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DESIGN IMPLICATIONS FOR THE VIRTUAL LANGUAGE LEARNING COMPANION ROBOT

Considering the Visual Appearance, Behavior and Rewarding

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ABSTRACT

Eshtiak Ahmed: Design implications for the virtual language learning Companion robot Considering the Visual Appearance, Behavior and Rewarding
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Second language learning has become very important in the current globalized world, which has led to the creation of many language courses in various platforms. Especially, online language learning platforms such as, Duolingo, Mondly etc. have gained much popularity in recent times, because of the accessible nature and convenience factor. Despite their popularity, these online language learning platforms still lack the human factor and meaningful interactions. Previous research has shown that meaningful interaction such as instructor's feedback and peer support can create a significant positive impact on online learning. Thus, the objective of this study is to investigate how to integrate these factors into an online language learning platform.

Robot Assisted Language Learning (RALL) is a concept where physical social robots are employed to assist language learners, giving peer support and sometimes acting as instructors. Our goal is to introduce the RALL concept into the online language learning platforms. To go with the online nature of the platform, we focused on Embodied Virtual Agents (EVA), which are referred to as virtual social robot in this study. In the context of online language learning, the proposed virtual social robot will be employed as a virtual language learning companion. The design process of such entities has not been widely reported before and thus, we wanted to address this research gap in this study. Additionally, we have included target users already in the design phase of the virtual social robots in a more human-centered approach.

This research study aims to understand user's perception and expectations of the virtual language learning companion robot focusing on three major characteristics of its design: appearance, interactional behavior and rewarding. Furthermore, the goal is to use the findings of the study to formulate solid design implications to aid future designs and developments in the area of online language learning. This is a qualitative study which employs a Human-Centered Design (HCD) approach. As pre-study, we conducted a co-design workshop with five groups of language students (n = 25) and theme interviews with seven design students. All the participants were asked specific questions about the appearance, behavior, movements, motivational factors, and rewarding of the virtual language learning companion robot. The idea of having an interactive virtual social robot to assist online learning was accepted and appreciated by all the participants. In addition to that, they sounded out different expectations and design suggestions about different characteristics of the robot. All the data gathered from the co-design workshop and theme interviews were qualitatively analyzed with thematic coding and divided into five themes for more specific analysis. The thematic analysis resulted in primary design suggestions, which were then used to create usage scenarios through the storyboarding technique. These scenarios were then evaluated and validated through semi-structured interviews with seven university students.

Data analysis showed that potential users preferred a robot-like appearance rather than a human-like one while human-like gestures and movements were appreciated. Constructive, contextual, and seamless feedback was expected from them as well in order to create meaningful interaction. Additionally, digital and incremental rewards were suggested while surprise factor was appreciated as a mega reward. Finally, considering the study findings as well as the related works, 7 design implications were formulated to aid the design of a virtual language learning companion robot.

Keywords: Robot Assisted Language Learning (RALL), Social Robots, Embodied Virtual Agents (EVA), Human-Centered Design (HCD), Virtual Social Robots

PREFACE

During my master's studies, I studied many courses. Among them, User Experience in Robotics was by far the most interesting and exciting. Robots have always been a fancy tech for me with which I never had a chance to work before and this course provided with the opportunity. So, when the time came to choose the topic of my MSc thesis, I had no doubt in mind that I would study Human Robot Interaction (HRI).

I would like to thank my supervisor, Dr. Aino Ahtinen for giving me this opportunity to work on a real-life topic which led to practical implementations. Her active supervision and guidance as well as drive towards a significant contribution have been crucial for the completion of this thesis. I would like to thank her for always being so responsive and insightful.

It has not been an easy journey, especially in terms of finding participants for user needs study as well as the evaluations. I would like to thank all of those who were generous enough to find some time for participating in the studies.

Finally, I would like to thank my family for supporting me throughout my journey and always believing in me. They are the only ones who never had any doubt in my abilities.

Tampere, 29 April 2021

Eshtiak Ahmed

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1. INTRODUCTION

This chapter introduces and explains the research topic at hand as well as the motivation behind it. The topic of the study is understanding users' perception and expectations for a virtual language learning companion robot to devise design implications for it. This chapter will demonstrate the background of the research, objectives and the research questions as well. In addition to these, the structure of the whole thesis is explained.

