Quiz-Ifying Education: Exploring the Power of Virtual Assistants

Todericiu Ioana Alexandra[a], Pop Mihai Daniel[b], Şerban Camelia[c] and Dioşan Laura[d]

Faculty of Mathematics and Computer Science, Babeş-Bolyai University
1, M. Kogalniceanu Street, 400084, Cluj-Napoca, Romania

Keywords: Virtual Assistant, Cloud, Education, Amazon Alexa, Amazon Web Services.

Abstract: Technology offers transformative potential for educational innovation. This paper introduces a novel approach by harnessing virtual assistants, specifically through an Alexa quiz skill tailored for university students, to enhance learning experiences. Supported by a preliminary evaluation, our solution demonstrates significant user satisfaction, indicating its effectiveness and areas for further refinement. Our tailored skill dynamically generates custom quizzes aligned with students' preferences and topics, providing a personalized and learning alternative to the one-size-fits-all content. Utilizing Amazon Web Services (AWS) for its cloud infrastructure, our methodology ensures scalability and a seamless user experience. We detail the theoretical foundations and technical implementations of our approach, showcasing its capability to tackle current educational . This work contributes to the ongoing discourse about modernizing education techniques by providing a comprehensive framework for an innovative, interactive learning tool that capitalizes on the power of virtual assistants.

1 INTRODUCTION

Virtual Assistants (VAs) like Amazon's Alexa present an opportunity to change educational experience. While VAs have become a trend, their potential in education extends beyond mere popularity(Agarwal et al., 2022). The motivation for this research comes from the necessity to address key educational challenges such as student engagement, personalized learning, and the effective integration of technology in educational settings. Our approach leverages the capabilities of VAs to create a more interactive, engaging, and tailored educational experience. Our focus is to illustrate skill development for educational VA applications, aiming to contribute to the field of educational technology.

If we are looking at the use of VAs in education for the past few years, it shows that they are here to stay. A study by Kuhail et al. (2022) (Kuhail et al., 2022) analyzed 36 papers and concluded that VAs and chatbots hold the promise of revolutionizing education by personalizing learning activities, supporting educators, and developing deep insights into learners' behavior. Studies also show that the most effective way of providing high-quality learning content is by leveraging a personalized learning environment (Shemshack and Spector, 2020). The content is adapted to the needs of students, to cover the gaps that they might have.

In the current technological landscape, Virtual Assistants (VAs) are increasingly being integrated with generative AI technologies, which are known for their ability to produce content autonomously. This integration is often seen in applications that require creative content generation, such as in writing, art, or music. However, our research takes a different path. While acknowledging the potential of generative AI, we focus our VA implementation on enhancing interactive learning experiences rather than content creation. This decision is driven by our goal to improve student engagement and learning outcomes through tailored interactions and adaptive quizzes. We believe this approach better suits the educational objectives of our study, providing a more direct and controlled impact on the learning process, as opposed to the broader and often less predictable outcomes associated with generative AI.

To achieve a personalized learning experience, we have developed a quiz skill that is customized for Alexa and based on a university subject. The skill is adaptable to students' requirements, as it allows the quiz-formation to be based on the topics specified by

[a] https://orcid.org/0000-0002-2469-134X
[b] https://orcid.org/0009-0000-1391-9292
[c] https://orcid.org/0000-0002-5741-2597
[d] https://orcid.org/0000-0002-6339-1622

589

the students, provided as verbal input. It generates quizzes from a diverse set of questions, covering various topics and levels of difficulty, to ensure a balanced and challenging experience for students. The idea of developing a quiz skill came from the desire to help the students who are using it, in particular, taking a quiz for a university course in an engaging manner (Serban and Lungu, 2020).

