Built Custom Alexa Skills using AWS

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Abstract: ***The creation of unique Alexa skills using the Amazon Web Services (AWS) infrastructure is the focus of this project. Alexa skills are voice-activated features that improve Alexa, the virtual assistant from Amazon, in terms of functionality. The project's main goal is to demonstrate the flexibility and adaptability of AWS in voice-activated interactions by developing custom skills that are suited to certain use cases or applications. During the development process, the bespoke Alexa skills are hosted and executed using AWS Lambda, an event-driven computing service. With AWS Lambda, code can be seamlessly integrated without requiring server management, guaranteeing a scalable and effective solution. The stability and dependability of the custom Alexa skills are further enhanced by the extensive suite of tools and services offered by AWS, including the Alexa Skills Kit (ASK), DynamoDB for data storage, and IAM (Identity and Access Management) for security. The complexities of voice-activated technologies, AWS infrastructure, and Alexa skill development are investigated through this research. With the help of the Alexa ecosystem and customized skills, companies, developers, and enthusiasts can use AWS's power to create unique and interesting voice experiences. The project's main ideas are summarized in this abstract, which highlights the use of AWS technology to develop customized and inventive Alexa skills.***

Keywords: Custom Alexa skills, AWS, Voice-activated technology, Alexa Skills Kit, AWS Lambda, DynamoDB, IAM.

1. Introduction

A new era of personalized and interactive user experiences has begun with the widespread adoption of voice-activated devices. Alexa, the virtual assistant from Amazon, is at the vanguard of this change and may be used with a variety of skills to improve its powers. This project explores the creation of personalized Alexa skills by utilizing the reliable infrastructure offered by Amazon Web Services (AWS). This program investigates the smooth integration of voice-activated applications utilizing AWS Lambda, Alexa Skills Kit (ASK), and other essential AWS services. It provides creative and customized solutions to address certain use cases.The way that AWS is included into the process of developing Alexa skills highlights how important scalability, efficiency, and security are to the creation of an engaging user experience. Through the use of AWS Lambda for serverless computing, DynamoDB for data storage, and IAM for identity management, this project showcases the extensive ecosystem that AWS offers for creating compelling voice interactions.

Through our investigation of the complexities involved in creating unique Alexa skills using AWS, we hope to provide insight into how speech technology may be used by developers, businesses, and enthusiasts. The next sections will explore the methods, resources, and results of this project, offering insightful information about combining Alexa with AWS to create cutting-edge voice experiences.While they are occasionally seen as merely a mechanism for content delivery, learning management systems (LMSs) are thought to be a crucial and important component of contemporary e-learning [13–15]. LMSs also offer a way to foster interaction between students, instructors, and the content [16]. The frequency of interactions between teachers and students via LMSs is steadily rising [17], despite the fact that schools have tailored their own LMS instances to suit the needs of the instructors. Recent research [18] emphasizes the difficulties that modern learning management systems (LMSs) have in meeting the unique demands of students in terms of usability and learnability [19, 20]. This can lower students' engagement with the platform and have an effect on their learning results [21, 22].

- **AWS Integration in Alexa Skill Development.**

The introduction sets the stage by emphasizing the increasing importance of voice-activated technologies and the central role played by virtual assistants, with a focus on Amazon's Alexa. It introduces the primary objective of the paper — to unravel the transformative potential of AWS integration in the realm of Alexa skill development.

- ***AWS Lambda and Serverless Computing***

This section delves into the foundational aspects of AWS Lambda and its role in enabling serverless computing for Alexa skills. It discusses the advantages of serverless architecture, such as scalability, cost-effectiveness, and reduced operational overhead, while acknowledging challenges and considerations in its implementation.

- ***Alexa Skills Kit (ASK) and Seamless Development***

The review explores the functionalities and benefits of the Alexa Skills Kit, showcasing how it streamlines the development process for custom Alexa skills. Attention is given to the versatility of ASK in designing voice interactions, handling requests, and enhancing user experiences.

