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# Alexa, What classes do I have today? The use of Artificial Intelligence via Smart Speakers in Education

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**Abstract**

**Looking back to the rumours from the early 2000's, when the world of technology bloomed together with the curiosity towards what was next to come, by 2020, robots should have assisted and supported almost every task from our daily life. While this may seem as a Sci-Fi movie scenario, it is partially a tangible reality, that we quickly got used to, thanks to the introduction of smart speakers.**

**As the world changes, so does the future of our students. In this respects, the evolution of the technology comes up with specific environments for educational purpose. Building smart learning environments supported by e-learning platforms is an important area of research in education domain within our days. The evolution of these smart learning environments is justified by some events (Covid19) that force students to learn remotely.**

**The paper proposes a software application component using Alexa smart speaker, that integrates different services (Amazon Web Services, Microsoft Services) for a proper virtual environment platform, for both students and teachers. It addresses the main concerns of the current educational system, and provides a smart solution through the use of Artificial Intelligence based tools. The proposed approach not only achieves unifying data and knowledge-share mechanisms in a remotely mode, but it brings also a good learning experience, increasing the effectiveness and the efficiency of the learning process.**



*Keywords:* e-learning; smart speakers; artificial intelligence; virtual learning environments

## 1. Introduction

We live in a dynamic era that offers great opportunities and also possess unprecedented challenges. In this context, the computational and communication capabilities of modern devices create an explosion of opportunities for the next generation of students. The rise of artificial intelligence (AI) and robotics technology brings for the new generation

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great challenges, which require abstract problem solving and impose some flexibility in their thinking [11]. Having all these in mind, it is important that the focus in educational system keeps up with the times changes, but the challenge is stark. This because, as Richard Riley, Former US Secretary of Education, described this challenge as: "We are currently preparing students for jobs that don't yet exist, using technologies that haven't been invented, in order to solve problems we don't even know are problems yet."

Relevant efforts have been made recently to evolve the educational system to the requirements and needs of the current generation of students. Active learning methods have replaced the classical methods, and it starts to show that E-learning platforms fit very well in the context of the digital native generation of students. Learning methods are promoted that bring the student to the center of the educational process, which involves the student, empowering him to actively contribute to the whole learning process.

As we begin our journey into the 2020s, things are going to change, reinforcing the reason for stepping into a new era of education. The actors of educational system must anticipate and adapt to these trends. The unprecedented event regarding the Coronavirus (Covid19) forces us to switch our physical classes with virtual learning environments (VLE). In order to attain our objectives in the learning process, we need methods and tools to create efficient, effective virtual learning environments that reinforce students motivation for learning and improve their learning experience [19]. In the coming years, technological forces lead by artificial intelligence will interact vigorously to create a very different future. In this respect, a considerable attention will be gained by "smart speakers".

This innovative practice work-in-progress paper proposes a software application component using Alexa smart speaker that integrates Microsoft Teams/Outlook framework. Its main goals come up with some new features for a smart learning environment that facilitates teachers/professors activities, increases students' engagement in classes, and also the efficiency of learning activities. Additionally, it was proven that using these Artificial Intelligence based tools, not only increase the efficiency of learning process in a virtual environment, but also creates a good learning experience both for students and teachers [21, 7].

While the major topic of the paper is the usage of a smart speaker as an assistant to the online academic environment, the way in which this is achieved should not be neglected. This project aims to be a relevant proof of concept for the ways in which cloud services can be used in achieving smart solutions, with low costs and adjustable to changes.

The novelty of this research comes from the integration of Alexa in the e-learning environments experience. It facilitates communication through different channels, updates regarding changes of classes schedule, and enables meetings management. In the same time, it operates also with a set of predefined data, connecting different systems and obtaining a great user experience through the whole process.

The rest of the paper is organized as follows. Section 2 describes the context that the proposed approach is based on. Section 3 presents the proposed approach whereas 4 discuses some related work found in literature. The conclusions are drawn in Section 5.

## 2. Setting the context

### *2.1. Virtual Learning Environments*

Student engagement is a very discussed topic in higher education in the last years, hence it drew a lot of research regarding the way this aspect can be met within the courses from universities [16]. In particular, Computer Science domain strives to come up with efficient solutions in this respect [16] due to the utmost importance to develop high quality software in an active and collaborative manner [17, 18].

