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Social Factors Impacting Cybersecurity Students' Learning and During Decision Making the Coverage of Major-specific Concepts

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As the cybersecurity field continues to grow, there are various factors that influence people's interest in seeking professional positions in cybersecurity. In academia, there are different methods that impact how students interact with others throughout an online course. This leads to important pedagogical research questions that relate to the factors impacting a person's interest in cybersecurity and the factors that help social interactions in an online course. Even though it is important to learn about the social factors that impact why students are studying in the field of cybersecurity, there is limited pedagogical research regarding this area of interest. As a result, this paper focuses on several factors that led students to learn more in the field of cybersecurity and what has impacted them in their interactions with others in an online course. Qualitative and quantitative data was provided by 103 students at a university located in the northeastern side of the United States. The Principal Investigator (PI) and five research assistants gathered the data of this Institutional Review Board (i.e. IRB) approved research. The quantitative data analysis depended on the statistical analysis of survey data and the qualitative analysis depended on the follow-up interviews administered by the PI. Follow-up interview participants received money compensation for further explaining their survey responses. Qualitative and quantitative results showed the participants' prioritization in learning materials posted in Learning Management System (LMS) and media posted in LMS for social interactions in an online course. The most significant reasons for cybersecurity students' interest in the cybersecurity field consisted of the news, teachers and professors, and educational videos in social media. Some participants expressed their strong interest in defending weak and vulnerable cybersecurity driven systems and making good money to have a good life.

Keywords: Cybersecurity education, cybersecurity interest, social interactions, learning management system, learning materials, media, news, teachers and professors, educational videos, social media

1. Introduction.

As the demand for cybersecurity professionals grows, development in cyber security programs throughout universities grows as well. The field of cybersecurity continues to change and develop as time goes by therefore having courses that teach students critical thinking skills in addition to technical aspects of cybersecurity is beneficial. Having a combination of people skills, management skills, and technical skills can help future cybersecurity professionals [6]. For

developing a pedagogical curriculum of such a demand, the initial step is having a better understanding of pedagogical aspects of social interactions of students in courses.

Social factors that impact cybersecurity students' understanding of major-specific concepts are important to understand. There is limited pedagogical research of cybersecurity students' learning based on the influence of social factors from a conceptual-learning perspective. The research literature concentrates on cybersecurity students' awareness of cybersecurity events [1], factors effecting cybersecurity awareness [2], the role of social media for increasing social media risk awareness [3], cybersecurity awareness in online education [4], and education of students to increase awareness of cybersecurity based on emerging social media [5]. There is a gamification-based cybersecurity awareness course that was created to help people learn about cybersecurity and protect themselves from cybersecurity attacks during regular usage of the internet. The course is based on self-regulated learning so that students can learn at their individual pace. Gamification applies game elements into real-world contexts. This can help people gain and maintain their knowledge. With lessons gamified, this aimed to encourage students to learn more about cybersecurity [7]. Unlike any of these studies, our focus is solely relying on data-driven understanding of cybersecurity undergraduate students' learning-based interests in their learning environment for major-specific concepts.

Over the past decade, there has been immense growth in the cybersecurity field; cybersecurity education continues to expand throughout the world, therefore there is significance in learning about the factors that affect students' social interactions in a learning environment as well as understanding the factors that affect students' interest in cybersecurity. This research aims to look at the social influences that help cybersecurity students to learn major-specific concepts. Factors including research, social media, professors, family, and friends can have a big influence on how students discover and gain interest in the cybersecurity field. To the best of our knowledge, there is no pedagogical study that aims to help cybersecurity educators understand the factors that impact cybersecurity students' social interactions in a learning environment and the factors that impact students' interest in cybersecurity.

The next section covers the research methodology of the study undertaken to report the results. What follows is the quantitative analysis of the data to quantify outcomes for the study. Section 4 has the qualitative results that relied on the video recorded interviews. The last part of this work focuses on the conclusions and possible future work that can be undertaken by other educators and researchers.

2. Research Methodology

The data depicted in this research was conducted in one of the public universities in the Northeastern region of the United States by a P.I and five research assistants. The data is gathered by the researchers following Institutional Review Board (IRB) approval to do the research. Pre- and post-data collection and evaluation consisted of two informed consent forms, a survey, and

video recordings of the interview participants with the transcription of the data. All data is gathered from cybersecurity students. The quantitative data is the numerical data attained from 103 students based on the following two research questions as a part of the survey they completed:

1. What factors do you believe impact your social interactions in an online course the most?
2. Which factors in social media are impacting your interest in the cybersecurity field?