In comparison to the built-in quiz capability on Alexa, our "Quiz for Uni" skill offers several advantages. While Alexa does come with a built-in quiz skill, it has certain limitations that may not meet the requirements of a personalized learning experience. The built-in skill typically offers generic quizzes and lacks the adaptability to cater to individual student needs. It may not allow students to specify their desired quiz topics or offer a wide range of questions covering various subjects and difficulty levels. Moreover, one of the limitations of our "Quiz for Uni" skill is its language constraint. Currently, the skill is developed in English, which may restrict its usage for non-English speaking students. Additionally, Alexa itself is available in a predefined set of languages, which limits the usability of the skill to students in those specific language regions. The skill we explored advances personalized learning by offering an engaging quiz-taking process with verbal input.(Kosslyn, 2017) Adding Practice Testing, where students test themselves, enhances retention and comprehension. This combination ensures both engagement and a deeper understanding of the material.

This paper aims to address the following research questions:

RQ1. *In what ways does the proposed Alexa quiz skill, tailored for university students, innovate upon current methods of active learning?*

RQ2. *What are the technical aspects and theoretical foundations of implementing an Alexa quiz skill for personalized learning?*

2 SETTING THE CONTEXT

2.1 Quiz-Based Learning

Quizzes have long been recognized as a potent tool for enhancing learning outcomes. They are a form of active learning that stimulate students' engagement, promoting deeper understanding and long-term retention of knowledge. They create an interactive environment where students can assess their understanding and knowledge gaps, encouraging subsequent targeted learning (Freeman et al., 2014).

In the context of the ongoing digitization in education, the incorporation of technology, particularly virtual assistants, into teaching methods has the potential to significantly enhance these active learning strategies. However, any novel technological solution, such as a new Alexa skill, needs to be grounded in scientifically validated learning theories.

The proposed Alexa quiz skill in this paper stands on the foundation of active learning and retrieval practice theories. These theories emphasize that learners can reinforce their memory and understanding by actively recalling information during quizzes.

This paper thus provides a comprehensive overview of the technical framework for this novel learning tool, demonstrating its potential to revolutionize education by making learning more engaging, stimulating, and efficient.

2.2 Virtual Assistants

A software agent that can carry out tasks or provide services on behalf of a human based on orders or inquiries is known as an intelligent virtual assistant (IVA) or intelligent personal assistant (IPA) (Lopatovska, 2019). The term "chatbots" is often used to refer to VAs that can be interacted with via online chat. This applies both to generic VAs as well as those that are tailored for specialized tasks. Certain VAs possess the ability to comprehend verbal language and respond using artificially created vocalizations. By utilizing voice commands, human individuals can perform routine tasks such as managing emails, creating to-do lists, and organizing schedules. Additionally, they can make queries to personal assistants, operate home automation devices, and playback media content. (Bohouta and Këpuska, 2018).

VAs use natural language processing (NLP) to match user text or voice input to executable commands. Many VAs continually learn using Artificial Intelligence techniques including machine learning and ambient intelligence (Polyakov et al., 2018).

In the continuous evolution of the world and new technologies, different types of VAs are already developed (Silva et al., 2020), (Schmidt et al., 2021). Some of the most remarkable ones are from: Apple (Siri), Google (Google Assistant), Microsoft (Cortana), Amazon (Alexa).

Virtual Assistants have become a vital part of our daily routines (Tavares et al., 2022). They are frequently used to manage and execute tasks in a more effective manner, thus enhancing our productivity and organization. In the context of VAs, these 'tasks' refer to specific actions or commands that they can execute in response to user input. Such tasks can include set-

ting an alarm, playing music, checking the weather, or even conducting interactive quizzes.

In this article, we will focus on a specific VA - Amazon's Alexa. Alexa has carved out a notable reputation as the first VA to have a dedicated device (Amazon Echo) specifically designed to manage and perform these types of tasks, including the interactive quiz feature.

2.3 Virtual Assistants in Education

Education serves several important functions. One of them is helping individuals acquire the knowledge and skills they need to pursue their interests and achieve their goals. This includes both academic and practical skills. With the help of a VA, all of that could lead to an environment where learning is more efficient than ever (Davie and Hilber, 2018) (Cóndor-Herrera et al., 2021). VAs create an interactive environment where students can assess their understanding and knowledge gaps, encouraging subsequent targeted learning (Freeman et al., 2014).

