

Library and Educational Use Cases

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In a world increasingly powered by machine learning, library and education environments alike share an emerging focus on artificial intelligence (AI). With an eye toward cultivating AI literacy and leveraging the twenty-first-century boom of voice assistant technology, a number of related library and educational applications have emerged. Such applications span all phases of education, from early learning through higher education institutions and beyond, into the realm of lifelong learning.

Commercial Product Applications for K–12 Environments

K–12 classroom and school library environments are rife with promise for AI development in support of learning initiatives. A few potentially useful voice assistant technology applications developed by commercial vendors include storytime and related comprehension quizzes to check for understanding and emphasize the reading and listening aspects of literacy development. One such commercial vendor dedicated to the primary school education market is Bamboo Learning, whose Highlights Storybooks skill is a collaboration with the well-established *Highlights for Children* and features animated story narration with accompanying exercises to support language acquisition.¹ Bamboo Learning’s collection of Alexa skills can serve as self-guided educational activities, supplementing traditional teaching and learning. These and other similar learning-oriented Alexa skills could be useful in the elementary school classroom or school library, in public library programming, in home-schooling environments, or in after-school enrichment programs. Such applications are not unlike the

self-guided classroom reading stations of yesteryear, formerly featuring vinyl record albums, cassette tapes, and compact discs of children’s audiobooks.

While the outlook for early learning educational applications is promising, reported drawbacks to interactive skills such as those of Bamboo Learning include an awkward processing lag and the more potentially harmful presence of language bias—errors in detecting correct answers when a skill fails to recognize a child’s pronunciation or word order.² In the United States, English language learners or children with speech language deficits are likely to encounter such difficulties more than peers without disabilities or whose primary language is English. Thus, educational applications of voice assistant technology should be used with thoughtful adult supervision to mitigate the risk of disadvantaging children who are likely already facing marginalization from human interaction.

AskMyClass is another emerging commercial vendor developing classroom activity-based Alexa skills for teachers and students in pre-K through fifth grade.³ Activities include community-building icebreakers, transitions from low energy to focused attention, thought starters for sharing during circle time, and at-desk yoga or meditation exercises.⁴ While the Teacher and Classroom Helper Alexa skill is free to enable, users can purchase individual or district-level plans to program personalized activities for their unique classroom environment, such as a random, bias-free student name picker.⁵ Such activities have the benefit of providing educators with exciting and helpful tools to support daily classroom routines with minimal risk of problematic or harmful interaction.

In the arena of mental health and education psychology, Kickboard is a commercial vendor with education products and services focused on response to

intervention (RTI), positive behavior intervention support (PBIS), social-emotional development, and restorative practices to reduce chronic absenteeism and suspension.⁶ Schools using Kickboard can optionally link to an accompanying Alexa skill offering real-time behavior information for families who wish to more closely monitor their children by engaging in daily communication with education professionals.⁷ In this use case, the Kickboard Alexa skill makes it possible to streamline parent-teacher communication, reducing time, paperwork, and the possibility of lost behavioral records. In turn, families have the opportunity to be more involved in their child's behavioral progress at pivotal developmental moments, toward the mutual goals of improving performance and decreasing detentions or suspensions associated with poor achievement. A mobile version of the free Alexa skill is available for parents or families who do not own an Amazon device.

In addition to the communication advantages for the aforementioned use case, proponents of voice assistants in K–12 classrooms also recognize the potential upside of leveraging AI technology to support the challenge of large class sizes, particularly when the oft-cited benefits of reduced teacher-student ratios are not feasible.⁸ Moreover, technology in the classroom is broadly tied to positive learning outcomes; recent data from the Center for Public Education underscores the positive association of digital resources in classrooms with student achievement in both reading and math.⁹

Commercial Product Applications for Libraries

Library vendors also recognize the potential of voice assistant technology for use with commercial product applications geared toward public, academic, or school library environments. One such vendor is Hoopla Digital, whose Alexa skill allows public library patrons to borrow and play audiobooks and full music albums using their linked Hoopla account.¹⁰ Another public or school library-oriented application is Beanstack tracker, an Alexa skill for use with schools or libraries leveraging Beanstack's data measurement tool for reading challenge events.¹¹