1.1 Background and Motivation

Learning a second language nowadays is more of a necessity due to globalization. In order to add convenience to the learning process, many online learning platforms have been created, such as Babbel, Mondly, Duolingo etc. These online learning platforms are becoming more popular because of their convenience and specific learning targets, gaining the trust and appreciation of learners all over the world [1]. Most of these platforms offer text or video-based lessons, sometimes both. While these platforms are considered useful, they lack proper interaction with the learners [2]. It has been reported that, social presence or the sensation of being part of the platform makes it easier to make good use of the lessons. The importance of interaction was emphasized in [3] where the study participants (students) mentioned that they expect a teacher or instructor should always be available to interact with them, giving feedback and available to answer questions.

Research have shown that online learning platforms usually lack the human factor which is easily achieved by F2F (Face to Face) teaching [4]. The presence of an educator as well as interaction between the learners and the educator plays a vital role in achieving the learning outcome. Studies have suggested that learning can be much more effective with the help of proper interaction as it can increase motivation and make it playful [5]. Studies also suggest that social interaction between learners and peers in online virtual platforms result in a high level of satisfaction and learning experience [6][7].

The popularity of virtual learning platforms has led to many features being included to them. One of the concept is Robot-assisted language learning (RALL), which as the name suggests is a concept of employing robots in language learning assistance [8].

This concept includes robots to be involved in language education to create an interactive environment. So far, physical robots have been widely used in education and learning [9], especially social robots. Social robots are one kind of robots that has the ability to communicate with in a way which is understandable to humans. The can also have abilities to relate to human factors of communication and react in a way that resembles human behavior [10]. These types of robots programmed to have social skills which allows them to operate close to humans in their day to day lives by adding meaningful interactions such as conversing, helping with chores, teaching things as well as providing entertainment [11][12]. In addition to having human-like communication capabilities, a social robot needs to have an appearance that is close to a human being or at least resemble humans in a natural way. This physical appearance should include movements, facial features, gestures etc. to make the interactions more natural [13]. The concept of RALL has been experimented in many studies with social robots, however, online language learning platforms have not introduced robots yet, at least not in terms of appearance and embodiment. Several online language learning platforms have chatbots, such as Duolingo, Mondly, Memrise etc. These are mainly conversational robots and do not have proper appearance or social features. They can only have a limited level of conversation with the users based on some pre-scripted dialogs.

While RALL based studies have investigated how social robots can aid in language learning, online language learning platforms have been out of this scope. The objective would be to introduce human-like interactions and seamless feedback, not just text based conversational agents. Interactions in virtual learning platforms can be introduced in several ways such as, voice-based interactions or sounds. However, voice coming out of a webpage cannot create a proper interactive engagement [14] and this leads us to the concept of embodied agents [15], more specifically embodied virtual agents (EVA). Embodied agents are agents that has a physical appearance and with which they can interact with their surroundings. EVAs are virtual agents that are animated objects that can move, talk, and look like human beings [16]. The embodiment of an agent ensures that it has appearance as well as physical features, such as face, body, movements, gestures and expressions. Several research studies have concluded that conversations are much more meaningful and effective if the agent has a face as well as gestures and expressions [17][18], which in case of online learning platforms can be embodied agents. In this study, both EVAs and embodied agents are referred to as virtual agents.

A related study [15] has shown that embodied agents can play a very important role in improving the learning experience as well as enhancing the way they engage in learning.

In addition to that, it can improve the construction of their knowledge, resulting in improved performance. While it is clear that embodied agents can make a significant difference in improving virtual learning platforms, there are many aspects that are needed to be considered while designing such an agent. Firstly, we need to consider the embodiment and appearance of the virtual agents. The degree of learning and engagement can be directly linked to the appearance of the agent and if not done right, it can even be the factor that pushes away potential learners [19][20]. Studies have reported that different user groups based on age difference have different preferences for the appearance of an embodied virtual agent [21]. In addition to the appearance of these agents, the interactional behavior is also regarded as a very important factor in online learning environments [22]. It has also been reported that social components in interaction affects the learning outcome in a positive way [23]. When it comes to affecting learning outcomes in a positive way, rewards can also play a very significant role. Reward based education increases playfulness and creates interest in a learner's mind, inspiring them to keep going and achieve more [24][25].

