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Abstract:

A library's website is a virtual point of contact for interacting with its patrons. Ensuring a library's website has easily findable content is critical for providing access to library resources and highlighting services and events. One tool for assisting with content findability is a chatbot, a form of artificial intelligence software. In this case study, Lehman College's Leonard Lief Library implemented Ivy, a proprietary educational software chatbot on its website, the first of its kind for an academic library. This chatbot functioned as a new tool that assisted users seeking information and provided insight to librarians about the kinds of topics students search for via the library website. This article provides the first detailed description in the literature of an implementation of a proprietary chatbot for an academic library.

Keywords: chatbots, chat, artificial intelligence, library websites, chatbot software, natural language processing, vendor relations

Introduction

A chatbot is defined as a software tool that simulates a person users converse with (Fichter & Wisniewski, 2017)**.** Chatbots are a form of artificial intelligence (AI), where a computer program generates responses to inquiries based on its existing knowledge base (O'Brien, 2019; Pickell, 2019). Typically, chatbots are strategically placed on websites in places that engage with users, such as a homepage or contact page.

In 2019, Lehman College's Leonard Lief Library was approached by its college's Information Technology (IT) department to join the college's Ivy chatbot software pilot. Ivy is an artificially intelligent chatbot used in higher education (*Chatbot Features*, 2021). The web services-online learning librarian and electronic resources librarian saw this invitation as an opportunity to add an enhancement to the website. For the implementation, three goals were outlined:

(1) Have the chatbot successfully answer students' basic questions via the library website. Questions could include topics such as library hours, instructions for accessing electronic resources from off-campus, and more.
(2) Have the chatbot reveal the kinds of topics students search for via the library website, based on the questions they ask it.
(3) Have the chatbot serve as another access point for basic reference questions in order to free up the librarians who conducted chat reference, who could then focus on research questions.

Specifically, the librarians felt a chatbot could assist patrons looking for specific or general information on the library's website by providing it for them. Furthermore, they

speculated that it might help users find content that they would not have otherwise discovered without mediation from a librarian. A chatbot's assistance was presumed to be especially helpful because students go to library websites specifically to find information or learn about library news and events (Chao, 2019).

By implementing the chatbot, the library hoped to gain new insights into the kinds of information users searched for on the library's website and how frequently they sought information about specific topics. Prior to this project, the library used Google Analytics to get information about keywords that patrons use to find library resources when they search Google. However, since 2013, the terms available to website administrators in Google Analytics have been very general (Burton, 2018; Chang, 2011). These limited terms did not provide most of the specific keywords or phrases related to the specific tools or services that patrons seek within the library's website. By having more specific information, the library hoped to facilitate improvements to the contents of its website. These improvements could include changing the placement of content items, expanding descriptions, or rewording descriptions of services to include more relevant words or phrases that corresponded with patron searches.

The library also wanted to explore how adding a chatbot could serve as another access point on the website for simple questions about library services. If the chatbot could successfully answer simple questions, it could also potentially allow librarians who performed chat reference to focus on more in-depth research questions. This was important because there are times where multiple questions are received on chat at the same time and a chatbot's ability to assist, especially with basic questions, would be advantageous. Furthermore, an additional appeal of the chatbot in this context was that the chatbot could operate 24/7 and could respond to questions after-hours and during periods when librarians were not available.

As the Leonard Lief Library is the first to implement and publish on its utilization of the Ivy. Ai chatbot in the United States, the authors hope it can serve as an exemplary case study for others presented with the opportunity to experiment with Ivy or other proprietary cloud-based chatbots. The article also describes modifications made to the software after implementation, as well as challenges, impressions, and future plans.

Literature Review

Chatbot History and Functionality

Chatbots have their origin in famed computer scientist Alan Turing's proposed "Imitation Game" (Turing, 1950). Turing's paper proposed a test, now referred to as the "Turing test," which was aimed to test whether computer users could tell the difference between a computer and a human. This concept was implemented as software at least as early as 1966, when Joseph Weizenbaum released ELIZA (McNeal & Newyear, 2013; Weizenbaum, 1966). Called a "chatterbot," by Weizenbaum, Eliza allowed users to communicate with a computer program, which looked for key words to help generate responses. Since then, many other chatbots have been released. Chatbots have also migrated from mainframes to desktop computers and are now most frequently found as cloud-based tools on websites.

