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Smart Speaker as Studying Assistant

Bachelor-Thesis

Presented by

Pargana Santos Silva, João Martim

6807391

First examiner: Prof. Dr. Hendrik Drachsler

Second examiner: Prof. Dr.

Supervisor: Dr. Jan Schneider

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Frankfurt, September 10, 2020

Full Name

Acknowledgments

My deepest gratitude goes to my family. I would especially like to thank my father and mother for always supporting and motivating me in the past. Without them this thesis would have never been finished.

And finally, a big shout-out to all of my friends and my colleagues at Goethe University.

Abstract

New forms of technology get released and adapted at an astonishing pace. Almost every year one of the major companies presents us with a new device or concept that can drastically change our habits in a matter of weeks. Studying and learning are fundamental aspects of what it is to be human. All we do on a daily basis is learn, adapt and develop ourselves to a never ending world of information.

The academic subset of learning/studying has managed to remain unchanged in many fields and has failed to adapt to most of the innovations, as a consequence of a conservative mentality regarding pedagogy. My attempt with this thesis is to create a tool that will facilitate some of the learning practices students could adjust to, by automating a simple yet entirely efficient method of studying, namely: learning by quizzing.

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1 Introduction

This project was conducted following five steps. Firstly, by analysing the historical background related to pedagogy with technologies and researching the related work. The second step was to establish a model with the ideal tool that could satisfy the goal set forth for the project. Third, define an evaluation method to justly judge and assess the efficiency of the implementation. Fourth, select a wide range of individuals that represent various classes of target users and perform the experiment and survey. And finally, draw conclusions and inferences from the resulting data to either prove the point accentuated in the Abstract section or to reevaluate and share the yielded knowledge with the academic world.

1.1 Background

As mentioned in the Abstract section, this projects sets forth with the important judgement that learning practices follow a seemingly delayed convention as to what tools and systems should be used. Modern technology adoption follows several phases or life cycles which obey the Roger's bell. As shown statistically [14], academic adoption of technology generally materializes in the closing end of the wave. This phenomenon has many factors and reasons that justify the norm. For instance, if we use teachers as an example, who mostly are accustomed to follow a model, of which they have come to feel experienced with, the change to different practices and principles has a high probability to jeopardize the productivity of the teaching process. Of course the point of this dissertation is not to question the patterns of teachers and the reasons why many choose to maintain the customs they feel most confident with, but instead to simply point out, that the learning process is an exercise carried out by and for the student, who has the choice and flexibility to undertake any system of learning and should as such be exposed to a wide variety. It is my opinion that students have a predisposition to discard newer technologies for their teachers disbelief's, which might end up having the unfortunate consequence of depriving a student from a more efficient practicing system than any other they may be familiar with.

The development of a Smart Speaker as Studying Assistant sets out to defy this norm and prove that early technology adoption might boost the learning productivity, if the software is easy enough to use. The Studying Assistant skill developed for Alexa devices follows no bleeding edge theories on efficient pedagogy, but merely simplifies the process to repeat and replicate a practicing dialog of asking and answering simple multiple choice questions, specially in parallel with any other activities that might not disrupt the oral communication with the device.

1.2 Related Work

This thesis exposes and uncovers three important learning fields that represent a vastly unknown part of the psychology behind teaching and learning processes and that can be better explored using technologies that try to connect learners socially and tackle more unorthodox learning processes that already take place passively. The resulting product will be assessed and the efficiency of it will answer the research questions set out in this chapter.

1.3 Research Questions

The research questions related with this thesis work are:

1. What is the learner's attitude towards less traditional learning tools, that:
 - a) take advantage of more informal practices?
 - b) use innovative technologies?
 - c) try to combine social, informal and micro learning in one place?
2. Are users aware of how important/efficient this less traditional ways of learning are?
3. Are users aware of how important/efficient use of technology to help the learning process is?

1.4 Outline

The remaining part of the thesis is organized as follows:

In the second chapter, we discuss the related work, namely the above mentioned fields of study that try to be addressed by the application, Communities of Practice, Informal Learning, Tacit Knowledge and Micro-Learning as well as the base model to assess the validity of the resulting product, the Technology Acceptance Model. The third chapter explains the implementation of the developed application, and how its architecture was planned and which technologies were selected. In the fourth chapter the evaluation process is reviewed from which population was selected and which methodology used to assess the productivity of the product. In the fifth chapter we discuss the results assessed in the previous chapter and how that information could help us answer the research questions and finally in the sixth chapter a conclusion is drawn to the application's efficiency and the general public attitude towards it.

2 Related Work

This section covers all the related work of what influenced this thesis. The most essential concepts are Communities of Practice, Informal Learning, Tacit Knowledge and Micro-Learning. These are both concepts that are related to the type of learning expressed in the project or that should be tackled by it. In other words, the application should serve as a form of method that implements a community of practice, that has a micro learning architecture, with micro content and has some form of informal learning, with all the advantages that it has and could as well serve as a gradual transition from the currently existing forms of tacit knowledge transmission to more of a method that incites the logical understanding of such disciplines in a more explicit form. Another important concept that plays an essential role in this thesis is the evaluation method selected, namely the Technology Acceptance Model. These topics will be exposed and explored throughout this chapter, reviewing the sources I found most valuable and my opinions and understanding of each of them.

2.1 Communities of Practice

Communities of Practice also referred to as CoPs are organized groups of people who share the same interests in solving problems, improving skills, learning from each other's experience, etc. As mentioned by Etienne Wenger [27], learning is central to human identity and social participation is imperative to learning, thus constructing and building ones identity through these communities. With CoPs, a student, besides all the learning advantages, can more easily integrate a social group, in school, at work, in a company, in a circle of friends, etc.

These communities are among the most efficient ways of transferring Tacit Knowledge [8], since it helps the adaptation of new members or learners via a sort of mentor-mentee relationship. Newer learners will feel a sense of belongingness as they become integrated in a CoP. This aspect is essential, for it increases the productivity and efficiency of learning, working and practice in any field. This form of interaction also helps all new members to mold their skills and talent to the shape of the group which puts everyone on the same ground, sharing and learning from each other in a fast pace. [10]

The pillars of communities of practice are three important concepts found across all different forms of implementations [4]:

- **Domain:** stands for a common ground. The domain of a CoP is the shared subject the inspires members to participate and develop their skills alongside the community.
- **Community:** is as mentioned above the social fabric for learning. The community is what

fosters and encourages the members to share ideas and creates a layer of trust that is essential for effective interaction.

- **Practice:** when given a domain, is the form in which these communities share and maintain the core of their knowledge.

There are different forms of implementation of a community of practice as mentioned above [5]. One can expect companies or schools to rapidly grow their members' efficiency in working or learning and to start thinking outside the box after brainstorming sections [21]. Most CoPs have non-canonical implementations, meaning they follow informal rules of organization and structure, but the goals and factors are common to most differing methodologies.

The goals that should be met are:

- **Lower Learning Curve:** perhaps the most important goal of any CoP is to decrease the learning curve for newer members, be those new workers or new members of a learning group, so everyone achieves a common ground.
- **Faster Goals:** goals here in terms of working goals or learning goals, like learning a new skill or topic as quickly as possible with the help of the group.
- **Reduce Rework:** this is mostly an issue where learners or workers are not organized enough and end up repeating work or reinventing strategies that have been done before.
- **New Ideas:** the most important goal, to generate knowledge at a faster pace.

And the factors that grant these goals are:

- **Independence:** all members and the community itself should have freedom to act as an independent organism, without the interference of a company or higher institution. This factor is essential to preserve the identity of a CoP.
- **Voluntary Membership:** members should have the freedom to be part of the group. Only with interest and motivation, can a CoP thrive and achieve all the wished goals.
- **Size:** the larger a CoP the better. The more members it has, the more knowledge and different points of view can be shared. Since the goal is to equalize everyone's knowledge, more members means higher common ground.
- **Equalitary Weight:** each member should have the same weight in expressing his or hers opinions and ideas. New and old members alike should have the same statute in the community.

2.2 Informal Learning

The term of informal learning represents all types of learning that are not incorporated in either what is considered formal learning or non-formal learning [6]. Formal learning denotes all academical learning or any other learning that delimits the crucial career road of a subject. Something like school, a university course, a professional formation, etc. Characteristic of this learning is that ideally a pedagogical road map has been layed out, there is a concrete goal, either a certificate or a degree and the learning process happens by following it. Non-formal learning stands for every type of course or extra curricular activity that also follows a plan and has a concrete goal in mind, but happens in a secondary plane. Joining a language course,

learning a musical instrument, for instance, are both clearly types of learning where a clear structuring of the pedagogical process is imperative, but training itself might not be required to fulfill a professional activity [18].

All other forms of learning can be considered informal learning. As most of us learn our abilities and skills outside of a curricular model, be those social skills, like how to interact publicly, motor and physical, like walking, running or eating, etc. As this field denotes most of learning, there are naturally many different forms to manifest it [23]. The following types differ mostly in intention and awareness, but all represent a form of informal learning. Auto-didactic and self-directed learning is an intentional and aware form. Incidental stands for not intentional but aware learning experience. Socializing can be both unintentional and unaware (at the time of the learning experience), as a sporadic phenomenon by participation.

The above mentioned three types of informal learning are cloudy concepts, in that social learning can still be self-directed and intentional. The main point is that informal learning represents the learners self-definition of the learning process, in theory, practice and experience.

By default informal learning takes part in places outside of the dedicated learning environments [7], be those physical or not, and usually there is no clear set objective in terms of learning outcomes and purely happens out of interest and motivation.

Some keywords can be used to describe the main factors that describe an informal learning experience. It makes use of heuristic methods, it's generally a more relaxed experience for learners. In many cases it involves socialization and enculturation, connecting this concept heavily to Communities of Practice.

As it has proven to effectively develop learners knowledge [7], new methodologies have been created that fit in the informal learning category, where learners enhance their knowledge via gamification by playing, and are part of ongoing social events. Informal learning can be spontaneous and creative and is an important subset of what learning represents that should be tackled when creating eLearning technologies.