The quantitative analysis of the data is based on the statistical distributions of the data as well as the statistical analysis of the numerical responses. The qualitative data is collected from students during scheduled interviews that last between 30-40 minutes to further understand their survey responses. The interviews are recorded and transcribed, and students are compensated with money for participating in interviews. The goal of the follow-up interviews is to gain a better understanding of the participants survey responses, hence the additional follow-up questions to gain more detailed responses. The recordings are analyzed to identify the details of responses collectively. Statistical calculations form quantitative results and voice-recorded interviews provide qualitative results.

3. Quantitative Results

The focus in this section is on the quantitative data analysis and the associated results derived from the collected numerical survey data. An initial investigation is conducted on the distribution of the collected data for further implementation of the statistical analysis. Following this approach, two statistical techniques, Wilcoxon Ranking Sum and the Mann-Whitney U tests, are applied due to non-normal discrete nature of the data for non-parametric analysis. Additional statistical percentage values will be displayed to explain specifics of the quantitative nature of the data. These quantitative results will be interpreted within the context of the results, and they will be integrated into qualitative results in the conclusion section to detail the overall analysis of the context.

3.1 Data Distributions & Statistical Analysis

The aim of this section is to focus on the analysis of the data collected with the associated distributions fitting to them. The nature of the distributions would tell us the level of how much students care about the factors playing the role in their choices to be explained. The two survey questions we focus on are the following two different social factors:

Part A. Factors impacting social interactions in an online course that include but are not limited to the following:

1. Learning materials posted in Learning Management System (LMS)
2. Textbook
3. Course topics
4. Communication with professors
5. Communication with classmates
6. On-time responses from professors

7. Media posted in learning management system
8. Others

Part B. Factors in social media impacting students' interest in the cybersecurity field that include but are not limited to the following:

1. News
2. Research
3. Social media influencers (such as the ones in Instagram, LinkedIn etc.)
4. Educational videos on social media (such as YouTube etc.)
5. Blogs and articles published by professionals online
6. Family members
7. Friends
8. Movies
9. Teachers and professors
10. Open houses

Part A of the research particularly leaves out some of the major factors (such as professors' content coverage style) with the focus on social interactions in an online course while Part B focuses on the factors in social media that impact cybersecurity students learning. These two parts will be analyzed in the rest of this work.

3.1.1 Factors Impacting Social Interaction in Online Learning

Focusing on Part A, the top choices of the research participants are shown in Figure 1 below. The model shown in this figure is an exponential model with about 90% fitting accuracy. Leaving professor factor out of the equation, the learning materials posted in LMS is picked to be the top choice at 37.14%. The second place is shared by textbook and course topics at about 20% each. Communication with the professor was determined to be the top choice of 15.71% of the participants while 7.14% chose communication with the classmates to be the most important factor for social interactions in an online learning platform.

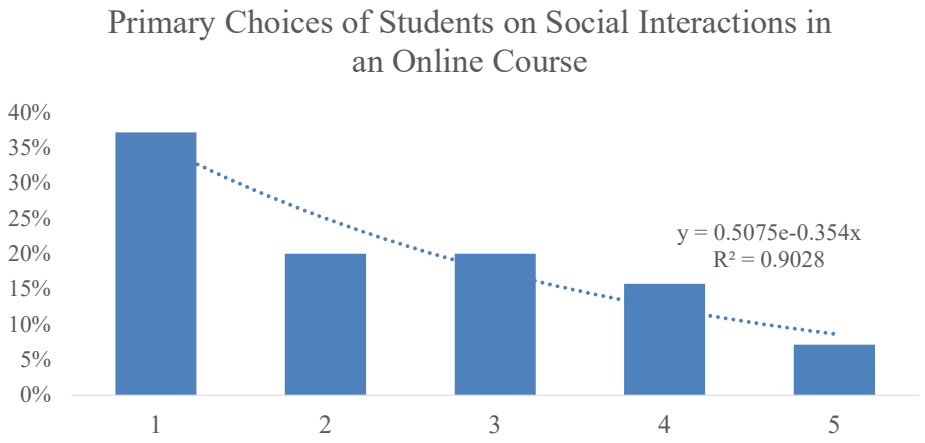

Fig. 1 Top priority of cybersecurity students for social interactions in an online course.