- ***DynamoDB for Data Storage***

A comprehensive analysis of DynamoDB's role in storing and managing data for Alexa skills is provided. The section discusses the scalability, performance, and cost-effectiveness of DynamoDB in the context of voice-activated applications, emphasizing its integral role in creating robust and responsive skills.

- ***IAM for Security and Identity Management***

The paper critically evaluates the importance of Identity and Access Management (IAM) in ensuring the security of Alexa skills developed on the AWS platform. It addresses key considerations in identity management, access control, and best practices for securing voice interactions.

- ***Advantages and Challenges***

This section provides a balanced assessment of the advantages and challenges associated with integrating AWS into Alexa skill development. It explores the enhanced scalability, flexibility, and cost-efficiency, juxtaposed with potential complexities, latency issues, and considerations for optimal performance.

Implications and Innovations

The paper discusses the potential future directions and innovations arising from the continued integration of AWS in Alexa skill development. It explores emerging technologies, trends, and areas for further research, providing insights into the evolving landscape of voice-activated applications.

This is how the rest of the job is organized. Part 2 provides an overview of relevant literature, and Section 3 details our study methods as well as the creation and application of the Alexa skill. Section 5 presents our research and findings, whereas Section 4 details the usability assessment conducted following the public release of the Alexa skill. Section 6 concludes by outlining the key findings and constraints from our study.

2. RelatedWork

Several scientific databases (Scopus, Web of Science, ScienceDirect, Springer, Wiley, and Tailor & Francis) were searched extensively, and a selection of publications was analyzed to evaluate the state-of-the-art in research on voice user interfaces for educational purposes. Our assessment of the available literature was split into two sections: first, we examined the research that did not make use of smart speakers, and then we reviewed the studies that did. In this division, a smart speaker was defined as a gadget that allows users to communicate with them via voice commands without having to physically touch the app [25]. We also prepared a comparison table (see Table 1) that lists the technical elements, platforms, frameworks, tools, and libraries utilized in each study to assist us detect any similarities between them.

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Table 1.Comparison Studies.

Article	Voice Platform	LMS	Development Tools
Grujic et al. [26]	Interactive Voice	Moodle	-
Pereira et al. [27]	Telegram app	open-MOOC	PHP, MYSQL
Todorov et al. [28]	Android app	DeLC 2.0	Java, CMUSphinx [29]
Kita et al. [30]	Google Simulator	Moodle	PHP, DialogFlow [31]
Kita et al. [32]	Google Home / PHP, DialogFlow, Alexa Cloud service	Moodle	Java, JADE (Java Agent Development Framework) [34]
Melton [35]	Amazon Alexa	Moodle	LAMP framework, Let's Encrypt

2.1. StudieswithnoSmartSpeakersUse

Grujic et al. [26] present a solution in their work that uses Interactive speech Response (IVR), a technique that allows a computer to communicate with people by using speech and tone input from a keypad, to link an e-learning platform like Moodle.

2.2. StudiesUsingSmartSpeakers

A more recent study by Kita et al. [32] builds on their earlier research on the application of VUIs in education. In their most recent effort, the authors create a speech app that can be downloaded for Google Home and Amazon Alexa devices, and it uses voice commands to search for documentation about Moodle capabilities (see Figure 1). The authors think that this kind of application would be beneficial since, while generating instructional materials, it is frequently necessary to search around Moodle for documentation regarding operations techniques and functions.

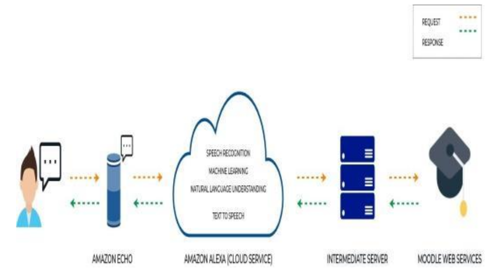

Figure 1.Graphical representation of Kita et al. [32]prototype architecture (Source:own authors' elaboration).