Chatbots strive to simulate human conversations with end users. This is accomplished through natural language processing, which is an AI technique for "giving computers the ability to understand text and spoken words in much the same way human beings can" (IBM Cloud Education, 2020, para.1). Natural language processing relies on a process of "pattern matching" in "natural language enquiries, simple statements, or semantic meaning of enquiries" (Abdul-Kader & Woods, 2015, p. 73). In addition to natural language processing, chatbots often rely on built-in knowledge bases, often described as a chatbot's "backbone" (John, 2020; Ramkumar,

2021; *The Process Creating Chatbots* [sic], 2021). The knowledge base is where information is stored, organized, and woven together, often by using ontologies. Ontologies, which are systems of related words and concepts, are often mapped using relational databases, then used "to compute the relation between these concepts, such as synonyms, hyponyms and other relations which are natural language concept names" (Abdul-Kader & Woods, 2015; Al-Zubaide & Issa, 2011, p. 74).

Chatbots are then customized for the application in which they are used. For example, chatbots on ecommerce sites traditionally serve as virtual customer service agents and assist customers with orders, returns, and other customer service issues. These chatbots thus simulate prior practices of calling and speaking with customer service representatives via phone or with in-person chat operators. Chatbots are now used in many contexts including education (Matthews, 2018; Singh, 2020), healthcare (Palanica et al., 2019), and retail customer service (Pickell, 2019).

Having a chatbot retrieve a website's information for a user can help acclimate them to that website. This can be especially useful for novice users who may feel overwhelmed when trying to navigate pages they are unfamiliar with. This trepidation is well documented, particularly in libraries. Library users have repeatedly noted issues with catalogs and databases, and with the websites they must use in order to access these tools (McPherson, 2015).

Therefore, studying library use of chatbots is especially important now as chatbot technology continues to improve and usage of these tools is expected to grow (Metz, 2020; Smutny & Schreiberova, 2020; Thompson, 2018; Weigert, 2020). Indeed:

> library users are already familiar with chatbots in other contexts in their everyday life, using them for example to find items on their phone with

> Apple's Siri, search their computer with Window's Cortana, or navigate the internet with Ok Google or Amazon's Alexa. (Mckie & Narayan, 2019, p. 268)

As a result, they may be more inclined to use a library chatbot to assist them.

Chatbots in Higher Education

In the field of higher education, chatbots have typically been implemented as tools for automation, especially in departments such as admissions, bursar's office, or registrar's office (Singh, 2020). These units have often reported receiving large volumes of student questions and have lacked sufficient staffing to respond to each individual question in a timely manner. Staffing issues can be especially acute during peak registration times, when the volume of student questions is high. Chatbots have been seen as an ideal tool to respond to this issue, as they "can be used to convert this time-consuming task of replying to each query personally into an automatic one" (Singh, 2020, para. 5). Thanks to the automation chatbots provided in these contexts, departments such as admissions, bursar's office, or registrar's office have reported providing better, more personalized or time-sensitive service to their students (Nietzel, 2020; Pappano, 2020; Stoller, 2019). While the aforementioned student services departments are the most frequent users of chatbots for automation purposes, other college and university departments such as IT and financial aid have also deployed chatbots to better serve their end users (McKenzie, 2019). In these areas, chatbots not only assist with automation, but can help "personalize experiences, reduce workloads, and assist with analysis of large and complex data" (Alexander et al., 2019, p. 27).

Chatbots have also been deployed as simulated teaching assistants within college courses. The first of these, the "Jill Watson" AI, was created at the Georgia Tech College of Computing in 2015 (Peterson, 2020). Dubbed "the world's first artificial intelligent teaching assistant," Jill

Watson was deployed in each course in that school's online Master of Computer Science degree program. Jill Watson was integrated with each class via the learning management system (Goel & Polepeddi, 2018). This setup allowed students to ask questions to the Jill Watson AI and access its knowledge base as answers to "basic student questions" 24 hours a day (Peterson, 2020).

Chatbots in Libraries

In libraries, chatbot implementation was initially led by European libraries. The first public library chatbot, Kornelia, was implemented in Bern, Switzerland in 2010 (McNeal & Newyear, 2013). According to Allison, the first academic library installation in Europe was the Stella experiment at the Bibliothekssystem Universität Hamburg (2012). This was followed shortly after by Chatbot Charlie at the Delft University of Technology (Akbayrak, 2012).

In Australia, the University of Technology Sydney developed a chatbot prototype based on research done by its librarians about the important role of librarians in the creation, maintenance, and development of chatbots (Mckie & Narayan, 2019).