2.3 Tacit Knowledge

The attribution behind the appearance of the term tacit knowledge goes to the Hungarian philosopher Michael Polanyi, mainly exposed in his book *Personal Knowledge* in 1958 [9]. As opposed to explicit knowledge, something that is codifiable in a easy to transfer mechanism, it can be written down, explained impersonally or new knowledge can be logically deducted, tacit knowledge also referred to sometimes as implicit knowledge stands for knowledge that can't be generated by logical deduction. Tacit knowledge can only be learned by observation, imitation and practice and it is something that can not be codified or described. [20]

According to Michael Polanyi all knowledge is rooted in tacit knowledge. It is ubiquitous. Examples of it are language speaking, car driving, bicycle riding, musical instrument playing, facial recognition (between humans). Tacit knowledge stands for ways of learning and teaching that are still very much misunderstood, the same way the human brain is. This type of knowledge generally requires extensive personal contact and regular interactions inside social networks with a determined context to be effectively transferred. Tacit knowledge can only be captured when observing and imitating or joining a community of practice [8].

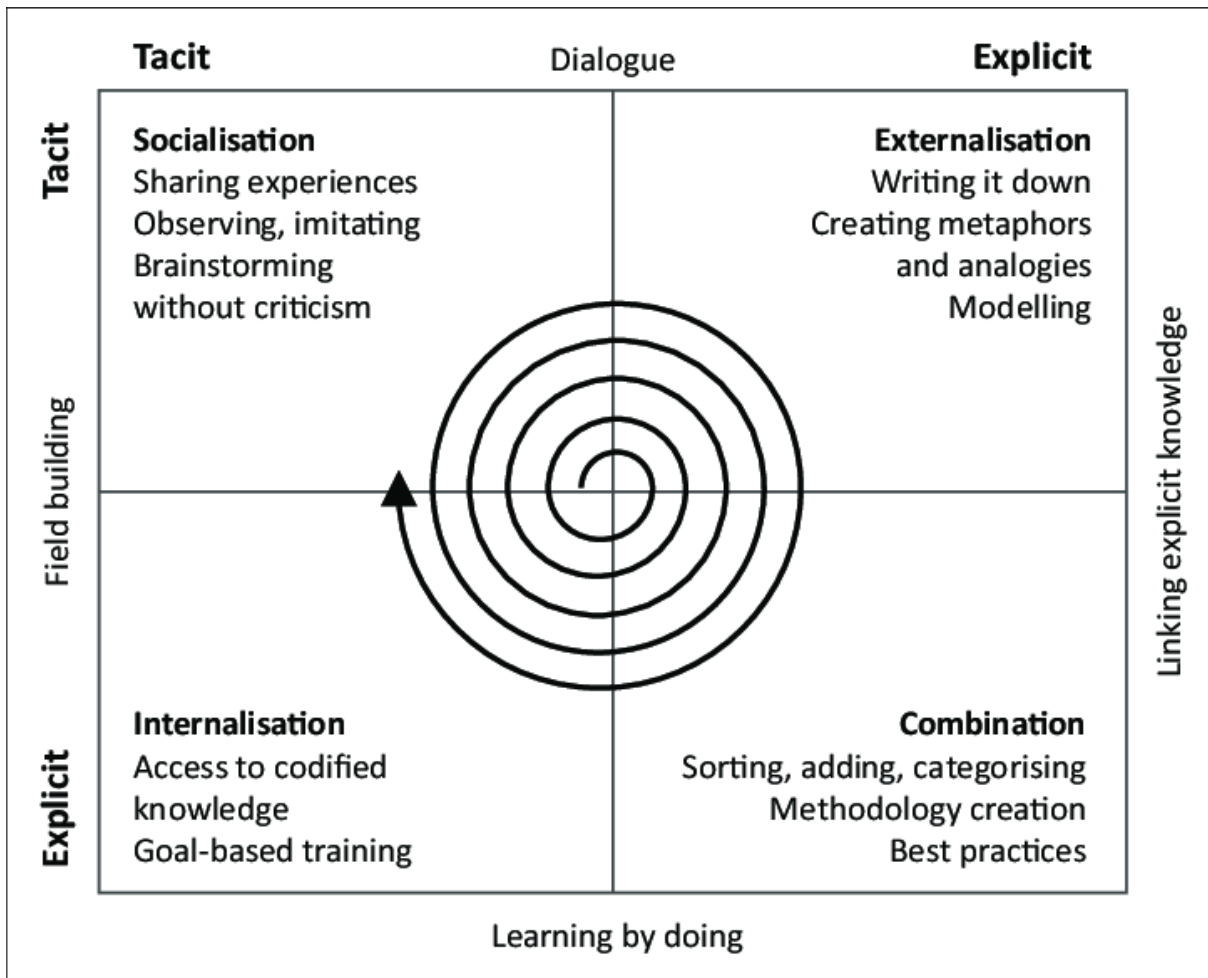


Figure 2.1: Two dimensional grid showing how the learning processes jump from tacit to explicit learning.

This type of knowledge is unintuitive and hard to communicate, but it represents a very big part of human knowledge, in many cases, knowledge that is vital to the communication, interaction and realization of many tasks, on any degree of complexity, school or professional. The separation of implicit and tacit knowledge is not always obvious [22], but it is believed that implicit knowledge is just explicit knowledge that hasn't yet been documented, and most of the tacit knowledge falls in this category, meaning it can or is in the process of becoming an understood topic that can be learned and taught logically and systematically.

The conversion between this types of knowledge is fundamental and some strategies have been developed for this ending. They usually follow similar principles as the traditional ways tacit knowledge is passed on (observation, imitation, etc.). This principles observed in musical instrument learning, or bicycle riding can be standardized and systematized following some steps:

- **Continuous Learning:** similar to the above mentioned methods, a continuous learning strategy has proven essential when adapting the transfer of tacit knowledge as explicit.

- **Current Knowledge Auditing:** the act of verbalizing the existing knowledge by auditing and identifying knowledge gaps is one of the most important steps in understanding and codifying it.
- **Build Intentional Learning:** many times this type of knowledge is transmitted while the authors are unaware. Building attention and intention is imperative to its transition to an explicit category.
- **Storytelling Injection:** since tacit knowledge is best understood through personal experience, describing it by telling stories as opposed to logical explanations is much more effective when codified.

2.4 Micro-Learning

The concept of Micro-Learning is not unique to technology-based learning practices, even though it is generally used in correlation with the latter. The term is fairly new compared to its counter part, micro teaching [12]. In the sixties in the University of Stanford, USA, new methods of teaching started being developed with much criticism to the then state-of-the-art as exposed by Dwight & Ryan 1969 [2]. Many Professors of this institution started to follow a much simpler and shorter cyclical teaching model that iterated over the following steps:

- teach
- critique
- re-teach
- critique

This approach to repetitively convey information, reviewing and analyzing it proved very efficient and the idea of dividing content into micro lessons, micro periods and laboratory phases has been advanced during the last decades to what is known today as Micro-Learning. Many forms and practices are used in Micro-Learning, according to [11] the main principles that define the concept is content that:

1. is self-contained, self-explanatory and can be presented without further context,
2. comprises a single learning activity that can be performed within seconds, and
3. provides immediate performance feedback.

Examples of micro learning activities would be reading a paragraph of text, listening to an informational podcast, watching a short video clip, viewing a flashcard, memorizing a word, vocabulary, definition or formula, sorting a set of items by chronological order, selecting an answer to a question, answering questions in quizzes, playful learning with micro-games, composing a short poem, writing or drawing a reflection on just-viewed content, rating confidence in an answer to a question, etc.

2.4.1 Micro-Content

Inseparable from the concept of Micro-Learning is the one of Micro-Content also referred to as *content nuggets*. There are multiple dimensions to this, but generally small segments and fragments of organized information can be used to describe Micro-Content. The adjective micro is used when comparing content in three levels, micro, meso and macro, the latter being the broader and more generalized and first the smallest and more compact as the name implies. In the context of language learning, alphabet and phonetics would be best taught in micro segments, while conversation skills and a broader linguistic comprehension would be considered macro content. The idea of separating learning content into this three layers can occur in different dimensions as explained by Hug [12]:

- **Time:** Ideally, Micro-Content should be fast to deliver, performed with relatively short effort with no operating expense.
- **Content:** The content should hold small or very small learning units with narrow topics and cover simple issues.
- **Curriculum:** It should only wrap a small subset of the curricular setting, parts of modules or small elements of informal learning.
- **Form:** The form of this segments should be divided in fragments or *knowledge nuggets* that isolate skill elements.
- **Process:** The process should be separate, concomitant or actual, situated or integrated in activities, such that they engage in attention management with complete awareness for a small period of time, since they should be encompassed in iterative methods.
- **Mediality:** Preferably this content should be delivered in a direct and fast means of transportation, either in face-to-face interaction, mono-media, where the information objects or learning objects carry high symbolic value.
- **Learning type:** The kind of learning practices should be repetitive, activist, reflective, pragmatist, conceptionalist, constructivist, connectivist, behaviourist. Learning by example with tasks or exercises that are goal oriented with real problem-solving content.

2.4.2 Micro-Learner

There are different theories about learning, but the micro, mesa and macro view would separate the process of learning into three stages or even levels, where a student repeats the learning process starting with a superficial approach where he gathers knowledge, and iterates every time more analytically. This process is also referred to in [1] on his guide on how to read a book, where he mentions inspectional reading or skimming, analytical reading and syntopical reading. These steps could be described as following:

1. absorb basic knowledge about a topic or subject (Learning I) - Behaviourism
2. actively acquire knowledge in a self-determined matter (Learning II) - Cognitivism
3. finally be able to construct knowledge (Learning III) - Constructivism

Typically, micro-learning systems focus on the Learning I phase.

2.4.3 Behaviorism

Behaviorism is a systematic approach, methodology and theory of psychology which was developed in the beginning of the twentieth century. Behaviorism treats animals and Humans alike and attempts to explain how they function purely by observation, thus completely disregarding any internal components such as the mind with thinking and emotions. The main goal of Behaviorism is to predict and control behavior via observation. Opposed to other theories of psychology, the behaviorists believe their subjects are born as a *tabula rasa* or with a clean state and learn by reinforcement or punishment. According to this theory, humans or animals have responses to stimuli based purely on their conditioning and surrounding environment. This conditioning is divided mostly into two categories, the classic and operant or behavior conditioning, which explains or treats their reactions in different ways. The classic conditioning explains the response to stimulus by combining the individual's history, motivation while the operant controls and manipulates the result by reinforcing it with a consequence such as punishment or reward.