In terms of public and academic libraries, Libro from ConverSight.ai is a versatile voice-based mobile application option with a smartphone voice product for libraries.¹² Current customers include Iowa State and the University of Iowa, whose Alexa skills are among the most robust of their peer institutions.¹³ Companies such as Pellucient are helping library environments build Alexa skills or Google Assistant actions, including the integration of Libro from ConverSight.ai into existing library systems.¹⁴ For example, patrons can use Libro's Alexa skill to search a library catalog for resource availability; recall, renew,

or place holds on library materials; find an item location in book stacks; or ask about library hours and events.¹⁵ Similarly, EBSCO has developed an interface that allows users to access content from its discovery service via Alexa and Google Home.¹⁶ Communico offers a suite of library products and can interact with Alexa for patron account management.¹⁷ Demco has also developed an app for its discovery service that lets patrons use Alexa to check library hours and services, place holds and renew items, discover and register for library events, or reserve meeting rooms.¹⁸ Lastly, Ex Libris has a "Hey Primo" feature, which is a voice search assistant allowing users to enter search terms using their device's microphone.¹⁹

In sum, public, academic, and school libraries can benefit from engaging with commercial vendor-developed voice assistant technology to support, enhance, or complement existing commercial library products.

Noncommercial Applications to Support Learning and Library Use

One blueprint for educational success in the twenty-first century is not merely to learn how to navigate existing structures, but rather to learn how to invent new structures. As one educational administrator noted, "It's bad for higher education and society at large if most students at universities are content to play within the existing system and lack the skills to challenge it."²⁰ What if the ubiquitous presence of AI and smart speaker technology gives us the opportunity to forge new structures rather than merely inhabiting old or emerging ones?

Educators are trying just that. At MIT Media Lab, Massachusetts Institute of Technology's interdisciplinary research lab is examining the trajectory of technology creation and adoption, toward the goal of positive social change. For example, a new middle school curriculum developed through the lab illuminates what's under AI's hood and how AI can be leveraged for the future—teaching and learning efforts that could incorporate voice assistant technology exploration or skill development.²¹ What if forward-looking Alexa skill design could be leveraged to combat problems facing library and education environments, from childhood obesity and bullying to fake news in today's post-truth era? In a classroom, experimenting with Alexa could offer lessons in information literacy, such as fact-finding quests to evaluate the veracity of sources behind answers given by a voice assistant or smart speaker. Students could learn how to question, verify, or challenge a voice assistant answer by exploring its source of truth and seeking out supporting or conflicting sources elsewhere. In this vein, a Google Home device in the library at St. Anne's-Belfield School in

Charlottesville, Virginia, provides ample opportunity for conversation on internet safety, privacy, and digital citizenship.²² Rather than shy away from the potentially inappropriate use of smart speaker technology by middle school students in a library setting, St. Anne's embraces the opportunity for students to explore a voice assistant device in a safe space within defined boundaries.

Virtual assistants and AI are among the emerging technologies identified in the *EDUCAUSE Horizon Report: 2019 Higher Education Edition*, with several cited use cases for college and university settings.²³ Between 2018 and 2019, top tech trend discussions at the Midwinter and Annual meetings of ALA's Library Information and Technology Association, LITA, included AI, machine learning, and library databases in the age of digital assistants.²⁴ Accordingly, AI labs, initiatives, digital assistants, and digital assistant applications are popping up at institutions of higher learning across the map, from college dorms to university library environments. For example, Northeastern University developed Husky Helper, a skill for Alexa designed to support student learning experiences by answering frequently asked questions; to support usage and experimentation, the institution gave sixty students Amazon Echo Dots to try out the skill.²⁵ At Saint Louis University, more than 2,300 Amazon Echo Dots are placed in the residence hall rooms, and the university's Alexa skill, Ask SLU, now can answer over 200 frequently asked questions, including library hours.²⁶ Similarly, at Arizona State University, 1,600 Amazon Echo Dots are deployed at the dormitory for engineering students to allow them to learn about voice technology and to work on course projects. ASU also developed its own Alexa skill, Ask ASU, to answer questions about campus-specific information, such as meal plans, sports events, and business hours for the bookstore, library, and fitness center.²⁷