In the United States, the Mentor Public Library (MPL) and the Akron-Summit County Public Library (ASCPL) were among the first to deploy chatbots, with each being listed as being in operation as of 2012 (Allison, 2012). U.S. academic libraries also developed chatbots, including the University of Nebraska-Lincoln Libraries, which released its Pixel project in February 2011 (Allison, 2012; McNeal & Newyear, 2013). The Pixel project was built using open-source PHP code with an SQL server for its database. The creator of Pixel felt the "key for this project [was] to find the balance between the users need for a quick answer (the machine's efficiency) and the need for the chatter to understand the research process (librarian's knowledge)" (Allison, 2012, p. 7).

These early chatbots were noted for their ability to "[give] immediate answers to questions about library services and resources" and "[help] researchers reach the right sources and problem solve similar to FAQs." From a web design perspective, Pixel was also noted for conceptually "flattening" the University of Nebraska-Lincoln Libraries' website. Flattening means the user does not need to know or interpret the website's contents or layouts in order to find the information they need. Instead, the information is presented to them after typing in their questions. Flattening reduced the need for patrons to wayfind on the website, which meant the patrons spent less time navigating through non-relevant pages as they tried to find the specific information they sought (Allison, 2012).

Based on its implementation, the goal for Pixel was to create a

> chatbot that can tap into a basic level of expertise compiled from subject experts (by mining LibGuides and other information provided by the experts), search hidden databases and suggest resources to bring together the best combination of answers to service questions with tips on research

while leaving the more complex research questions to the librarians (Allison, 2012, p. 15).

In 2013, The University of California, Irvine (UCI) began development of its chatbot ANTswers, which was completed and released the following year (Kane, 2019). Also built on an open-source platform, ANTswers was intended as a point-of-need reference tool to complement existing online reference services without the need for a live person to staff it. As with the University of Nebraska-Lincoln's Pixel, UCI's library hoped the chatbot could fill the specific need of answering fairly simple and frequently-asked questions such as library hours, policies, printing, and restrooms (Kane, 2017). ANTswers proved to be a complex system which required

a lot of maintenance, though this was eventually reduced and managed by the university's librarians and programmers after the chatbot's beta testing period.

More recent chatbot installations have included San Jose State University's Kingbot and University of Oklahoma's Bizzy. Released in 2020, Kingbot was created using Kommunicate, a proprietary software, which utilizes Google's Dialogflow tool (Rodriguez & Mune, 2021; Rodriguez & Ronquillo, 2021). The University of Oklahoma's Bizzy chatbot uses Ivy, the same software used by the authors (*Introducing "Bizzy,"* n.d.).

Methods

Case Study Design

A framework generated by Stake (1995) classifies case studies as "intrinsic", "instrumental", or "collective".

> An intrinsic case study is when the aim is fundamentally to understand the case. An instrumental case study aims to provide insight into an issue or refine a theory in which the case itself here is secondary and might be atypical in other cases. A collective case study explores differences within and between cases ideally to replicate findings across them (Lucas et al., 2018, p. 2).

The authors' implementation of Ivy for their library could serve as an intrinsic case study for other libraries interested in adopting a chatbot. This case study is novel in that it is the first detailed description of the implementation of proprietary chatbot software. It may provide additional insight for other institutions considering adopting a vendor-supported tool.

Case Study Setting

Lehman College is CUNY's senior college in New York City. It offers more than 90 undergraduate and graduate programs in the liberal arts, sciences, and professional education. The College's Leonard Lief Library Library serves more than 14,000 students, providing space to research and gather to share information. The library provides services both in person (prior to COVID-19) and online. Its website serves as its primary point of contact, used by approximately 46,000 unique users, across 225,000 sessions, with 340,000 page views during calendar year 2020.

Preparing the Chatbot

In the Fall semester of 2019 (August-December), Lehman College began preparation to install Ivy, an AI chatbot geared towards higher education. According to Ivy's website:

> [Ivy's] Natural Language Processing (NLP) is powered by a human-supervised deep learning algorithm called a Convolutional Neural Network (CNN). Using a massive set of highly curated training data, Ivy is able to accurately predict what your users are asking and get them to the answers they need (Ivy, 2020, para.1).

To power Lehman College's Ivy chatbot, the bot needed to be "fed" information, which it gathered by crawling a set of webpages the college provided. The data gathered by the chatbot filled its "brain," which organized the information into answers for questions, which Ivy and other chatbots refer to as "intents". These can be found in the administrative portal.