Behaviorism tries to link the subjects' responses to the entire surrounding environment, without creating any assumptions of the internal organisms. In learning, this can be considered as the most basic form of practicing, where reinforcement and repetition shape the future behavior. In the context of Micro-Learning or Micro-Content this means that the first phase, in which the learner gathers samples he neglects all the thinking and emotions from the learning process and sticks to his instincts.

2.4.4 Cognitivism

The psychology theory of Cognitivism emerged in the late fifties mainly as a reaction to both challenge and dispute the then settled Behaviorism. Cognitivism as a learning philosophy opposes Behaviorism in that instead of guiding the learners towards the desired direction, it uses feedback to assist learners to create accurate mental connections of the desired learning Schemas.

Cognitivism denies the "black box" approach of behaviorists and seeks to understand the Human mind during the learning process. It endeavors to recognize the mental patterns needed to store new information and generate individual logic. According to cognitivists, students have existing structures or Schemas, and the information absorbed during the learning process gets selected, processed and organized to fit and enhance these memory patterns. [13] Attention and memory are essential elements of the learning process, for they function as connection to the already existing Schemas and help map and contextualize new information.

This process of internal codification of mental structures, following the steps of planning, goal setting and organization strategies [13], are responsible for knowledge acquisition and conservation. Learning is though a process that depends highly on the what the learner already knows and his or her methods of acquiring new knowledge. Information can be organized in different ways according to the already existing structures, and it is the teachers job to convey data in a way that facilitates the conversion in to this structures, such as by analogies or other hierarchical relationships. Once information is stored and implemented in different contexts it is said to be transferred. [24]

Cognitivism justifies and represents a second level of learning which is retained in long-term memory and used every time the stored information is applied.

2.4.5 Constructivism

Constructivism is an even further interpretation theory of the learning process as explained by Behaviorism and Cognitivism. According to Constructivism, learners build or construct their own knowledge through personal experience. They give meaning to information and assemble it upon the foundation of previous learned knowledge, hence the name Constructivism.

According to this theory, new knowledge gets absorbed influenced solely on the existing one. The learner constructs or stacks the knowledge understanding the new information and concepts molded by what he has learned previously. This process is active [1] as all types of learning processes are, where aided or unaided the learner must constantly interpret and analyze the new information, relating it to the existing one, only then creating a new layer of understanding when enlightened. This process of active engagement is individual, thus the same lessons can create very different outcomes, since the learner decides how to construct new meaning combining the new information with the already available mental models.

Teachers who wish to convey new meaning as Constructivists, tend to use active engaging teaching methods, such as experiments or real-world problems to incite learners to utilize their understanding and layer them with the new information.

According to John Dewey [6], this process is a highly social one. Interaction between learners will enhance their construction of meaning, the same way physical work will be assembled more effectively if collaborating. John Dewey defends also that even unaided forms of learning, via books or other resources require indirect socially interaction in order for the learning process to work effectively. This idea is also shared by a major contributor to this theory, Lev Vygotsky [26], who developed the Social Constructivism, where he justifies with a community, the process of making meaning, also labeled by Cognitivists as meaning transfer, can occur more effectively with sharing and negotiating.

Learning exists only in the mind and is an iterative process that keeps updating the mental models to adapt to new information. Learning is the constant construction of our own interpretation of reality.

2.5 Technology Acceptance Model

All the above mentioned topics are important concepts about the science of learning and ideas that should be tackled by the smart speaker application, either by trying to achieve the goals set out in Introduction or analyze the results accordingly. This section will summarize an important measuring model that can predict a technology's adoption. This model was changed and shaped into the evaluation model used in my thesis.

Since technology has become an vital part of our lives in a accelerated and unpremeditated transition, the creation and expectation its creators have about its adoption has turned out to be unanticipated. The fast paced adoption of a certain technology might seem surprising, the same way another will unexpectedly not be widely adopted. This unpredictability about a new

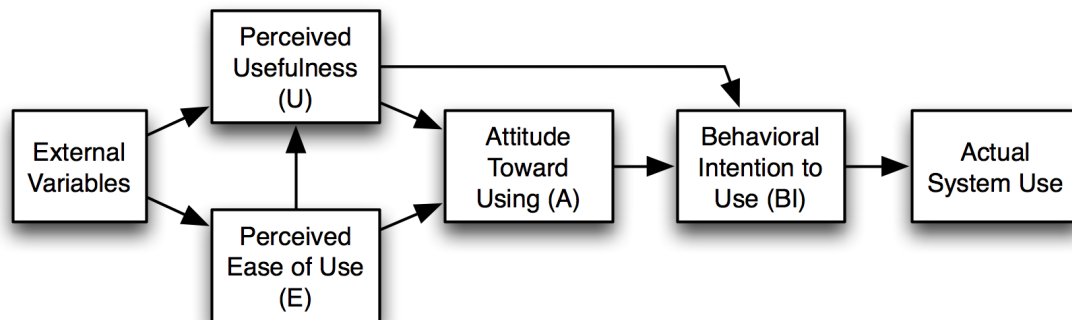


Figure 2.2: The initial diagram model to describe the technology acceptance model. The two pillars of perceived usefulness (PU) and perceived ease of use (PE) have direct influence on the attitude (A) and behavioral intention (BI) of the user.

technology's adoption has inspired academics to design a measuring system, that could predict and quantify how it shall be accepted by a general or particular public.

One of this models, and perhaps the most widely used and influential is the technology acceptance model, also referred under the acronym of TAM. The TAM has been under scrutiny for years, since its first introduction by Davis [3]. The model focuses mainly on the user's behaviour towards technology in general and the technology in focus in particular. It does so, by trying to quantify both the perceived usefulness and perceived ease of use. The adjective perceived is not to be disregarded, for it mirrors and takes into consideration above all else, the behaviour and attitude the user has towards the object in question, and not an absolute and objective perception of its usefulness and ease of use.

The perceived usefulness attempts to quantify the degree to which a person believes the use of the technology in question will improve his or hers performance of a certain task. How much better will it be to solve a given problem with it, comparing to without. The perceived ease of use measurements considers the degree to which a person believes the use will be effortless. How much does he/she have to adapt in order to operate and employ the technology. Will it be an easy transition. The entire model revolves around these two fields, which represent different questions with different directions, but try to evaluate the user's behavior and attitude towards technology and the one in particular.

The perceived ease of use will also go deeper, by enquiring the user about a concept of self-efficacy [17], which stands for the more a user has contact with the technology, the more control he will feel over the activity it covers in general. This self-efficacy also referred to as instrumentality are considered to be alongside the attitude, the main factors behind the user's motivation, which is essential to the future adopting.

According to the original TAM, the intention to use a system and perceived usefulness override the perceived ease of use for the final decision. If the users already has the intention, he will disregard how difficult it is, if the result proves a positive a positive outcome.

The TAM is a model that is very general and focuses on psychological aspects that vary from

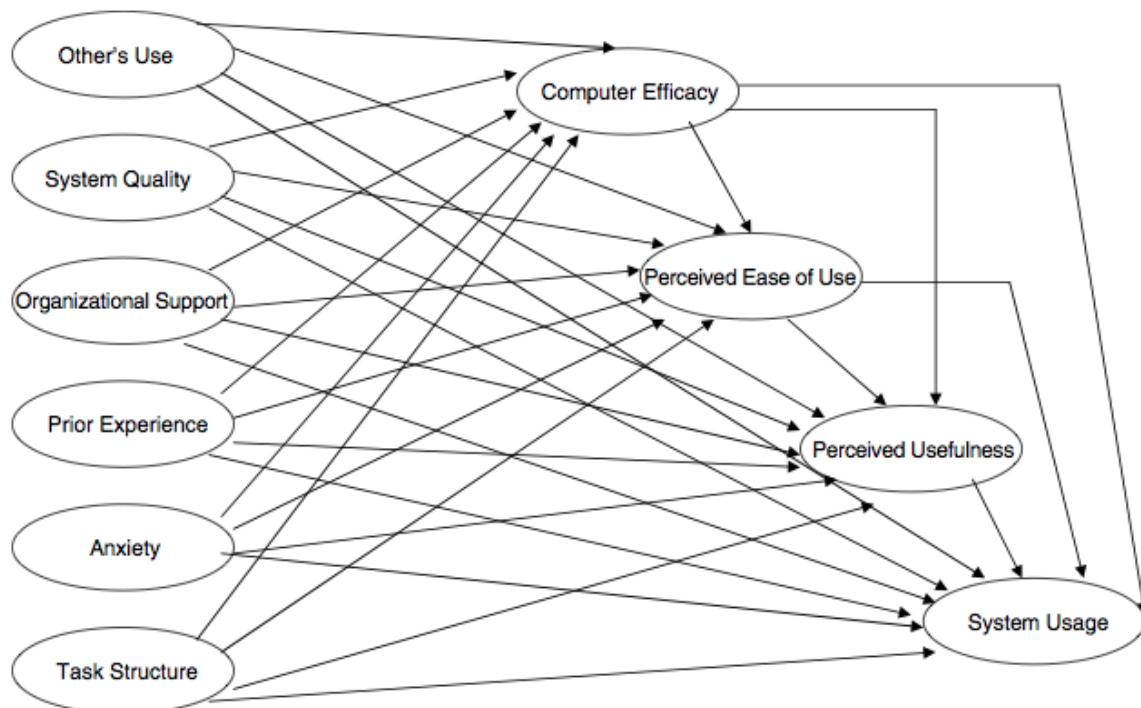


Figure 2.3: This diagram represents an expansion to the original TAM as explained in McFarland & Hamilton 2006 [19]. In this version of the TAM, all external factors influence not only the two pillars PU and PE but also the Computer Efficacy plays a equally important role.

experience to experience, from target to target and tends to be adapted in each study to take into consideration certain aspects. For these reason it has been consider a parent model to many others, which has inspired other researchers to develop an unified model [25].

The unified TAM also known as TAM2 takes into consideration other important aspects, such as:

- **Subjective Norm:** this stands for the importance the technology in question has for the user subjectively. What his opinion of it is, without any objective qualities being taken into account.
- **Voluntariness:** very important is how the user feels it is mandatory to be part and use it. This will affect in many cases the whole approach.
- **Image:** how will the status of the user change in society subsequently to the use of adoption plays an important role to certain classes of users.
- **Job Relevance:** in career fields, this parameter is undeniably vital, to the future users in question.
- **Output Quality:** this stands for how efficient is the system in question. How will the output be in comparison to previously.
- **Result Demonstrability:** also important is what images are reflected from the results. Are the resulting products significantly better, at least the impression of it.