Stanford University Libraries has a budding AI Studio aiming to develop AI for internal information processing assistance to support collection research and discovery.²⁸ The University of Rhode Island Libraries also have an AI Lab replete with resources and tools for AI exploration, including Google Home and Amazon Echo devices.²⁹ The University of Oklahoma has created a Projects in Artificial Intelligence Registry (PAIR) for cross-institutional collaboration, as well as a Digital Skills Hub for AI literacy development.³⁰ PAIR, a global directory of AI projects in higher education, centralizes scholarly activity by allowing institutions to register, collaborate, and increase scholarly impact.³¹ The registry also includes a searchable grant project directory as well as relevant news links. Finally, University of Oklahoma participates in the Alexa in Education initiative by encouraging its students to develop Alexa skills supporting their academic experiences.³²

Amazon's Alexa in Education program aims to support the education community in enhancing student learning and engagement with voice technology.³³ In 2019, Amazon further launched the Alexa Education Skill API allowing Alexa to closely integrate with campus systems, such as learning management systems, student information systems, and classroom management systems. As a result, students can ask for their assignments and coursework directly through Alexa. Currently, several LMS vendors, including Kickboard, Blackboard, Canvas, and Coursera, are developing their Alexa skills using this API.³⁴

For higher education, Amazon identifies four broad use cases for its digital assistant technology:

1. **"Help students study."** For example, an Alexa quiz skill can help students study; a virtual office hours skill lets instructors offer answers to the most commonly asked questions at any time.
2. **"Build smart campus experiences."** For example, instructors can ask Alexa to turn on the projector and screen, dim the light, and adjust the temperature; students can ask Alexa to book a group study room or check computer availability in the library.
3. **"Foster engagement and productivity."** For example, students can ask Alexa for directions to a location on campus, look up campus events, or connect to campus resources and services.
4. **"Build student-driven Alexa skills."** For example, faculty and staff can involve students in developing innovative Alexa skills by hosting a hackathon or incorporating skill development in class or work-study projects.³⁵

Beyond the aforementioned use cases, additional Alexa skills exist for higher education, as well as for academic, public, and special libraries; a query of the Alexa skills database sheds further light on the variety of skills emerging for library and education environments.³⁶

Alexa Skills Database Query for Library

Amazon announced its January 2019 milestone of surpassing 80,000 Alexa skills worldwide, including over 56,000 skills in the United States alone. A search for *library* in the Alexa skills database yielded ninety-seven results one year later on January 2, 2020, compared to fewer than a dozen results from a similar search in August of 2018—an exponential increase in available skills.³⁷ Roughly half of the latest search hits (fifty Alexa skills) may be broadly categorized as recreational or educational in nature, spanning a variety of subject areas such as entertainment,

gaming, literature, news, nutrition, mindfulness, music, religion, technology, tourism, wine, and zoology. An additional thirty-four search hits include skills designed to enhance services or content access at public libraries (nineteen skills), special libraries (four skills), or academic libraries (eleven skills). Two search hits feature skills developed broadly for higher education institutions, and three search hits are skills by commercial vendors whose products are tailored for libraries. Additional commercial vendor skills of this nature exist, as well as skills developed for people with disabilities.

In the realm of lifelong learning, Alexa allows public library patrons to keep up with library events, hours of operation, and fun facts at Delaware County District Library, while Houston Public Library's Alexa skill (developed by a third party) allows users to query the online public access catalog.³⁸ A dozen other search hits reflect skills in similar categories supporting public library usage or content discovery. Additionally, a handful of public libraries or third-party developers have created distinctive Alexa skills for miscellaneous use cases, including managing patron accounts at Granville Public Library, providing facts about forthcoming facility improvement at Spokane Public Library, delivering a Sioux City Public Library-produced literary culture podcast, and listing popular fiction titles at Los Angeles County Public Library (this last skill developed by a third party).³⁹

Additionally, several special libraries have developed unique Alexa skills, including some in support of health education and patrons with disabilities. The skill NLM in Focus is an online newsletter developed by a third party to offer Alexa users a behind-the-scenes glimpse of the US National Library of Medicine programs and services.⁴⁰ The same third-party developer created Disaster Health News, providing Alexa users with disaster-related news and health information from the Disaster Information Management Research Center at the US National Library of Medicine and the US National Institutes of Health.⁴¹ The Recording Library of West Texas, a nonprofit dedicated to recording text to audio for people with mental, physical, or visual impairments, developed a skill that allows patrons to listen to books, newspapers, magazines, grocery ads, stories, and more.⁴² Lastly, the Blind Foundation of New Zealand has a skill that allows its registered users to access the foundation's audio library of over 15,000 titles, including books and magazines.⁴³

