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Digital literacy and cybersecurity in higher education: the unseen power of academic librarians

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ABSTRACT

The increasing reliance on digital technologies in higher education has amplified the need for students to develop digital literacy and cybersecurity awareness. However, many undergraduate students lack the competencies required for responsible and secure digital engagement, posing significant risks in the digital landscape. Academic librarians, as key facilitators of information literacy, are uniquely positioned to address these challenges, yet their roles in promoting digital literacy and cybersecurity awareness remain underexplored. The study addresses the following key issues: how do academic librarians play their roles on undergraduate students' digital literacy and cyber security awareness; what are the challenges related to library initiatives; and, perhaps most importantly, what are the strategies do librarians employ to improve it? Using a qualitative research methodology, data were collected through interviews with six academic librarians and analyzed using thematic analysis. The findings reveal that academic librarians play critical roles in fostering digital literacy and cybersecurity by teaching information literacy, promoting ethical online behavior, and enhancing students' digital safety practices. Challenges identified include limited resources, diverse digital skill levels among students, and difficulties in maintaining student engagement. Librarians address these issues through strategies such as faculty collaboration, integrating digital literacy programs, employing interactive learning tools, and pursuing continuous professional development. This research offers actionable insights for integrating digital literacy and cybersecurity initiatives into library services, improving librarian training, and enhancing the sustainability and visibility of academic libraries within higher education institutions.

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1. INTRODUCTION

The public's reliance on digital technology is remarkably high. Moreover, the digital divide appears to be narrowing in some countries [1]. This signifies a positive shift, as digital advancements continue to accelerate. With the emergence of technologies such as artificial intelligence (AI), the internet of things (IoT), blockchain, and the explosion of digital content, those unable to adapt risk being left behind. Teaching and learning processes have also become more convenient, with many countries recommending the integration of AI in education. The use of tools like ChatGPT has proven highly beneficial for educators in developing teaching modules and for students in completing assignments [2]. Additionally, digital content is

being produced rapidly, leading to an overwhelming abundance of information on the internet. The sheer volume of information has made it difficult to determine which sources are trustworthy. This is a direct consequence of rapid digital technological development, with students being among those most affected by this phenomenon.

To facilitate learning, students, particularly at the university level, refer to a variety of reference sources. Some students even utilize social media platforms as a source of information. Students rely on various platforms for multiple purposes, including accessing information and assessing its reliability [3]. Nonetheless, the overwhelming volume of information on social media can significantly influence students' cognitive processes [4]. Studies suggest that students are increasingly susceptible to scams perpetrated through social media platforms. For instance, research on Malaysian university students revealed that over one-third had fallen victim to scams on social networking sites [5]. Factors such as impulsive behavior, limited use of devices, and extended social media usage were identified as contributing risks [6]. Social media also provides a fertile ground for scammers to create fake profiles, often blurring the line between legitimate investment opportunities and fraudulent schemes [7]. Among the prevalent cybercrimes targeting students are incidents of kidnapping, sexual harassment, bullying, credit card fraud, and other forms of threats [8]. In response, various preventative measures have been introduced, including parental control features on platforms like Facebook and monitoring applications for communication tools such as WhatsApp [9]. A growing number of scams targeting university students through social media have raised alarm, with high-profile cases emphasizing the severity of the issue [7]. Despite the potential benefits of social media as an initial source of information, it is imperative for students to cultivate critical thinking skills to effectively assess the accuracy and credibility of information obtained from such platforms [10]. These insights underscore the importance of digital literacy education and the evolving responsibilities of academic librarians in fostering digital literacy and cybersecurity awareness [11].

The focus of literacy instruction has progressively shifted from basic skill acquisition to the development of higher-order thinking skills and the establishment of online learning communities. Consequently, academic libraries have emerged as pivotal agents for supporting the broader academic community [12]. To navigate the complexities of the digital era, librarians must enhance their expertise in digital literacy by adopting innovative strategies, including leveraging AI and data analytics, curating reliable digital resources, teaching critical evaluation of online information, and promoting equitable access to digital tools. This underscores the critical role of academic librarians in addressing this issue. While various platforms are utilized, the primary objective remains to equip students with the necessary skills to protect themselves in the digital environment [13].