Nowadays, software systems are very large and complex applications that have to support the ever changingrequirements of the business. The code becomes more and more complex and drifts away from its original design.A small change in one part of it could propagate unforeseen effects in completely other parts, leading to potentialdisasters. In order to prevent this, developers have to assure the quality of software design during its developmentlifecycle [17, 15].

To keep up with our new generation of students which are digital natives and whose different ways of thinking is a challenge for those who teach, educational systems have to push their limits at least on step ahead of scholars. Thus, the adoption of technology to assist learning and teaching has become a necessity of today's life. E-learning platforms are a solution for these challenges and their evolution come up with virtual learning environments (VLE) that provide

synchronous and asynchronous interaction, social, interactive and dynamic learning experiences according to learners' individual needs [5].

An important feature provided by a VLE system offers for students the feeling of presence when interacting and participating in the learning environment. Presence is a measure of the extent to which the students feels present in the VLE in comparison with a physical presence [9], by living the illusion of 'being there', no matter if 'there' does exist in the actual scenario [22].

It has been proved that increasing presence also increases learning and performance [9]. Also, some studies suggested that when applied properly, the learning methods in a VLE can increase student engagement and improve learning [4]. It was identified that presence is positively correlated with learning success, because it motivates and engages students in learning process[6].

Having all the above mentioned into account we delineates in what follows the main features of a virtual learning environment as they are identified in [5]:

1. A virtual learning environment is a designed information space.
2. A virtual learning environment is a social space: educational interactions occur in the environment, turning spaces into places. The virtual space is explicitly represented: the representation of this information/social space can vary from text to 3D immersive worlds.
3. Virtual learning environments are not restricted to distance education: they also enrich classroom activities
4. Students are not only actors, but at the same time they are co-designers of the virtual space.
5. Virtual learning environments integrate heterogeneous technologies and multiple active learning methods. A VLE integrates a student-centered approach in education.

With the use of technological forces lead by artificial intelligence, we aim to decorate these learning environments with smart speakers. The next paragraph offers an introduction for this subject.

### 2.2. *Smart speakers*

Smart speakers devices support quick actions through voice commands, being able to interact with the users and to maintain a basic conversational flow [2, 1]. To detect when a user makes a request, the multiple microphones of a smart speaker continuously listen for the activation keywords (e.g., "Alexa" or "Hey Google"). The devices come in different shapes and sizes, with or without displays, pretty affordable and easy to use and personalize. The power of smart speakers can be used towards automating jobs, simplifying processes and keeping the "human-like" element. They can be connected to a multitude of smart home devices, and their functionality can be extended easily by the consumer. From Alexa, to Google Home, Siri, and even Cortana, it seems like the choices are increasing continuously, directly proportional to the demand. Typically, smart speakers integrate with the services provided by their "parent company"; for example, users can access their Google Calendar through Google Home while Amazon Echo users can make purchases from Amazon. Smart assistants' capabilities can be expanded through third party applications, also known as "skills" for Alexa and "actions" for Google.

The main key features that a smart speaker is associated with are described by Sheppard in the paper [20]. These features can be summarized as follows: i) the ability to understand and process human languages (Natural Language Processing); ii) the ability to use stored information and data and use it to draw new conclusions (Data Mining); iii) the ability to adapt to new things by identifying patterns (Machine Learning).

Several studies [8, 15, 23, 10] investigate the impact of using smart speakers in education. They state that limited studies show encouraging results of using smart speakers in education, emphasizing the need for more research on the topic. Thus, the use of technology by itself is not enough. Proper methods are needed in order to adopt and use smart speakers in the classroom. Also, there are many concerns regarding privacy and security that smart speaker companies should address in order for the devices to be used in the classroom.

Trying to mitigate the above mentioned limitations regarding the use of smart speakers in the classrooms, this paper designs and implements a software component that aims to integrate a virtual learning environment with a smart speaker. In this respect, one of the top-tier smart speaker in the industry, Amazon Alexa [**?** ] was chosen and integrated within a virtual learning environment. Throughout this paper, we will present the power of voice control

in simplifying the life of students and teachers in our university. This feature fits very well within the context of COVID-19, when more than ever, the need of unifying information into data-sets is vital.

### 2.3. Microsoft Teams and Outlook integrated with Alexa

The world as we used to know it changed dramatically in the last few months, bringing remote connectivity into day-by-day life. While the world keeps going by, human interactions stand still, and technology comes into play in order to balance the scale.