Given the top priority choices are made, the secondary choices distribution displayed in Figure 2 also follows an exponential distribution with a fitting accuracy of about 95.5%. The top second option was determined to be the media posted in LMS with a percentage of 28.57% while the second-best option was picked to be on-time responses from professors by 21.43% of the participants. Options 2-5 displayed in the figure remained to be anywhere between 10-15% of the participants' choices with the corresponding order of communication with classmates (14.29%), communication with professors (11.43%), course topics (10%), and textbook (10%).

Following the top two choices, the tertiary-level choices of the students are displayed in Figure 3 below. As can be seen, the choices do not allow a direct distribution to fit the data in its original form. The top tertiary-level choice is the communication with the professor (21.43%) with the secondary placement is shared by both course topics and textbook (20%). Communication with classmates remained to be the third option at 12.86% with the learning materials posted in LMS and on-time responses from professors remaining at 10%.

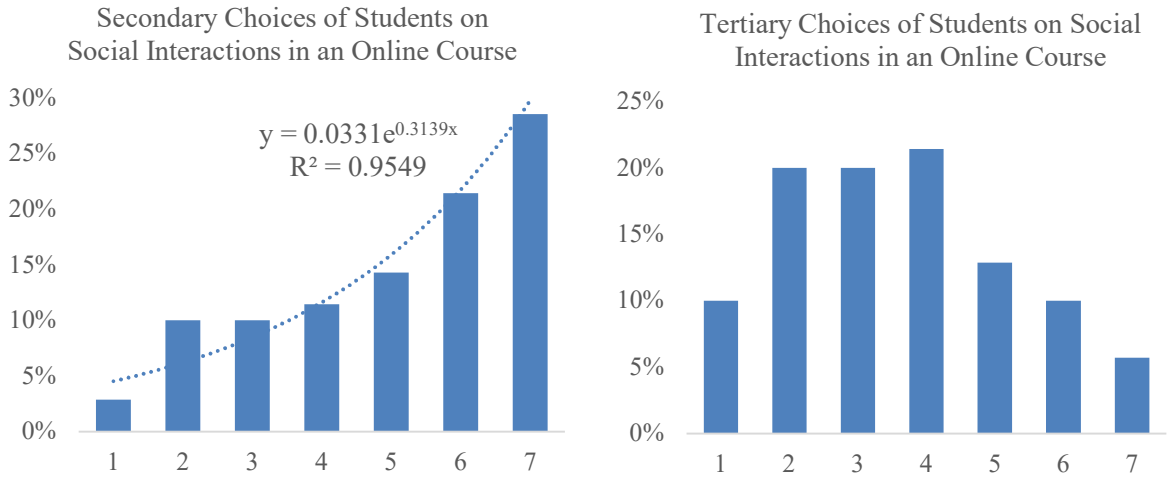

Fig. 2 Secondary and tertiary choices of cybersecurity students for online social interactions.

Overall, the numerical results indicated high-level priority given to learning materials posted in LMS, course topics, and communication with the professor. The next section focuses on factors in social media that are impacting students' interest in the cybersecurity field.

3.1.2 Factors Impacting Students' Interest in Cybersecurity Field

There are a variety of external factors that impact students' interest in cybersecurity that takes place in social media impacting their interest in the cybersecurity field. Given the flexibility of choosing any of the options stated in Part B, 16.14% of the responses determined the top choice as the news that are related to the cybersecurity field. What followed this option as second option was shared by two options: Educational videos in social media and teacher and professor options with each one attained at a level of 14.56%. Research option followed these two options at the

third place with 14.24% of the participants' choices. Blogs and articles remained at 10.44% of the participants' interest. The rest of the options are determined to be lower than 10%.