Against this background, a study was undertaken in Malaysia's education setting with these aims: i) to examine how academic librarians influence undergraduate students' digital citizenship and cybersecurity awareness; ii) to investigate the challenges associated with library initiatives in enhancing digital citizenship and cybersecurity awareness among undergraduate students; and iii) to identify strategies employed by academic librarians to improve undergraduate students' digital citizenship and cybersecurity awareness. The research questions as:

- How do academic librarians play their roles on undergraduate students' digital literacy and cyber security awareness? (RQ1)
- What are the challenges related to library initiatives towards digital citizenship and cyber security awareness among undergraduate students? (RQ2)
- What strategies do librarians employ to improve digital citizenship and cyber security awareness among undergraduate students? (RQ3)

While much of the existing literature emphasizes the roles of educators and information technology (IT) professionals in promoting digital literacy and online safety, this study offers a novel perspective by foregrounding academic librarians as key enablers of these competencies. By explicitly focusing on the intersection of digital literacy and cybersecurity awareness through the lens of academic librarianship, an area that remains underexplored in current scholarship, this research addresses a critical gap in the literature. It examines not only the influence of librarians but also the challenges they encounter and the strategies they employ to enhance students' digital competencies. In doing so, it provides a comprehensive and context-specific understanding of how libraries can evolve as proactive agents in the digital education landscape, contributing original insights into the cultivation of digital safety practices within higher education institutions.

2. LITERATURE REVIEW

2.1. Cybersecurity awareness

The rapid advancement of digital technology has significantly transformed various aspects of human life, including education, communication, and business. Over the past few decades, the proliferation of

internet connectivity, cloud computing, and smart devices has facilitated the seamless exchange of information and increased reliance on digital platforms [14]. In higher education, digital technology plays a crucial role in supporting academic activities, such as research, collaboration, and information retrieval. The integration of digital tools into learning environments has enhanced accessibility to knowledge and fostered innovative teaching methodologies [15]. However, the widespread adoption of digital technology has also introduced significant challenges, particularly concerning data security and privacy. Cyber threats such as phishing, identity theft, and ransomware attacks have escalated, posing substantial risks to individuals and organizations [16]. As universities continue to embrace digitalization, it becomes imperative to equip students with the knowledge and skills necessary to navigate the digital landscape safely. This necessity highlights the growing importance of cybersecurity awareness, particularly among undergraduate students who frequently engage in online activities.

The current digital era emphasizes the critical need for cybersecurity awareness, particularly among university students, as they increasingly rely on digital platforms for academic and personal activities. University students frequently use online resources for coursework, communication, financial transactions, and social networking, making them prime targets for cyber threats [17]. The transition to remote learning during the COVID-19 pandemic further heightened students' dependence on digital tools, emphasizing the necessity of robust cybersecurity practices [18]. Studies indicate that a lack of cybersecurity awareness can lead to severe consequences, including data breaches, financial losses, and compromised personal information [19]. Furthermore, students' decision-making processes, particularly in evaluating online sources, sharing information, and handling sensitive data, are significantly influenced by their level of cybersecurity knowledge [20]. Given the increasing sophistication of cyber threats, universities must integrate cybersecurity education into their curricula and promote awareness initiatives to cultivate responsible digital behavior among students. Enhancing students' understanding of cybersecurity not only protects their personal information but also contributes to the overall security of academic institutions.

The concept of cybersecurity has been widely discussed in academic literature, with varying definitions proposed by researchers over time. Initially, cybersecurity was defined as the practice of protecting computer systems and networks from unauthorized access and cyberattacks [21]. Over time, this definition evolved to encompass broader aspects, including risk management, digital ethics, and regulatory compliance [22]. More recent studies have defined cybersecurity as the application of technologies, processes, and controls to safeguard digital systems, personal data, and organizational information from cyber threats [8]. This evolving definition reflects the increasing complexity of cyber threats and the necessity for a comprehensive approach to cybersecurity. In this study, cybersecurity is operationally defined as the awareness, knowledge, and practices that enable university students to protect their digital assets, personal information, and online activities from cyber threats. This definition emphasizes the proactive role of students in recognizing and mitigating cybersecurity risks within academic and personal contexts. By adopting this operational definition, the study aims to examine students' cybersecurity awareness levels and their ability to implement preventive measures effectively.