2.6 Summary

In this chapter were introduced and explained to a certain extent four learning concepts that are related to the idea behind this thesis and the base model for its evaluation.

Communities of Practice, Informal Learning, Tacit Knowledge and Micro-Learning are not only interesting but also ideas that are still being currently explored to understand the depths of human learning. This still very misunderstood psychological and social processes might define a new future of efficient learning that is still not recognized, and that can take advantage of the ever increasing development of new technology.

Smart Speaker is just one proposition in a sea of unexplored hypothesis that can revolutionize how humans study and learn in general. The ideas mentioned in this chapter are key to understanding how to approach this problem and in creatively innovate the tools available.

Technology Acceptance Model is not the norm but a good base that can interpret and assess how efficient the new technologies are and should be an integrative part of any such study.

3 Implementation

As mentioned above this project's tool consists of two parts, the web application where users create and upload textbooks and questions for their common topics and the alexa skill which is the main interaction tool used to study and practice.

3.1 Web Application

The web application is a full stack server that communicates both with the website as well as the alexa skill. It is a platform where users can administrate and have an overview of all the available topics, questions, textbooks as well as the ones created by the user.

The architecture principles behind the design of this web application are the following: it aspires to be scalable, extensible, flexible and modern. Why exactly these adjectives and not others? Well, as any living platform, the application will hopefully change and develop over time, if it is going to be used. Since one important criterion is to create Communities of Practice overtime, by connecting users who intend to study similar topics, the software will have to be adaptable to any changes that might occur in the future and so it needs to be scalable. Users will determine in what direction the software should go, what features need to be added to make the whole studying process of interacting with the website and uploading questions easier and more useful overtime, so it needs to be extensible. It needs to be flexible to changes, so it adapts in any direction required and it needs to be modern to both take full advantage of the latest available technologies and ideas as well as pleasant to use, specially for users in the habit and knowledge of the latest technologies.

The server side of this web application communicates both with the front-end shown in the browser, but also with the alexa skill, which fetches all the data stored in the database.

3.2 Programming Environment

3.2.1 Major Technologies

With the later in consideration, the programming technologies selected needed to regard exactly those aspects, so the system was developed with the following:

- **ReactJS:** Statistically the most widely used front-end framework, React was created

by the Facebook Team back in 2013. The most characteristic feature of React is its component-center design. In React the developers can very easily separate concerns by extracting HTML, CSS and JavaScript from small snippets and create "Components" which are higher level Abstractions of reusable pieces of code that live in the application in a very Object-Oriented style.

With React the developers can in a very clean way extend or replace small pieces of their web application making it the perfect choice of technology to develop this volatile learning platform, likely to change in any direction as required by its users.

- **TypeScript:** A superset of JavaScript, TypeScript as the name implies creates a layer of security over normal JavaScript code by statically analyzing types at compilation. This makes development safer, as it automatically covers most of the use needed by unit testing and showing the developer most potential dynamic bugs at compile time and making them obvious when refactoring/adapting and extending.
- **Go:** The choice for back-end was Google's young Programming Language, Go. It provides the same advantages of TypeScript with its strict typing system. It also makes use of concurrency fairly easy, with its plain and simple syntax, making it a very performant choice for the server that communicates with the front-end and alexa skill.
- **MongoDB:** A NoSQL database architecture, very performant and based on JavaScript Object Notation (JSON) syntax, which is also used by all alexa skills to communicate via HTML. It
- **Auth0:** *a flexible, drop-in solution to add authentication and authorization services to your applications. Your team and organization can avoid the cost, time, and risk that comes with building your own solution to authenticate and authorize users [15].* It is a perfect extension to add user functionalities to the web application by safeguarding their privacy and data with a third party library specialized just in that.
- **Gorilla/Mux:** One of the most popular and well written server side frameworks written in the Go Programming Language, Mux aspires to create a perform transition between server and single page requests efficient and performant.

3.3 Front-end of Web Application

The front-end of the application consists on a very basic structure. Users need to login either with their google accounts via OAuth Protocol or by creating an account just for the platform, shown in 3.1 and 3.2.

3.3.1 Topic Creation

After being logged in users can create or join topics in topic selection page. The user is prompted with a text field that uses fuzzy finding, as shown in 3.3 to quickly narrow the search down to similar topics available. If none was found, the user can press the Create button which opens a creation dialog 3.4.

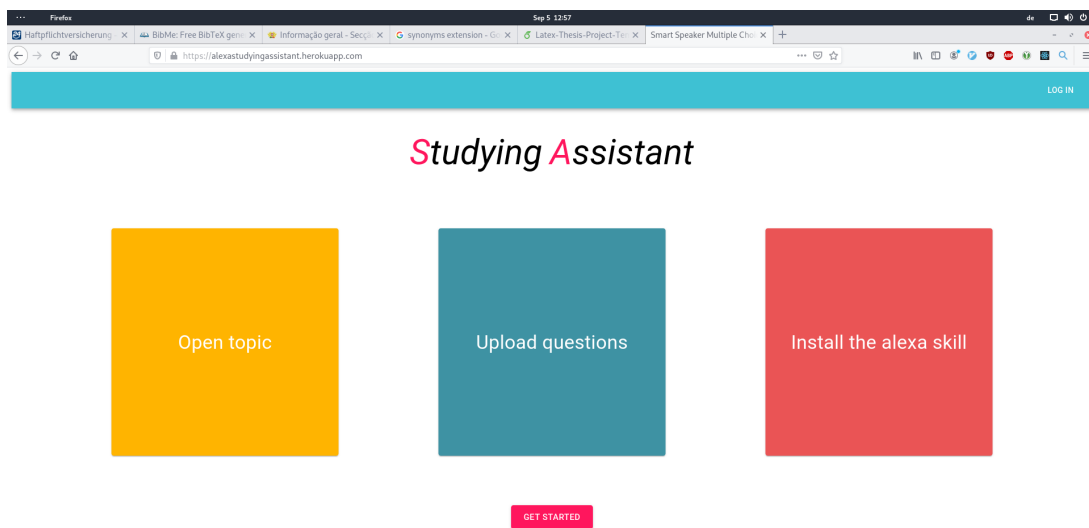


Figure 3.1: Homepage of the web application.

3.3.2 Questions and Textbooks

After they have created or loaded a topic they will have two columns, one showing a list with all the textbooks provided by other users, the other with the list of all questions currently associated with the given topic 3.5.

Both lists consist of expandable blocks which show firstly just the titles of both questions and textbooks and on click expand to show everything, which is the entire contents of the textbook on one hand and the multiple choice answers with the correct marked one on the other.

The idea behind this piece of software was to have commonly useful snippets of text with valuable information begin available at the time of creation of the new questions, so that for instance, if a user is currently studying in a course and wants to practice a given topic, he can upload the corresponding textbook, read paragraph by paragraph on the website and create questions as he comes up with important concepts we wishes to study.

3.3.3 Potential Future Improvements

Another reason behind these parallel layout would be to easily add a feature in the future where students could bind given questions to a given textbook, or even a given location in the textbook, so that questions could be sorted by textbook or by chapter, etc. Also a similar idea, would be to read text snippets from each textbook out load by the alexa skill, and prompt the related questions by the end of each paragraph for example. All of the aforementioned ideas can be easily incorporated in the web application by either creating new short components or by extending the existing ones.

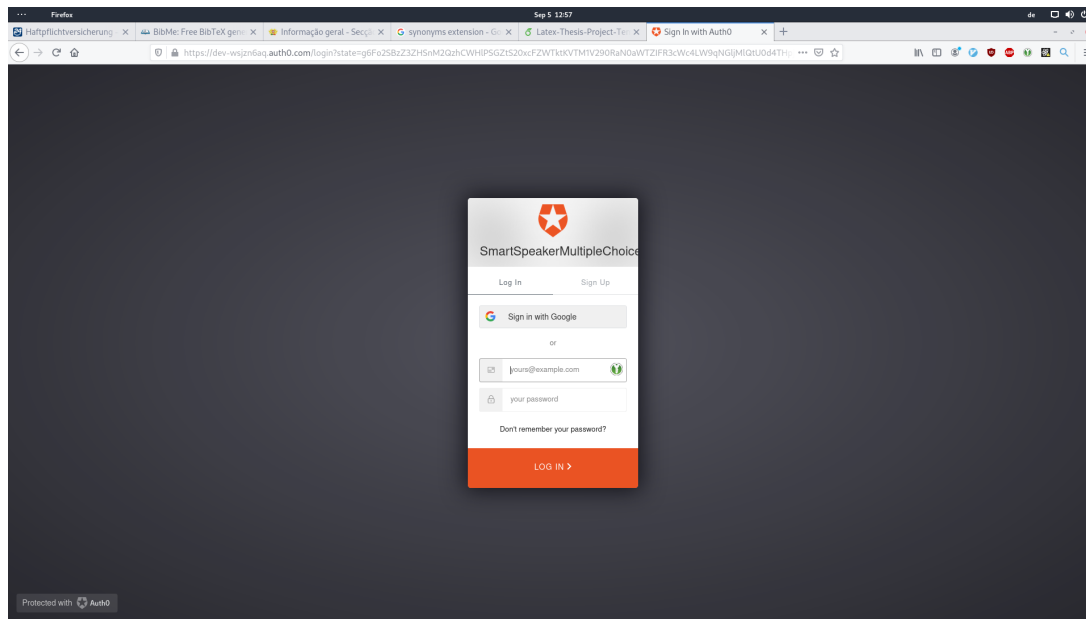


Figure 3.2: Login dialog via Auth0 plugin.

3.3.4 Upload Dialogs

The following shows the Dialogs shown when a user wants to upload a textbook (3.7) or question (3.6). For the textbook uploads, a functionality was written in the server side back-end of the application, where one can upload the contents on the textbook and it will be translated from PDF format to plain text and added to the input field. This ability has many advantages. Firstly, all text content is saved in the same format, and one that's easily changeable. Second, its format that can be send via HTML and directly read by the alexa skill. And third, it will be easier to add tags in the end of each sentence, paragraph, chapter, etc, by writing extra words in the middle of the text.

The question Dialog shows a very easy form with only two fields, and the user can add any variable number of answers for each question.