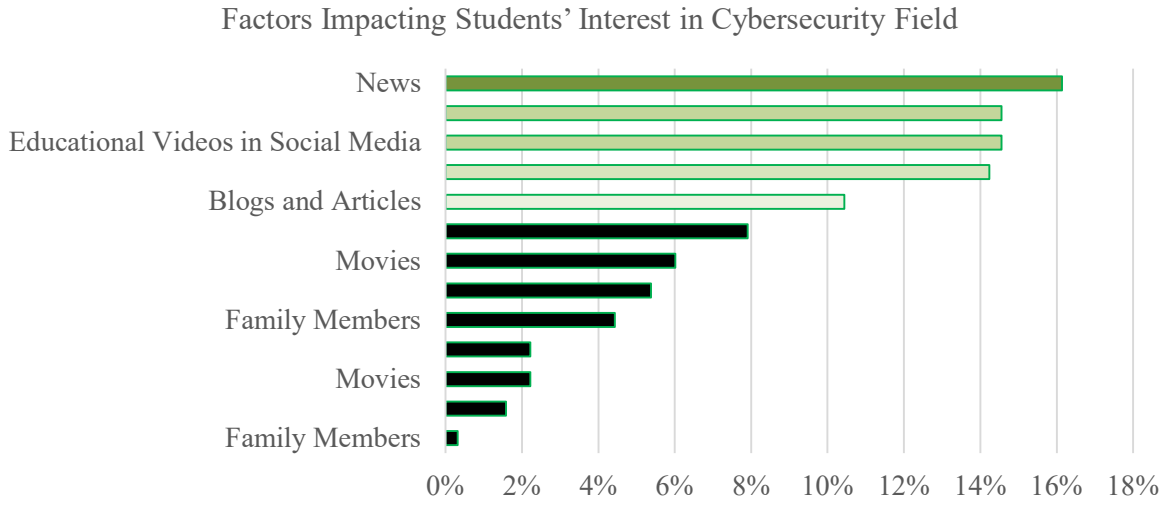

Fig. 3 Bar chart of factors that are impacting students' interest in cybersecurity field.

Next section is devoted to more two of the tests that are used for non-normal data sets with discrete nature.

3.2 Correlation

The correlation values displayed in Table 1 demonstrate the relationship between the top choices made among the research participants to Part A based on their responses 1-7. Looking at these options, it is easy to see that those participants who picked values LMS materials also picked classmate communication indicated by the correlation value of 98.43%. A high-level of correlation occurred at a rate of 95.52% by choosing professor communication and media posted in LMS together. The rest of the options remained below 95% accuracy level of relevance.

	LMS Materials	Professor Communication	Topics	Classmate Communication	Textbook	On-time Responses	Media Posted in LMS
LMS Materials	100%	-55.24%	49.51%	98.43%	6.03%	-48.85%	-55.91%
Professor Communication		100%	-3.18%	-53.13%	24.47%	67.87%	95.52%
Topics			100%	60.98%	72.29%	-7.88%	-26.13%
Classmate Communication				100%	14.31%	-49.91%	-57.42%
Textbook					100%	44.36%	1.97%
On-time Responses						100%	57.01%
Media Posted in LMS							100%

Table 1. Correlation table of Part A choices of the participants.

3.3 Mann-Whitney U and Kruskal-Wallis Tests

In this section we apply the Mann-Whitney U and Kruskal-Wallis Tests to determine the significance levels of the categorized data. The categorized data consisted of the choices of the information outlined in Table 1 and the associated ranking of numbers. Non-normal distribution nature of the data collected for Part A formed 7 categories with 7 selection options for each category. Initially, non-parametric statistical Mann-Whitney U test is applied to each coupled category that required 15 times application of the statistical test. In all comparisons the null hypothesis is accepted indicating that the survey results agree with each other at $\alpha=0.05$ confidence level. Overall, the averages of the prioritization levels of the students do not have significant differences with each other.

The Kruskal Wallis is used for data rank evaluation. This procedure ranks all the sample data from low to high which then averages the ranks for all groups. If the results are statistically significant, then the average group ranks are not all equal. Using the Kruskal-Wallis test, the Chi-square distribution applied to 7 categories with the 7 options indicated a statistically significant outcome at a p-value of 0.00503. This result indicates the significance of the difference in averages of the ranked categories.

4. Qualitative Results

The qualitative results form the foundation of a better understanding of the quantitative results obtained in this research. Given the large quantity of the collected data, we will demonstrate samples of some of the popular answers and the students' justifications of their choices.