Despite the growing emphasis on cybersecurity education, university students continue to face numerous cybersecurity-related challenges. One of the most prevalent issues is the lack of awareness regarding phishing attacks, where cybercriminals use deceptive emails or messages to steal sensitive information [23]. Studies indicate that students often fall victim to phishing scams due to their inability to recognize fraudulent communication [8]. Another common problem is weak password management, as many students use easily guessable passwords or reuse the same credentials across multiple platforms, increasing their vulnerability to cyberattacks [24]. Additionally, inadequate knowledge of data privacy policies and the improper use of social media platforms expose students to risks such as identity theft and cyberbullying [19].

Furthermore, the rise of remote learning and online assessments has introduced new cybersecurity threats, including unauthorized access to educational platforms and academic dishonesty through digital means [25]. The absence of proper cybersecurity training exacerbates these issues, as many students remain unaware of best practices for securing their devices and online accounts. To address these challenges, universities must implement targeted cybersecurity awareness programs that educate students on risk mitigation strategies and encourage responsible digital behavior. Enhancing cybersecurity literacy among students is essential for fostering a secure academic environment and reducing the likelihood of cyber threats. Cybersecurity awareness plays a vital role in safeguarding university students against cyber threats that may compromise their academic and personal digital activities. The increasing reliance on digital technology necessitates proactive measures to educate students on cybersecurity best practices. By understanding the key issues surrounding cybersecurity and addressing potential challenges, universities can equip students with the necessary skills to navigate the digital landscape safely and responsibly.

2.2. Digital literacy skills of students

In the digital age, literacy extends beyond the ability to read and write; it encompasses the competencies required to navigate, evaluate, and create information using digital technologies. Digital literacy is essential for students as it facilitates academic success, enhances critical thinking, and prepares them for the demands of the modern workforce [26]. With the increasing integration of technology in education, students must develop digital literacy skills to effectively engage with digital platforms, conduct research, and communicate in virtual environments. Furthermore, digital literacy fosters lifelong learning, enabling students to adapt to evolving technological advancements [27]. The importance of digital literacy extends beyond academics, influencing students' ability to critically assess online information, engage in responsible digital citizenship, and protect themselves from digital threats [28].

Digital literacy has been defined in various ways by scholars and institutions over the years. Gilster [28] initially conceptualized digital literacy as the ability to understand and use information from digital sources. More recent definitions have expanded this concept to include competencies such as critical thinking, ethical considerations, and digital communication skills [29]. The American Library Association (ALA) defines digital literacy as the ability to use information and communication technologies to find, evaluate, create, and communicate information effectively [30]. In the Malaysian context, digital literacy is emphasized as a crucial skill for achieving national digital transformation goals, particularly in higher education institutions [31]. For this study, digital literacy is operationally defined as students' ability to critically interact with digital content, utilize technological tools for academic and personal development, and navigate the digital environment safely and ethically.

Globally, academic libraries play a crucial role in fostering digital literacy among students. In developed nations, universities have implemented structured digital literacy programs within their library services, focusing on research skills, online collaboration, and information evaluation [32]. For instance, academic libraries in the United States and the United Kingdom provide digital literacy workshops and online modules to help students navigate academic databases and enhance their research capabilities [33]. In Malaysia, the role of academic libraries in digital literacy development is gaining prominence. The Malaysian government has emphasized digital literacy as part of its national education agenda, leading to the incorporation of digital literacy programs in university libraries [34]. Malaysian university libraries offer digital literacy training sessions, online tutorials, and collaborative initiatives with faculty members to equip students with essential digital skills. Despite these efforts, challenges such as a lack of standardized curricula and varying levels of student engagement remain prevalent [34]. Addressing these challenges requires continuous investment in digital literacy education and the development of tailored programs that meet students' specific needs.

Academic librarians serve as key facilitators in enhancing students' digital literacy skills. By integrating digital literacy training into library instruction, librarians can equip students with the necessary skills to locate, evaluate, and utilize digital information effectively [26]. One effective approach is the incorporation of digital literacy modules into university curricula, ensuring that students receive systematic training throughout their academic journey. Additionally, academic librarians conduct hands-on workshops, provide individualized consultations, and develop online resources to support digital literacy education [35]. Collaborating with faculty members enables librarians to embed digital literacy skills into subject-specific courses, fostering a more integrated learning experience. Furthermore, academic librarians can leverage emerging technologies, such as AI and virtual reality (VR), to create interactive learning experiences that enhance students' engagement and comprehension. To maximize impact, libraries must also ensure continuous professional development for librarians, equipping them with the latest knowledge and instructional strategies to teach digital literacy effectively. Beyond digital literacy education, academic librarians also play a pivotal role in raising cybersecurity awareness among university students. As cyber threats become increasingly sophisticated, students must be equipped with the knowledge to protect their digital identities, secure their online accounts, and recognize cyber threats such as phishing and malware attacks [36]. Academic libraries can serve as information hubs where students learn about best cybersecurity practices through workshops, informational campaigns, and access to credible resources on digital security.

