

The Future of Academic Reference Services in the Age of Artificial Intelligence: An Overview

Li Lili

Georgia Southern University Libraries, USA

Kay Coates

Georgia Southern University Libraries, USA

Abstract

The purpose of this study explores the deep impact of ChatGPT on reference services in academic libraries. Based on the identified research literature, this study used the method of descriptive content analysis to evaluate the general capabilities of generative AI applications, such as ChatGPT, to transform reference services in academic libraries. With the homepage of the Georgia Southern University Libraries, two experienced librarians examined the potential of generative AI applications like ChatGPT to impact future reference services in ever-changing academic libraries. Based on the word limit, this study only focused on a few key areas of reference services, such as chatbot, online chat, information literacy, and web search, in academic libraries. Also discussed are opportunities and challenges of generative AI applications for library creation and innovation in the age of artificial intelligence.

Introduction

Since the 1990s, the prosperity of the Internet and the World Wide Web (WWW) have made it possible for academic libraries worldwide to build up ubiquitous information resources and services for faculty, staff, students, and local community users. Since November 30, 2022, OpenAI's ChatGPT (<https://chat.openai.com/>) has been leading the surging waves of Generative AI applications to stir the whole world. When the surging waves of the Generative AI applications, such as AlphaCode, Bard, ChatGPT, Claude, Cohere, Dall-E3, Deepfakes Web, GitHub Copilot, Google Gemini, Midjourney, Microsoft Copilot, Synthesia, etc., are creating rave and raging concerns. Academic faculty, librarians, and other professionals have started exploring the applicability of promoting Generative AI applications in the academic landscape to support the missions of the universities and university libraries.

Objectives of the Study

The main objective of this study is to explore the deep impact of generative AI applications such as ChatGPT on reference services in academic libraries. This study aims at:

1. assessing the potential of generative AI applications including ChatGPT in service-oriented and student-centered academic libraries;
2. identifying in which ways ChatGPT could impact current and future reference services in academic libraries; and
3. tracking how the advance of generative AI applications including ChatGPT could shape the

future reference services in ever-changing academic learning environments.

Research Questions

The following research questions guide this study:

RQ1. What are the latest research works focusing on reference services in academic libraries?

RQ2. In which areas can generative AI applications like ChatGPT impact current reference services in academic libraries now?

RQ3. How will generative AI applications like ChatGPT impact the transition between academic libraries and library intelligence in the age of artificial intelligence?

Literature Review

The rapid advance of generative AI applications has inspired the academic society's great concerns for impacts of generative AI applications on research fields of AI ethics, chatbots, cyber security, information literacy, reference services, web search, etc. In response to RQ1, the existing research literature indicates that there are increasing numbers of scholarly research works focusing on impacts of generative AI applications on the following key issues of reference services in academic libraries:

ChatGPT and Online Chat:

In the field of reference services of academic libraries, Adetayo (2023) explored the capabilities of ChatGPT to transform reference services, including online chat services, in libraries. With five selected questions, Chen (2023) evaluated the general capabilities of ChatGPT for online chatting services in academic libraries. Chen's research proved that the potential of ChatGPT is noticeably impacting the current reference services in academic libraries. Deike (2023) conducted a comparative study to assess the capabilities of two generative AI applications (ChatGPT and Perplexity AI) for business reference services in academic libraries. Panda & Kaur (2023) investigated if ChatGPT could be used as an alternative to common chatbots widely used in academic libraries. Daugherty (2023) analyzed the positive and negative impacts of ChatGPT on reference services in academic libraries. Saeidnia (2023) measured the capabilities of ChatGPT for digital reference services in academic libraries. From a much wider perspective, Samala et al. (2024) deeply investigated ChatGPT's advantages and disadvantages for utilizing ChatGPT to answer educational questions. Their research provided insights regarding the potential of ChatGPT for the more accurate information resources and improved personalized responses.