Despite the progress in educational technology, several challenges remain that prevent the optimization of student learning. One fundamental issue is the lack of personalization in traditional education systems, which fails to cater to the diverse learning styles, paces, and abilities of students (Kulik and Fletcher, 2016) (Guskey, 2007). Personalization in education refers to the tailoring of teaching methods, instructional content, and learning experiences to meet the individual needs, skills, and interests of each student. This approach recognizes that students have unique learning styles, paces, and abilities, and aims to provide a more relevant and effective educational experience by accommodating these differences. Personalized learning often involves using technology to assess and address individual learner needs, thereby enhancing student engagement and improving learning outcomes. (Makhambetova et al., 2021)

Feedback is another key aspect where current educational systems often fall short. Regular and timely feedback is crucial for learning, but it's challenging for teachers to provide immediate, personalized feedback consistently, especially in larger classes (Hattie and Timperley, 2007). The heavy reliance on high-stakes testing for assessment is another area of concern. These tests often lead to increased stress among students and may not accurately reflect a student's comprehensive understanding and mastery of a subject (Stobart, 2008). Lastly, maintaining regular and active engagement with each student is often difficult due to the constraints on teachers' time and resources (Fredricks et al., 2004).

VAs like Alexa can play a crucial role in addressing these challenges. They can provide instant feedback, helping reinforce learning concepts and correct misconceptions promptly. Moreover, Alexa can supplement traditional high-stakes testing with low-pressure quizzes for continuous assessment and reduce student stress.

3 PROPOSED APPROACH

The proposed approach, "Quiz for Uni", is a skill developed for Alexa, designed to augment personalized learning through interactive quizzes. The primary goal of the skill is to provide students with a stimulating learning tool that adapts to their individual needs and preferences. We will outline the key stages involved in the development process, including the selection of technologies, the modeling of the conversational flow, and the implementation details.

We selected Alexa as our interface due to its wide user base and the Alexa Developer Console, which streamlines skill development. This console offers comprehensive tools for creating, testing, and deploying interactive voice applications, making it ideal for our quiz system. Additionally, the integration between Alexa and AWS is seamless as both are Amazon products. This synergy allows for efficient and coherent development, with AWS providing robust backend services like Lambda and DynamoDB, ensuring scalability, reliability, and ease of management for 'Quiz for Uni'.

3.1 Alexa-Based Interactive Quizzes in Software Engineering Education

This solution is for now developed for second-year students in Software Engineering (SE), with a focus on enhancing their understanding of the Java programming language and object-oriented programming (OOP) concepts. At this stage of their education, students are transitioning from basic programming skills to more complex concepts and practices in SE. The Alexa-based interactive quiz system is tailored to meet the educational needs of this learning phase.

The implementation of this solution in SE education involves:

1. Java Programming: The quizzes are designed to test and reinforce students' knowledge in Java, covering fundamental aspects like syntax, data types, control structures, and error handling, and extend to more advanced topics such as exception handling and file I/O operations.

2. Object-Oriented Programming Concepts: Quizzes will challenge students on key OOP principles such as encapsulation, inheritance, polymorphism, and abstraction. Multiple-answer questions will be used to deepen their understanding of how these concepts are applied in Java.

3. Continuous Learning and Assessment: This system serves as a continuous learning and assessment tool, that in the future could enable educators to track student progress in understanding Java and OOP concepts, and to provide targeted feedback for improvement.

By integrating our Alexa-based interactive quiz system into the routine for second-year SE students, we aim to provide a more engaging, personalized, and effective learning experience in Java and OOP. This approach can aid in the comprehension of theoretical concepts but also could prepare students for the practical challenges.