Digital literacy and cybersecurity awareness are inherently connected, as both involve the ability to critically assess digital content, recognize risks, and implement safe online practices [33]. Students who are digitally literate are better prepared to identify misinformation, avoid online scams, and maintain data privacy. Therefore, embedding cybersecurity education within digital literacy training can enhance students' overall digital resilience. Universities should consider developing comprehensive programs where librarians collaborate with IT departments to deliver cybersecurity training, ensuring students gain a holistic understanding of both digital literacy and cybersecurity. Strengthening digital literacy initiatives and incorporating cybersecurity awareness will contribute to students' ability to utilize digital tools responsibly, protect themselves from cyber threats, and thrive in an increasingly digitalized world.

3. RESEARCH METHOD

This study adopted a qualitative research approach, aligning with the methodologies utilized by Al-Kumaim *et al.* [4]. Qualitative research is designed to explore the complexities of human experiences, perceptions, and behaviors within their natural settings [18]. By emphasizing non-numerical data obtained through open-ended surveys, observations, and interviews, this approach facilitates an in-depth exploration of the subject matter. The chosen method allowed for a nuanced analysis of participants' responses, providing a comprehensive understanding of the research topic. Participants were chosen by using purposive sampling, a method that selects samples based on specific criteria that related to research questions. The criteria for the selection of the participants were as librarians from academic library (university) and librarians who involve in digital literacy and cyber security programs.

3.1. Data collection

This study utilized in-depth interviews as the primary method of data collection, focusing on a specific group of six librarians from two academic libraries, public universities in Malaysia. Participants were selected using purposive sampling, a technique that allows researchers to deliberately choose individuals possessing characteristics relevant to the research objectives. Each participant engaged in face-to-face interviews lasting between 2 and 3 hours, conducted with careful attention to detail. The discussions centered on their perspectives regarding their roles, challenges, and strategies in promoting digital literacy and cybersecurity awareness among undergraduate students. All interviews were recorded and transcribed verbatim to ensure accuracy and facilitate a rigorous analysis of the information.

The sample size of six participants is considered adequate for qualitative studies where the objective is to achieve depth rather than breadth of understanding. Creswell and Poth [37] recommend 5 to 25 participants for phenomenological qualitative studies, depending on the complexity of the topic and the point at which data saturation is achieved. In this study, thematic saturation was reached after the 6th interview, as no new themes emerged, confirming the sufficiency of the sample size.

3.2. Data analysis

In this study, data obtained from interviews with academic librarians were analyzed using thematic analysis, a well-established qualitative research method. Thematic analysis is widely recognized for its flexibility and effectiveness in identifying, analyzing, and interpreting patterns within qualitative data [4]. Thematic analysis offers several key advantages that enhance its applicability in qualitative research. It provides a systematic yet flexible approach to identifying meaningful patterns in data, allowing researchers to engage with the richness and complexity of participants' responses [38]. This adaptability makes thematic analysis suitable for various research designs and subject areas. It facilitates data-driven analysis while also allowing researchers to incorporate theoretical frameworks where relevant, enabling a balanced interpretation of findings. Additionally, it helps uncover latent insights by moving beyond surface-level descriptions, capturing deeper meanings and experiences [39]. Thematic analysis follows a 6-step process: i) familiarization with the data involves thoroughly reviewing interview transcripts to gain an overall understanding of the content; ii) generating initial codes requires systematically coding key data segments to identify important concepts; iii) searching for themes entails grouping coded data into broader themes that capture significant patterns; iv) reviewing themes involves refining and ensuring coherence with research objectives; v) defining and naming themes provides clear representations of their meaning and significance; and vi) producing the report synthesizes themes into a coherent narrative, integrating supporting excerpts and linking findings to research questions. By applying thematic analysis, this study effectively captured the nuanced experiences and perspectives of academic librarians, providing valuable insights into their roles, challenges, and strategies in fostering digital literacy and cybersecurity awareness among students.

