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Promoting Diversity in teaching cybersecurity through GICL

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Abstract: In summary, it is necessary to develop a diverse group of K-12 students' interest and skills in cybersecurity as cyber threats continue to grow. Evidence shows that educating the next generation of cyber workers is a crucial job that should begin in elementary school. To ensure the effectiveness of cybersecurity education and equity at the K-12 level, teachers must create thoughtful plans for considering communities' interests and needs, and to continually reconsider what's working and how to adjust our strategies, approaches, design, and research plan to meet their specific needs, challenges, and strengths, particularly with students from under-served and underrepresented populations in the cybersecurity fields. By building a series of guided inquiry collaborative learning activities in the cybersecurity area, we hope that our approach could build a diverse group of students which creates a more holistic view of the problem and delivers a range of valuable problem-solving hard and soft skills. Professional development must be provided to teachers to get them prepared for adopting guided inquiry collaborative learning activities in classrooms
Keywords: collaborative learning,online learning,diversity,Guided Inquiry Collaborative Learning

Introduction

There is a shortage of cybersecurity professionals in the coming decades. According to Cybersecurity Workforce Demand (National Institute of Standards and Technology, 2021), the lack of cybersecurity professionals is about 3.12 million globally. With the growing number of cyberattacks and a shortage of cybersecurity professionals, educating people about cybersecurity is essential. The government has been increasing investments in cybersecurity education over the past decade to build a diverse and skillful workforce for cybersecurity.

However, the cybersecurity workforce is still not diverse despite the efforts. For example, women only represent about 14% of the cybersecurity workforce in North America (Reed et al., 2017). The lack of diversity in the cybersecurity area creates gaps in identifying hidden security issues that could be exploited by hackers (Eddy, 2021). Innovative approaches must be developed and used to address the diversity issue in the cybersecurity workforce. In this paper, we introduced the Guided Inquiry Collaborative Learning (GICL) approach to promote diversity in teaching cybersecurity. To promote diversity and facilitate teaching of diverse students, teachers need to be innovative in their teaching methods and adopt different strategies (Guri-Rosenblit, Šebková, & Teichler, 2007). Naz and Murad (2017) reported that innovative teaching has a positive impact on the performance of diverse students.

Guided Inquiry Collaborative Learning

The guided inquiry collaborative learning approach provides a possible way to promote diversity in teaching cybersecurity (Yuan et al., 2019; Yang et al., 2019). A guided inquiry collaborative learning approach activity comprises several sections, including learning objectives, key concepts of a small security topic, activity examples, critical thinking questions, exercise, discussion, and conclusion. In the classroom, 4-5 students can work together in one group to work on a guided inquiry collaborative learning activity given by the instructor. This activity will help them construct their knowledge learned in the class and stimulate their learning and research abilities while working on the assigned work.

The team members act in different roles, including a recorder (recording all answers & questions and providing copies to team & facilitator), speaker (talking to facilitator and other groups), manager (keeping track of time and making sure everyone contributes appropriately), and reflector (considering how the team could work and learn more effectively) while completing the guided inquiry collaborative learning activity (Showed in Table 1). Then the team will follow the instructions to complete the activity step by step as a group, report what they learned from this activity and provide answers to the questions listed in the learning activity. This process will help students develop their individual responsibility, communicate with one another, and learn from each other. The instructor will serve as the facilitator for each team and provide guidance as needed.

Table 1: Team Roles in Guided Inquiry Collaborative Learning Activities (Mitchell & Hiatt, 2010)

Team roles	Responsibilities
Recorder	Recording answers and questions and providing copies to team & facilitator (instructor)
Speaker	Communicating with the facilitator and other teams
Manager	Monitoring time and ensuring every group member contributes appropriately
Reflector	Summarizing and reflecting on how group members could improve their work and learning

Promoting Diversity in Teaching Cybersecurity through GICL

Through a project funded by the National Science Foundation, we have developed materials for teaching diverse topics in cybersecurity (available at https://blog.utc.edu/li-yang/gicl/) by following the GICL approach for face-to-face and online courses. We assessed student learning outcomes, learning experience, student attitudes, and motivations by pre-and post-survey.