The qualitative results are attained via video recorded follow-up interviews of the participants. Participants are compensated for taking place in a 30–40-minute video recorded interview that served as a follow up interview to better understand survey responses. The P.I. conducted the video recorded interviews with the participants while research assistants worked with the P.I. on the survey data collection from the students. A comprehensive analysis and overview of the integrated qualitative and quantitative responses will be presented in the last section of the article. Several examples of qualitative data will be demonstrated in this section for both Parts A and B.

Cybersecurity students' choices of factors are driven by the underlying experiences as expected with the factors that motivate them the most based on their traditional learning and life patterns. Noting that Covid 19 caused a big shift from in-class learning to online learning, students initiated a new development stage with their accumulating experiences that resulted in integrating into existing choices. Each person's additional real-life experiential learning experience included more to that person's online learning preferences to either expand or shrink in the number of choices made. For instance, the following participant chooses to be in the classroom for learning concepts instead of taking online courses due to his experiences and the top choice for Part A is connected to communication with the professor. Prior experiences of this participant with the movies motivate him to be in the cybersecurity field.

Interviewer. *What factors do you believe impact your social interactions in an online course the most? Again, if you go from one being the most helpful and eight being the least helpful, if you list them here.*

RP 7 *OK. So again, my experience with online class, I learned the most with the direct one-on-one communication with the professors, so that would be my one. Communication with classmates was number 2, with some of the labs and some of the other coursework. I really understood it by asking some of them. I would say. Learning materials #3. I'm a little confused by the course topics. What exactly does it mean? Like I get it like in the sense that like certain topics might be easier, but…*

Interviewer. *I can't clarify that for you. So that simply means, for example, you may have more interest in network security therefore you're more motivated to take network security related courses or relevant concepts within a certain course. While you're not really interested in cryptography too much. Therefore, that's not really motivating you too much…*

RP 7. *Right. OK. But that would impact my social interactions in the online course for like if it being a network course or not.*

Interviewer. *So, when that's the case, you're more into it and could boost your online interactions, social interactions with others. If you are posting discussion posts then the topics may motivate you more, and this may be the type of social interactions that we are talking about here in an online course.*

RP 7. *OK. Gotcha. So let me just go back on communicating with professors. I put one communication with classmates, I put 2 on time responses from professors. I put that #3, probably course topics. Learning materials posted in Brightspace I put 5. Media post in learning Management post 6. And textbook, I'd put seven because I don't really see how. Again, maybe that's probably has to do with course topics, but it yeah, I would put that 7.*

Interviewer. *Which of the following factors in social media impacting your interest in the cybersecurity field? If you mark these, any of these factors that you believe impact you, which ones would you choose? There's news, research, social media influencers, education videos and social media blocks and articles published by Professions Online, family members, friends, movies, teachers and professors open houses. And if you have any other, you can also list them.*

RP 7. *OK, so for me particularly I really found out about cybersecurity and what really got me interested was from like movies and stuff like that. Like, you know, sci-fi like. Spy thrillers and stuff like that, Mission Impossible and all those movies. So, I put movies #1. Probably put News #2; Like the big stories about hackers and stuff and situations like that is number 2. Again, blogs and articles. Three. Probably. research four. Social media influencers at five, I believe a match. Probably teacher 6, and Friends 7. Family members eight. I'm not sure what open houses you guys exactly mean, though I don't know if you want to clarify that one, but probably put that one last.*

Interviewer. *OK. Open houses are designed to provide information to interested students…Professors and staff are available to provide information to interested parties. And when you go there, you get to talk to a professor, for example, within the cybersecurity field about the curriculum courses, the research done, the associated degree completion requirements, job opportunities, internship opportunities etc. So that's what it meant by that.*

RP 7. *OK. Got you. I haven't done any of those yet, so I'll just put that as the last option.*

The following participant prioritized the learning materials posted in LMS that agrees with most of the other participants' choices. This participants' experience indicates reliance on the course materials in the LMS. Reading online posted blogs is this participant's top choice when it comes to boosting interest in the cybersecurity field.