3.4 User Management

Another non visible, but important feature is that all uploads are assigned to a user ID, meaning that in the future following all the uploads and content from another user, or even creating groups with common interests, hence creating a proper Community of Practice would be trivial. All of these were left, since the idea was to just create the basic functionalities to interact with a smart speaker and assess if that functionality in itself with be enough to attract and gather new users for newer niche technologies with the intend of learning.

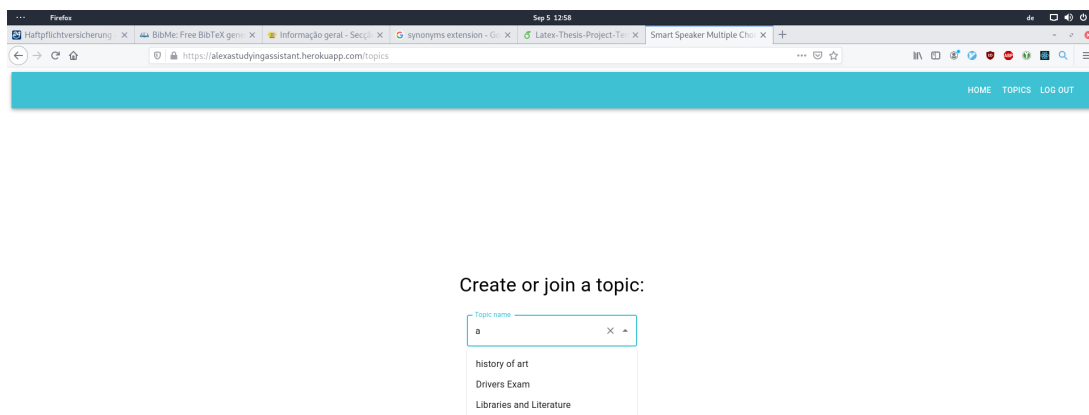


Figure 3.3: The search for the topics uses a fuzzy finding mechanism.

3.4.1 Additional Technologies

Besides the main technologies used as a skeleton for the web application, the following additional tools are also essential:

- **Docker:** One of the most popular tools for DevOps of our times. Docker containerization does two things. It makes deployment of the web application completely cross platform and it creates an important layer of security and sandboxing via its containerization process.
- **Heroku:** *A cloud platform that lets companies build, deliver, monitor and scale apps — we're the fastest way to go from idea to URL, bypassing all those infrastructure headaches* [16]. Meaning, the perfect setup to quickly deploy a docker container with the existing web application and to start testing with real users. Another big advantage of Heroku is that it uses certified SSL endpoints recognized by the Amazon Web Services, which means the alexa hosted skill can communicate with a server deployed in Heroku without further configuration.

3.5 Alexa Skill

The Alexa Skill is the other half of the application and contains the essential part of its interaction. As the name of the thesis implies, the core and principle point of the project is to create an interactive learning experience using a smart speaker, although in reality the creation and connection between users during the process of creation topics and questions is just as important as the latter. Nonetheless same features provided by the skill were key and essential to the whole experience.

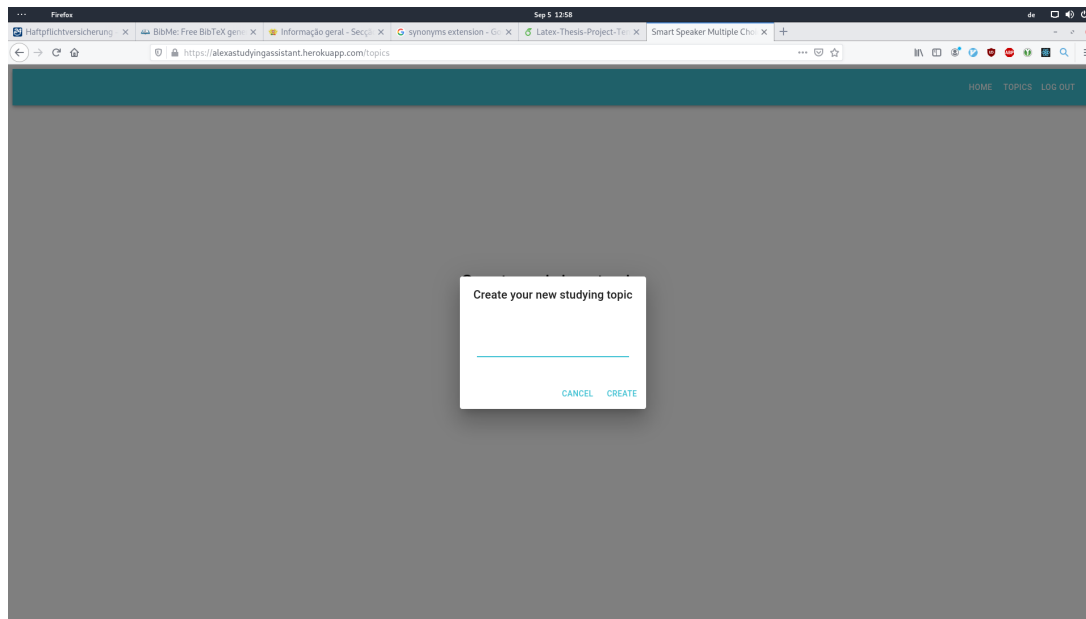


Figure 3.4: An example of a topic creation.

As most smart speaker applications, there is a fine balance needed for its success. The skill needs first and foremost to simplify the whole procedure of sitting down reading the multiple choice questions from either cards (which would consume a lot of time in their construction) or from the website or different sources, followed by a straightforward conversation with the device, where users can practice simultaneously with other daily tasks, say washing the dishes, hanging clothes, sweeping the floors or even just by laying down in the couch. Whether this habits are effective or not is a whole different question and like with many things matters studying in pedagogy, this will most likely depend on the student. The main point that needs to be covered by the skill is to demonstrate the ability and practicality to study and interact with the smart speaker device in a much simpler and effortless way.

For this to be achieved, a compromise had to be found regarding how to dose the features provided by the skill and their clarity. It was settled to solely use the speaker to fetch all questions from the web server given a topic title posing them to the user and keeping track of the correct answer pro question ratio. Besides this basic usage the skill can also explain how to upload and create more questions if needed. The pictures below show a valid conversation with the smart speaker 3.8 3.9 3.10 3.11.

3.5.1 User Management Roles

The user management roles differ in the alexa skill from the web application. This was a design choice which might change in the future if needed. While the web application stores all public question, textbook and topic creation to a given user or email with the OAuth protocol, the skill solely keeps track of the sessions. The reason behind this decision, lies on the fact that users will very likely want to repeat the same multiple choice questions more than once to practice even if no new questions were uploaded. *Repetitio est mater studiorum; Repetition is the*

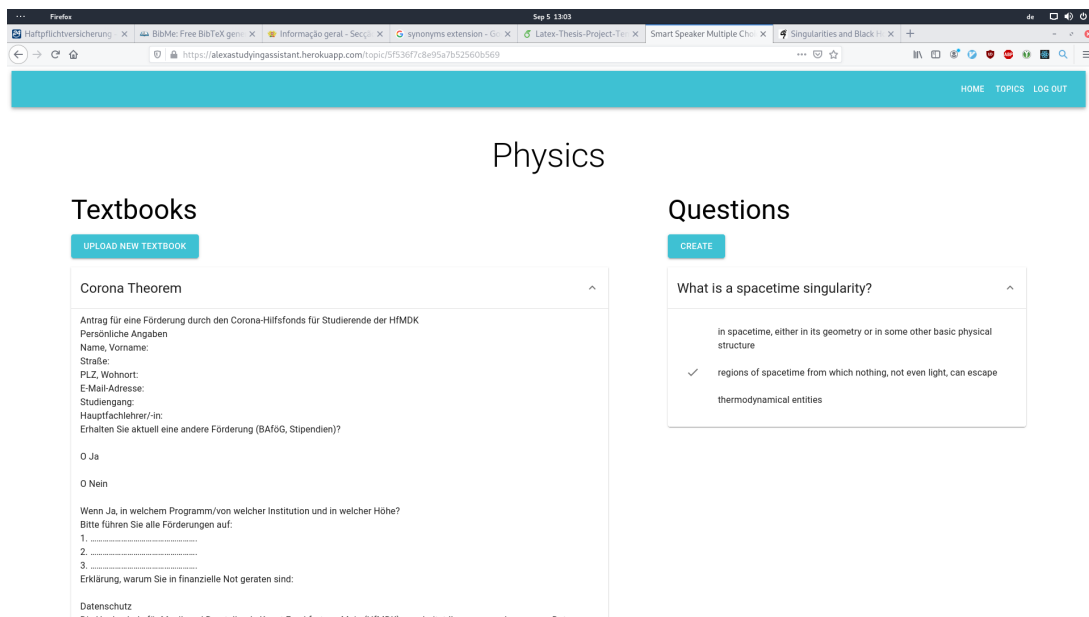


Figure 3.5: Two columns with the uploaded textbooks and questions for referencing and studying inside the app.

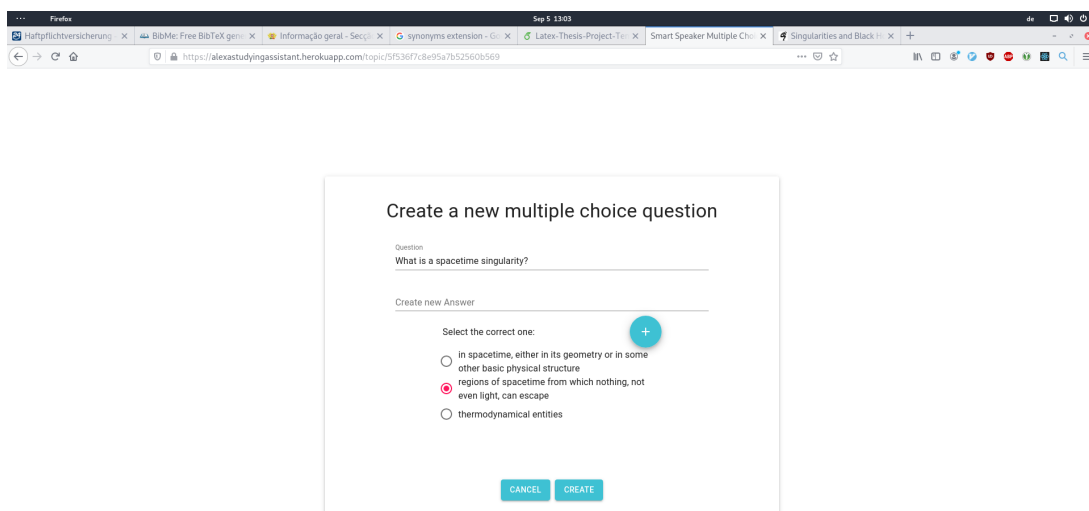


Figure 3.6: The upload dialog for questions. The user can add as many answers as he/she wishes and select the correct one.