For this study, we consider embodied virtual agents as virtual robots who have all characteristics of embodied agents such as appearance, expressions, movements as well as gestures. The virtual robot concept also includes social features such as human-like communication capabilities, ability to relate to human situations as well as human-like behavior. Thus, it can be said that there are no characteristic differences between virtual robots and embodied virtual agents other than the way they are implemented in different situations.

1.2 Objective and Research Questions

In the context of online language learning, virtual robots are yet to be explored properly. The popular platforms do have feedback related features and some of them have conversational chatbots, however, the interaction and feedback still come from the webpage or application itself. As per improving the interactions, embodiment of these agents seems to be of great value. Adding embodiment as well as social features to the feedback mechanism of the language learning platforms can have a significant impact. In this thesis study, we plan to address this gap and investigate how the embodiment of a virtual robot on a language learning platform should be. Additionally, the process and thinking behind the of designing a virtual robot from the beginning has not been reported in previous works. We plan to address this gap as well.

The goal of this thesis is to understand the users' expectations about virtual robots as a learning companion and create solid design implications, which reflect the users' needs.

In addition to that, this study includes potential users already in the beginning of the co-design process. The design implications will focus on three major aspects, *the physical appearance of the virtual robot, its behavior while interaction with the user and the rewarding system*. This particular study will focus on a virtual language learning platform, Elias [26], developed by Utelias Technologies. So, the study phases as well as the design implications will be based on and linked with the Elias platform. Following are the specific research questions that are addressed and investigated in this thesis.

RQ1. What type of physical appearance should a virtual language learning robot have?

RQ2. How a virtual language learning robot should react and behave to create meaningful and engaging interaction? What type of movements and gestures should be included?

RQ3. What type of rewards can motivate the users in a virtual language learning platform?

This study follows the human-centred design (HCD) approach which is the process of solving a problem or designing a product by involving humans in all the phases [27]. The research has been conducted in several phases. The first phase was to conduct an online co-design workshop with university level language students who are the primary target group of this study. Next, theme interviews were done with university level design students who had previous experience in robotic design as well as user experience in robotics. Data from both the co-design workshop and the theme interviews were then analyzed qualitatively to find out users' expectations. Based on these findings, scenarios were developed and then evaluated to devise specific design implications for a virtual language learning companion robot.

1.3 Structure of the Thesis

The chapter 2 focuses on the related works to the topic at hand as well as insights from literature where virtual robots were investigated. The topics covered in the related works chapter are online learning platforms, role of robots in learning and the design factors of a virtual robot. Chapter 3 describes the research approach and methods applied for this study which includes the data collection and analysis methods. The research study phases are also mentioned and described in this chapter. The user needs study findings are discussed in chapter 4 which includes findings from both the co-design workshop and the theme interviews. Chapter 5 focuses on the scenario development based on user needs study findings including the design and descriptions of the scenarios. This chapter also discusses the scenario evaluation process as well as the finding from the

scenario evaluation. Chapter 6 includes the discussion of the findings of this study considering the related works as well as the limitations and challenges.

2. LITERATURE REVIEW

This chapter includes a literature review on three main factors related to this thesis. The first section (2.1) discusses the virtual education space as well as its effectiveness to provide a sound quality education and adding value to the traditional system. The second section (2.2) explores existing research on educational virtual robots along with their contexts of use and usefulness. The next section (2.3) explores the related works on designing a virtual robot focusing on three major factors, appearance (2.3.1), interactional behavior (2.3.2) and rewarding (2.3.3). Finally, all the related works are summarized in terms of the research questions and the research gap has been analyzed.