4. RESULTS

4.1. Demographic information

The demographics of the participants are summarized in Table 1. This study involved six academic librarians from two university libraries in Malaysia. The participants were evenly distributed, with three librarians from each institution. Among the participants, 5 were female (83.3%) and 1 was male (16.7%), reflecting the common gender trend in the library profession. The 2 librarians held a master's degree (33.3%), while 4 had a bachelor's degree (66.7%). This mix of qualifications provides insight into how academic background influences their roles in digital literacy and cybersecurity awareness. The participants' work experience ranged from 5 to 23 years. The most experienced had 23 years of service, while the least had 5 years. The remaining had 11, 12, 13, and 16 years, offering a broad perspective on how experience impacts their approach to digital literacy and cybersecurity education.

Table 1. Participant's information

Organization	Participants	Gender	Education level	Experience
Academic library 1	Librarian 1	Female	Master	13 years
	Librarian 2	Female	Bachelor	12 years
	Librarian 3	Female	Bachelor	5 years
Academic library 2	Librarian 4	Female	Bachelor	23 years
	Librarian 5	Female	Master	16 years
	Librarian 6	Male	Bachelor	11 years

4.2. Academic librarian's initiatives

Academic librarians initiate several initiatives influence undergraduate students' digital citizenship and cybersecurity awareness:

4.2.1. Teaching information literacy

Academic librarians serve as key facilitators in developing students' information literacy skills, ensuring they can assess the credibility of online sources and conduct effective research. Among the participants emphasized the importance of information literacy training:

> "*As academic librarians, we actively teach students how to evaluate online sources, differentiate credible information from misinformation, and use digital tools responsibly. Many students struggle with identifying trustworthy resources, so we integrate information literacy sessions into library programs and collaborate with faculty to reinforce these skills. For example, we conduct workshops on 'effective online research strategies' and organize 'fact-checking challenges' to enhance students' critical evaluation abilities.*"

These workshops empower students with the necessary skills to critically assess digital information, thereby strengthening their research capabilities.

4.2.2. Promoting ethical online behavior

Ethical digital engagement is essential for students to maintain academic integrity and responsible online interactions. Academic librarians take proactive steps to educate students on plagiarism, copyright laws, and responsible digital communication. One participant highlighted initiatives to uphold ethical online practices:

> "*We emphasize ethical online behavior by educating students on plagiarism, copyright laws, and responsible content sharing. Through workshops and one-on-one consultations, we guide them on proper citation practices and the importance of academic integrity in the digital age. One of our key initiatives is the 'academic integrity week,' where we hold seminars on avoiding plagiarism and using citation management tools like EndNote and Mendeley.*"

These initiatives not only equip students with the knowledge of academic honesty but also provide them with practical tools to manage citations effectively. Academic libraries also serve as hubs for digital literacy training, equipping students with essential technological skills needed for academic and professional success. One participant elaborated on digital literacy initiatives:

> "*To foster digital literacy, we organize hands-on training where students learn to navigate online databases, use reference management tools, and critically assess digital sources. These skills are crucial for their academic success and lifelong learning. We have developed a 'digital literacy certification program' that includes self-paced online modules and practical assessments to ensure students acquire essential competencies.*"

This structured program ensures that students progressively build their digital literacy skills at their own pace.

4.2.3. Enhancing cybersecurity awareness

With the increasing prevalence of cyber threats, cybersecurity education has become a vital responsibility of academic librarians. Through various awareness campaigns, students are educated on safe digital practices and potential online risks. One of participants shared the importance of cybersecurity training:

> "*Many students are unaware of cybersecurity threats, so we conduct awareness campaigns on topics such as phishing, data privacy, and secure password management. We also provide step-by-step guidance on protecting personal information when using online platforms. For instance, we run an annual 'cybersecurity awareness day' featuring guest speakers from IT security firms, live demonstrations on recognizing phishing scams, and interactive activities on safe digital practices.*"

By incorporating real-world examples and expert insights, these programs help students build resilience against cyber threats.

As digital platforms become integral to academic and personal activities, students must understand responsible digital citizenship. Academic librarians educate students on issues such as cyberbullying, misinformation, and online etiquette. One of participant discussed efforts to instill responsible digital behavior:

> "*Raising awareness about ethical online behavior is a priority. We discuss issues like cyberbullying, misinformation, and responsible social media use. Our goal is to help students develop a strong digital identity while maintaining respect for others online. We collaborate with student organizations to host panel discussions on 'ethical digital citizenship' and role-playing activities where students navigate real-world ethical dilemmas in digital spaces.*"

These collaborative efforts create engaging learning experiences that encourage students to reflect on their digital behaviors and responsibilities.