Along the lines of the above special libraries use cases geared toward people with disabilities, Hennig lists a case study from a retirement community in Carlsbad, California, where a majority of the respondents were in their eighties and had hearing or visual impairments, mobility impairments, or hand tremors that made it difficult to type or use a smartphone; 100

percent of respondents trying out Alexa reported it made their lives easier; uses included audiobooks, a potential benefit of connecting users with disabilities to libraries as digital repositories.⁴⁴

A dozen search hits reflect skills designed for higher education institutions and their libraries. At Iowa State University Library, patrons use Alexa to learn about library collections, spaces, and history, as well as manage devices in group study rooms.⁴⁵ This skill, Parks Libro, is the only academic library-developed Alexa skill presently listed on the Projects in Artificial Intelligence Registry (PAIR) maintained by the University of Oklahoma Libraries.⁴⁶ However, there are several institutions whose projects could benefit from being included in the registry. One is Northwestern Law Library, whose Alexa skill answers basic questions relating to the Northwestern Pritzker Legal Research Center, as well as legal research more generally.⁴⁷ The University of the West Indies also has an Alexa skill showcasing the range of campus library services offered and answering frequently asked questions such as hours of operation for each campus library.⁴⁸ Additional skills developed for academic institutions and academic libraries include library catalog search queries, patron account management, library hours of operation, library or campus event information, library collection facts and historical information, library FAQs, library locations and contact information, and library- or campus-related news (summarized in table 2.1).

Parks Libro

<https://www.lib.iastate.edu/spaces-computers/computers/parks-libro>

Case Study: Inside the Development of Alexa Skills for USC Libraries

At the University of Southern California Libraries, a pilot project was conducted in 2018 with the goals to explore possible Alexa library use cases as well as learn more about voice assistant technology. The project team included staff members from both public services and library IT. With funding from the dean of the libraries, six second-generation Alexa devices were purchased, and several computer science students were hired to support the development of Alexa skills. The project began by experimenting with Alexa; each team member was given an Alexa device to try out. To learn more about Amazon's voice assistant, team members reviewed library literature on voice assistant technology, tested a handful of existing library-related Alexa skills, discussed ways Alexa can meet the needs of various USC Libraries user populations (e.g., undergraduate, graduate, faculty, staff,

Table 2.1Higher education search results from Alexa skill database *library* keyword query

Institution	Skill Details	Use Case Category
California State University, San Bernardino ^a	Flash Briefing skill Rated: Guidance suggested Contains dynamic content	Campus news
Florida International University ^b	Contains dynamic content Invocation name: f. i. u. libraries	Library FAQs, library hours of operation
Iowa State University Library ^c	Contains dynamic content Invocation name: parks libro Developed in collaboration with Libro ThickStat	Library catalog search, patron account management, library events, library hours of operation
Iowa State University Library ^d	Contains dynamic content Invocation name: iowa state library	Library collection facts & history
Northwestern Law Library ^e	Contains dynamic content Invocation name: northwestern law library	Library FAQs, library hours of operation
Purdue Libraries ^f	Flash Briefing skill Contains dynamic content	Library news
University of California, Los Angeles ^g	Flash Briefing skill Contains dynamic content Third-party developer not officially affiliated with UCLA	Campus news, campus events
University of Illinois Library ^h	Contains dynamic content Invocation name: library checker	Library hours of operation, library locations & contact info
University of Iowa Libraries ⁱ	Contains dynamic content Invocation name: info hawk Developed in collaboration with Libro ThickStat	Library catalog search, course reserve search, library hours of operation
University of Southern California Libraries ^j	Rated: Guidance suggested Contains dynamic content Invocation name: u. s. c. events	Library hours of operation, library events
University of Southern California Libraries ^k	Rated: Guidance suggested. Contains dynamic content Invocation name: u. s. c. trojans	Library catalog search, library hours of operation
University of Southern California Libraries ^l	Rated: Guidance suggested Contains dynamic content Invocation name: u. s. c. libraries	Library FAQs
University of the West Indies Libraries ^m	Contains dynamic content Invocation name: my u. w. i. library	Library FAQs, library hours of operation