3.2 Technical Overview

The technical architecture of the prototype involves several components that work together to provide a quiz skill for Alexa devices (see figure 1). To develop Alexa skills, Amazon provides developers with various tools and services, including the Alexa Developer Console and AWS services (Amazon Alexa, 2023). The technical architecture of the quiz skill presented in this work utilizes various AWS services, such as AWS Lambda, Amazon S3, Amazon DynamoDB, and Amazon CloudWatch. This architecture allows for the creation of a scalable and reliable quiz skill for Alexa devices, while also providing monitoring and logging capabilities to ensure the skill's performance (Amazon Web Services, 2023).

Alexa Devices. Alexa devices are the hardware devices that allow users to interact with the Alexa Voice Service. These devices include physical components, such as: Amazon Echo, Echo Dot, Echo Show, and many others. The devices are equipped with microphones and speakers, which enable users to talk to Alexa and receive responses. Some of them also have an integrated display, which can be helpful to maintain the user's attention to the device.

Alexa Developer Console. The Alexa Developer Console is a web-based interface provided by Amazon that developers can use to create, test, and publish Alexa skills (Pilling and Coulton, 2020). The console includes tools for defining the skill's interaction model, configuring the skill's endpoints, and testing the skill's functionality.

Quiz Skill. A basic quiz skill exists within the Alexa Developer Console, although it's static and not cus-

tomizable. Our custom quiz skill, however, offers its users the ability to choose from various topics, and different difficulty levels, and provides feedback after the questions are answered. This quiz skill directly interfaces with and uses various other tools and services mentioned above.

AWS Services. The proposed quiz skill is developed using various AWS services, including AWS Lambda, Amazon S3, Amazon DynamoDB, and Amazon CloudWatch. These services provide the necessary infrastructure and resources for the skill to function correctly.

Lambda Function. The Lambda function is the primary component of the quiz skill. It is a serverless function that is executed in response to requests from Alexa devices. The function generates quiz questions, retrieves content from S3, and manipulates the question pool database stored in DynamoDB. The Lambda function also logs its activities in CloudWatch, which provides monitoring and logging capabilities.

Amazon S3. Amazon S3 is a cloud-based storage service that provides developers with secure, durable, and scalable object storage. The quiz skill uses S3 to store and retrieve media files such as images.

Amazon DynamoDB. Amazon DynamoDB is a fully managed NoSQL database service provided by AWS. The quiz skill uses DynamoDB to store the question pool database, which contains the questions and answers used in the quiz, as well as characteristics for each question such as difficulty level, and topics.

Amazon CloudWatch. Amazon CloudWatch is a monitoring and logging service provided by AWS. The quiz skill logs its activities in CloudWatch, which allows developers to monitor and troubleshoot the skill's performance and behavior. The logs can also serve as historical data to see how the skill serves the users.

As this initiative is currently in the prototype phase, we are actively exploring data privacy and security measures to ensure the protection of user information as we further develop the solution.

Overall, the technical architecture of the quiz skill leverages several AWS services to provide a scalable and flexible platform for developing Alexa skills. The architecture allows developers to easily create and deploy quiz skills for Alexa devices, while also providing monitoring and logging capabilities to ensure the skill's reliability and performance (Todericiu et al., 2021).

3.3 Conversational Flow

The conversational flow of the university quiz skill is broken down into four main components: invocation,
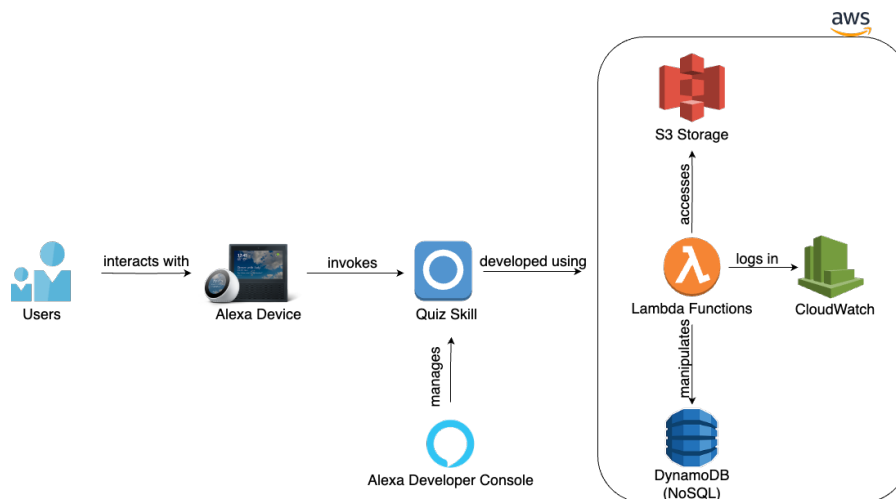
Figure 1: Technical architecture of the proposed quiz skill.