3. Method

Speech is sent to the cloud-based Alexa service, which manages speech recognition and conversion, when a user speaks to an Alexa-enabled device. The cloud-based Alexa service interprets voice, ascertains the user's preferences, ascertains whether any of the available skills can satisfy the user's request, and then sends a structured request to the specific skill [37]. For a custom skill to process a user's request and deliver the appropriate response, a cloud-based service is needed. Using AWS Lambda is the simplest approach to develop the cloud-based service for a bespoke Alexa skill, as suggested by Amazon. An Amazon Web Services (AWS) product called AWS Lambda operates code just when required and scales on its own, saving provisioning and ongoing server operation. Once the custom code for the Alexa skill is uploaded to AWS Lambda, the service takes care of the rest, automatically managing the compute resources and running the code in response to voice interactions with Alexa [37]. Furthermore, because of the nature of the skill we created, we needed to utilize some of the Moodle Web Services' functions, which meant that our custom code needed to be connected to a Moodle instance.

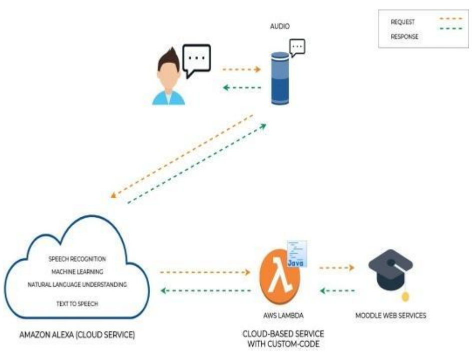

Figure3. DiagramforprocessingarequestbyourcustomAlexaskill(Source:own authors elaboration).

3.1. MoodleWebServices

In order to build our prototype, we must establish a programmatic connection with Moodle. More specifically, our prototype used the REST protocol, which is made available immediately when Mobile Web Services are enabled. A built-in web service called Mobile Web Services was created to make it possible for mobile applications and Moodle to communicate [38]. Running the official Moodle Mobile app or if a third-party app specifically requests it, you must have this web service. We can access the same data as the official Moodle app does in order to enable functionality like seeing course grades, tracking personal progress, and browsing course content by using the Mobile Web Services [38].

3.2. AlexaSkillImplementation

Initially, we had to choose the kind of Alexa skill that we should develop. Alexa comes with a number of pre-installed functions, or "skills." Through requests or inquiries, users can use Alexa's additional capabilities. But what kind of skill needs to be constructed depends on the functionality that needs to be provided, which also defines how the skill interfaces with the Alexa service [37].

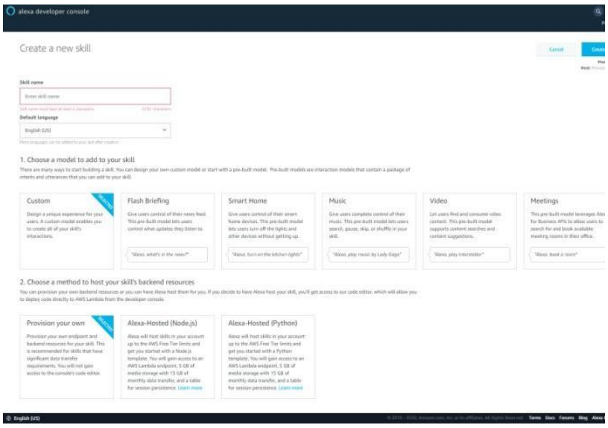

Figure4. AlexaDeveloperConsole:Viewforcreating anewskill.

3.2.1. AccountLinking Web Service

When users enable the skill for the first time, we needed another web service to manage the Account Linking procedure with the Alexa service. To put it briefly, Account Linking is a feature of the Alexa service that allows authentication through a third-party service. It is built on top of the OAuth2 authentication protocol (for further information on OAuth2 protocol, see Perez [39]).