These intents comprised the knowledge base that Ivy could then query and choose the most suitable intent for each question it was asked. The most frequently-asked questions that the

chatbot received were collated into a category, which Ivy called "ontologies". While the bot could usually respond to queries, sometimes its knowledge base would not be sufficient. When this happened, the bot would get “stumped.” where it would state that it cannot provide an adequate answer to the question. In such cases, the chatbot provided an option to submit a trouble ticket, which was then routed to a member of the institution with administrative privileges, in this case the electronic resources librarian or the web services-online learning librarian. Figure 1 illustrates the chatbot workflow from start to end.

[INSERT FIGURE 1 NEAR HERE]

In the weeks after the chatbot’s set-up, each question was reviewed by data curation specialists at Ivy to assist the chatbot with better predicting the topics of questions to provide better answers. Questions that could not be satisfactorily answered through re-crawling for information or predicting the question’s topic were routed to a feature called “inbox zero,” where those with access privileges manually supplied the correct answers. Those with access privileges were also able to create custom intents for questions that had been asked and were able to add more information than what the bot had found and included in its answers.

Ivy's sophisticated design and anticipated low maintenance appealed to the library. As discussed earlier in the examples of other library chatbot implementations, in-house installation, testing, and maintenance were typically required to successfully launch each chatbot and ongoing maintenance was critical to a chatbot’s success. Since the implementation of Ivy was an IT initiative, much of the installation and initial set-up was done by its department, with the library doing initial testing of the bot, supplying feedback on responses, and sending IT an initial list of questions to serve as ontologies. After initial implementation and following a meeting with Ivy and IT, the library was then given control over its own chatbot instance. This chatbot was

assigned to the library and the college's Blackboard administrator, and was populated with the questions provided to Ivy in the pre-implementation stage. The library was also given access to the Ivy admin portal. Having access to the admin portal proved vital to accessing the usage statistics of the chatbot and making improvements.

Each institution that uses Ivy can customize its bot to represent a mascot or concept that complements the institution it is representing. At Lehman College, feedback from a student focus group led the college to title its bot the "Lehman Lightning Bot," named after the "Lightning" nickname used by Lehman College's sports teams. The bot's logo is designed to look like an anthropomorphized firefly. (See Figure 2.)

[INSERT FIGURE 2 NEAR HERE]

Implementation

The chatbot launched in November 2019 and was placed on several college webpages including Student Affairs, Campus Life, General Advising, the Library, Blackboard, IT, and the Bursar's Office. The college's administrators from IT thought that multiple placements would be advantageous for users who might grow accustomed to using the bot for one department and would then be more likely to use it with others.

On the library's website, the chatbot was placed on the bottom-right corner of the library's homepage, above the fold. When clicked or activated by a patron, the bot would grow and present a "welcome" dialogue. The bot could also be dismissed when a "close" button was clicked or activated. Initial feedback from librarians about the chatbot reflected uncertainty about the utility of a chatbot and concerns about the bot's usability. Accordingly, the electronic resources librarian and the web services-online learning librarian demonstrated to them that the

bot could be collapsed. This helped assuage the librarians who feared that a bot could be distracting to patrons using the website. Like other departments who chose to have the chatbot displayed only on the homepage of their college webpages, the library also decided that the bot should only be included on the library's homepage. Librarians also provided feedback that the bot's size should be made larger to be more accessible. This was a priority to the librarians not affiliated with the project. In response, IT adjusted the size of the bot's widget and made the "close" option more prominent.

The chatbot was configured so that questions that stumped the chatbot were routed directly through the previously-mentioned ticketing system to the electronic resources librarian and web services-online learning librarian's email addresses. When the librarians received a ticket, it contained the student's name, email address, IP address, and their question. The librarians could then respond directly to the email and go into the admin portal to review the transcript of the chat between this user and the chatbot, to try to pinpoint why the chatbot could not answer the question successfully.

Results

Initial Chatbot Impressions

About two weeks after the chatbot was activated, the library received a ticket with a complex reference question concerning finding educational sources. The authors routed it to the education librarian. Based on the content of the questions patrons asked, some librarians were concerned that students might have been mistaking the chatbot for the library's online reference chat service. Therefore, a decision was made to tweak the welcoming script that the chatbot provided. Until then, Ivy's default script was in place, in which the chatbot introduced itself and explained its purpose as "a virtual assistant and can answer your most common questions." To

note that this was a new, experimental technology, the bot also had a line saying: “Please be patient with me, I'm just spreading my wings and learning to fly”.