intent, slot type, and prompt. We will define these concepts and describe their implementation and exploitation in the university quiz skill.

An **invocation** is the trigger phrase that the user says to initiate the university skill. The invocation phrase for our skill is "Alexa, start the university quiz.". An **intent** represents a user's goal when interacting with the quiz skill. Intents are primarily focused on answering user's requests. We divide our intents into two categories: built-in intents, which are provided by Amazon Alexa, and custom intents, which we created to facilitate the quiz process. *Built-in Intents:* Amazon Alexa provides several built-in intents to handle common user requests. These intents include AMAZON.CancelIntent, AMAZON.HelpIntent, AMAZON.StopIntent, AMAZON.NavigateHomeIntent, AMAZON.FallbackIntent. *Custom Intents:* We have defined three custom intents to facilitate the quiz process: Setup Intent, Response Intent, and Question Prompt.

Setup Intent. It is activated after the invocation of the skill. The user is asked to select from a list of available topics for the quiz. The user's selection initiates the quiz.

Response Intent. The Response Intent follows each question and is activated when the user chooses one or more options from the multiple-choice responses.

Question Prompt. The Question Prompt presents the user with the questions for the quiz. The questions are displayed one at a time, along with their possible responses.

Slot Type. A slot type extracts specific pieces of information from the user's input. Each of our custom intents uses a specific slot type to process the user's input.

Prompt. A prompt is the university skill's response to the user's input. The prompt depends on the user's intent and any associated slot types.

Conversational Flow Instance. To illustrate the flow of conversation, we present a practical example, following the flow described in the following figure:

User: "Alexa, start the university quiz."

Invocation: The user's input triggers the Quiz Skill, implemented as a Lambda function in AWS.

Prompt: The Quiz Skill returns a prompt, "Welcome to the university quiz! What topic would you like to learn about?"

User: "I want a quiz about inheritance and access modifiers in Java."

Intent and Slot Type: The university skill recognizes the user's intent to start a quiz and extracts the slot types "inheritance" and "access modifiers in Java".

Prompt: The university skill responds with a prompt that provides a quiz on the selected topics.

3.4 Technical Implementation Details

The brain of this skill is the lambda function, a serverless computing service from Amazon Web Services, which processes the requests from the Alexa Developer Console. Moreover, this is considered to be the "backend" part of the skill, where all intents have their handlers. All the communication with other Amazon Services is performed inside the Lambda Function, and it makes the process a lot easier to go through developing the skill.

Lambda Function has 3 important roles:

- Generate a quiz based on the input received from the user

- Send back a response with one question at a time/ quiz score for the final interaction of the quiz skill

- Handle the response of the user (the correct answer to each of the quiz questions)

In order to generate a quiz based on the user input, our function utilizes a question pool with predefined more than 300 questions and answers, stored in the DynamoDB database. Each question is defined by: topics (covered by the question) and difficulty level (easy, medium, hard). The quiz consists of 20 questions, which are equally divided among topics and difficulty levels. Some questions contain code snippets, which aren't meant to be read out loud by the voice assistant. In order to have the questions, together with their corresponding code, we used an external service that transforms plain text to images, that will be displayed next to the question on the Alexa device screen, as can be observed in the following figure.