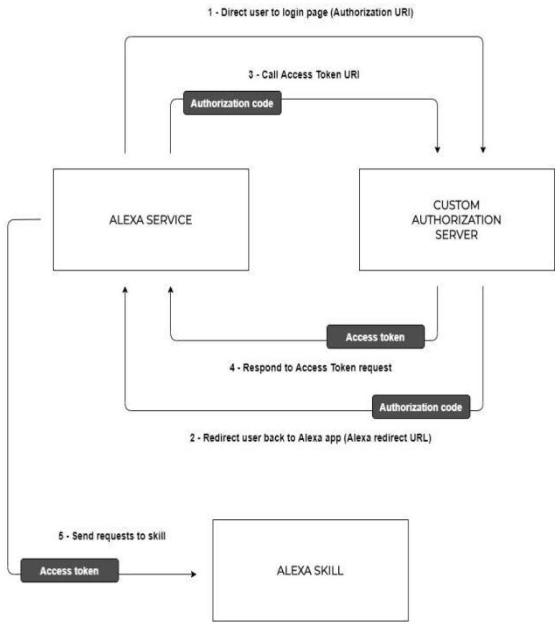

Figure5. AccountLinkingflowforauthorizationcodegranttype(Source: own authors elaboration).

To guarantee the privacy and integrity of the transferred data while in transit, HTTPS was used for every communication. We made the decision to not save the Moodle token anywhere, just like we did with the passwords. But when we sent a request for information to Moodle Web Services, we would need the token. We chose to utilize the Alexa access token for this activity so that we could keep the token without having to save it ourselves (see Figure 7).

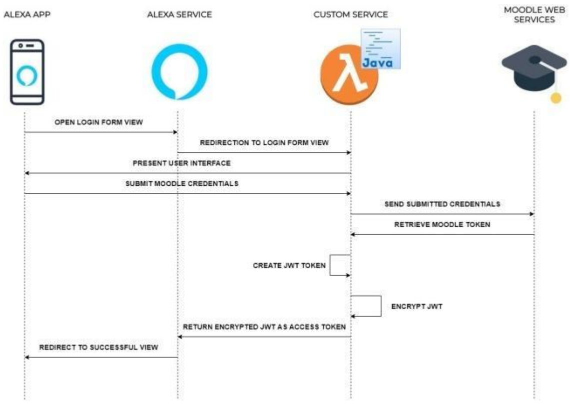

Figure7. FlowdiagramforAlexaaccesstokenexchange(Source:own authors elaboration).

Every time the Alexa service sends out a request, the user who initiated the request can be identified thanks to the Alexa access token that is provided.

We made use of this capability and stored a JSON Web Token (JWT) that we had constructed using the Alexa access token. The JWT would include the Moodle account token that was previously exchanged through the login form, together with other details that would enable us to identify the user (see Listing 2).

3.2.2. ImplementationProblemsandWorkarounds

When developing the skill, we encountered unforeseen problems with the user experience when generating spoken dialogue using the data we obtained from Moodle Web Services. As explained in Section 3.1, we build the logic that would allow the user to access the calendar event data by combining a number of Moodle methods. UsabilityEvaluation. A total of sixty-one students were registered for the course that was used for the usability assessment. Written informed consent from each participant and approval from the University of Burgos Bioethics Committee were acquired before the start of the study (refer to the Ethics Statement section at the end of this article). There were five male and 56 female students in the student group; Table 2 provides additional statistical information.

Table2. Description Of The Evaluation Sample.

ParticipantGender	**Count**	**MeanAge**	**StandardDeviationAge**
Male	5	22.00	2.24
Female	56	23.54	6.30
Total	61	23.36	6.01

The assessment was carried out from February 1, 2020, to March 31, 2020, a span of two months. The Alexa Developer Console's Analytics section provided the information about the skill's usage (Figure 8). This tool allows for the monitoring of numerous aspects related to the performance and usage of the skill by users. With the help of these measures, we will be able to investigate whether and how a skill's technical performance may affect how usable it is as well as identify any potential trouble spots during user engagement.