- a. https://www.amazon.com/CSUSB-News/dp/B074WRD8TK/ref=sr_1_79?keywords=library&qid=1578636648&s=digital-skills&sr=1-79
- b. https://www.amazon.com/FIU-Libraries-RefTech-FAQ/dp/B0837L42D5/ref=sr_1_14?keywords=library&qid=1578635464&s=digital-skills&sr=1-14
- c. https://www.amazon.com/ThickStat-Parks-Libro-Public/dp/B07HF6VCZN/ref=sr_1_69?keywords=library&qid=1577389523&s=digital-skills&sr=1-69
- d. https://www.amazon.com/Iowa-State-University-Library-IowaStateLibFacts/dp/B07BH2DXW9/ref=sr_1_44?keywords=library&qid=1578635952&s=digital-skills&sr=1-44
- e. https://www.amazon.com/Northwestern-Pritzker-Legal-Research-Center/dp/B07WZJNX1Q/ref=sr_1_10?keywords=library&qid=1578634829&s=digital-skills&sr=1-10
- f. https://www.amazon.com/Illiana-PC-Purdue-Library-News/dp/B07K5DQQ3S/ref=sr_1_24?keywords=library&qid=1578635770&s=digital-skills&sr=1-24
- g. https://www.amazon.com/Gerard-Au-UCLA-Newsroom/dp/B074X6YQYQ/ref=sr_1_75?keywords=library&qid=1577389523&s=digital-skills&sr=1-75

- h. https://www.amazon.com/University-of-Illinois-Library-Checker/dp/B07HGW7W72/ref=sr_1_19?keywords=library&qid=1577335910&s=digital-skills&sr=1-19
- i. https://www.amazon.com/ThickStat-InfoHawk/dp/B07MZY4JBS/ref=sr_1_86?keywords=library&qid=1577390684&s=digital-skills&sr=1-86
- j. https://www.amazon.com/USC-ILS-Libraries-Events/dp/B07MD161WW/ref=sr_1_20?keywords=library&qid=1578635320&s=digital-skills&sr=1-20
- k. https://www.amazon.com/USC-ILS-Libraries-Search/dp/B07L7KHPKB/ref=sr_1_23?keywords=library&qid=1578635584&s=digital-skills&sr=1-23
- l. https://www.amazon.com/USC-ILS-Libraries-FAQ/dp/B07H854LPP/ref=sr_1_27?keywords=library&qid=1578635584&s=digital-skills&sr=1-27
- m. https://www.amazon.com/The-University-the-West-Indies/dp/B07SK6QMMY/ref=sr_1_10?keywords=library&qid=1577318189&s=digital-skills&sr=1-10

and alumni), and brainstormed possible use cases for Alexa in library settings.

During this initial exploration phase, the IT team members started studying the Alexa Skills Kit, the tools for developing custom Alexa skills, as well as attending Alexa skills-building workshops and exploring the cloud-based Alexa skill development environment. The IT team members learned that there are two platforms for building an Alexa skill: the Amazon Developer Console (ADC) and Amazon Web Services (AWS).

Alexa Skills Kit

<https://developer.amazon.com/en-US/alexa/alexa-skills-kit>

Amazon Developer Console

<https://developer.amazon.com/en-US/alexa>

Amazon Web Services

<https://aws.amazon.com/>

ADC is where Alexa skills can be created, managed, tested, published, and tracked in terms of user analytics. The IT team members determined they could use ADC to design a potential library skill's interaction model and define its intents (an action to fulfill a user's inquiry), slots (variables in the intent), and utterances (alternative versions of the intent). For example, when patrons ask for a specific newspaper in the library, the Alexa newspaper intent includes the following possible utterances: "Does the library have the *Los Angeles Times*?" "Do you have the *Los Angeles Times*?" "Where is the *Los Angeles Times*?" "How do I access the *Los Angeles Times*?" "How do I find the *Los Angeles Times* in the library?" The slots or variables of the newspaper intent can be *Wall Street Journal*, *New York Times*, or *Washington Post*.