Interview. *What factors do you believe impact your social interactions in an online course the most? And again, if you list them from one being the most helpful trade, being the least helpful here in this list, how would you list up?*

RP 2. *Sure! So, I'd say the learning materials are definitely number one. They make a huge difference because, in an online course, we rely on them a lot. Most students don't really use textbooks anymore—maybe just a few do—but if the learning materials, like slides and other resources, are well-prepared, it's easier for everyone to follow along and engage. Number two would be the course topics. If the topics are interesting and well-organized, they encourage more interaction, whether it's with classmates or professors. For example, in cybersecurity, we might start with something basic like an introduction to cybersecurity and then build on that with digital forensics or more advanced topics. Having continuity in the topics helps us connect better with the material and each other. Number three would be communication with professors. Having open communication is so important in an online setting because professors can clarify things, answer questions, and keep the course interactive. Number four is the learning management system and how user-friendly it is. If the system is easy to navigate, it encourages students to engage more, whether it's through discussion boards or other tools. And finally, number five would be textbooks. I honestly think most students don't rely on them much in online courses, especially when the learning materials are strong. The slides and other posted materials are usually more accessible and directly helpful.*

Interviewer. *Which of the following factors in social media impacting your interest in the fields? And again, if you choose the ones that are listed here, which ones would you code?*

RP 2. *So, I'd say research is probably the biggest one for me. Reading articles every day is such a great way to stay updated. There's always new information coming out, and it really helps to gather all those updates and keep up with what's happening in the field. So yeah, research would be my number one. After that, I'd say educational videos on social media, like YouTube. Some creators, even professors, post videos that explain what's going on in cybersecurity, and those can be super helpful. Sometimes, they even line up with what we're learning in class, so it all connects and adds to what I'm already studying. So yeah, for me, it's research first and then educational videos. Those are the two things that really impact my interest.*

The follow-up qualitative results agreed with the quantitative results with furthermore justification of the participants' written survey responses. One major take-away is the reflection of the participants' mixed experiences based on pre-, during, and post-Covid 19 pandemic experiences with online learning. It was evident that the traditional in-class learning strategies were adopted to match with online learning as much as possible. Given that the design and modality (such as hybrid, synchronous, and asynchronous) of online courses change, it would be natural for the participants choices to change. This portion of the research requires furthermore understanding of the participants' responses particularly focusing on this aspect of online learning and we invite other researchers to invest time in such investigations. In addition, some of the explanations particularly focused on the participants' strong interest in defending the weak and vulnerable

cybersecurity driven systems and making good money for having a good life to be in the center of the justifications.

5. Conclusions & Future Works

The focus of this work was on factors that impact cybersecurity students' social interactions in an online course and social media impacting students' interest in the cybersecurity field. The data collected in this study received IRB approval and 103 students in a cybersecurity program on the northeastern side of the United States volunteered to participate the study. Quantitative data is formed by the responses of the participants to a survey that included open-ended responses while the qualitative data consisted of the follow-up interviews of the participants. Money compensation is provided upon the completion of the oral interviews that are video recorded and transcribed for data reporting purposes. Excluding the open-ended responses, Figure 4 displays a summary of the quantitative responses attained for the factors that impact cybersecurity students' social interactions in an online course.