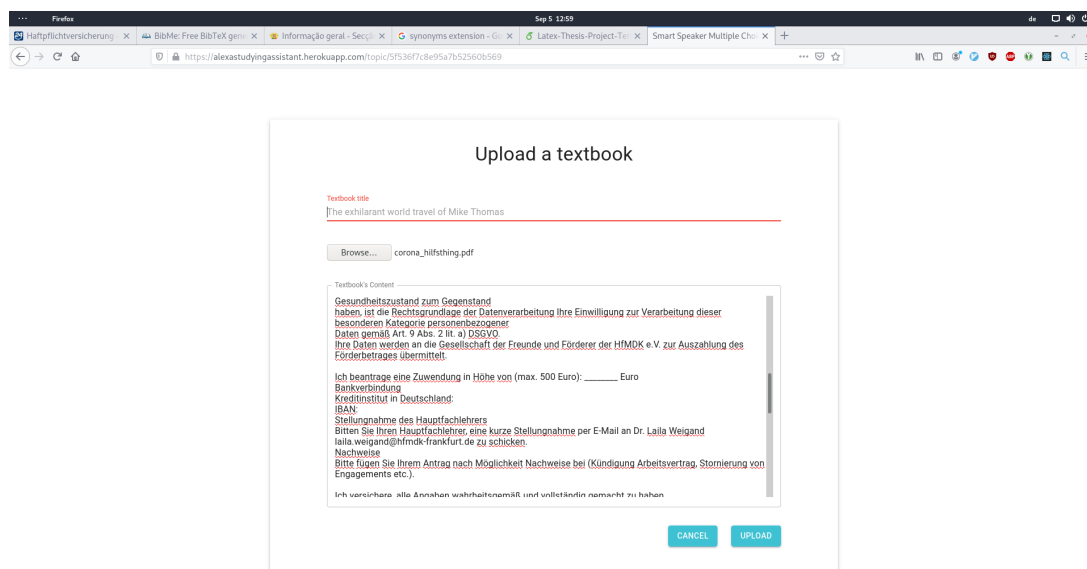


Figure 3.7: The upload dialog for textbooks. It can convert a large pdf file to text which can be marked and manipulated more easily.

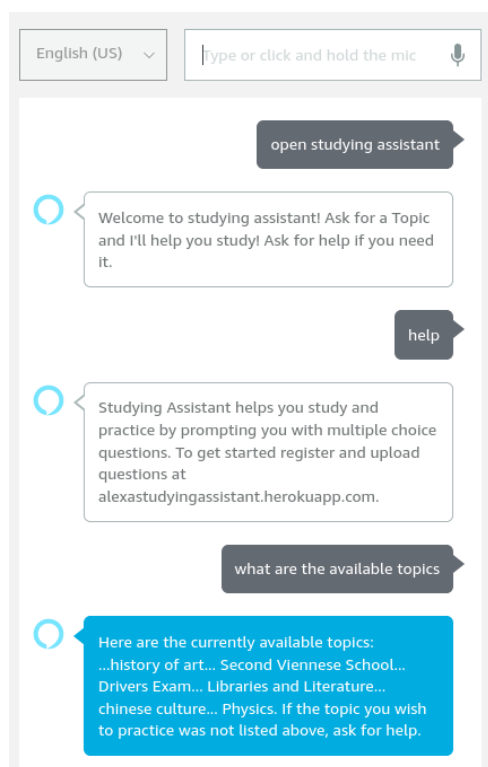


Figure 3.8: Starting conversation with alexa skill.

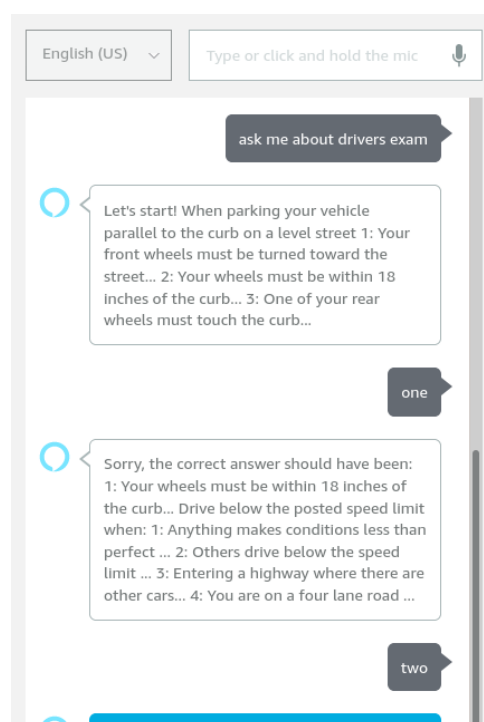


Figure 3.9: Example of interaction after request to study given topic.

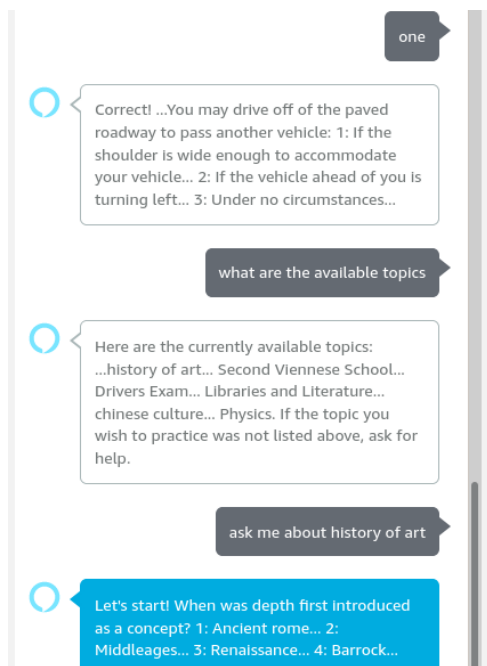


Figure 3.10: Example of the user asking the alexa skill to switch the topic to be studied.

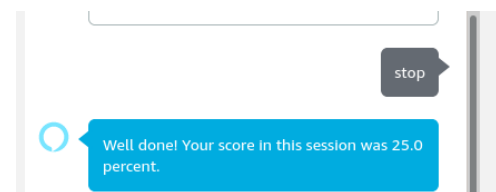


Figure 3.11: Alexa let's you know the session's score after closing the skill.

mother of all learning.

Accordingly once a user starts to interact with the smart speaker, a session is loaded where it keeps track of all answered questions pro topic, so if the student switches between topics and later returns, the last prompted question will still be prompted and no question will be repeated. Additionally, every time a session starts a topic is selected all its questions are shuffled so the user learns the proper answers and not the correct order of answers.

3.5.2 Python Hosted Skill

Originally the Go Programming Language was selected to write the implementation of the alexa skill for the same reasons referred previously in its description. This plan changed to the alternative Python Programming Language since the Amazon Web Services allow developers to host in a local server as an incentive, that greatly simplifies and secures any vulnerabilities in the communication between skill and smart speaker device.

Another great advantage of having an alexa skill hosted by the AWS is the uncomplicated process of publishing the skill. This process is undertaking at the moment, and most of the third party certification was skipped.

3.6 Application Workflow

The whole workflow of the skill ends up being fairly straightforward, the user simply needs to:

1. Visit the <https://alexastudyingassistant.herokuapp.com>.
2. Join or create a topic to study.
3. Upload questions or textbooks to share with other users.
4. Download and install the alexa skill **Studying Assistant**
5. Start the interaction by launching the skill.
6. Ask the available topics or start practice a given one.
7. Stop when done and check for the score.

This workflow is of course divided in two steps, but users could and should just iterate more often between the 5th and 7th step.

3.7 Summary

In a nutshell, in this chapter the basic architecture and potential of both applications, both the alexa skill and the web server and website were described. Some suggestions were also made on ways how the software could grow in the near future, and although all the source code was unrevealed, the latter can be examined following the URL, <https://github.com/jmpargana/AlexaStudyingAssistant>, where a public open-source licensed repository was published.

4 Evaluation

Even though this project was mainly thought of as a development thesis, the potential for interesting conclusions that could be drawn from this experiment was so high that it was decided to do some research with the resulting eLearning tool as well.

This chapter of my thesis presents the whole evaluation of the developed program. It also serves as proof of my exposed theory in the abstract section, that technology can be easily adopted by a general public to assist and facilitate learning habits.

The chapter is organized as follow: I'll start by describing the methodology used to evaluate the skill, explaining how it profiles the users and their behaviors. I will follow the aforementioned by the statistical data provided by the experiment, showing the scope of the users' characteristics and how they represent certain classes. I'll then finish the chapter with the valuable results and suggestions received with feedback in addition to my academical interpretation of the accomplished.

4.1 Methodology

The methodology behind the survey is heavily inspired by the TAM 2.5. The features it tries to outline, are the user's perceived usefulness and ease-of-use. In addition to these attributes, my survey has a heavy focal point on defining the user's profile, or establishing a classification class or target group which shares the stipulated characteristics of the aforementioned profile. The latter's objective is to draw supplementary conclusions, such as to discover whether or not a certain group is more prone to a wide adoption of the/a new technology and is ready to promptly change its learning customs. Furthermore, the survey inquires its user about suggestions on improvements or other features that could make the software more appealing to the target class and a more global scope of attainable users. For logistical reasons, mostly the incapacitating restrictions originated by the COVID-19 virus, this survey and experiment was only performed on a sorted out set of six individuals, all representing different classification classes, namely different age groups, professional backgrounds and studying purposes (academic, professional or recreational). As such, the extent of the survey is much larger than the commonly used TAM studies, for it contains much more extensive and particular questions, in order to derive prevailing and accurate deductions.