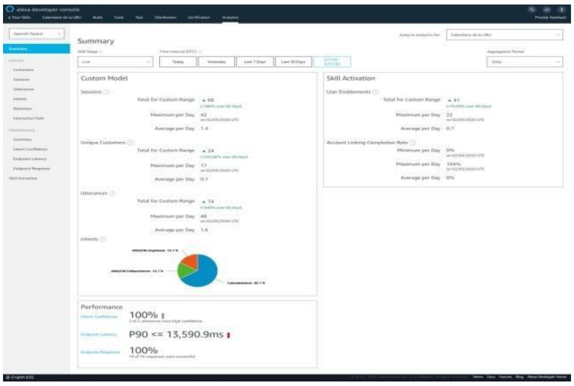

Figure8. ScreenshotoftheAnalyticssectionwithinthe AlexaDeveloperConsole.

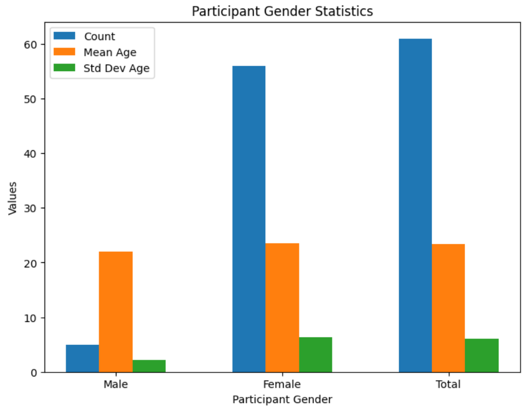

Figure 9.Statistical Data Deviated From Initial Survey(Source:own authors elaboration).

Lastly, at the conclusion of the course, a feedback survey was created and distributed to the students. This survey had three open-ended questions in addition to one multi-choice and one with binary response options (yes/no).

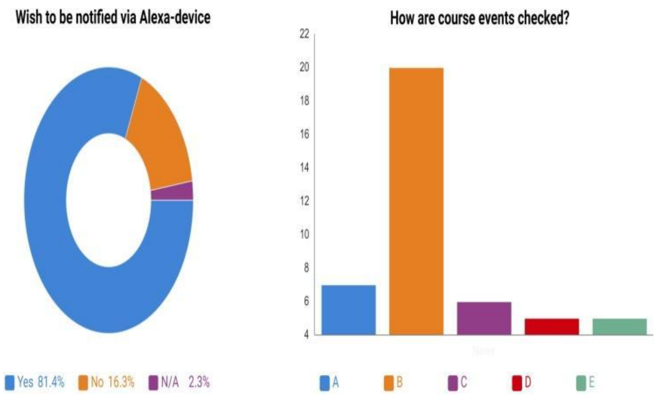

Figure 10.Statistical Data Deviated From The Feedback Survey(Source:own authors elaboration).

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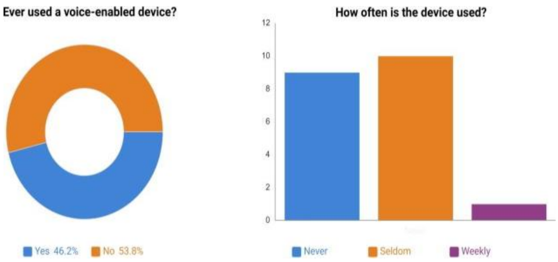
4. Results

After the usability evaluation was over, we looked into the outcomes of using the Alexa skill in more detail and contrasted those outcomes with the input we had previously received from the students. The



skill was not used very much. The students were exposed to the Alexa skill on February 3rd, the first day of the course. The majority of the interactions with the Alexa ability took place during that brief introductory period, which lasted for about 15 minutes. Figure 11 shows how the Alexa skill was used during the evaluation period. The next few days and weeks saw a few scattered interactions with the skill. But those infrequent exchanges took place on the days when the teacher reminded the class of the Alexa talent.