ChatGPT and Information Literacy:

Akakpo's (2024) case study deliberately introduced library instructions by assisting students to learn the power and the limitations of OpenAI's ChatGPT. James & Filgo (2023) tried to connect ChatGPT with six threshold concepts of the ACRL Framework for Information Literacy for Higher Education. In their case study, Johnson et al. (2024) used generative AI applications like ChatGPT as a leverage to promote library information literacy instruction.

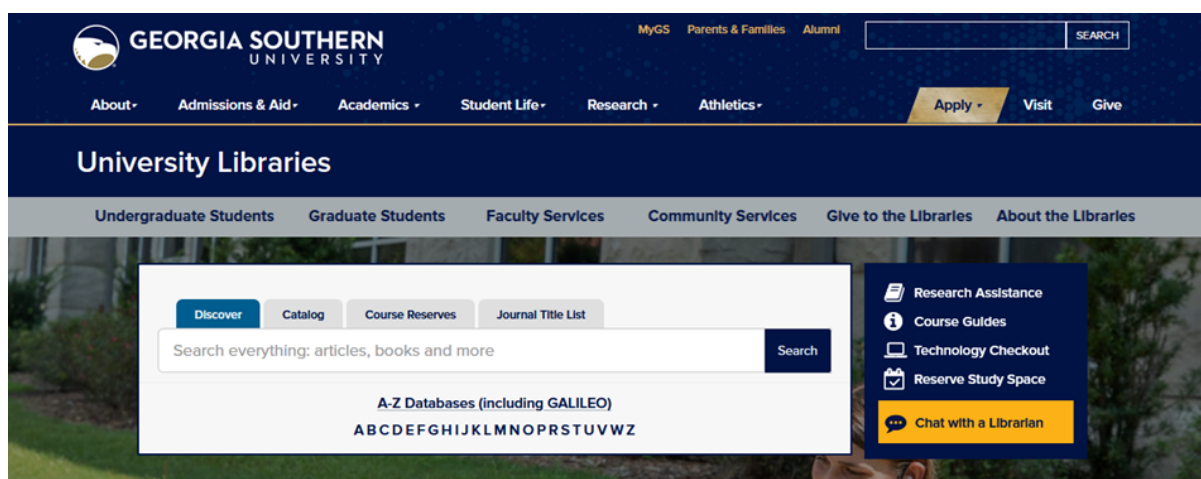
Tiernan et al. (2023) reviewed the impact of AI technology on current and future information retrieval and creation processes regarding digital literacy and media literacy. With real-world samples, Walter (2024) examined the impact of AI on higher education by emphasizing the crucial role of AI literacy for critical thinking and problem solving. Zhang (2024) shared insights regarding the impact of generative AI on teaching and learning to include a call for integrating AI with current library instruction programs in academic libraries.

ChatGPT and Web Search:

In this study, additional valuable research literature has been identified to explore if the potential of generative applications like ChatGPT could replace conventional web search engines in academic learning environments. Utilizing these applications as AI-based search tools, Ojala (2023) compared the OpenAI's ChatGPT with Google Gemini (<https://gemini.google.com>), which was formerly called Bard, and Microsoft Copilot (<https://copilot.microsoft.com/>) as well as Anthropic Claude (<https://claude.ai>). That exploration confirms that the overwhelmed AI-based information search tools are enriching current ways of information search. Bradley (2023) indicated that the AI-assisted information search had already challenged ways of traditional web search. In Bradley's view, generative AI applications like ChatGPT are leading the way towards the future of information search. In another report, Strzelecki (2024) demonstrated the latest trend of integration of among top rated web engines. Top web search giants like Google (<https://www.google.com>), Microsoft (<https://www.microsoft.com/>), and China's Baidu (<https://www.baidu.com>) are exerting their efforts to embed AI-powered services into their existing web search engines. These enhancements will definitely revolutionize web-based information retrieval in the academic and commercial fields. More detailed information is available in the section of Findings and Discussions.