4.2 Survey Candidates Sampling

For logistical reasons, mostly the incapacitating restrictions originated by the COVID-19 virus, this survey and experiment was only performed on a sorted out set of six individuals, all representing different classification classes, namely different age groups, professional backgrounds and studying purposes (academic, professional or recreational). As such, the extent of the survey is much larger than the commonly used TAM studies, for it contains much more extensive and particular questions, in order to derive prevailing and accurate deductions.

The most important distinctions, which represent fundamental differences between users were found in:

- **Age:** Perhaps the most important from all the parameters categorized in the sampling process, age has an almost direct influence on all the other criteria. If the test subject is in its twenties, then he will more likely be using the software to practice for school or some certification needed. The subject will also more likely be more knowledgeable of newer technologies. If the subject is over his seventies, he will very unlikely be learning for professional purposes, etc. This class will be divided in five main age groups that share learning purposes and habits: 6-18 as a pupil, who will most likely be studying either for school or a certification. 19-28 as a student or junior starting his career mostly gathering certification, academical degrees or learning for some hobby interest. 29-50 as a professional that either learns for his professional career or out of interest. 51-65 as a senior worker that will either need to learn some new skill for his work or for a hobby. 66+ as a retired individual who will most likely only learn and practice something out of interest with absolutely no professional goals in mind.
- **Purpose/Goal:** This was indeed a very important distinction in the sampling process. This parameter was divided in three categories. Professional/career, academical/school/certification or hobby/recreational. Even though the attitude towards learning can be the same or different across these different categories, for example, a student might be equally inspired learning for an university topic as he is for something he might be learning for entertainment purposes only, the type of motivation in the background is very different. Someone studying for professional reasons, being motivated or not, is to expect similar consequences regarding their work. Either to get a promotion, or to improve the workflow, but the type of expectations, clearly affect the *drive* that guides the corresponding learning process.
- **Professional/Academic Background:** Also an important mean of measurement is the academical background of the interviewee. If the user has a extensive educational context, he is expected to have gathered a framework of methods to assist in his learning habits, while someone without it will more likely resort to different tools. This field could be separated with four main categories, namely: high school or equivalency diplomas (pupils would be automatically included in this field), professional degree or academic degree, where the latter will create distinctions for minor/major and PHD.
- **Practicing Habits:** Although this point is heavily influenced by the others, as are all the five by each other, the habits a learner has to enhance his knowledge of the given topic is very important regarding his approach to A: sensibility to change and B: perspective on use of technology. This class will be split into people that study less than 1 hour a week,

from 1 to 3 hours a week or more than 3 hours a week.

- **Attitude Towards Technology:** Perhaps the most important factor, although already mentioned and deliberately influenced by the practicing habits, the attitude towards technology plays an essential role in the users apprehension of the system and potential change of behaviour. This field will be dissected into three groups, someone with negative view on technology, that for instance actively tries to avoid usage of technology as much as possible, someone with neutral view, that ends up using technology very widely, but is not particularly kin on it, and someone that has a very positive view, a person that will be a typically early adopter of new technologies.

A major field used to categorize and distinguish users in a survey is gender. I made a conscience choice to avoid this differentiation, as although it might regularly show interesting dissimilarities, a sample of 6 test subjects is much too small, and any differences will likely be biased by the other parameters mentioned above, which in my opinion play a much bigger role in the learning habits and practices of learners.

As one might observe, the combination of all different evaluation parameters with their given subclasses means at least 540 test subjects would need to be part of the survey, which would be impossible given the conditions mentioned in the beginning of the chapter. For that reason, the users chosen to represent the classes are the 6 most distant points in the 5 dimensional space of these characteristics.

As such, the first selected 6 test subjects were:

4.2.1 Toddler

The first test subject was a nine year old toddler, who is learning English to improve his grades at school. Is profile can be shown in the following table:

| | |
|-----------------------------|-------------------------------|
| Age | 6-18 |
| Goal | Extracurricular Consolidation |
| Educational Background | High School |
| Practicing Habits | <1h a week |
| Attitude Towards Technology | Positive |

4.2.2 University Student

The second test subject was a twenty two year old university student practicing for a bachelor's subject. The following table shows his profile:

| | |
|-----------------------------|-------------|
| Age | 19-28 |
| Goal | Academical |
| Educational Background | High School |
| Practicing Habits | 1-3h a week |
| Attitude Towards Technology | Neutral |

4.2.3 Junior Getting Certification

The third test subject was a twenty six year old young musician with a masters degree studying to get her drivers license. The table shows her profile:

| | |
|-----------------------------|--------------------|
| Age | 29-50 |
| Goal | Certification |
| Educational Background | Minor/Major Degree |
| Practicing Habits | <1h a week |
| Attitude Towards Technology | Negative |

4.2.4 Professional Learning For Hobby

The fourth test subject was a thirty seven year old professional who wants to study music theory to enhance her piano playing skills. Her profile is shown below:

| | |
|-----------------------------|-------------|
| Age | 29-50 |
| Goal | Hobby |
| Educational Background | PHD |
| Practicing Habits | 1-3h a week |
| Attitude Towards Technology | Neutral |

4.2.5 Senior Office Worker

The fifth test subject was a sixty two year old office worker who wants to practice knowledge needed at work, as the leader of the library department of the Portuguese Ministry of Education, and was opened to try a new methodology, even though she had a negative view on technology. The table shows other parameters:

| | |
|-----------------------------|---------------------|
| Age | 51-65 |
| Goal | Professional |
| Educational Background | Professional Degree |
| Practicing Habits | 3h+ a week |
| Attitude Towards Technology | Negative |

4.2.6 Pensioner

The last test subject was a seventy two year old pensioner who is very kin on the use of technology and an early adopter and used it to practice his studying of the Chinese culture. The profile is shown below:

| | |
|-----------------------------|--------------------|
| Age | 66+ |
| Goal | Hobby |
| Educational Background | Minor/Major Degree |
| Practicing Habits | 3h+ a week |
| Attitude Towards Technology | Positive |

4.3 Interview Process

The interview process was planned to follow the following steps:

1. Meet with the interviewee either personally or via Skype call.
2. Introduce the concept behind the experiment and explain the procedures.
3. Start with the pre-questionnaire.
4. Give the URL of the web application and setup the alexa skill. If the interview takes place personally, no setup is required, if not, the user's email needs to be added to the collaborators lista in the alexa developer console.
5. Allow the interviewee to explore the website and skill as he pleases only intervening if the interfaces are not clear or help is needed.
6. Observe the interaction and take notes, also limiting the amount of time spent in the web application (15 minutes) and alexa skill (10 minutes).
7. Finish off the experiment by filling the post-questionnaire.

4.4 Survey

As mentioned above the survey was adapted from generalized TAM questions, which are used on experiments with 100+ users, to a more detailed set of questions which focus mainly on three big aspects. The learner's attitude towards technology, the ease-of-use and the perceived usefulness of the developed system.

There is a short profile section that inquires the user about the list of parameters mentioned earlier in this chapter, followed by a pre-questionnaire to be inquired before the use of the application and a post-questionnaire. Besides asking more extensive questions about the overall experience, the survey also urges to learner for suggestions that could improve the efficiency of the still young and incomplete software.

The following can be observed here 6.2.

The results are going to be divided into each one of the participants, since they yield very different conclusions.

4.4.1 Toddler

The six year old toddler that used the smart speaker application to improve his English as a foreign language skills, showed very positive results. He already had a very positive view on technologies and had a tablet as mentioned by his primary teacher to assist on some home-work.

The toddler had a positive experience and was thrilled to use such a fun piece of technology. From his feedback not many conclusions can be drawn, for the simple fact that he still lacks experience and knowledge of other methodologies and represents a highly volatile class of learners.

4.4.2 University Student

The university student was very pleased with her experience with the smart speaker and felt it could prove useful in many daily life situations, though discarding it as a main means of practicing and studying for the future.

She also proposed very interesting features that could be added to the web application to improve the overall experience. It was suggested that the web platform should implement more social features. Each user should be able to have a profile where her topics would be exposed to others and one should also be able to follow and see which user created and uploaded which topics, textbooks and questions. The suggestion very strongly hinted that a community of practice should be built and the web application should take advantage of the useful social networking capability.

4.4.3 Junior Getting Certification

This participant had some trouble setting up and getting started with the alexa skill, although she thought the web application was of easy and practical use.

The junior had many suggestions on how to improve the user experience and the effectiveness of the tool which focused mainly on the smart speaker. The user suggested that it didn't make much sense to divide content from web and alexa applications and that one should be able to upload the desired content immediately via voice to the alexa, simplifying the whole procedure. This suggestion opened many questions about the whole architecture of the tool, but the proposal to add it as an extra feature to the skill sounded very interesting.

4.4.4 Professional Learning For Hobby

This professional had a good experience. It took some time to understand the whole mechanism, but afterwards it worked smoothly. One important suggestion was made, in which the learner proposed that users should be able to rate questions, either by difficulty or by quality. Such as to sort them according to difficulty when using the skill and to be able to delete some other questions that would be considered poorly formulated by the community sharing them.

This, she suggested, should only be done on the web application, since the alexa interface would become otherwise too complex.

4.4.5 Senior Office Worker

The senior office worker, who already had a very negative opinion on newer technologies had difficulty setting up the environment and could solely proceed with my accompaniment. By the end of the experiment she admitted it could be useful but wasn't convinced she would keep practicing with it.

A suggestion was made, so that textbooks could be used in the web application more widely, by either marking passages, creating questions just for some paragraphs, and have the alexa skill read them out loud before prompting the user with the questions.

4.4.6 Pensioner

And finally the pensioner had a very positive experience. He needed some rounds to understand the engine of the alexa skill but was very happy and excited to keep studying his topics of interest using it. This result wasn't very surprising, for he already had one smart speaker in the first place and was looking for an excuse to use it on a regular basis.

4.5 Summary

In summary in this chapter the whole evaluation procedure and model were presented. Firstly the technology acceptance model's variation, then the selection of learner individuals that could represent a broader class, who would have similar outcomes, followed by the description of the survey and the experiment's outcome. The following chapter will present my inference and interpretation of the results and all proceedings observed.

5 Discussion

In this chapter I will discuss the diverse results of the experiment, analyzing the learners' interaction with the developed technology and my opinion on their experience and how I interpret the changes, if any. I'll try to summarize my ideas and answer each of the research questions mentioned in Introduction chapter, subsequently analyzing the chosen evaluation methodology, and how the results could have been foreseen, or in others words, if anything new could be learned from the procedure.