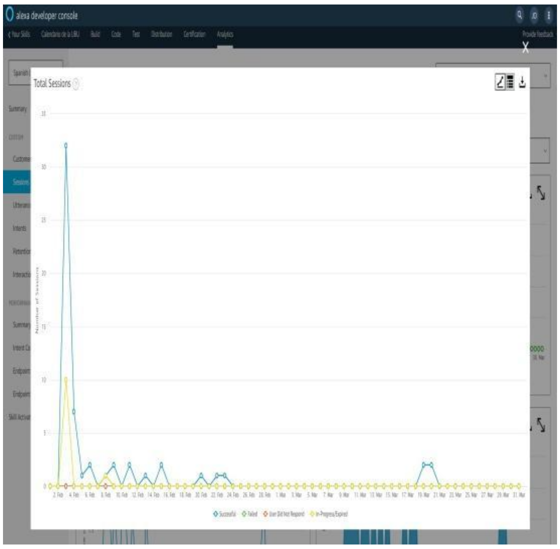
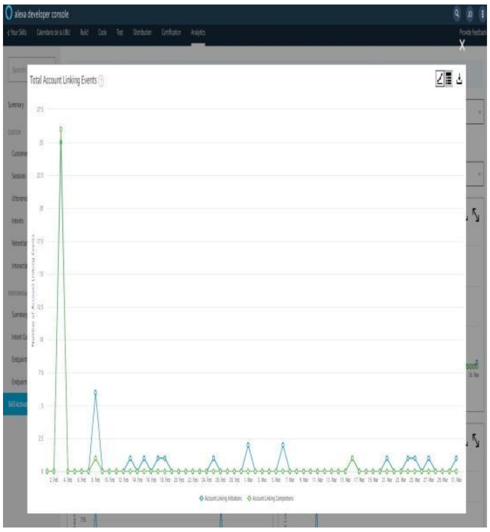


Figure11. TotalsessionsopenedtowardstheAlexaskill.

Our goal was to find out if the skill's usability could be negatively impacted by a technological problem. We started by examining the procedures for account linkage and skill activation

Figure12. AccountLinkingdataforAlexaskill.



5. ConclusionsandFutureWork

In response to our research question (RQ1), we discuss in this paper the work done to design an Alexa skill for educational purposes, including its connection with Moodle. The construction of this skill takes into consideration the current body of scientific knowledge. By disclosing our achievements and mistakes from the choices and technical implementations made during the development process, we hope to offer fresh scientific knowledge to support and direct researchers on future works with comparable features.

We designed our Alexa skill prototype to be immediately released and publicly accessible, in contrast to the typical approach used by earlier research in the field. The available literature, on the other hand, primarily consists of studies where prototypes are tested under controlled conditions and conclusions are made regarding the possibility of releasing a production-ready version in the future [33, 35].

However, we also conducted a usability assessment to give us information on how the skill is used. In order to better grasp the feedback that students offered in subsequent surveys and to gain a deeper understanding of the findings obtained from the analytical data retrieved from the usage of the skill, we were able to develop participant profiles with the help of an initial survey.

Regarding our research question (RQ2), our findings suggest that Moodle does not now offer the essential tools for creating voice content, which contrasts with some of the results we found on papers published in recent years. Our results suggest that a middle layer is required to process the data and generate coherent phrases that users can understand when a voice device speaks to them in order to provide a voice experience using Moodle data. Another way to provide the missing layer of interoperability would be to make changes to Moodle so that voice content creation is possible. Our team is thinking about adding these features to Moodle as future projects, either as a plugin or as a stand-alone software that functions like the Moodle mobile app but for speech devices. Furthermore, developing a different platform that would serve as a link between Moodle and speech devices might be an option.

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