The authors added a message to the chabot’s default script, stating: “for help from a librarian to find journals or articles for research, please use our 24/7 Librarian Chat which can be accessed by going to http://lehman.edu/library/studenthelp.php?ask-us=1.” This URL was the location of the library’s pre-existing "Ask-a-Librarian" chat service. This line was added based on consultation with all the Lehman College librarians, who felt it was essential to clarify that this bot was not intended to be used for in-depth research questions.

Library staff thus expected that students who were used to asking a librarian for help would realize that the chatbot was not a librarian, but a different entity that could aid in other ways. Still, the librarians continued to monitor the ticket queue to gauge the volume of reference questions submitted to the chatbot, and to see whether questions asked were mainly basic reference questions or in-depth research queries. From December 2019 until March 2020, nine research questions were received in the chatbot’s queue that were routed to the librarians. Examples of research questions included how to find demographic information for local areas and historical and cultural information about specific countries.

COVID-19's Influence on the Chatbot

On March 14, 2020, the library closed its building because of reports of an increase in COVID-19 cases in its region. In the days that followed, the number of cases being reported within the City University of New York system continued to grow, and library and college administration indicated that the library building would remain closed longer than anticipated. Classes were suspended for a week in preparation for going fully remote. At this time, chatbot questions changed as the bot began receiving technology-related questions such as how to access

email and register college accounts. These questions reflected a change in student behavior as many in-person students had begun to prepare for fully online coursework. While many of these questions were not library-related, given the sudden transition to a remote environment, the electronic resources librarian and web services-online learning librarian answered these questions that were routed to them to the best of their ability. Luckily, they did not have to address all questions that came in, since the library shared its chatbot instance with Lehman College's Blackboard site, which was monitored by the college's Blackboard administrator. This colleague was often better equipped to handle technology questions, especially those related to online learning. The chatbot's ability to assist with these questions benefited students who were grappling with new and unexpected technology issues and needed prompt answers.

Chatbot Ontologies and Ticket Categories

The questions received by the chatbot also gave the librarians some insight into what students were looking for on the library website, which was one of the goals of the implementation. To obtain specific search terms and topics, Ivy's administrative portal provided a list of ontologies, which are the most common intents that users select during their interactions. While these are not the exact search terms of users, they reflect what users most-commonly-selected from the chatbot's responses to their questions. Therefore, they reflect the search terms or topics users are searching for. Examples of common search topics from the chatbot transcripts are listed in Table 1.

Sample Intents
• How-to-Find • Hours • Email

• Circulation • Journals • Peer-Reviewed Articles • Return Books • Find Journal Article • Articles
Sample Ontologies • How-to-Find::Journals::Articles – Generates responses associated with questions like “How to Find Journal Articles” • How-to-Find::Hours – Generates responses associated with questions like “What are the Library’s Hours?”

Table 1. Examples of intents and ontologies.

A review of the questions received via the ticketing systems from March 14 until the end of the Spring semester (January-May 2020) showed three dominant areas of questions: reference, off-campus access, and textbooks. Figure 3 shows the breakdown and volume of each category.

[INSERT FIGURE 3 NEAR HERE]

The authors decided to respond to the increase in questions surrounding accessing library resources and textbooks from off-campus by creating a "Remote Resources" research guide. This guide covered COVID-19-related news and resources from the college and local governments and had a dedicated page on accessing the library from off-campus. This page included the required access credentials, a troubleshooting ticket form, and links to the library’s Ask-a-Librarian chat service and the IT department. In addition, the guide had a page dedicated to

vendors offering free access to textbooks, links to obtain open educational resources (OER) materials, and details about database access to eBook platforms available from the library.

At the end of May 2020, questions related to COVID-19 and off-campus access to library resources began to slow down, but students continued to use the chatbot.

Further Chatbot Reference Questions

After implementation and the creation of the "Remote Resources" research guide, students continued to submit reference questions that involved research queries to the chatbot. This behavior has continued until present, even after the modification discussed earlier, which prompts students to use the library's Ask-a-Librarian chat service before even asking the user how it can assist. The dummy transcript in Figure 4 is one example.