Taking into consideration the main goal of the application, namely to create an effective eLearning tool to help students learn using an innovative smart speaker application also functional for informal activities such as multitasking, then the results show that yes, the users' reception of the technology was very positive and it serves its purpose. If on the other hand we define the goal as a more complex learning tool, that actively creates a community of practice, that functions as an informal learning tool, that transfers tacit knowledge to a more explicit and codifiable form through repetition and simplicity, a tool that conveys micro content effectively, then the analysis can start becoming more vague and blurry, for these facts were not so vastly assessed with the experiment, and could only be observed in a much larger time scale firstly and with many more users and experiments secondly. If lastly the goal of the experiment was purely to assess the research questions and to try to understand users' learning processes using eLearning tools in comparison to traditional ones and more orthodox methodologies, then the results were even less certain, for these conclusions can not be so easily drawn from such a brief experiment.

With that being said, one can still hypothesize taking the results into consideration for more vast and general points, such as the complex learning tool and difference in the learning processes as above mentioned.

I will start by interpreting how these results could answer the research questions and followed by why they implement all the more abstract features as presented in the Introduction.

5.1 Research Questions

Referring back to the presented research questions exposed in the Introduction chapter:

1. What is the learners attitude towards less traditional learning tools, that:
 - a) take advantage of more informal practices?
 - b) use innovative technologies?

- c) try to combine social, informal and micro learning in one place?
- 2. Are users aware of how important/efficient this less traditional ways of learning are?
- 3. Are users aware of how important/efficient use of technology to help the learning process is?

1a: As observed in the experiment, the attitude towards practices that take advantage of more informal practices depends from learner to learner. Their attitude towards informal practices can take three shapes. One, they are unaware of the importance and unopened to change, two, they are unaware of the importance but opened to change and three, they are aware of the importance and already have a positive attitude. The ones with the unopened attitude remained so, even if the experience was enjoyable, and the other two types remained pleased and positive. So according to this experiment, learners can have these three stand points and their opinion is unlikely to switch polarity.

1b: These question has a similar answer as the previous one, though in this case another factor comes into play, namely the fear that such technologies will be difficult to learn from some parties. This fear of learning just adds complexity to the already hard learning process in the first place, so even though it might prove easier for the given task in the future, it serves as a strong unmotivation.

1c: Regarding this question all participants had a positive mindset, for they were all aware of how important social circles are to learning, and a tool that combines that with other learning styles can only present positive outcomes.

2: Most users were not aware of the importance of such learning ways. Even though most of them already used such methodologies, in some cases completely unaware of the fact, they mostly considered it a lack of understanding of the more traditional learning habits, in a form of inferiority almost, completely neglecting the possibility that such ways of learning could be as important.

3: Here the participants of the also differ. Every single one of the participants agree and admitted the importance of technology as something ubiquitous and advantageous in almost every field. But regarding learning habits, the answer was not so obvious anymore and needless to say, didn't change after use of the developed tool.

5.2 Complex Learning Tool

Reexamining the tool's second goal, to become a complex eLearning application, to cover the four goals and ideas expressed in the Introduction and Related Work sections, my opinion regarding each of the topics is the following:

- **Communities of Practice:** the ability to engage in communities of practice, forming bonds on common interests and sharing knowledge is not fully covered by the application and not completely understood by its users. The fact that the users use the platform associated with an online account, is still not enough to consider it a CoP platform, for all the necessary conditions are missing. The main architecture was layed out to further improve this aspect in the future, where only small steps are needed to implement the right conditions. The next steps would be to create user profiles, where one could follow

and display which topics he/she is currently studying or interested in. Another thing would be to leave comments and flags, so learners leave suggestions on how to change or improve some questions or content. Rating questions would also be important to allow the interaction and build hierarchical systems between the users.

- **Informal Learning:** this next topic is the most widely covered learning paradigm of the entire application. The fact that its an extracurricular form of learning is already in itself a form of informal learning, but the application also makes use of a smart speaker, which allows the student to interact and learn whilst performing different daily tasks.
- **Tacit Knowledge:** this aspect can not be easily assessed. The transformation of tacit into explicit knowledge is a very vague and abstract concept. But the fact that using this application one can practice any topic, also topics that are better learned with tacit knowledge techniques, and that it codes the knowledge into a written form hints that this characteristic too is achieved by the tool.
- **Micro-Learning:** this concept is also very accurately covered by the application. it certainly compels its users to invest small but regular intervals of time, for it can be matched with any hand activity that doesn't protrude the students' concentration, making it optimal for the conveyance of small portions of micro content at a regular pace. According to the experiment as well, this was one of the most complimented features.

5.3 Analysis of Evaluation

Looking back at the procedure, I think the methodology chosen was appropriate, for the fact that it takes in consideration mostly the users' reviews of the tool and tries to gather suggestions on all missing features and potential future improvements. The size of the experiment was in my opinion small. It should have been much larger both in terms of time as for the participants. I think the experiment should take place repeatedly during a time span of maybe one semester, following the learning habits and interaction with the application across different learning episodes. That would potentially change the opinion of the participants with experience, as opposed to fast impressions. These was unfortunately unfeasible, for the development of the application, which was the main part of the thesis already took half of a semester of effort and the logistical difficulties caused by the global pandemic crisis were unforeseen.

The expected results beforehand changed from before the application was written, to after, as well as before the related work and concepts were understood to after, but in general the results were expected. It was expected that people with more eagerness would keep the same mentality, despite the effectiveness and utility of the tool, and the ones less eager would also remain unchanged.

One can learn that the attitude and behaviour towards technology is more important than the experience itself. If one wishes to implement efficient tools in a learning system the attitude towards technology of the people in power needs to be clear. That is the number one factor in psychology and the power of the tool itself comes in second place.

For the future I would wish to enhance the written tool with all remaining features, as well as the suggested ones and attempt once again the experiment, this time observing the learners across a longer time span.

6 Outlook

6.1 Conclusion

In conclusion, two goals were achieved with this thesis. One, a eLearning tool set out to assist learners with a very contemporary form of technology, namely a smart speaker, was created to cover the type of informal learning that could only undertake using it. And two, an evaluation of the impact of such a technological tool amongst users of all kinds, analyzing how adoption and transition to newer learning procedures can occur.

The application, although not complete in terms of all the potential features it could integrate to represent the ideal tool comprising a framework with the capabilities to form communities of practice, be used in all types of informal learning, carrying out a smooth transition from tacit knowledge practicing to a more explicit one and ultimately conveying well packed micro content, it certainly fulfills its first and main purpose, such as act as a simplifier of the type of question-based learning done with multiple choice quizzing. This aspect can be proved by reviewing the positive results all the participants in the experiment delivered.

On the other hand, the evaluation and assessment showed that the previous attitude towards technology has a very large weight over the whole procedure, and that adoption for those less willingly is at best gradual and slow. The results of the survey are not conclusive, in the sense that the experiment was most likely fractional to the numbers and methods needed to assess it more definitely, but the inference that this aspect plays the largest role in the adoption of new technology, especially for learning purposes is undeniable.

6.2 Future Work

For the future remain two steps that can be improve the verdict. First, the missing and suggested features, both the ones exposed in the Potential Future Improvements section of the cha:implementation chapter, as well as the ones suggested by the users, for example a more interactive social network that would implement a proper community of practice. And secondly, perform a more vast evaluation that could follow both more users of each of the defined categories/classes 4.2, as well as through a longer period of time following more learning episodes.

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Appendices

Appendix 1: Questionnaire

Alexa Quiz questions

This survey has the sole purpose of providing the developer feedback about his software, as well as valuable information on either who might be the target group for this application, or what changes are essential to simplify a wide adoption of this technology.

All data disclosed is guaranteed to be kept only by the developer and only further shown in his thesis as purely statistical data, anonymising the survey's participants.

Pre questionnaire

User Profile

- Age
- Field of Occupation/Study
- Habits with technology
- Usage purpose; what is the topic to be studied (professional, academic, hobby)

Mindset and behaviour

Practicing habits

- What are you currently studying?
- What is the purpose of your studies?
 - getting a degree,
 - Getting a certification,
 - Hobby
 - Other _____
- How many hours a week do you study?
- What technologies do you use for your studies?
- Have you ever used "quizzing" as a practicing method?
 - If yes

- How effective do you consider quizzing to be?

On technology

- What is your opinion regarding the usage of technology for daily tasks?
- What is your opinion regarding the usage of technology for learning tasks?
- Has that opinion changed before

Post Questionnaire

User experience

Web application

The web application was easy to use (1 not at all - 10 totally agree)

Alexa Skills

- On a scale from 1 to 10, with 1 being very awkward, and 10 being very natural, how would you rate your experience with the application
- On a scale from 1 to 10, with 1 being very bored, and 10 being very motivated, how motivated would you be to use this application again?
- On a scale from 1 to 10, with 1 being very likely, and 10 being very unlikely, how likely would you be to use this application in your free time?
- On a scale of 1 to 10, with 1 being not at all, and 10 being completely, do you feel like you learned anything while interacting with the application?
- On a scale of 1 to 10, with 1 being much worse, and 10 being much better, how does using this application compare to how you would normally learn the same content in a traditional classroom?
- I would recommend this application to a friend (1 not at all - 10 totally agree)
- The application is fun to use (1 not at all - 10 totally agree)
- Have you ever used an application that was similar to the one that you just tested?

On software

- The topics were well organized (1 not at all - 10 totally agree)
- Finding topics of interests is easy (1 not at all - 10 totally agree)
- Which extra categories should be added?
- Ranking questions would be a good idea. Yes - No

If yes

- What kind of rankings would be good?
- Easy/Difficult
Good/Bad
- Other please specify

- List the 3 most negative aspects of the website
 - List the 3 most positive aspects of the website
- What 3 improvements would you add to the Website

•

- List the 3 most negative aspects of the Alexa Skill
- List the 3 most positive aspects of the Alexa Skill
- What 3 improvements would you add to the Alexa Skill

Technology acceptance What changed?

- Using the application changed my perception on technology (1 not at all - 10 totally agree)
- Using the application changed my perception regarding the use of new technologies for learning (1 not at all - 10 totally agree)
- My current perception of learning technologies would be different if the application was easier to use or if it has some extra features.
- If you have any additional comments or feedback, please share them here.