of a reliable Career and Technical Education (CTE) early college online cybersecurity career pathway for high school students in rural communities is both desirable and in today's workforce development environment, urgent. Unfortunately, most cybersecurity educational recruitment, retention and persistence efforts in rural communities so far operates within the traditional and non-traditional college student profiles who have graduated from high school as opposed to applying and taking advantage of the new early college enrollment trend to include the high school continuum with a focus on minorities and young women.

Next steps in this project include expanding this researcher-practitioners and development model to neighboring islands, examining parallels between the online learning and teaching pedagogies, support service methodologies, and environmental factors among different school-community contexts.

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Appendix 1 – Course Description of Cybersecurity College Courses

ICS 101 - Digital Tools for the Information World - Emphasizes production of professional level documents, spreadsheets, presentations, databases, and web pages for problem solving. Includes concepts, terminology, and a contemporary operation system.

ICS 169 - Introduction to Information Security - *Prereq: ICS 101 with grade C or better, or consent.* Provides the basic foundation to information security, including identifying threats, planning for business continuity, and preparing for various security attacks. Focus will be given to threats to financial security such as attacks on banking and other related financial information. Special emphasis on ethics and legal issues that covers hacking and other cybersecurity techniques and tactics.

ICS 184 - Introduction to Networking - *Prereq: ICS 101 with grade C or better, or consent.* Provides the student with the knowledge and skills to manage, maintain, troubleshoot, install, operate and configure basic network infrastructure, as well as to describe networking technologies, basic design principles, and adhere to wiring standards and use testing tools.

ICS 171 - Introduction to Computer Security - *Prereq: ICS 101 or consent.* Examines the essentials of computer security, including risk management, the use of encryption, activity monitoring, intrusion detection; and the creation and implementation of security policies and procedures to aid in security administration.

Highly Recommendation Course: ICS 110 - Introduction to Computer Programming - *Prereq: ICS 101 with grade C or better, or consent.* Teaches fundamental programming concepts including sequential, selection, and repetition flow; variables and types; syntax; error types; compilation; linking; loading; and debugging. Introductions algorithms flow charts, UMI, and other analytic tools. Explains and practices problem solving and critical thinking methods.