2.1 Online Education and its Effectiveness

Online learning platforms are getting more and more popular every day and as a result, it's important to maintain the quality and effectiveness. Especially, due to the remote learning nature of education nowadays, online learning platforms have become a necessity. However, the quality and effectiveness of this type of education still remains questionable. Studies have suggested that multiple aspects influence the learning quality and experience in virtual learning platforms. Such as, content design, interactivity, trust and demographics [5][28]. The content can engage better if they are attractive and well structured. Also, there needs to be a continuity through the lessons so that it does not feel scattered and there should be incremental addition to the level of knowledge to the lessons. Interactivity is one of the major requirements for creating meaningful learning environment [6]. Interactivity mainly encourages the engagement of the users to the platforms. Trust is another very important parameter when it comes to adopting online learning as it affects the commitment of the learner to the platform as well as reducing the sense of uncertainty. The increase in trust factor can increase seamless engagement on online platforms and at the same time reduce drop-out rates [29]. Demographics also plays a significant role as people from different age groups, professions and cultures perceive thing differently. To be effective and successful, these platforms either need to focus on specific demographics such as specific age groups or specific cultures or should try to be culture neutral to some extent. The level of expertise in using technology related product is another important demographic [30].

Several previous studies have investigated the factors influencing virtual learning and learners' satisfaction. According to [31], the students' perception of the instructor's credibility in subject matter defined their level of confidence on the course and resulted in

better learning satisfaction. Their qualitative study findings suggest that the presence of the instructors and the interaction with them can create a sense of satisfaction among the students. According to the students, counselling and support from the instructor are especially important for achieving proper knowledge construction as well as for increasing the satisfaction with the course. Another very important factor that has come to light is the social interaction between learner and peers as well as the instructor. Social interaction increases motivation and question answering between peers and instructors make the learning more spontaneous [6][7][32]. These works emphasize on the importance of having peer support and social components in an online learning platform to increase engagement. This increases the option to ask and answer questions to resolve confusions and conflicts to achieve a common learning goal [33].

Reward based learning on virtual platforms are another way of engaging students. In [34], the effect of virtual achievements such as online badges based on learning performance were investigated. The findings suggest significantly higher quantity of students engaging and contributing on the platform being motivated by the badges and achievements. In addition to that, the quality of learning stayed on an expected level. Students reported that they enjoyed having these kinds of online badges and it motivates them to keep working to earn them.

Positive learning outcomes in online learning platforms can differ based on the expectations from the courses. However, there are several factors that can influence this such as engagement, virtual competency and collaboration between peers [14]. Engagement with the platform as well as meaningful interaction plays a big role in motivating the students to keep up and keep going. Here, meaningful interaction can be defined as the types of interactions that can create experiences. Almost all the platforms have some type of interaction, such as, clicking, tapping, voice feedback etc. However, these interactions do not necessarily mean anything other than navigating through the platform. A meaningful interaction could be created by adding real life contextual relations with the study materials, introducing social factors in conversations as well as variable feedback based on context [35]. Working in a team to collaborate and learn new things is another factor that influences learning motivation and quality. In [36], the authors have investigated how peer interactions between learners can influence the sense of community and how it can lead to sustainable usage of virtual learning platforms. The findings suggest that the interaction between instructors and students as well as among students play a vital role in strengthens the students' sense of community and motivates them to achieve common learning goals. The most prominent finding of this study was that the interaction factor influences the learners most when it comes to being motivated to keep learning.

As online learning platforms are of self-learning nature, a major concern is the dropout rate. A couple of studies [37][38] investigated this problem and hypothesized that gamification could be a potential solution for this. This includes creating a playful interactive environment as well as more motivation focused feedback. The results show that gamification with proper meaningful interaction combined with an online platform can lead to more engagement and less dropout rates.

2.2 Social Robots in Language Learning

In the language learning paradigm, social robots have been used widely. This significant adaptation has been the result of these robots having social features such as human-like communication, context-based feedback as well as the ability to relate with humane circumstances [10]. They also have human-like appearances to a great extent, resulting in more natural feeling interactions. Social robots these days have become significantly advanced in terms of understanding context as well as human language. They can recognize and understand the language and provide feedback accordingly. This helps them create meaningful interactions with the users [12].