Our evaluation results reveal some positive aspects of teaching cybersecurity through GICL (Yuan et al., 2017; Zha & He, 2021). Students were often assigned to work on the same GICL activity with others with diverse backgrounds, skill sets, races and genders whenever possible. Since students played different roles in the GICL activity, they had to communicate with others in the same group, bouncing ideas off each other and making their voices heard. Discussing concepts with other students in the same group increased and solidified students' understanding of security concepts. They had the chance to ask questions or directly get help from group members as needed. For example, a student said: "my teammates know this and I didn't know it. They explained it to me." Students in the group learned to value teamwork and to explore security concepts by listening to various perspectives from different students. In one of the web security activities, over 75% of students agreed that the GICL learning experience taught them how to work well with other people despite differences. 80% of students agreed that this learning experience taught them how to talk about ideas with their peers of different backgrounds or skill sets.

Conclusion

Cybersecurity is an interdisciplinary field, which requires a diverse and engaged workforce to address the ever-changing cybersecurity challenges. Developing innovative pedagogy is necessary to encourage a diverse student population to pursue cybersecurity education and careers and to achieve more diversity in cybersecurity education. The guided inquiry collaborative learning approach has a great potential to engage a diverse student population to study cybersecurity and allow the voices of diverse students to be heard during the learning process. Professional development must be provided to teachers to get them prepared for implementing guided inquiry collaborative learning activities effectively in classrooms to broaden diversity.

Reference

Eddy, N. (2021, April 19). Diversity In the Cybersecurity Workforce. Security Boulevard. https://securityboulevard.com/2021/04/diversity-in-the-cybersecurity-workforce/.

Guri-Rosenblit, S., Šebková, H., & Teichler, U. (2007). Massification and diversity of higher education systems: Interplay of complex dimensions. Higher Education Policy, 20, 373-389.

Mitchell, E., & Hiatt, D. (2010). Using POGIL techniques in an information literacy curriculum. The Journal of Academic Librarianship, 36(6), 539-542.

National Institute of Standards and Technology. (2021). Cybersecurity Workforce Demand Retrieved from https://www.nist.gov/system/files/documents/2021/08/04/NICE%20Cybersecurity%20Workforce%20Demand%20One-Pager%202021%20%28508%20Compliant%29.pdf

Naz, F., & Murad, H. S. (2017). Innovative teaching has a positive impact on the performance of diverse students. SAGE Open, 7(4), 2158244017734022.

Reed, J., Zhong, Y., Terwoerds, L., & Brocaglia, J. (2017). The 2017 global information security workforce study: Women in cybersecurity. Frost & Sullivan, Santa Clara.

Yang, L., Yuan, X., He, W., Ellis, J., & Land, J. (2019). Cybersecurity education with pogil: Experiences with access control instruction. In Journal of The Colloquium for Information Systems Security Education (Vol. 6, No. 2, pp. 14-14).

Yuan, X., Yang, L., He, W., Ellis, J. T., Xu, J., & Waters, C. K. (2017). Enhancing cybersecurity education using POGIL. In Proceedings of the 2017 ACM SIGCSE Technical Symposium on Computer Science Education (pp. 719-719).

Yuan, X., Zhang, T., Shama, A. A., Xu, J., Yang, L., Ellis, J., He, W., & Waters, C. (2019). Teaching cybersecurity using guided inquiry collaborative learning. In 2019 IEEE Frontiers in Education Conference (FIE) (pp. 1-6). IEEE.

Zha, S. & He, W. (2021). Pandemic pedagogy in online hands-on learning for IT/IS courses. Communications of the Association for Information Systems, 48(1), 13.