[INSERT FIGURE 4 NEAR HERE]

Chatbot Adoption Rate

From November 2019 until March 13, 2020, a total of 2,202 chat sessions with the chatbot were recorded, with a daily mean of 20.4. Between the COVID-19-related closure of the library building on March 14, 2020, and the end of the Spring semester on May 22, 2020, the chatbot recorded a total of 1,571 chat sessions, with a daily mean of 23.5. Interestingly, the volume of troubleshooting tickets from users received by the authors seemed to increase during this time period. Based on a review of the authors' inbox of troubleshooting tickets, the authors estimate the volume of tickets increased from an average of approximately one per week before March 13, to approximately two or three at times a week until the end of May 2020. The increase in chat sessions was encouraging to the authors who speculate that the closure of in-person

services led to an increased reliance on the library chatbot. The reasons for these findings would require further investigation but the authors were also pleased to see the increase in troubleshooting tickets, because they provided insight into questions that stumped the chatbot.

The chatbot from March 14, 2020, until March 14, 2021, had a total volume of 3,699 sessions, with a daily mean of 10.1. Classes were held completely online during this time period. During the following 12-month period from March 15, 2021, until March 15, 2022, chat sessions decreased to 2,810, with a daily mean of 7.7. Figure 5 illustrates the monthly distribution over these time periods.

[INSERT FIGURE 5 NEAR HERE]

Based on this data, the chatbot showed a 24% decrease in usage as the campus resumed in-person classes (the proportion of in-person classes increased from 30% in the Fall 2021 semester to 70% in the Spring 2022 semester). The continued decrease in usage since the beginning of COVID-19 suggests that the chatbot needs more marketing from the library to facilitate more engagement. Tickets to the authors since May 2020 have remained steady at an average of one per week, consisting of the similar topics referenced previously; namely off-campus access, textbooks, and more in-depth reference questions.

Discussion

Librarian/Chatbot Confusion

The behavior shown in the previous section showing a sample transcript raises several interesting possibilities about how students use a library chatbot. Firstly, students may not be reading the script and instead assume that the chatbot is staffed by a live person. Students then

proceed with their query and when the chatbot cannot answer it, fill out the form confirming that a librarian will get back to them. Secondly, students may not know how to use a chatbot or what its purpose is. Finally, students may be confusing the chatbot with the library's chat service. Each of these possibilities merits further research and the authors plan to revisit these topics.

Furthermore, while the chatbot identifies itself as a virtual assistant, the student behavior may indicate that the library should add more reinforcement about what a chatbot is and how it works. This could be done via additional text on the library homepage or on a separate, dedicated page about the chatbot. Such a page could then help users understand what a chatbot is, what it does, and how a chatbot is different than a live librarian staffing a chat reference queue. This approach was used by UCI with its ANTswers bot. They noted in "four places that it is an experimental computer program" (Kane, 2017, p. 482). These informative notes were displayed "in the initial short introduction, within the chat window itself, under the chat window and also in the about ANTswers" (Kane, 2017, p. 482). UCI's approach proved successful since in an analysis of 2,786 chatbot transcripts, very few patrons asked the bot in-depth research questions.

While the Leonard Lief Library could adopt a similar approach, its necessity is uncertain at present because in the case of the Lehman College library, patrons usually route questions that stump the chatbot to a librarian who can usually answer them or re-route them to a subject specialist. From a workload standpoint, given that the frequency of this type of question was approximately once or twice a week, this step may not be necessary.

Based on the initial data from the implementation, the chatbot appears to be functioning successfully as another access point for reference questions on the library website. This is different than the outlined goal of answering basic questions to free up the library's Ask-a-Librarian chat service for in-depth research questions. The chatbot in practice appeared to do

both, which fulfilled a goal for implementation and one that was unintended. Whether or not users sometimes mistake the bot for a reference librarian, if they receive a valid answer, it is the authors' opinion that having the chatbot serve users in this manner is a worthwhile enhancement to the library website.

Having the chatbot route reference questions it receives but cannot answer also offers further insight into the research students conduct and this can be included in the planning and statistical activities of the library's reference services. If reviewing the transcripts of the chatbot revealed many reference questions that were not satisfactorily answered and resulted in students leaving without routing their questions to the authors, more modifications would be warranted.