After successfully generating the quiz, each question is sent to the user, one at a time. The quiz skill moves to another question only after it receives an answer for the current question. Once it does, it checks if the answer that it receives is a valid one (one or multiple letters from the ones available as answers). If not, it returns a prompt that lets the user know that the answer does not comply with the answer expected, and awaits for another reply. The user's score is tracked after each question, and once they reach the end of the quiz, it is provided as an output along with relevant information, such as the questions that they answered incorrectly.

To adhere to the separation of concerns principle, each of these tasks is handled separately by different functions grouped in different modules. The connection between the Quiz skill and the lambda function is done via lambda's Amazon Resource Name (ARN). As both Alexa Developer Console and the Lambda Function are Amazon products, the integration is seamless and quick. There is no noticeable latency throughout the course of the interaction between the skill and the user.

4 PRELIMINARY EVALUATION

In this study, we conducted a preliminary evaluation of our prototype with a diverse group of 6 participants, comprising 3 undergraduate students and 3 graduate-level individuals who possessed substantial experience in the relevant field. The evaluation process involved the administration of a comprehensive questionnaire containing both closed and open-ended questions, totaling 13 in number. Our analysis of the results revealed significant insights into the user experience and usability of the prototype. Notably, we observed that both undergraduate and graduate par-

ticipants expressed a high degree of satisfaction with the system's interface and functionality. Furthermore, the open-ended responses provided valuable qualitative data, highlighting specific areas of improvement and potential enhancements for future iterations of the prototype. These findings constitute a critical foundation for refining our system and advancing its effectiveness.

5 RELATED WORK

In this part of our paper, we look at other studies that focus on using Virtual Assistants (VAs) and advanced interactive systems in teaching software engineering. We chose research that talks about how interactive technology is used in education, especially studies that use VAs like Alexa. These studies are particularly relevant to teaching software engineering. In the research we found, there's a strong interest in using smart technology in education. This is a key trend that's changing how we teach and learn.

Göksel and Bozkurt (Göksel and Bozkurt, 2019), who look at the present in order to gather relevant data to forecast the future of AI in education, believe that the future of education will go hand in hand with AI-applied solutions. One such applicability they mention is NLP tools, such as Alexa, which have the potential to serve one of the themes listed in their work as a "personalization and learning system". Our contribution demonstrates a practical example, showcasing an Alexa quiz skill that enhances personalized learning, embodying the concept they introduced.

Another study that enhances the importance of intelligent solutions in education is the work of Dasic et al. (Dašić et al., 2016) Their work offers a comprehensive review of 15 intelligent tutoring systems in education, that aim to simplify the learning journey for students. Although their work provides a broad overview, it doesn't explore in-depth how such technologies can adapt to different learning styles or contents. By designing a versatile Alexa quiz skill that can handle various topics and difficulty levels, our approach addresses these areas, providing a more nuanced and adaptable tool for educational purposes.

Alexa and other similar voice VAs turned out to be a powerful tool when it comes to education. Terzopoulos and Satratzemi (Terzopoulos and Satratzemi, 2020) present different real-case scenarios where education embraced smart speakers and VAs, from Alexa skills created for teachers that help them generate practice quizzes using voice commands, to custom actions for Google Assistant that help students learn Java. While this use case is benefi-

cial, it predominantly serves educators. Our quiz skill expands on this, serving the students directly, engaging them in an interactive learning experience that is challenging and educational.

There are numerous ways in which custom skills for Alexa serve educational purposes. Another study (Ochoa-Orihuel et al., 2020) discusses the implementation of an Alexa skill that connects to Moodle, a popular open-source learning platform, for getting information related to courses and events from a Moodle instance and present it to students through voice interaction. A similar approach (Serban and Todericiu, 2020) follows the details of a skill that offers organizational information to students (eg.: class schedules, exam dates) and integrates with Microsoft products such as Outlook and Teams, for facilitating conversation on channels and emails with professors and colleagues, by using voice commands.