In addition to digital literacy and ethical awareness, cybersecurity education remains a key focus for academic libraries. Ensuring students understand fundamental cybersecurity principles can mitigate risks associated with online activities. One person spoke about his personal experience on cybersecurity training within library services:

> "*We integrate cybersecurity awareness into our library orientations, teaching students how to recognize online threats and secure their digital presence. Simple practices like enabling two-factor authentication and avoiding suspicious links can significantly reduce their vulnerability to cyber risks. We also run a 'cyber hygiene campaign,' which includes interactive quizzes, password security workshops, and real-time hacking demonstrations to help students understand the importance of digital safety.*"

Through these initiatives, students develop essential cybersecurity skills that protect their digital identities and personal information. By conducting targeted workshops, organizing awareness campaigns, and integrating digital literacy training into library services, they equip students with essential skills to navigate the digital landscape responsibly. The insights provided by the six academic librarians underscore the importance of continuous efforts to foster a digitally literate and cybersecurity-aware student population. Their initiatives not only enhance academic success but also contribute to responsible digital citizenship and safer online practices within the university community.

4.3. Associated challenges

Academic librarians frequently experience different challenges associated with library initiatives in enhancing digital citizenship and cybersecurity awareness among undergraduate students:

4.3.1. Limited resources

Many academic libraries face budget constraints, limiting their ability to implement comprehensive digital literacy and cybersecurity programs. Financial limitations affect the availability of up-to-date technology, training materials, and expert-led workshops. One of participants shared concerns about resource limitations.

> "*One of our biggest challenges is the lack of funding for digital literacy programs. We want to introduce more hands-on cybersecurity training, but without sufficient resources, we have to rely on free online tools and in-house expertise. This limits the depth and reach of our programs*."

Librarians often face difficulties in acquiring new learning materials, updating technological tools, and organizing training sessions due to financial and institutional constraints. The challenge is further compounded by the need to continuously adapt to the evolving digital landscape, requiring updated resources that may not always be accessible.

4.3.2. Diverse digital skill levels among students

Students entering university have varied digital competencies, making it challenging for librarians to design one-size-fits-all training programs. One of librarians explained the difficulties in catering to different digital skill levels.

> "*Some students are highly proficient in digital tools, while others struggle with basic functions like searching for academic articles. This gap makes it difficult to create standardized training sessions that benefit everyone equally.*"

Meanwhile, other librarian added:

> "*We've had cases where students needed personalized assistance because they found general digital literacy workshops too advanced. To accommodate different skill levels, we now offer tiered training sessions such as beginner, intermediate, and advanced to ensure that every student benefits.*"

The inconsistency in digital literacy among students makes it difficult to structure training programs that cater to all proficiency levels. Some students may require extensive guidance, while others may find basic workshops redundant, leading to a disparity in engagement and learning outcomes.

4.3.3. Difficulties in maintaining student engagement

Despite offering valuable digital literacy and cybersecurity training, librarians often struggle to attract and retain student participation. Students may perceive these topics as secondary to their academic coursework, leading to low attendance and engagement. One participant highlighted the difficulty in encouraging participation:

> "*Students are often reluctant to attend library workshops unless they are linked to their coursework. They see cybersecurity awareness as something optional rather than essential.*"

Other participant emphasized the challenge of making sessions more engaging:

> "*Traditional workshops and lectures don't always capture students' interest. Many prefer self-paced learning or hands-on experiences rather than passive instruction.*"

Another participant added another issue:

> "*We notice that when digital literacy training is not a formal requirement, attendance is significantly lower. Students tend to prioritize assignments and exams over voluntary sessions.*"

Engagement remains a critical issue as students often struggle to see the immediate relevance of digital literacy and cybersecurity training. Without a clear incentive, participation levels remain inconsistent, making it challenging to ensure widespread digital competency among students.