Chatbot Limitations

During the case study period, several limitations surrounding the chatbot became clear. The first of these concerned the college's license for the Ivy software. Due to the college's agreement with Ivy, only a limited number of chatbot instances were allowed to be deployed, and some departments had to share a single instance. In the library's case, its instance was shared with the college's Blackboard administrator. Therefore, questions pertaining to Blackboard were received by the library, while questions pertaining to the library were received by the Blackboard administrator. This was also complicated by the fact that several other departments had their own Ivy bots. While the bots were supposed to be able to share knowledge, it was unclear how this process worked, and answers about many topic areas did not appear to be shared. This sometimes resulted in incorrect or outdated answers being given to students.

In addition, the college's license with Ivy limited the number of webpages that could be crawled by the bot's indexing service to five. These five pages could not be changed, even as URLs were updated, and pages were moved or discontinued. This proved problematic as two of

the five links given to Ivy were changed a few months after implementation. This meant that Ivy was crawling pages with old and inaccurate information, and in one instance, the bot continued to crawl a page that no longer existed. The outdated links necessitated the creation of more custom intents to compensate for this bot behavior, which increased the librarians' workload. Luckily, IT offered to help create custom intents if the library supplied the updated information.

This limited crawling also meant that the Leonard Lief Library was only allowed to list one research guide in the specified pages to crawl, so the library's extensive collection of research guides was not able to contribute to the bot's knowledge base. The bot's crawl frequency was also uncertain. As a result, users sometimes encountered outdated information when the bot had not recently crawled a site it indexed.

The chatbot logs also showed that the library's website had design elements that were confusing to patrons, and which the bot could not present effectively for those same patrons. This was due to the website's use of accordion elements on many pages, where users needed to un-collapse open accordion panels to read information on a page. Each page had several topics, and to explore these, a user typically opened the individual accordion panel of interest, which also collapsed previous accordions other panels. While this accordion behavior could be changed, it is not generally considered a best practice (Barnard, 2020). This issue was compounded by the fact that Ivy would identify specific elements on each page as being relevant to student users, but would not un-collapse the appropriate accordion, which left users uncertain about which accordion element contained the information they were searching for.

Finally, the electronic resources librarian and web services librarian were initially given user level accounts. This initial level of user access control did not include the ability to look at ontologies or to make other changes to the bot's "brain" and how it associated terms and

questions with the most relevant resources. In addition, as the library began using the chatbot, there was confusion about whether doing these kinds of updates to the ontologies or inbox-zero tools was the library's responsibility, IT's, or the vendor's. Ultimately, the library, IT, and Ivy's representatives met, and the vendor agreed to give the library more access to the administrative interface. Once this was achieved, the authors found that they could better customize the bot to serve patron needs.

Privacy Considerations

By default, Ivy's platform does not approach privacy concerns as strongly as the Leonard Lief librarians would have preferred. Ivy tracks several features about users, including IP address, time of chat, device/browser, and referring URL. It also maintains copies of each chat's transcript. Concerned by this, the web services-online learning librarian and electronic resources librarian asked IT and the vendor if the bot could be set up to not track patron IP addresses. IT and the vendor promised to change the bot accordingly, however, this took several months to implement, and in the meantime, patrons' IPs continued to appear in transcripts. In addition, discussions surrounding retention periods after which data would be removed have not been fully clarified as of the time of this article's publication.

Furthermore, while Lehman College's legal department must review all third-party contracts and terms of service documents, the library did not receive a copy of the agreed-upon document. Therefore, it is not certain what legal agreements that govern data retention or ownership of chatbot or patron data may exist between Ivy and Lehman College. Libraries considering adopting this software should be aware of Ivy's standard terms of service (*Terms and Conditions*, 2016). This document states that Ivy does not own chatbots, devices, applications, or

customer data. It does, however, have access to data, and is licensed to

> use and disclose your Customer Data to provide the Ivy Content and the Ivy Platform; (ii) use your Customer Data for Ivy's internal business purposes; (iii) disclose your Customer Data as may be required by law or legal process; and (iv) otherwise use and disclose your Customer Data in accordance with the Ivy Privacy Policy. (*Terms and Conditions*, 2016, para. 7).

Accessibility Considerations

The ability for all patrons to use the chatbot was of paramount importance to library staff. With that in mind, the chatbot was designed to conform to Web Content Accessibility Group (WCAG)'s Version 2.1 AAA accessibility standards (https://www.w3.org/TR/WCAG21/). Accordingly, the library ensured that the bot's color scheme had sufficient contrast to meet the AAA standards, and that patrons could navigate to the chatbot using their keyboards. To avoid distraction by the other content on the library's site, the bot was placed below the rest of the content in the navigation order, and an appropriate aria-label was added. Ivy prioritizes accessibility and publicizes these features and broad compatibility with screen readers in its accessibility statement (*Accessible AI Technology*, 2020). As mentioned in the implementation section, the library also worked with the vendor to increase the size of the chatbot's box (div) on the homepage and the fonts used in each chat in order to make the chatbot more visible and easier for patrons to use without increasing font sizes or zoom levels.