AWS is where the IT team members determined they could craft the functionality of each custom Alexa skill, such as the return responses to an inquiry. This is also where the programming code is developed. The supported programming languages include Node.js, Java, Javascript, Python, C#, or Go. For the above newspaper intent, the return response is

The USC Libraries does have access to the *Los Angeles Times*. To find this, or any other newspaper:

- Go to the USC Libraries main homepage
- Select Find from the main menu
- Select Journals from the drop down menu
- And search for *Los Angeles Times* or any other newspaper.

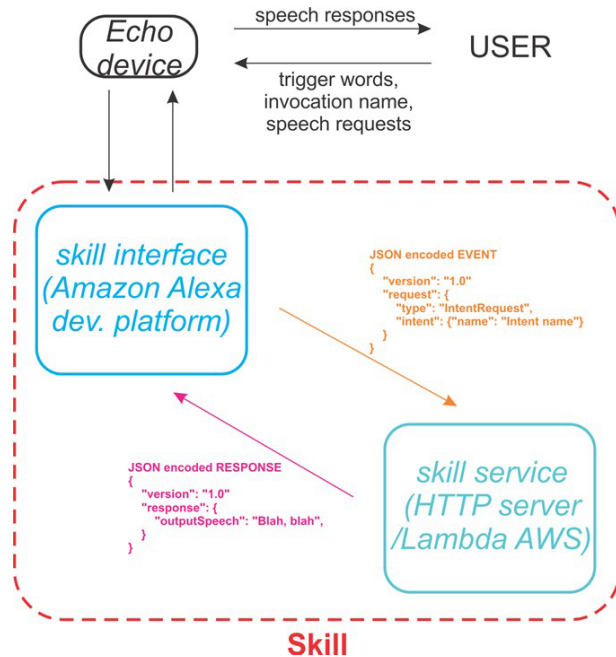


Figure 2.1
Alexa skill diagram

Figure 2.1 illustrates the information flow and interaction in a typical query transaction.

The team's research and discussions led them to develop three Alexa skills based on their local needs, requiring coordination across multiple systems. Application programming interface (API), a communication protocol allowing data exchange between two systems, is used for Alexa to access resources in library systems, such as a library website or library catalog.

After each skill was developed and tested, the team had to submit it to Amazon for review and certification. The skill needed to meet Amazon's policy guidelines and security requirements, in addition to passing all required functional tests. Once a skill becomes certified, Amazon publishes it in the Alexa Skills Store and makes it freely available for anyone to use. The certification process takes about a week.

Alexa Skills Store

<https://www.amazon.com/alexa-skills/?ie=UTF8&node=13727921011>

For each skill listed below, the project team wrote a brief description of what the skill does, its invocation name (the name used to invoke the skill), the source from which the answer is drawn, the APIs used (available on GitHub⁴⁹), and usage examples:

1. **USC Libraries FAQ:** https://www.amazon.com/USC-ILS-Libraries-FAQ/dp/B07H854LPP/ref=sr_1_5?keywords=USC&qid=1551201521&s=digital-skills&sr=1-5

Description: Provide answers to frequently asked questions about USC Libraries, Collections, and Services

Invocation name: USC Libraries

Source: LibAnswers FAQ database by Springshare

Examples:

- “Alexa, open USC Libraries”
- “Alexa, ask USC Libraries, are books available to be borrowed by alumni?”
- “Alexa, ask USC Libraries, how do I renew a book?”

GitHub software repository link: <https://github.com/ilsstudent/LibrariesFAQ>

2. **USC Libraries Events and Hours:** https://www.amazon.com/USC-ILS-Libraries-Events/dp/B07MD161WW/ref=sr_1_3?keywords=USC&qid=1551201469&s=digital-skills&sr=1-3

Description: Provide information about USC Libraries current events and library hours

Invocation name: USC Events

Source: Drupal API from library’s event site (<https://libraries.usc.edu/events>) for library event information and Ex Libris Alma library management system API for library hours

Examples:

- “Alexa, open USC Events.”
- “Alexa, ask USC Events, what are the events this week?”
- “Alexa, ask USC Events, what are the library hours for Leavey today?”