Overall, the existing literature highlights the importance of leveraging smart technologies in education, with emphasis on the potential of VAs and NLP tools like Alexa. The studies discussed in this section demonstrate the variety of ways in which Alexa and other VAs can serve educational purposes, from assisting the learning process to providing organizational information and facilitating communication with professors and colleagues. With the development of a custom skill for interactive quizzes, this paper contributes to the growing body of work exploring the potential of these technologies in education and provides a valuable addition to the literature.

6 DISCUSSION

The results of the research aim to shed light on the potential roles of virtual assistants in education. However, it's important to note that the conclusions drawn here are primarily theoretical and based on a conceptual understanding of the technology. To strengthen these answers, future work should include empirical data and a more systematic research methodology. The current discussion addresses the research questions as follows:

RQ1. In what ways does the proposed Alexa quiz skill, tailored for university students, innovate upon current methods of active learning?

A1. The proposed Alexa quiz skill enhances active learning in several unique ways. It allows for personalized quiz creation based on students' chosen topics and preferences, thus catering to individual learning needs and styles. This tailoring of content increases student engagement, a key aspect of effective active learning. Moreover, the Alexa quiz skill incorporates

a variety of question diffi culty levels, promoting cognitive growth by challenging students' understanding at different levels. It also offers immediate feedback, which aids in the reinforcement of learned concepts and quick identification of knowledge gaps, leading to a more effective study plan. The Alexa quiz skill inherently incorporates Practice Testing principles. By emphasizing regular self-assessments through the skill's immediate feedback and varied questions, it boosts retention and supports active learning.

RQ2. What are the technical aspects and theoretical foundations of implementing an Alexa quiz skill for personalized learning?

A2. The technical framework for implementing the Alexa quiz skill involves using Amazon Web Services (AWS) as the cloud provider. This ensures a scalable, secure, and reliable infrastructure, which is fundamental for creating a seamless user experience. The use of AWS allows the system to handle a large number of requests, ensuring its availability to a vast number of users at any given time. On the theoretical side, the design of the Alexa quiz skill draws from scientifically validated learning theories like active learning. These theories emphasize the importance of student engagement, recall practice, and personalized learning experiences in enhancing learning outcomes. Overall, the Alexa quiz skill promises to offer a potent tool for effective education.

7 CONCLUSION

Through the course of this paper, virtual assistants have found their way into the educational sphere. We presented how VAs can be customized in order to be fitted for students on account of personalized skills, more specifically, a quiz skill that can make testing knowledge enjoyable, engaging, and efficient. Future recommendations include expanding language support, conducting larger-scale user studies, and exploring additional features. While the current research has its limitations, such as language constraints and the need for further evaluation, our skill stands as a valuable contribution to personalized learning environments powered by VAs.

In the future, we hope to roll out the prototype to a larger group of students and see what are the outcomes of the tool applied to our university. We would also like to enhance the question pool with a larger set of data and extend the skill to various courses.

In conclusion, virtual assistants have the potential to revolutionize the way students learn and engage with educational content. By tailoring these assistants to the individual needs of students, we can provide a

more personalized and effective learning experience. With the development of our quiz skill, we have taken a step towards making this a reality. As we continue to refine and expand our tool, we are excited to see the positive impact it can have on the education landscape. After all, the future of learning is not just about technology, but about how we can use it to better ourselves and the world around us.

8 DATA AVAILABILITY

The data supporting the preliminary questionnaire used to assess the skill of this study are available in the following repository, ensuring transparency.

REFERENCES

Agarwal, S., Agarwal, B., and Gupta, R. (2022). Chatbots and virtual assistants: a bibliometric analysis. *Library Hi Tech*, 40.

Amazon Alexa (2023). Alexa Developer Console.

Amazon Web Services (2023). AWS Services.

Bohouta, G. and Këpuska, V. (2018). Next-generation of virtual personal assistants (microsoft cortana, apple siri, amazon alexa and google home).

Cóndor-Herrera, O., Jadan-Guerrero, J., and Ramos, C. (2021). *Virtual Assistants and Its Implementation in the Teaching-Learning Process*, pages 203–208.

Davie, N. and Hilber, T. (2018). Opportunities and challenges of using amazon echo in education.