Background

As a public institution of higher education located in the Southeast of Georgia, United States, Georgia Southern University (<https://www.georgiasouthern.edu/>) is one of the twenty-eight member institutions of the University System of Georgia <https://www.usg.edu/institutions/>. "With over 26,100 students, Georgia Southern University's 10 colleges, schools and departments offer 132 different degree programs at the bachelor's, master's and doctorate levels" (Georgia Southern University, 2024). Taking Georgia Southern University Libraries as an example, the following screenshot shown in Figure 1 explicitly presents how current information resources and services are organized inside the university libraries:



*Figure 1. Homepage of the Georgia Southern University Libraries
(<https://library.georgiasouthern.edu/>)*

As a service platform, the homepage of the Georgia Southern University Libraries centralizes reference services, such as Ask-A-Librarian, Citing Sources, Digital Commons (InstitutionalRepository), EBSCO Discovery Service, Interlibrary Loan (ILL), Library Consortium Service (Gil-Express), Library Guides, Library Liaisons and Outreach Services, Online Chat, Research Assistance, Schedule Instruction, Special Collections, Web OPAC (Gil-Find), etc., together. Benefiting from the technical composition of the Internet and the WWW, academic libraries have evolved as two-dimensional entities. In the real world, academic libraries are multi-purpose landmark buildings on campuses. In the architecture of the WWW, academic libraries are information network nodes for information delivery, information discovery, and information retrieval. Therefore, academic library users have 24x7, any time round-the-clock access to scholarly information resources and library reference and bibliographical services without any geographical limitations beyond access verification constraints for some specialized services.

Methodology

This study utilized a content descriptive method to review the existing literature regarding impacts of generative AI on reference services in academic libraries. To complete this study, the following sections specified the related searching methods, including the web search engines selection, keywords search, plus keyword search combined with a relevant Boolean Operator.

Search Engines Selection:

The EBSCO Discovery Service (<https://www.ebsco.com/products/ebsco-discovery-service>) is one of the top library discovery tools widely used by academic libraries worldwide. Two librarians selected it to search for the peer-reviewed scholarly papers regarding impacts of ChatGPT on reference services for academic libraries. Running as a one-stop cloud-based online search engine, the EBSCO Discovery Service is accessible from the homepage of Georgia Southern University Libraries, which is previously presented as Figure 1. Google Scholar (<https://scholar.google.com/>) was also used to retrieve additional research literature, as needed.

Keyword Search + Boolean Operator (And):

Keyword refers to an important word or multiple words describing the topics regarding the information search. Since the dawn of Web search beginning in the 1990s, Keyword Search is the most powerful way of culling the needed web-based information sources. An Information Search Bar + an Enter key is the most common method for users to start a keyword search. Starting from the Graphic User Interface (GUI) of a web search engine like Google, users need to type the desired keywords inside the information search bar before they click the Enter key on their computer keyboards to search for the related web sources as shown in Figure 2.



Figure 2. The Information Search Bar for Keyword Search

Keyword Selection:

Due to the limit of 5000 words, two librarians decided to only select limited keywords to focus on the needed research literature. They divided the selected keywords into two groups. Group A only has one keyword: ChatGPT, while Group B has other six selected keywords: Chatbots, Information Literacy, Online Chat, Pros and Cons, Reference Service, and Web Search. These selected keywords in Group A and Group B are connected by the Boolean Operator “AND.” Their combinations consisted of the primary queries to target specific peer-reviewed journal articles for impacts of ChatGPT on reference services in academic libraries. Their logical associations can be seen below in Figure 3:

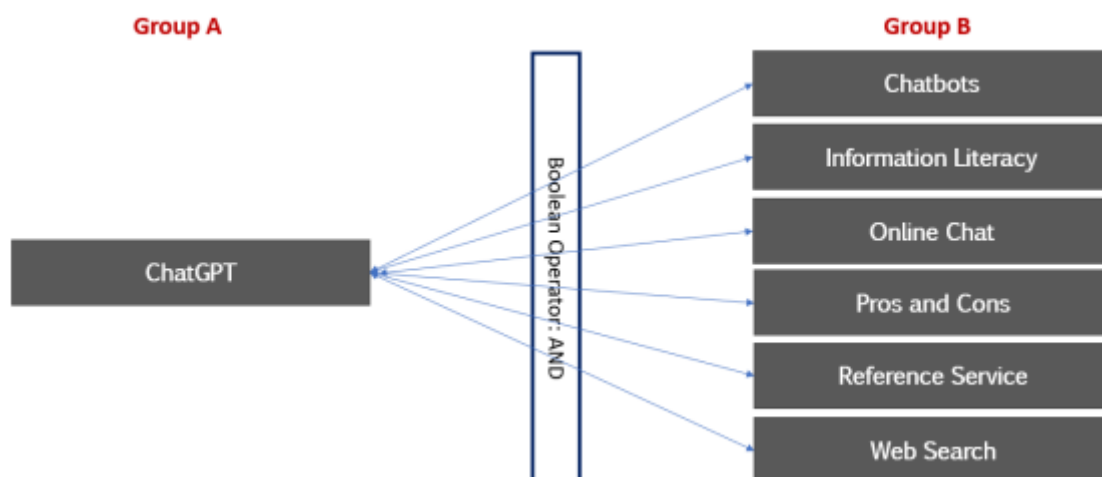


Figure 3. The Logical Association between ChatGPT and Selected Keywords

Findings

Reference services are one of the key services for academic libraries to provide faculty and students with the needed information resources and services. In response to RQ2, this study found the generative AI applications including ChatGPT are primarily impacting current reference services of academic libraries in the following areas:

1. Online Chat Services: Over the Internet platform, online chat services often refer to real time communication between reference librarians and library users. The emergence of generative AI applications like ChatGPT is challenging the current online chat services at academic libraries. However, the research literature identified for this study has confirmed that the current technical level presented by ChatGPT still cannot completely replace human-operated online chatting services. Generative AI applications including ChatGPT can only be a complimentary tool while reference librarians are off duty.

2. Information Literacy Instruction: Defined by the ACRL (2015), information literacy is a set of abilities to discover, understand, and use information ethically in academic learning environments. Academic librarians are obligated to promote information literacy instruction to support excellence in teaching, learning, and research. The rise of generative AI applications including ChatGPT is challenging current modes of teaching and learning across the academic community. Also, AI Literacy is emerging as a new focus for academic faculty and librarians while promoting information literacy instruction. There are still many debates regarding the range and scope of promoting generative AI applications including ChatGPT in academic learning environments.

3. Web Search and Web Search Engines: Web search is an information retrieval process based on web search engines. Web search engines refer to software specifically designed to search for the web-based information via the WWW. Using different web search engines, such as Bing, Google, Yahoo, and the like, users can find the needed information from different web pages or websites. In academic learning environments, various discovery services, such as EBSCO Discovery Service, ProQuest-ExLibris Primo, ProQuest-ExLibris Summon, and WorldCat Discovery, are available for faculty and students to search for the scholarly information resources and services in academic libraries. However, the rise of generative AI applications like ChatGPT has been challenging the dominating positions of traditional web search engines. More detailed information is available at the section of Discussion.

While the study is being conducted, OpenAI's ChatGPT has two different versions: ChatGPT3.5 and ChatGPT4.0. ChatGPT3.5 offers free access to the registered general public, while ChatGPT4.0 is only accessible for ChatGPT Plus subscribers who agree to pay \$20.00 per month. To know more about different versions of ChatGPT, Hackett (2023) discussed the pros and cons of ChatGPT from the perspective of an Electronic Resources Librarian from the University of Arkansas Libraries (<https://libraries.uark.edu/>). In addition, Diaz (2024) created a comprehensive guide for the general public. Diaz answered the question of how to use the ChatGPT and how to start writing your prompts and questions, plus the ZDNet's ChatGPT guides for tips of using ChatGPT in various scenarios. Whitney (2023) explained the different cutoff dates for ChatGPT3.5 and ChatGPT4.0. Below is a simple table to compare the primary differences between ChatGPT3.5 and ChatGPT4.0:

Table 1: Simple Comparison between ChatGPT 3.5 and ChatGPT 4.0

No.	Features	ChatGPT3.5	ChatGPT4.0
1	Access	Free Access for the general public.	Fee-Based Access: (\$20/per month) for the ChatGPT Plus subscribers only.
2	The Cut-Off Date for the Knowledge Scope	By September 2021.	By April 2023.
3	3. Input/Output Methods	Text-based Input/Output	Multiple Methods: Text + Image
4	Multi-Language Support	Yes	Yes
5	Web Sources Provided	None	Yes

Based on the identified research literature, this study found that ChatGPT has the following features when they are adopted for reference services in academic libraries.