GitHub software repository link: <https://github.com/ilsstudent/EventsAndHours>

3. **USC Libraries Search:** https://www.amazon.com/USC-ILS-Libraries-Search/dp/B07L7KHPKB/ref=sr_1_4?keywords=USC&qid=1551201521&s=digital-skills&sr=1-4

Description: Query USC Libraries catalog by author, title, and keyword

Invocation name: USC Trojans

Source: Ex Libris Alma library management system API

Examples:

- “Alexa, open USC Trojans.”
- Title search: “Alexa, ask USC Trojans to search for the title Harry Potter.”
- Author search: “Alexa, ask USC Trojans to search for the author Hemingway.”
- Keyword search: “Alexa, ask USC Trojans to search for artificial intelligence.”

GitHub software repository link: <https://github.com/ilsstudent/AlexaLibrarySearch>

Case Study Assessment

Among the three skills developed, the USC Libraries Search skill allows users to query the library catalog by author, title, and keyword through API. The skill was complicated to develop and its performance less certain as there are unlimited search terms, phrases, and languages for catalog search. To learn more about how accurately Alexa recognizes pronounced search terms as well as retrieves items from the library catalog, the project team created a set of ten search queries for each type of search. Sixteen library staff and student workers volunteered to perform these searches. As illustrated by the test results in table 2.2, keyword search was the most successful, with an 87 percent success rate, followed by title search (78 percent). Author search was the least accurate, with a 58 percent success rate. The lower success rate of author search is attributed to the failure of Alexa’s automatic speech recognition system to transcribe proper names, especially foreign author names, into correct written words. Famous authors, such as Pablo Neruda or Ernest Hemingway, might be in Alexa’s vocabulary, but it failed to recognize most of the foreign authors. In addition, Alexa currently has no way to distinguish names with the same pronunciation. For example, a search for *Jane Austen* retrieved titles by *Jane Austen*. This finding coincided with the research results from Loup Ventures; in its testing of four smart speakers, it found that “nearly every misunderstood question involved a proper noun, often the name of a local town or restaurant.”⁵⁰

Foreign accents affect Alexa’s performance as well. The project team found that there is a slight difference in the outcomes between native English speakers and non-native speakers. In general, native speakers had a higher success rate. Other frustrations cited by the project testers included long pauses after query, interference from background noise, long wait times as Alexa read through the search results, and

Table 2.2

Successful rate of library catalog searches with Alexa skill testing

No. of Testers	Title	Author	Keyword
Total (n = 16)	77.50%	58.13%	86.88%
Native Speaker (n = 12)	76.67%	58.33%	89.17%
Non-native Speaker (n = 4)	80.00%	57.50%	80.00%

difficulty with searches with too many hits.

In a recent study of searching the top thirty *New York Times* bestsellers in both fiction and nonfiction categories, Metrock found that the five voice assistants (Alexa, Google Assistant, Siri, Cortana, and Samsung's Bixby) were capable of recognizing only 43.2 percent of basic queries related to these bestseller titles. Google Assistant performed the most optimally, with a 72.5 percent success rate, followed by Cortana's 60.8 percent, then Alexa's 44.2 percent.⁵¹ According to Metrock, such poor performance by voice assistants can potentially lead to publishers' lost sales of \$17 million.⁵² The less-than-satisfactory performance of Alexa in both this study and the USC Libraries case study indicates that a better approach and further improvement is necessary before voice assistants can be reasonably used for searching library catalogs.

Other Voice Assistant Technology in Higher Education

At Deakin University in Australia, the library participates in a campus-wide development of a smartphone-based virtual assistant, Deakin Genie.⁵³ Based on IBM's Watson AI services, Deakin Genie was launched in 2017. Designed as a smart digital assistant, Genie is available at the Apple or Android app stores and offers a range of utilities, tools, and services to support student learning. Similar to Siri, Genie comes with a conversational interface. Students either can ask or text Genie a question, and Genie will respond with the answer on the student's mobile device, sometimes with links to resources and websites for more information. Some of the Deakin Genie uses cases are the following:

- **Library support:** Students can ask Genie to search the library catalog and access library resources, course reserves, and instructional videos. Genie will answer frequently asked questions and provide library hours, refer patrons to the library's website to book a room, display patron's checkout items and holds, or check availability of library computers.

- **Personal organizer and time management tools:** Genie can display a student's class schedule, due dates for assignments and exams, task lists, and campus news or events. It can also send out reminders, as well as supportive and motivating messages.
- **Communication:** Students can chat and message with peers, mentors, and student support staff.⁵⁴

While USC Libraries has demonstrated what is possible with regard to a variety of library support tools as separate Alexa skills, Deakin University's smartphone-based virtual assistant Deakin Genie represents what is possible in the realm of a comprehensive range of student support services.