There are several studies which investigate language learning with social robots which falls under the concept of robot-assisted language learning (RALL). RALL is an area of human-robot interaction (HRI) which promotes the usage of social robots in teaching language lessons, contexts, comprehension as well as conversational skill. It includes speaking, writing, reading, or listening in either native or any other language [39], whichever is convenient to the learner. In a RALL based study [40], major aspects of the solution have been discussed, such as the context of learning from a robot, embodiment of the robot as well as the social behavior. Significant issues like age effect, meaningful interaction, verbal and non-verbal behavior have also been discussed. Their experiments using NAO robot found that age plays a significant role in defining the type of interaction and engagement with a robot tutor. A comparative experiment with children under six and teenagers revealed that the older children gazed for longer times towards the robot while interacting while the younger children did not maintain gaze contact for long. This could mean that younger children have a shorter attention span and it needs to be addressed when designing for that specific group. It was also found that children respond to meaningful interaction which they can relate to, resulting in higher learning gain. Non-verbal behavior, such as gestures were also found to be effective, especially iconic gestures to represent physical features of the object to learn. However, they are an area of concern because of the limitations of social robots' movement due to their limited degrees of freedom.

A study [41] investigated children's anthropomorphic beliefs about robots to understand their effects on learning a second language. The findings suggest that children anthropomorphise the robot both before and after the lessons at a similar rate while some changes to the beliefs were reported after the lessons. A weak but significant relation was also found between these beliefs and the learning efficacy. Another study [42] that investigated the impact of RALL in second language learning on the junior high school level reported similar findings. Lower anxiety and more positive attitude were observed in RALL based learners compared to the traditional learners. They also reported having fun in the learning process and they felt that they were learning more effectively, resulting in boosted motivation in continuing the learning. A study [43] that focused on anxiety, motivation and interaction in pre-school students has reported similar findings to the previous one. They have reported increased motivation and reduced anxiety in students due to the interaction with the robot which has been reported to have created a friendly atmosphere. While robot tutors have been proven effective to a great extent, they also introduce moral and ethical challenges. Concerns about the robots negatively affecting aspects like moral values, ethics, trust, privacy and security have been mentioned [44].

RALL based studies have also been quite common engaging adults. A study investigated the effectiveness of RALL based methods to help immigrants to learn a second language [45]. The findings reported that it offers unique learning experience as well as many insights for keeping up the learning motivation and learners' attention. They have reported their exploratory study in a qualitative manner with 10 immigrants as participants, focusing on a customized RALL based solution to understand their user experience (UX) for a language learning solution at work settings. The findings of the study reported that participants had positive attitude towards RALL and there was an easy-going learning environment created. However, there were some concerns found such as, frustration while the robot does not respond and difficulties in understanding the robot. It was also evident that a support was needed from a human language trainer at times to make the learning interactions understandable. Another user study [46] presented an anthropomorphic robot head to 33 adult second language learners for Swedish language practicing. They tried to understand how interacting with a robot can influence the interaction and peer support. Findings suggest that the learners were more positive about having a one to one conversation compared to, however, they were observed to be more active in the sessions where the robot acted as facilitator to encourage peer interaction. This was also influenced by the learners' proficiency level as well as previous connection with peers and how well they know each other.

There have been several studies where robot-assisted learning was investigated with physical social robots, however, using virtual robots have not been reported in the language learning context. So far, none of the major platforms have introduced virtual robots to assist in language learning. Several research studies have been reported where virtual robots were investigated in other areas of learning. In [47], a virtual robot solution has been presented to aid programming learning. The solution helps a novice student to understand basic programming concepts through simulations. According to the results, the virtual robot has introduced a significant amount of tangibility to the outcomes. Much needed visualizations had been introduced with this concept that helped the learner relate the programming logic to significant real-world scenarios. In [48], learners' participation in several online courses were investigated with and without a virtual robot that was employed as a chatbot to encourage robot-learner and learner-learner interaction. However, the course topics were not disclosed explicitly.The results showed significant positive difference in participation behavior and achievements of the learners in situations the robot was present and interacting with them. Increased motivation and attention was observed in learner-learner communication also. Another study [49] investigated the embodiment and gender preference for a virtual instructor in a virtual field trip for a geoscience course. The results were investigated in terms of social presence, perceived learning effectiveness and performance of students. There was a total of 22 participants in the study, 11 of the were male and the other 11 were females. Results show that both gender and embodiment of virtual instructor affects the learning experience. Also, embodied and female virtual instructor was preferred to disembodied and male instructor. However, preference from specific target groups for female instructors were not mentioned in the results.