Microsoft (MS) takes a major part in this scenario, as the constant provider of innovative solutions for "empowering others to achieve more", as its own motto states. The numbers prove this theory, being given that MS stands still as the only US company evaluated to more than 1 trillion dollars after the COVID-19 economy decline, as Business Insider states.

As the world changes, so does the future of our students. In this respects, Microsoft comes up with specific environments for educational purpose [14]. One of this educational tools is Microsoft Teams [13] launched in 2017, part of MS Office365 Suite, as a platform workplace chat, supporting video meetings, file storage (including collaboration on files), and applications integration. It can be used as a virtual learning environment and could serve as a e-learning platform, bringing together students with their teachers involved in learning activities.

In this paper, we aim to contribute to an easy access to Teams through voice control. Alexa smart speaker is used to develop a software component for our virtual learning environment in Teams, named Alexa For Uni. This smart component will help users to skip several steps normally used in a online chat communication flow (launching the app, navigating to teams section, selecting the right channel and team, so on) by having as intent a voice command that Alexa will intercept and execute. In this manner, communication is more fluent, simulating the real experience on one end, coming as a big plus for people with disabilities.

Taking it a step forward, but still gravitating around Office 365 services, Outlook [12] comes into picture as another leading software solution during these times. Facing the need of transforming the paper blanks agendas to digital ones, the solution of Outlook Calendar is a common approach, embraced by an increasing number of people. As the meetings we were used to attend in person are now moved to the online environment, a concrete example for this paper being the university courses, verbal in-person announcements being replaced by emails, Alexa aims to facilitate the access to these data through a simple vocal request.

Having this in mind, Alexa for Uni intends to be a proof of concept of a vocal-interaction device that contributes towards the engagement of students, providing relevant functionality though a friendly communication device. It also helps teachers in their activities. The integration of a smart speaker into a VLE facilitates the involvement in academic activities, while enabling the users to stay focused with the help of a different kind of "human-factor".

### 2.4. Cloud computing

The notion of cloud computing started to grow in 2006, when Amazon introduced Elastic Compute Cloud. Now, it is an area which took over the software industry, without which the biggest titans in the business would have a hard time.

The main advantage that cloud computing offers is the "pay as you go" concept. It introduces the "serverless" term as an attractive option. In this manner, clients pay only for the what they use, instead of going for servers and not reaching the full capacity for which they paid for. The provisioned capacities can be adjusted as the needs and requirements change, proving great elasticity and agility.

Amazon Web Services(AWS) is the first company that took over the market in 2008, and still surpasses every competitor, being the biggest cloud provider there is. With top-notch services already in production and new releases every year during annual re:Invent conference, it brings smart solutions and powerful features to the table.

Having as goal the development of an affordable solution for our university, which can deliver a high-performance E-learning platform, adaptable to change and responsive to software trends, AWS was the obvious approach for Alexa for Uni Skill. The integration with services such as Lambda, Cloudwatch, IAM, S3, DynamoDB brings great value not only towards the quantitative factors (time speed and complexity of execution, scalability), but also towards embracing the unpredictable character of how education methods, channels and environments will change in the future.

## 3. Implementation details of the proposed solution

The current section aims to focus on how the Alexa for Uni was designed and why it brings value to the final product. Cloud services used and the connection between them are explained in detail, and theoretical concepts presented before now are shaped by concrete examples and scenarios used while developing the solution.

### *3.1. Alexa For Uni Features*

The project evolves around the development of an Alexa skill that will help to shift the educational environment towards the digital era.

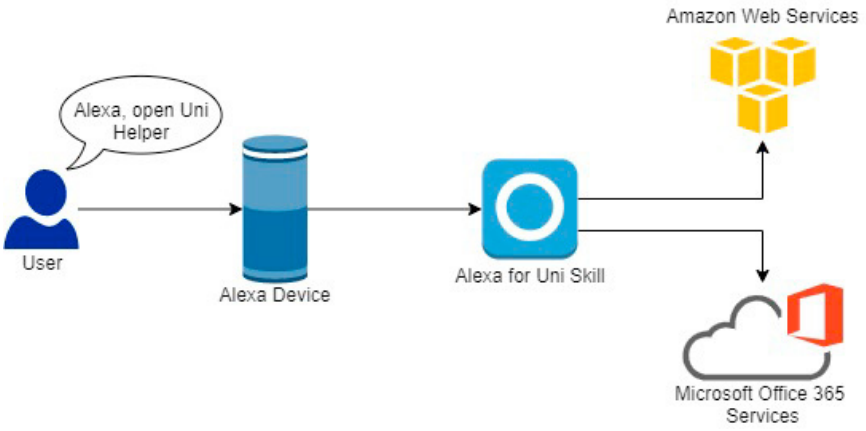


Fig. 1: Services used for creating Alexa for University Skill

The flow is a simple one, as we can notice from *Fig. 1*. The users, students and teachers, can invoke the Alexa for Uni skill by saying one of the following commands: *"Alexa, launch Uni Helper", "Alexa, ask Uni Helper to ...".* There are several way of invoking the skill, covering a wide range of rephrasing the invocation request.