Study Limitations

This case study is limited as it reflects the experience of only one academic library, and other libraries may experience different results and have different user bases. In addition, no

surveys or other formal assessment tools were used to determine the effectiveness or utility of the chatbot. Furthermore, the authors were not able to find similar case studies that used similar implementations of Ivy.

In addition, cloud-based chatbots are still an emerging technology (Mckie & Narayan, 2019) and the marketplace for them is still developing. There appear to be no clear market leaders, and documentation of best practices is limited at present.

The study is also limited in that most libraries who have published on chatbots discuss experiences using tools they created and maintain themselves. While this is common among early adopters, many libraries lack the means and resources to build their own chatbots, and their best hope for implementing a chatbot is to use a vendor like Ivy. Until there are more studies discussing vendor-based chatbots, there is no way to be certain that Lehman College's library experience is similar to others or in contrast.

Best Practices

Based on Lehman College's implementation of the chatbot, the authors suggest several best practices for other institutions interested in adopting Ivy or other chatbots. Firstly, the library should insist on being given complete administrative rights to manage its chatbot instance from the start. This will allow the library to make initial and continuous changes based on feedback from the community and effects from the chatbot on the library website. Examples include the request to increase the size of the chatbot and adding a customized welcoming script.

Because library websites contain multiple pages and convey the library's many purposes, the chatbot needs to be customized to work alongside the website. Customization includes the size and placement of the chatbot, which, as the library discovered, played a major role in being positively received by the librarians at Lehman College. In addition, libraries should also have

control of which pages the chatbot is deployed on, as not every page may benefit from having a bot. The ability to edit the chatbot's answers and responses is also important, as chatbot-generated answers or those tailored by a vendor might not use library terms and might not be aware of library-specific issues.

Another recommended best practice is to employ branding, so patrons know that a chatbot is part of the library's website, and not an advertisement. Along with this, the fact that a chatbot is an AI and not a live person should be shown clearly. Librarians may also wish to consider how to balance what content is included in bot knowledge bases and from other sources, especially when a chatbot is shared with another department as it was at Lehman College.

Future Research

To assess the full impact of the chatbot on the library website, the authors believe that a thorough analysis of the chatbot's answer transcripts will be necessary. This type of analysis would likely be the best way to determine how effectively the bot answers questions. Transcript analysis could include content analysis of each chat transcript, along with ratings from users about how effectively the chatbot answered their question. This rating system is already provided by Ivy. Transcript analysis could also study how many questions must be routed to a librarian for further assistance or to inbox zero for custom intents. A review of transcripts could focus on which subjects receive the most questions, which could better assist in making description and placement changes to content on the library website. While this goal was partially achieved through adding information to the remote resources research guide, a more detailed analysis could reveal how effective a chatbot is for flattening the library website.

The authors plan to continue to track the questions that get routed to them via the chatbot. By combining this observation with the transcript analysis, the library hopes to examine whether

the use of custom intents, website updates and general improvement of the software make a difference in chatbot efficacy, and if so, how much. These questions would also be analyzed for recurring questions and content areas, which could then result in further improvements to the chatbot, allowing the chatbot to continue to serve as a unique tool for enhancing the library website.

The chatbot's presence has revealed weaknesses of the library website, including the accordion design that makes certain content difficult to find. A future project will be to look critically at these pain points and see how they can be modified to result in a more accessible website where content is more findable. Furthermore, the chatbot could function as a form of usability testing to help provide a better experience for the website's users, as is suggested in research by Mckie and Narayan (2019).

Conclusion

A chatbot can be a powerful tool to enhance a library's website. By serving as an access point for basic reference questions, retrieving information for answers to questions, and revealing student search topics, a chatbot can act as a valuable tool on an academic library's website. Regular maintenance and review of chatbot intents is essential to ensuring its success, which proved sustainable for the Leonard Lief Library when using the Ivy software. Libraries that are presented with the opportunity to implement a chatbot may be well-served to accept it with the guidelines and considerations presented.

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