4.4. Academic librarian's strategies

Academic librarians employ various strategies to improve undergraduate students' digital citizenship and cybersecurity awareness:

4.4.1. Faculty collaboration

Collaboration with faculty members is a key strategy to embed digital literacy and cybersecurity topics into the academic curriculum. By working closely with lecturers, librarians ensure that students receive relevant and structured guidance on these essential skills. Participants highlighted the importance of faculty partnerships:

> "*We collaborate with faculty to integrate digital literacy workshops into specific courses. When students see these skills as part of their coursework, they are more likely to take them seriously and actively participate.*"
> "*One successful collaboration involved embedding a library-led session on online research ethics into a first-year writing course. This ensured that students received structured guidance on responsible digital engagement from the beginning of their academic journey.*"

4.4.2. Integrating digital literacy programs

Embedding digital literacy programs within library services allows students to develop these skills progressively through structured learning modules. One of librarian shared an approach used in their institution:

> "*We developed a series of workshops that align with the university's academic programs. Students can take introductory sessions on basic digital literacy skills and progress to advanced cybersecurity training.*"

Other librarian emphasized the value of structured programs:

> "*We offer certification programs where students complete a set number of digital literacy workshops to earn a certificate. This not only motivates participation but also enhances their employability.*"

4.4.3. Employing interactive learning tools

To enhance student engagement, librarians incorporate interactive tools and activities that make digital literacy and cybersecurity training more dynamic. One of participant explained how gamification helps in training:

> "*We use gamified approaches like cybersecurity escape rooms where students must solve online safety challenges. This makes learning fun and ensures they remember key cybersecurity concepts.*"

Another participant added:

> "*Interactive quizzes and scenario-based learning have been effective. Students respond better when they can test their knowledge in real-time situations.*"

4.4.4. Pursuing continuous professional development

Academic librarians actively engage in continuous learning to keep up with evolving digital literacy and cybersecurity trends, ensuring they can effectively guide students. Librarians discussed ongoing training efforts:

> "*We regularly attend workshops and webinars on digital literacy and cybersecurity. Staying updated helps us provide relevant and up-to-date training to students.*"

Other librarian highlighted the significance of professional networking:

> "*Engaging with librarian networks allows us to share best practices and adopt new strategies that have been successful at other institutions.*"

These approaches play a crucial role in ensuring that students develop the competencies needed to navigate the digital world responsibly and securely.

5. DISCUSSION

The aim of this study, as previously discussed, is to address three research objectives. The following section presents a discussion of the research outcomes, organized according to the research objectives.

5.1. Findings related to research objective 1

Based on the results of the findings, it is evident that academic librarians play a central role in influencing digital citizenship and cybersecurity awareness among undergraduate students. Through structured initiatives, they equip students with skills to navigate digital environments responsibly and securely. The finding highlights several strategies: teaching information literacy, fostering ethical online behavior, and organizing cybersecurity awareness programs. These efforts align with scholarly consensus that libraries are essential agents of digital literacy in higher education [40]. One of the most consistent initiatives involves teaching students how to critically evaluate information sources and distinguish between credible and false content. As one librarian noted, workshops such as "effective online research strategies"

and "fact-checking challenges" are key tools. These activities are grounded in broader trends; for example, Haleem *et al.* [41] found that integrating digital literacy into instruction improves students' abilities to evaluate information, especially in the context of online misinformation.

Promoting ethical online behavior is another important initiative. Many librarians run programs centered on plagiarism prevention, copyright compliance, and digital ethics. A notable example is "academic integrity week," where students attend seminars on avoiding academic dishonesty and using citation managers like EndNote. According to Sefcik *et al.* [42], such initiatives reinforce institutional values and enhance student understanding of digital responsibility. Moreover, fostering ethical digital engagement contributes to students' digital identity development, enabling them to participate in online spaces respectfully and responsibly [43].

Cybersecurity awareness has also become a primary focus for academic librarians due to rising threats such as phishing, data breaches, and identity theft. One participant described organizing an annual "cybersecurity awareness day" featuring live hacking demos and workshops on secure password management. Similar campaigns are growing across academic libraries globally. Reed and Miller [44] argue that students often underestimate their digital vulnerabilities, making cybersecurity literacy an essential component of academic support services. Libraries that integrate cybersecurity content into orientation sessions or provide interactive tools like quizzes and games tend to be more successful at engaging students and improving digital safety practices [44].

5.2. Findings related to research objective 2

One of the most pressing issues is limited resources. Budget constraints restrict the ability of libraries to host expert-led workshops or invest in up-to-date tools. According to Paganelli and Houston [45], underfunded libraries often depend on freely available online materials, which may not meet students' diverse needs. Staffing shortages also reduce the capacity of librarians to offer tailored instruction or sustain new digital literacy programs [46].