Advantages of utilizing ChatGPT in academic reference services:

1. 24x7 Availability:

ChatGPT can provide users with 24x7 availability. ChatGPT permits ubiquitous access without any geographical limitations.

2. Extensive Knowledge Coverage:

With its powerful large language model (LLM), ChatGPT has extensive knowledge in response

to users' inquiries, especially in the fields of foreign language translation, general knowledge,

information retrieval, language and writing, problem solving, psychological consultation, etc.

Also, ChatGPT can cover topics such as biology, computational science, engineering, and mathematics, and other interdisciplinary subjects.

3. Immersive Personal Experience:

ChatGPT can provide users with immersive personal experiences. While interacting with ChatGPT, users always feel like a human-like conversation is being had, instead of communicating with chatbots.

4. Input/Output Methods:

ChatGPT 3.5 can only generate text responses based on text inquiries input by users. ChatGPT 4.0 can generate images, texts, and videos in response to the images and texts inputted by users.

5. Multi-language Support:

Based on the work of Flensted (2023), ChatGPT can support 95 foreign languages, including some dialects, even as this study is being conducted.

6. Virtual Consultant, Virtual Study Advisor, or Virtual Tutor:

In academic learning environments, ChatGPT can function as a virtual consultant, a virtual study advisor, or a virtual tutor to assist students whenever needed. ChatGPT can empower skills for critical thinking, decision-making, and problem-solving.

Disadvantages of utilizing ChatGPT in academic reference services:

1. False or Incorrect Information:

Many instances prove that ChatGPT may generate false or incomplete information. The authors directly asked Microsoft Copilot (ChatGPT4.0) to list some samples for the false or incomplete information it generated before. Microsoft Copilot (ChatGPT4.0) immediately responded with five error samples it generated in the fields of historical events, language fun facts, scientific facts, space exploration, and weather forecast.

During Zhang's interaction with ChatGPT, Zhang (2024) asked ChatGPT to cite the articles in MLA styles. Although their MLA formats are correct, ChatGPT generated five fabricated MLA citations as follows:

1. Doe, John. "The Impact of Artificial Intelligence on Privacy." *Journal of Privacy Studies*, vol. 12, no. 2, 2022, pp. 45-62.
2. Smith, Jane. "Privacy in the Digital Age: Balancing Technology and Individual Rights." *Harvard Law Review*, vol. 78, no. 4, 2021, pp. 112-130.
3. Johnson, Sarah. "Ethical Considerations of AI and Privacy." *Ethics in Technology Quarterly*, vol. 5, no. 3, 2023, pp. 78-95.
4. Thompson, Michael. "The Tradeoff between Convenience and Privacy: Exploring User Perceptions of AI Assistants." *Journal of Human-Computer Interaction*, vol. 25, no. 2, 2020, pp. 145-163.
5. Davis, Emily. "Data Privacy in the Era of Artificial Intelligence: Challenges and Solutions." *ACM Transactions on Privacy and Security*, vol. 18, no. 4, 2023, pp. 234-251. (ChatGPT, 2023) (p. 68).

2. General vs. Specific:

ChatGPT stands for Chat Generative Pre-Trained Transformer. In most cases, the capabilities of ChatGPT can satisfy the common information needs of the general public. In some specific subject fields, such as complex legal or medical fields, the power of ChatGPT will be noticeably inadequate. At the current technical level, ChatGPT still cannot replace human medical doctors or human attorneys completely.

3. No Citations:

A citation is a reference regarding an article, author, book, paper, publisher, report, etc. in a published work. Although it can provide web sources, ChatGPT4.0 still cannot provide any citations, such as APA, Chicago, IEEE, MLA, Turabian, etc., for its users.