To understand users' preference for virtual learning companion agents, several studies have made user-centred evaluations. In [50], six different embodied virtual agent designs were presented to students and they were asked to evaluate the agents considering seven key aspects. The keywords were attractiveness, expertness, effective, intellectual, enjoyable, pleasant and intelligent. Each agent was employed to narrate study related materials and later were evaluated by the students. The observations indicate that the presence of the agents increased the satisfaction between the learner. The need of user centred development of such agents were appreciated as well. A similar study [51] employed two different virtual agent designs, one robotic and one human-like, both having different behavioral attributes. The study tried to understand, which design can better connect with the user with their appearance and non-verbal behavior to create feelings of warmth and competence. They found out that the robot-like agent was better to create

a feeling of warmth initially which decreased over time, while it remained constant for the human-like agent. Also, agents with gestures were perceived as more competent compared to agents with no gestures.

2.3 Virtual Social Robot Design

Embodiment: There are several aspects of virtual robot design that can increase the effectiveness and acceptability. Physical embodiment is one such aspect. A study [52] which focused on investigating the physical and social presence of robots found that social features as well as embodiment of a virtual agent is vital for interaction with people. However, this study did not find major differences between physical agents and virtual agents in terms being socially present as long as they had embodiment and social features. Both types of agents were considered socially present and this indicates that a virtual agent with social features can have similar impact as a physical social robot. Another study [53] explored the attitude of humans and their decision making scenarios with different embodiments for robots. For the experiment, they employed four types of robots which were then compared. These were a virtual reality (VR) robot, an augmented reality (AR) robot, a physical robot, and a physical robot that was tele-presented on a display. For each participant, faith or trust, attachment and social presence of the robot were investigated. It was evident that, physical presence of a social robot was preferred to the virtual presence of it, however, embodiment seemed to be important in both cases. Additionally, results show that embodiment of a robot creates faith in the users' mind, making it easy for them to trust the robot [54][55]. On the contrary, lack of appearance resulted in less trust among users.

Interactional Behavior: Another important aspect of robot design is interactional behavior such as non-verbal cues, gestures and body movements significantly affect the overall user experience [56]. Studies [44][57] have suggested that learning companion robots should be designed in such a manner that it can adapt to the diverse nature of learners, understand their approach and act accordingly. It's very important to try and build a trust to support long term interactions. Providing effective feedback as well as using meaningful gestures are also considered to have a very significant impact on the interaction. However, it needs to be investigated if these factors differ when it comes to virtual robots.. Another study [51] has reported that robot-like appearance and movements is preferred by users when it comes to virtual agents in learning environments. The findings suggest that, the rating of trust and warmth depends on the type of interaction as well as the timespan of the interaction. The more time the users spend with the robot, the better the interaction becomes, ideally because of better understanding of the robot's behavior

and interaction cues. The robot's competence in demonstrating something also seem to be connected to the interaction timespan and nonverbal behavior.

Rewards: In any learning platform, it's very important to motivate the users to stick to the learning. Most of these platforms use different types of rewarding schemes in order to keep the users motivated. Digital badges, reward points, ranking systems are some of the rewarding schemes implemented by many virtual learning platforms [58][59]. In terms of robot specific rewards, there are gestures, voice-based appraisals and visual cues, as example, candy eyes [25]. One study [60] investigated the effects of rewards and punishment feedback mechanisms to understand the effects of them in learning performance. The findings suggest, feedback is always more effective in creating learning gain compared to no feedback. Interestingly, punishment mechanism has worked better to increase learning gains in certain scenarios compared to positive feedbacks like rewards. To clarify, the punishment feedbacks used here are simple negative feedbacks like shaking head or telling the learner that they are wrong or not doing well.

2.4 Summary

Related works suggest that there has been a significant amount of work that has been done when it comes to virtual agents, however, their connectedness and usefulness to online learning platforms have not been broadly explored. There have also been many studies that propose design suggestions connecting them to motivation, effectiveness, and trust factors of a virtual agent. However, the design process of a virtual robot for language learning companion purpose from beginning has not been widely reported. All the previous studies have employed pre-created agent avatars and tried to compare their credibility with user studies. None of these studies have reported the actual process and thinking behind the design of the agents they have employed. Related works also show that there are no existing proper guidelines for designing a virtual language learning robot from the beginning. This study aims to address this research gap and attempts to start from the very beginning of the design process. To make the design process more robust and to make it credible, we have included potential users as participants already in the co-design phase. Later, design implications were formulated for a virtual language learning companion robot.