We can classify the questions that the user can ask Alexa into two categories, based on the services that they use in order to send back a response. These two types of questions are: AWS based questions and Microsoft Office 365 questions. In the next paragraphs, we will describe and exemplify these questions.

#### *3.1.1. AWS based questions.*

These questions concern classes schedule and administrative concerns that teachers and students might have. These cover a wide range of data that can replace the chaotic systems with unstructured data that most of the universities have, due to the lack of time. Some of the questions that can be asked are:

- What classes do I have today?
- When is the laboratory for subjectName happening?
- When does the teacher teacherName have classes?
- When is the final exam for subjectName happening?
- What are the latest news from my faculty?

These are only a few examples of questions that can be asked by the users. The scenarios are broader, being given that anything regarding the schedule of classes and universities administrative information can be queried.

#### *3.1.2. Microsoft Office 365 questions*

The novelty of this paper comes from the use of fusion between Alexa and Microsoft services, that cope with the current changes happening in the world and simplify the actions needed from the user side. Some of the commands that can be invoked are:

- Post in Teams, in team teamName, channel channelName.
- Read the latest email.
- Read out calendar.
- Create a meeting invite.

We aim towards pushing down interaction barriers and facilitate the online communication between teachers and students. By having functionalities that can be triggered by voice control, we want to increase efficiency and bring all the channels together through a smart voice speaker, designed to bring a change.

### *3.2. Architecture Overview*

In this section, we are going to take a look at the architectural structure of the project, as well as diving deeper into the implementation details.

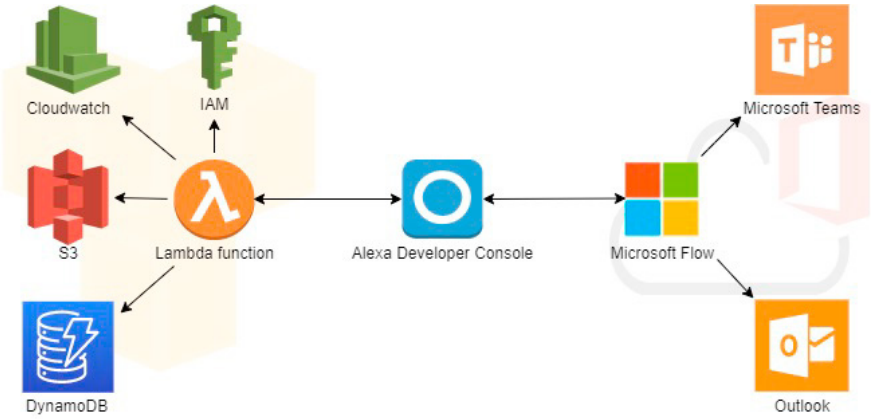


Fig. 2: Services used for creating Alexa for University Skill

As we can observe from *Fig. 2*, the application revolves around Alexa for University (Alexa for Uni) skill, developed in Alexa Developer Console. Using the endpoints for resolving the verbal request of a user, we integrated AWS services, as well as Microsoft Office 365 services.

The connection between Alexa skill and AWS is done by triggering a lambda function, with a proper IAM role attached to it. This function queries a NoSQL database, and sends the results back to Alexa. The logs of the function calls are maintained by AWS CloudWatch service. Taking into consideration that some smart speakers have also a screen, visual elements are used, stored in a private S3 bucket.

Moving to Microsoft Office 365 services integration, here we talk about Microsoft Flow as the bridge between Alexa and MS Teams and Outlook. Microsoft Flow intercepts the HTTP request, and acts like a connector between them.

The role and functionality of each of the above mentioned services will be described in the following sections.

### *3.3. Alexa Developer Console*

The development of Alexa for Uni Skill is done by using Alexa Developer Console as main platform for the connection between all the other services. Considering its unique features and functionalities, a custom skill was created, with its own provisioned backend.