Another challenge is the wide variation in digital competencies among students. Some undergraduates arrive on campus with advanced digital skills, while others struggle with basic functions like file organization or database navigation. Designing one-size-fits-all workshops is ineffective. Interviewed librarians responded to this by offering tiered learning programs; beginner, intermediate, and advanced. However, such customization requires additional time and effort. A study by Cheng [47] supports this observation, concluding that "digital inequality" within student populations presents a persistent barrier to library engagement.

Maintaining student interest in digital literacy and cybersecurity programs is also a major obstacle. Many students see these topics as peripheral to their core academic concerns. Attendance at workshops tends to be low unless participation is tied to course credit. As one librarian put it, "students prioritize assignments and exams over optional sessions." The literature echoes this sentiment. Mawardi *et al.* [48] notes that students engage more deeply with digital literacy content when it is embedded in the curriculum and directly tied to academic success.

5.3. Findings related to research objective 3

Among the innovative strategies is collaborating with faculty to embed digital literacy topics into academic courses. One librarian described co-developing an online research ethics module for a first-year writing class. This approach is validated by Rafi *et al.* [49], who found that such integrations significantly improve students' digital competencies and awareness of ethical issues. When librarians work closely with faculty, students see digital skills not as optional extras but as integral to their academic journey.

Librarians also enhance engagement by using interactive and gamified tools. Cybersecurity-themed escape rooms, interactive quizzes, and scenario-based simulations transform abstract concepts into memorable experiences. Hilliard *et al.* [50] report that these methods boost student motivation and improve retention of key cybersecurity concepts. Additionally, many libraries offer digital literacy certification programs where students earn credentials by completing a series of workshops which an approach that not only motivates participation but also adds value to students' professional profiles.

Another key strategy involves librarians' continuous professional development. Staying current with technological trends and cybersecurity risks allows librarians to provide relevant, up-to-date guidance. One librarian mentioned attending webinars on cyber threats and maintaining ties with campus IT departments. This is consistent with findings by Diseiye *et al.* [51], who argue that ongoing librarian training is essential for effective digital literacy instruction. Professional networking and collaboration across institutions also enable the sharing of best practices and successful programming models.

6. CONCLUSION

This study has highlighted the critical role of academic librarians in fostering digital literacy and cybersecurity awareness among undergraduate students. As digital technology continues to shape modern education, the ability to navigate online spaces safely and responsibly has become essential. Academic librarians serve as key facilitators in this process, equipping students with the necessary skills to critically evaluate digital content, uphold ethical online practices, and safeguard their personal information. Through qualitative research, this study explored how academic librarians contribute to digital literacy education, the challenges they face, and the strategies they employ to enhance students' competencies. The findings reveal that librarians actively engage in teaching information literacy, promoting ethical online behavior, and enhancing cybersecurity awareness. However, their efforts are often hindered by challenges such as limited resources, diverse digital skill levels among students, and difficulties in maintaining engagement. These barriers highlight the need for continuous institutional support to ensure that libraries can effectively deliver digital literacy programs.

Furthermore, the study underscores the interconnectedness of digital literacy and cybersecurity awareness. Students who possess strong digital literacy skills are better equipped to recognize online threats, protect their digital identities, and make informed decisions when navigating digital spaces. As such, the role of academic librarians extends beyond traditional information management to actively shaping students' digital citizenship. The strategies employed by librarians, such as faculty collaboration, integrating structured digital literacy programs, leveraging interactive learning tools, and pursuing continuous professional development, have proven effective in addressing some of these challenges. These initiatives not only enhance students' academic experiences but also prepare them for the broader demands of the digital workforce. Ultimately, this research contributes to the growing discourse on digital literacy and cybersecurity education in higher education. It emphasizes the need for academic institutions to invest in library resources, support professional development for librarians, and integrate digital literacy into curricula to ensure that students are equipped for the digital era. Future research may explore the long-term impact of digital literacy programs and assess the evolving roles of academic librarians in response to emerging digital threats. By prioritizing digital literacy education, universities can foster a more informed, responsible, and digitally resilient student community.

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AUTHOR CONTRIBUTIONS STATEMENT

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C : **C**onceptualization
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Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

INFORMED CONSENT

We have obtained informed consent from all individuals included in this study.

DATA AVAILABILITY

The data that supports the findings of this study are available on request from the corresponding author [MFB]. The data, which contains information that could compromise the privacy of research participants, is not publicly available due to certain restrictions.

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