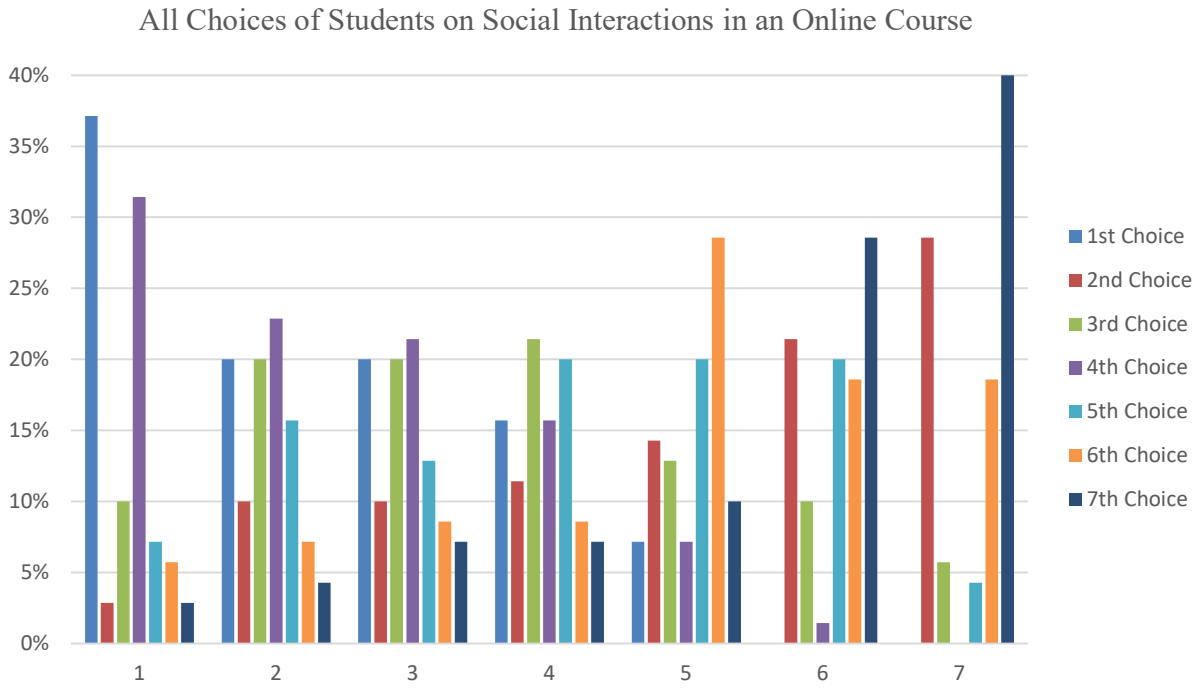

Fig. 4 A summary of the cybersecurity students' choices for Part A of the study.

Table 2 demonstrates a heat map of the responses to Part A. As can be easily seen from this designed heat map, LMS materials and communication with the professor remain to be the top-level priority of the cybersecurity students when it comes to online learning. The heat map intensity level increasing from top to bottom, right to left in most of the table.

	LMS Materials	Professor Communication	Topics	Classmate Communication	Textbook	On-time Responses	Media Posted in LMS
Count of 1	37.14%	31.43%	10.00%	7.14%	2.86%	5.71%	2.86%
Count of 2	20.00%	22.86%	20.00%	15.71%	10.00%	7.14%	4.29%
Count of 3	20.00%	21.43%	20.00%	12.86%	10.00%	8.57%	7.14%
Count of 4	15.71%	15.71%	21.43%	20.00%	11.43%	8.57%	7.14%
Count of 5	7.14%	7.14%	12.86%	20.00%	14.29%	28.57%	10.00%
Count of 6	0.00%	1.43%	10.00%	20.00%	21.43%	18.57%	28.57%
Count of 7	0.00%	0.00%	5.71%	4.29%	28.57%	18.57%	40.00%

Table 2. Heat map of Part A responses of the research using the enumeration in Section 3.1.

Figure 5 contains a summary of the quantitative results for Part B with the main drivers of the cybersecurity students' interest in the field to be stemming from News, Teachers and Professors, Educational videos in social media, and research:

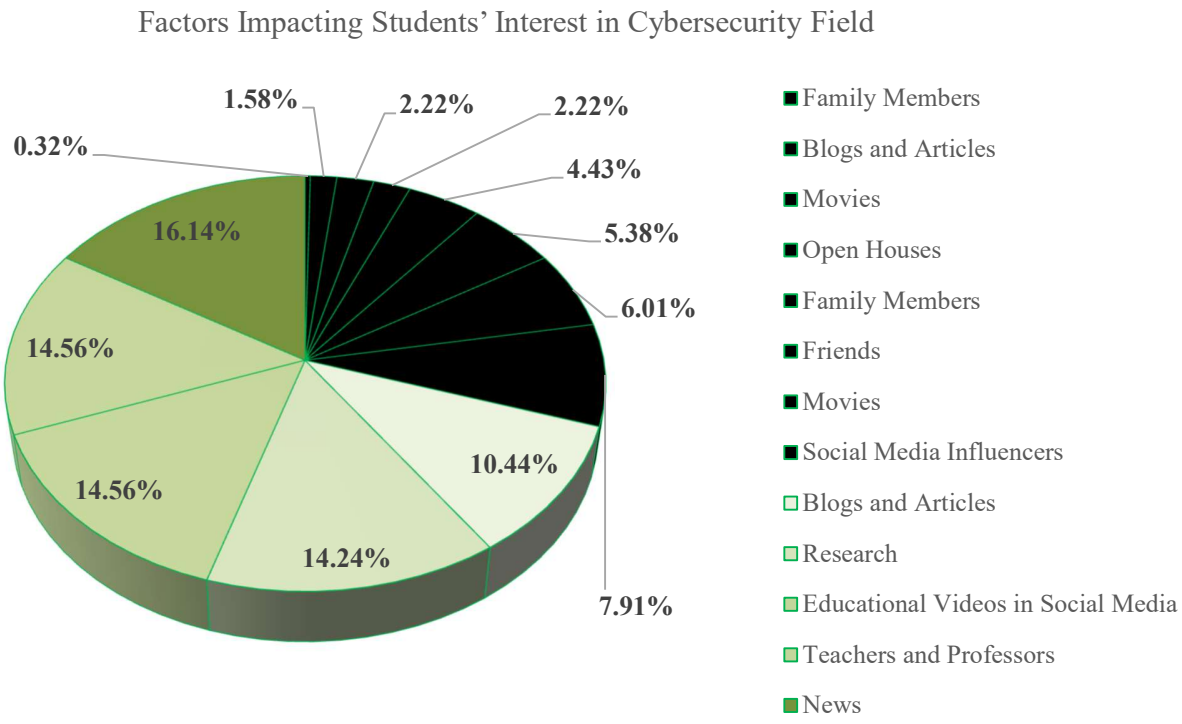

Fig. 5 A summary of the cybersecurity students' choices for Part B of the study.

Integrating these quantitative results with the qualitative results, the following are the key takeaways:

- The top choice of factors analyzed for Part A are the learning materials posted in LMS is picked to be the top choice at 37.14%. The second place is shared by textbook and course topics at

about 20% each. Communication with the professor was determined to be the top choice of 15.71% of the participants while 7.14% of the participants picked communication with the classmates to be the most important factor for social interactions in an online learning platform. The qualitative results agreed with the quantitative results with furthermore explanations indicating the participants' focus points to be based on their prior experiences of university courses completed in a general framework and the impact of Covid 19 in this result is one of the major factors that caused a shift from traditional in-class lectures to online learning.

- Part B of the survey focused on main drivers of the cybersecurity students' interest in the cybersecurity field and the top choices indicated news (16.14%), teachers and professors (14.56%), educational videos in social media (14.56%), and research (14.24%). Some of the participants' explanations particularly focused on the participants' strong interest in defending the weak and vulnerable cybersecurity driven systems and making good money for having a good life to be in the center of the justifications.
- Correlation computations showed 98.43% of the research participants valuing LMS materials in online learning also valuing classmate communication. Similarly, a high-level of correlation occurred (at a rate of 95.52%) among the participants that picked professor communication and media posted in LMS together.

All other researchers and educators are also invited to participate in the efforts made for this kind of cybersecurity-based pedagogy research and even applying National Science Foundation grants together with the P.I. of this research to further improve and enhance the educational needs of the cybersecurity students.

6. References

1. Bhatnagar, N., & Pry, M. (2020). Student Attitudes, Awareness, and Perceptions of Personal Privacy and Cybersecurity in the Use of Social Media: An Initial Study. *Information Systems Education Journal*, *18*(1), 48-58.
2. Alqahtani, M. A. (2022). Factors affecting cybersecurity awareness among university students. *Applied Sciences*, *12*(5), 2589.
3. Alqurashi, D. R., Alghizzawi, M., & Al-Hadrami, A. (2024). The Role of Social Media in Raising Awareness of Cybersecurity Risks. In *Opportunities and Risks in AI for Business Development: Volume 1* (pp. 365-376). Cham: Springer Nature Switzerland.
4. Erendor, M. E., & Yildirim, M. (2022). Cybersecurity awareness in online education: A case study analysis. *Ieee Access*, *10*, 52319-52335.
5. Amankwa, E. (2021). Relevance of cybersecurity education at pedagogy levels in schools. *Journal of Information Security*, *12*(4), 233-249.
6. Justice, C., & Sample, C. (2022, March). Future needs of the cybersecurity workforce. In *International Conference on Cyber Warfare and Security* (Vol. 17, No. 1, pp. 81-91).
7. Tran, T. M., Beuran, R., & Hasegawa, S. (2023). Gamification-based cybersecurity awareness course for self-regulated learning. *International Journal of Information and Education Technology*, *13*(4), 724-730.