4. Peer-Reviewed Sources:

Generally, peer-reviewed sources are scholarly publications. Among its generated web sources, ChatGPT4.0 still cannot specify which sources qualify as being peer-reviewed

sources in response to the users' questions. Students should be alert while citing or using web sources generated by ChatGPT. Academic faculty and librarians are obligated to help overwhelmed students whenever possible.

5. Real-Time Information:

While the study is being conducted, the cutoff date for ChatGPT3.5's knowledge base is September 2021, while the cutoff date for ChatGPT4.0's knowledge base is April 2023. Therefore, both ChatGPT versions cannot provide real-time services to reflect the latest information resources and services available from academic libraries and their consortia.

6. Web sources:

The free ChatGPT3.5 has no capability to generate any web sources in response to the users' questions, while ChatGPT 4.0 does. Academic faculty and librarians are obligated to tell students about the differences between the free ChatGPT3.5 and the fee based ChatGPT4.0. Also, they should guide students how to brainstorm using Microsoft Copilot.

Discussions

The literature identified key areas of reference services in academic libraries impacted by the revolution of generative applications like ChatGPT. It was found that the boom of the generative AI applications could pave the way for the future library innovation in service-oriented and student-centered academic libraries.

Opportunities

AI Literacy vs. Information Literacy. With the boom of generative AI applications, AI literacy has created a new opportunity for academic librarians to promote information literacy instruction for higher education. AI literacy refers to a set of experience, knowledge, and skills of using AI applications, such as generative AI tools like ChatGPT. AI literacy has become a new component of information literacy instruction in academic learning environments. Academic executives, faculty, and librarians need to work collaboratively to promote information literacy instruction involving AI literacy for undergraduates and graduates. Without the needed abilities and skills for using AI tools, their students will never have the indispensable competitive power in the future career arenas.

Library Intelligence: Library intelligence refers to the onsite and virtual intelligent sources and services provided by AI technology, big data, cloud computing, Internet of Things, etc. The advance of generative applications including ChatGPT is the cornerstone for the breakthrough of AI-assisted reference services in academic libraries. The rise of generative AI applications, including AlphaCode, Bard, ChatGPT, Claude, Cohere, Dall-E3, Deepfakes Web, GitHub Copilot, Google Gemini, Midjourney, Microsoft Copilot, Synthesia, etc., is only the prelude of the future library intelligence. Library intelligence will be the terminal goal for the transition between current academic libraries and intelligent libraries in the coming years of the 21st century.

Library Robot Services: Defined by Moravec (2024), a Robot is a machine device which automatically performs tasks programmed by human beings in advance. As one of the

research areas of artificial intelligence, the definitions, classifications and scopes of the Robot are still evolving. From the early industrial applications to today's diverse functions, a robot has the ability to sense its surroundings and perform computations, make decisions, and perform many other actions. The generative AI applications including ChatGPT are enhancing and integrating the robots' capabilities to interact with human beings. The future customized generative applications including ChatGPT will enable robots to directly communicate with users in academic learning environments. Library robot services will be one of the significant components for future reference services in academic libraries in the age of artificial intelligence.

Challenges

AI Ethics and Supervision: Based on Liu, Z. & Zheng (2022), AI ethics refers to a set of guidelines, principles, and regulations that the stakeholders should follow while implementing and using AI technologies. However, the topic of AI ethics is still a debatable issue. Browne (2023) reported that Italy became the first European country to ban ChatGPT. Reported by Matt O'Brien on May 16, 2023, Sam Altman, CEO of OpenAI since 2019, told the U.S. Congress that the "artificial intelligence should be regulated by a US or global agency" (O'Brien, 2023). Kharpal (2023) reported that China had finalized its regulations governing generative AI applications like ChatGPT. If possible, institutions of higher education and academic libraries should create their specific AI ethics and AI code of conduct.