The trigger for the skill is also known as an ”invocation”. In order to enable the users to call the skill, an invocation name needs to be specified, in this case ”Uni helper”. This enables the user to activate the custom-made features by saying: ”Alexa, launch Uni helper”, or ”Alexa, ask Uni helper to ...”.

Once this basic setup is done, the next steps would be to start creating the *interaction model*. The interaction model represents the core of a skill, being the collection of build-in competences. For the creation of a fluent dialog between

the smart speaker and the user, we need the map the verbal requests to *intents*. Alexa already comes with predefined intents such as Amazon.StopIntent (for stopping the skill), Amazon.FallbackIntent (for handling the error that might occur), but of course, these are not enough. New intents shall be added for covering a wide range of inputs scenarios coming from the consumer of services. For distinguishing between different types of intents, each intent must have a unique name assigned to them. We need to anticipate what the spoken input might be, and specify them as *sample utterances*. For examples, if we want the user to be able to ask Alexa for Uni skill about the temperature outside, we shall capture this request in a string-format sentence such as: ”what is the temperature outside”, ”what is the weather like”, ”how many degrees are today” and so on. There is not a restriction set on the number of rephrasing utterances that can be specified. Each sample utterance can contain a certain numbers of arguments, referred to as *slots*. They need to be specified between curly brackets, and further on, their type needs to be specified. The type can be a predefined one (e.g., Amazon.DayOfTheWeek, Amazon.SearchQuery), or it can be a custom-made one, created by the developer in Slot Types section. For the Alexa for Uni skill, build-in slot types, as well as custom-made ones were used. Slot filling is another nice feature offered by the Dev Console, where we can create a fluent dialog interaction between the speaker and the user, in order to obtain relevant data for the request variables specified (e.g., it can offer suggestions of values for the slot filling, such as ”I can tell you about the weather conditions on *Monday*, *Tuesday* ...”). If a user vocal request is considered to be in any manner subject to further validations, there is an intent validation option, as well as slot validation option, which triggers Alexa to verify the correctness of its interpretation of the spoken input. All the previously mentioned mappings are used in the process of Alexa for Uni creation.

Moving on to the backend integration, the notion of *endpoints* comes into the picture. Because we integrated AWS services, as well as Microsoft services, we are talking about two different types of endpoints, one being *AWS Lambda ARN*, and the other one *HTTPS*. In the next sections, we will talk about each of them.

### *3.4. Amazon Web Services integration*

The integration with the powerful Amazon Web Services is done via a *lambda* function, providing its *ARN* in a the endpoint section from Alexa Dev Console.

*AWS lambda* is a service for running code in a ”serverless” manner, without concerning about *provisioning and managing servers*, as AWS official documentation states. It supports a wide variety of programming languages, NodeJS being the one used for developing Alexa for Uni skill. This lambda function is uniquely identified by an *Amazon Resource Name(ARN)*, which is passed to Alexa skill as an endpoint. In this manner, the lambda function is triggered by Alexa, which receives the request, decides which invocation is the request corresponding to, queries the database, formulates the response, and sends it back to Alexa.

*AWS IAM* - Identity and Access Management - is a services that enables systematic access to different resources in a secure manner. In order to be able to access the database, a IAM role is required, with AWS DynamoDB policy attached to it, as well as AWSLambdaBasicExecutionRole policy. This role has a unique name, which gives permissions to the lambda function that uses it.

The classes schedule is stored in *DynamoDB*. DynamoDB is a NoSQL database, that saves data in a JSON format, and uses a partition and a sort key, in comparison with a SQL database. The decision of going for a NoSQL DB is due to the flexibility it offers. The unpredictable nature of recent events was a concrete impact factor over the DB schema, some attributes being irrelevant now (rooms and buildings where classes are held), and some new attributes became essential (virtual rooms). Having this in mind, the decision of going for a NoSQL database which can easily adapt through changes, operates fast, and is cost-efficient was a strength in the architectural overview picture.

Screen speakers are starting to bloom in the smart speakers industry, and this was taken into account in the designing phase of the project. Small UX/UI sweeteners were added to the skill, for which S3 service was used. By creating a private storage bucket, logos and visual elements are stored. Lambda function access the bucket, gaining access to them, and displaying those for the screen smart speakers.