Iowa State University and the University of Iowa are both leveraging the ThickStat Libro product developed to connect Alexa with Primo, the integrated library system in place at both institutions, yet the specific use cases vary by institution despite the range of possibilities offered by the commercial vendor. This illustrates the reality that differently size institutions have different needs and options informed by levels of institutional flexibility as well as resources dedicated for project sustainability and stakeholder buy-in. Amanda Wheatley and Sandy Hervieux noted the possible advantage of small private institutions of higher education with a more dedicated focus among faculty over larger institutions more bound to bureaucratic processes.⁵⁵

Summary and Takeaways

Public library use cases for Alexa skills are broadly ranging, from facility improvement facts to popular fiction titles. While several public libraries have developed Alexa skills for patron account management, library catalog search, and library hours and events information, special library use cases include a health-oriented focus and can support users with visual impairment. Of note is the fact that Alexa skills are still something of a Wild Wild West, meaning they can be created by third-party developers. While this reality can be leveraged for powerful collaborations between commercial product vendors and clients, this can also make for less-than-optimal skills developed by no-name individuals unaffiliated with the named institutions they purport to represent. Depending on how or when organizations choose to take the plunge into smart speaker or voice assistant technology applications, individual pioneers may have already begun, for better or for worse.

In K-12 school environments, learning-oriented Alexa skills can be used to supplement teaching efforts so long as teachers and coaches aren't replacing traditional educational methodology with skills running

on autopilot without adult supervision. Activity-based Alexa skills can support pre-K and elementary school classroom routines and transitions, while skills communicating real-time classroom behavioral interventions from educators to parents can offer new, rapid avenues for family engagement at critical moments in a child's development. At middle school and high school levels, exploring what's under the hood of smart speaker and voice assistant technology can provide valuable learning opportunities on information literacy and digital citizenship.

In higher education environments, students can engage with voice assistants to support library usage and learning experiences. Some students may even dive into developing Alexa skills through the Alexa in Education initiative and emerging institutional resources to support AI literacy. USC Libraries is one of several institutions of higher education engaged in skill development and testing processes. Learnings from USC Libraries and Deakin University in Australia, among others, underscore the importance of embracing new technology initiatives to enhance and support learning and discovery. USC Libraries in particular identified several broadly applicable lessons learned from its experience in Alexa skill development which may prove useful for institutions considering their own foray into creating and implementing skills:

- Alexa voice recognition technology is limited by its available *source contents* (i.e., Alexa doesn't search Google, though it can search Wikipedia, limiting reliability, breadth, and veracity of source material from an information literacy perspective).
- Projects are both propelled and bound by their level of *sustainability*, as determined by resources. At times, resources may be limited in term or scope of project, which can be at odds with long-term needs or user expectations.
- There is strategic or *symbolic value* in investing in development of Alexa skills, or value added for the library as a modern institution embracing available technology and positioning itself for future evolution as libraries continually seek to remain relevant in their communities and spheres of influence.

In terms of other higher education applications, Iowa State and the University of Iowa are both collaborating with a commercial product vendor whose Alexa skill, Libro, can interact with the Primo integrated library system to support user search through voice assistant technology. Interestingly, the specific skill configurations of each institution are different, although they share the same skill development vendor, illustrating the varying budgets, needs, and implementation flexibility within higher education.

This further highlights the beneficial purpose of the University of Oklahoma's PAIR directory to register higher education projects in AI so that beta skill development in one institution can strengthen and inform the development experience of another, increasing scholarly impact across the board. Ultimately there are varying options for institutions interested in incorporating voice assistant technology:

- **Buy:** Use a commercial product, such as Libro.
- **Build:** Develop your own skills.
- **Collaborate:** Be part of the campus initiative, working with campus IT and other groups in developing a campus-wide Alexa skill.

In all, library and education use cases abound for voice assistant technology, increasingly used by today's generation of digital natives. Organizations interested in implementing smart speaker or voice assistant applications can benefit from surveying the current ecosystem for existing developments in similar environments. Opportunities for collaboration in higher education can further pave the way for future trail blazing in AI literacy, learning, and discovery as library and education institutions seek to stand on the cutting edge of tomorrow.

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