ChatGPT vs. LibChat: Defined by Springshare (2024), LibChat is an online chat service platform embedded inside the LibAnswer System. Widely used by thousands of libraries worldwide, LibChat provides real time online chat services for library users. This is the first area where many academic experts, faculty, librarians, and scholars would like to examine if the potential of ChatGPT is applicable to academic libraries. After a careful comparison, Professor Xiaotian Chen, Electronic Services Librarian at the Bradley University Library (<https://www.bradley.edu/academic/lib/staff/>) concluded that ChatGPT "could do a better job than the traditional chatbots for the library reference services" (Chen, 2023, p. 126). Based on 58 reference questions categorized in seven different question types, Katie Lai, an academic librarian at the McGill University Library (<https://www.mcgill.ca/library/>) in Canada, used a rubric personally designed to measure the capabilities of ChatGPT. After intense qualitative and quantitative analyses, Lai wrote that "Using real-life library inquiries received, this study reveals that ChatGPT is not yet able to provide satisfactory answers to all seven types of questions raised by music users in a large academic institution. ChatGPT's ability to handle reference inquiries is limited" (Lai, 2023). At the current technical level, ChatGPT still could not completely replace human-operated online chatting services. Due to the limitations of its knowledge base, ChatGPT cannot provide the real time information regarding the latest information resources and services available from academic libraries and their consortia. However, ChatGPT can still function as an auxiliary tool to answer inquiries. ChatGPT can provide general guidance for faculty and students, especially when the librarian assisted LibChat is not available during the

non-service hours.

Web Search Methods

Since the 1990s, users have been required to input the related keywords or topics inside an information search bar before they click the Enter key from their keyboards. However, “people don’t want to search the internet, they want to find information. Google and all other traditional search engines help, but there’s still an obstacle in place, which ChatGPT overcomes” (Bradley, 2023, p. 37). The emergence of generative AI applications like ChatGPT is challenging traditional ways of information retrieval. Users now can ask ChatGPT, Gemini, or Microsoft Copilot to provide answers to their questions directly. “This is a major shift in the way that ‘search’ works. We are moving from an interrogatory approach to a conversational approach, one that will appeal to people who just want an answer to a question, not the challenge of sifting through links to webpages” (Bradley, 2023, p. 39). Of course, generative AI applications like ChatGPT still cannot completely replace web search engines, based on their current technical performance. The adoption of AI is still relatively slow in academic libraries in Canada (Guy et al., 2023).

Limitations

Adhering to word limit stipulations, this study did not examine impacts of AI Literacy on the ACRL Framework for Information Literacy for Higher Education. It did not deeply investigate impacts for AI ethics, such as academic integrity, false information, copyright infringement, plagiarism, supervision, etc., either. Additional studies are needed to further explore these issues in academic learning environments.