A complete log of the function invocations is maintained by *CloudWatch* service. Relevant running scenarios are observed using logs insights, such as the requests that Alexa is not able to fulfill, the reason of failures. From this data, enough information can be gathered, that helps developers to make adjustments in slots or sample statements for a better user experience. The service enables users to query and search for logs registered in a specific time interval, so the performance improvements can be observed.

### 3.5. Microsoft integration

*Microsoft Flow*, also known as *Power Automate*, represents the bridge between Alexa and Microsoft services. It is cloud-base service that enables workflows creation and triggers events by specifying the action and the result.

In order to use Teams and Outlook, we use an automated flow from blank, which is invoked by Alexa as un HTTPS call. We need to map the request body JSON schema sent by Alexa in the HTTP request section from Flow. When the corresponding HTTP request is received, it is intercepted, and the extraction of input variables begins. By using *Compose* action, we start to extract the input data, and start creating the actions we need in order to get the others MS Services. MS Power Automate comes with build-in actions helpful for the purpose of our features, such as *Teams - Post a message (V3), Outlook - Get emails*. Once this actions are configured by setting up their values, mapping the input variables we fetched during the previous steps, the last step would be to send the response back to Alexa, which will intercept it, and will send a confirmation to the user accordingly. For creating more specific actions which are not already build-in actions, we can create an *Invoke an HTTP action*, where we can call custom-created URLs that are able to reach Teams or Outlook and perform the desired activity.

### 3.6. SOA Patterns used

Using Amazon Lambda we follow the event-driven architectural pattern, which brings the loose coupling and composability among the cloud services. By building and answering to events, we can easily integrate new changes and requirements by adding ad-hoc services and enabling a upscale the features. There can be many ways to trigger a Lambda function (e.g., API Gateway, S3, AWS IoT), in our case the trigger if *Alexa Skill kit*, but the designer console allows to extend the triggers section (Alexa for Business) in the future, for a wider functionality.

## 4. Related Work

Nowadays there are different e-learning systems. All these systems offer courses contents in different formats (text, image, sound) for students, as well as facilitating interact with teachers and/or colleagues, via message boards, forums, chats, video-conference or other types of communication tools.

A concrete example of a university that already implemented an Alexa skill is *Northeastern University*. It changed the way the students were thinking and the way that they were engaging in their daily students activities. Through a custom skills, *My Husky*, they were able to ask Alexa about events and classes schedule through voice control. All the student data have been accumulated and gathered in one place, and by looking at the systems, they delivered a skill able to serve it all out to the students, so they can use it when they need it, wherever they are. Having this in mind, one of their goals was to bring the university to the students, instead of bringing the students to the university. They managed to connect universities' systems, unify large amount of data, and made it look like a seamless experience. Several Alexa Echo devices were placed in students' dorms, and the feedback received was overwhelmingly good [3].

In comparison with Northeastern University, our smart-bot brings into picture the integration with other relevant services for 2020 COVID situation, major communication channels such as Microsoft Teams and Outlook, that keeps the connection between students and teachers. It accommodates changes and embraces different variables, such as new virtual classes, new classes schedule, and it keeps the users updated through it all.

## 5. Conclusions and Future Work

The year of 2020 is the proof of the unpredictability of the future. The last months changed not only the course of life, but also the purpose and functionality initially planned for Alexa for Uni. What started as a smart speaker for useful university data turned into something more, incorporating remote connectivity and access to new ways of staying informed, by the integration of Microsoft services. The purpose of the speaker surpasses the initial plan, turning into a 'human-like' presence for students and teachers during COVID-19 times, while facilitating education and performance of the users.

Even though the future is an unknown road of challenges, we would like to set new goals for Alexa for Uni, in a way that accommodates and embraces changes that might come. First of all, the next step would be to share the smart

speakers to a targeted group of students, personalising the features and adjusting the skills to fit the needs of each of them. In order to achieve this, we plan to use Alexa for Business from Amazon Web Services, making the most out of the power of cloud. Additional functionalities represent another novelty we would like to have, such as: taking quizzes and tests on Alexa for exam preparation, integration with more Microsoft Office services such as Word (essay writing through dictation), OneDrive (for saving the essays in cloud). A more interactive UI for devices with screens is on the to-do list as well, for a better interaction, using visualisation also.

In conclusion, Alexa for Uni has big plans for the period to come for the students and teachers of our university, and looks forward to improve connections and data manipulation through smart cloud services, Microsoft integration and constructive feedback.

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