Dašić, P., Dašić, J., Crvenković, B., and Serifi, V. (2016). A review of intelligent tutoring systems in e-learning. *Annals of the Oradea University – Fascicle of Management and Technological Engineering*, 15:85–90.

Fredricks, J. A., Blumenfeld, P. C., and Paris, A. H. (2004). School engagement: Potential of the concept, state of the evidence. *Review of Educational Research*, 74:60–80.

Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., Okoroafor, N., Jordt, H., and Wenderoth, M. P. (2014). Active learning increases student performance in science, engineering, and mathematics. *Proceedings of the National Academy of Sciences*, 111(23):8410–8415.

Guskey, T. R. (2007). Closing achievement gaps: Revisiting benjamin s. bloom's "learning for mastery". *Journal of Advanced Academics*, 65:73.

Göksel, N. and Bozkurt, A. (2019). *Artificial Intelligence in Education: Current Insights and Future Perspectives*, pages 224–236.

Hattie, J. and Timperley, H. (2007). The power of feedback. *Review of Educational Research*, 77:81–112.

Kosslyn, S. (2017). *The Science of Learning: Mechanisms and Principles*.

Kuhail, M. A., Alturki, N., Alramlawi, S., and Alhejori, K. (2022). Interacting with educational chatbots: A systematic review. *Education and Information Technologies*, 28:1–46.

Kulik, J. A. and Fletcher, J. D. (2016). Effectiveness of intelligent tutoring systems: a meta-analytic review. *Review of Educational Research*, 38.

Lopatovska, I. (2019). Overview of the intelligent personal assistants. *Ukrainian Journal on Library and Information Science*, pages 72–79.

Makhambetova, A., Zhiyenbayeva, N., and Ergesheva, E. (2021). Personalized learning strategy as a tool to improve academic performance and motivation of students. *International Journal of Web-Based Learning and Teaching Technologies*, 16:1–17.

Ochoa-Orihuel, J., Marticorena-Sánchez, R., and Sáiz-Manzanares, M. C. (2020). Moodle lms integration with amazon alexa: A practical experience. *Applied Sciences*, 10(19).

Pilling, F. and Coulton, P. (2020). What's it like to be alexa? an exploration of artificial intelligence as a material for design.

Polyakov, E. V., Mazhanov, M. S., Rolich, A. Y., Voskov, L. S., Kachalova, M. V., and Polyakov, S. V. (2018). Investigation and development of the intelligent voice assistant for the internet of things using machine learning. In *2018 Moscow Workshop on Electronic and Networking Technologies (MWENT)*, pages 1–5.

Schmidt, R., Alt, R., and Zimmermann, A. (2021). A conceptual model for assistant platforms.

Serban, C. and Lungu, I. (2020). Qlearn: Towards a framework for smart learning environments. *Procedia Computer Science*, 176:2812–2821.

Serban, C. and Todericiu, I.-A. (2020). Alexa, what classes do i have today? the use of artificial intelligence via smart speakers in education. *Procedia Computer Science*, 176:2849–2857.

Shemshack, A. and Spector, J. (2020). A systematic literature review of personalized learning terms. *Smart Learning Environments*, 7.

Silva, A., Gomes, M., André da Costa, C., Righi, R., Barbosa, J., Pessin, G., Doncker, G., and Federizzi, G. (2020). Intelligent personal assistants: A systematic literature review. *Expert Systems with Applications*, 147:113193.

Stobart, G. (2008). *Testing Times: The uses and abuses of assessment*. Routledge.

Tavares, R., Sousa, H., and Ribeiro, J. (2022). *Smart Speakers and Functional Diversity: A Scoping Review*, pages 48–64.

Terzopoulos, G. and Satratzemi, M. (2020). Voice assistants and smart speakers in everyday life and in education. *Informatics in Education*, 19:473–490.

Todericiu, I.-A., Serban, C., and Laura, D. (2021). Towards accessibility in education through smart speakers. an ontology based approach. *Procedia Computer Science*, 192:883–892.