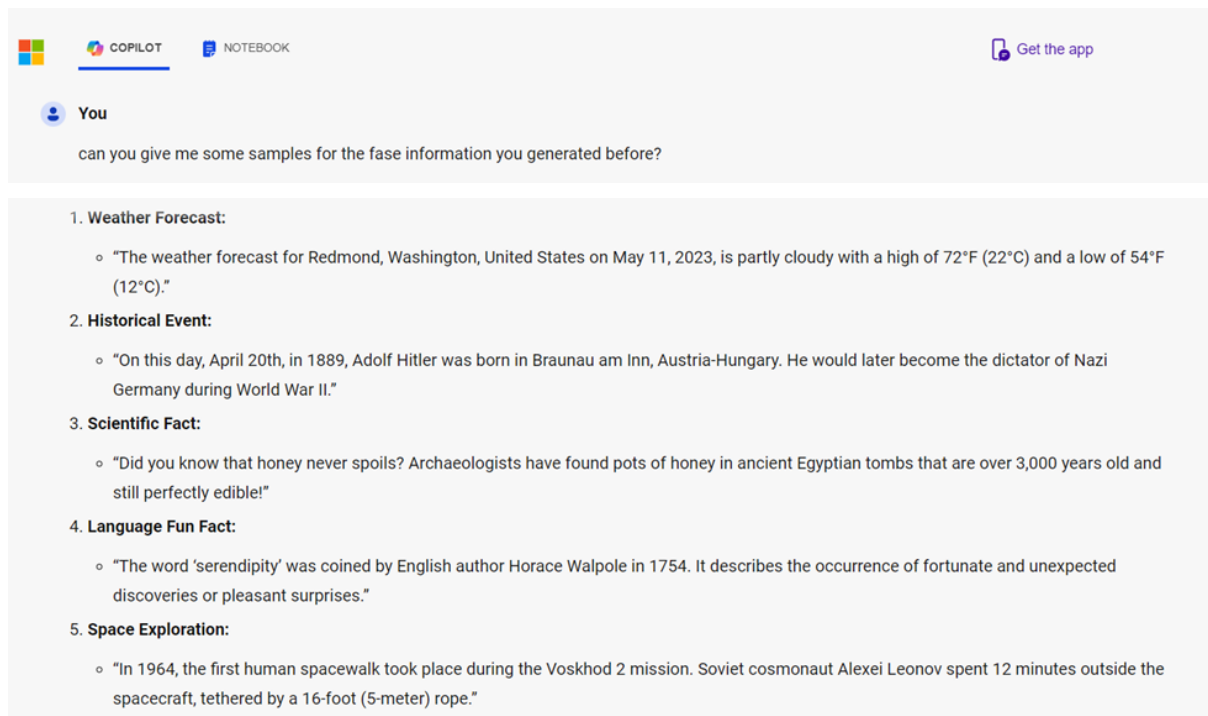
Conclusion

“Overall, the literature suggests that ChatGPT has the potential to transform the reference services landscape, offering a complementary option for virtual assistance and enhancing the user experience for library patrons” (Adetayo, 2023, p. 136). As the pioneer of generative AI technology, OpenAI ChatGPT has been evolving at an astonishing speed. Pichman (2023) issued

a warning for harnessing the potential dangers of AI in four predictable scenes: *Scene 1*: Navigating the River of Misinformation; *Scene 2*: Confronting the Cyber Underworld; *Scene 3*: Battling in the Catacombs of Privacy and Ethics; and *Scene 4*: Climbing the Mount of Literacy. While IT experts, police, specialists, and other government agencies are fighting with crimes undertaken by AI tools, academic librarians can collaborate with faculty members to promote AI ethics in higher education. From this perspective, academic librarians should provide students with guidance on how to use the AI applications ethically, legally, and safely. Futuristically, further evolution of generative AI technology will encourage more creation and innovation in the library. The generative AI applications including ChatGPT are setting a solid foundation for the transition of library intelligence in the age of artificial intelligence.

Appendix:

04/20/2024



The screenshot shows the Microsoft Copilot interface. At the top, there are logos for Windows, Copilot, and Notebook, along with a 'Get the app' button. Below the header, a user profile icon is labeled 'You'. The user's prompt is: 'can you give me some samples for the false information you generated before?'. The Copilot response lists five categories of false information, each with a fabricated example:

- 1. Weather Forecast:**
 - "The weather forecast for Redmond, Washington, United States on May 11, 2023, is partly cloudy with a high of 72°F (22°C) and a low of 54°F (12°C)."
- 2. Historical Event:**
 - "On this day, April 20th, in 1889, Adolf Hitler was born in Braunau am Inn, Austria-Hungary. He would later become the dictator of Nazi Germany during World War II."
- 3. Scientific Fact:**
 - "Did you know that honey never spoils? Archaeologists have found pots of honey in ancient Egyptian tombs that are over 3,000 years old and still perfectly edible!"
- 4. Language Fun Fact:**
 - "The word 'serendipity' was coined by English author Horace Walpole in 1754. It describes the occurrence of fortunate and unexpected discoveries or pleasant surprises."
- 5. Space Exploration:**
 - "In 1964, the first human spacewalk took place during the Voskhod 2 mission. Soviet cosmonaut Alexei Leonov spent 12 minutes outside the spacecraft, tethered by a 16-foot (5-meter) rope."

Samples of False Information from Microsoft Copilot

Reference

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