3. RESEARCH APPROACH AND METHODOLOGY

This chapter elaborates the research process, approach, methods as well as the phases of this thesis. The first section focuses on the research approaches and methods that have been employed to design the user studies. The next section provides an overview of the whole research process detailing the phases.

3.1 Research Process

There was a total of 5 phases for completing this thesis research. Specific tasks, their timelines as well as the outcomes for each phase has been demonstrated in the Figure 1.

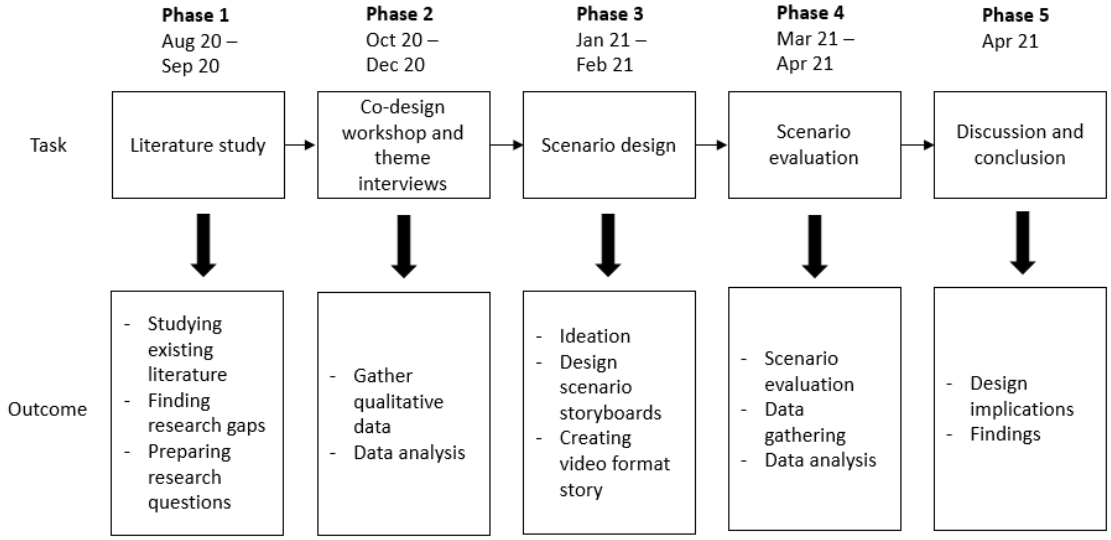

Figure 1. *Phases of the research process.*

Phase 1: In this phase, related literature to the topic were searched and analyzed to find existing knowledge. At the same time, multiple meetings and discussions with Utelias Technologies took place to decide a common goal. This also helped in understanding the research gap in the field and helped to identify the research questions to be answered. During this phase, the objective and flow of the thesis became clearer. This phase lasted two months and laid a strong foundation for the later phases.

Phase 2: This phase consisted of the user needs study in forms of a co-design workshop and theme interviews. This phase focused on understanding the expectations and perception of the users towards a virtual language learning companion robot. Later in this

phase, the gathered data from the co-design workshop and theme interviews were analyzed. The phase was around three months long.

Phase 3: This phase mainly focused on ideating based on the data gathered in the previous phase. There were also multiple meetings with Utelias Technologies the keep everything in the right direction. Three scenarios were designed and agreed upon using storyboarding. The storyboards were converted to a video format for convenience of evaluation. This phase lasted two months.

Phase 4: In this phase, the concept scenarios were evaluated with a semi-structured interview method. The gathered data was then analyzed to find supporting information for design implications. This phase lasted two months.

Phase 5: This was the final phase of the research where all the gathered data were analysed that included the literature study, pre-study and the scenario evaluations to devise the final design implications. Also, the findings were analyzed in light of the existing literature. The research questions were answered, and the research gaps were addressed in this phase. This phase lasted one month and was concluded in April.

The ethical conduct was strictly followed throughout this research process. For the co-design workshops as well as the theme interviews and the concept evaluation, all the participants were asked to sign a consent form. Any personal data was either not recorded or removed during the data analysis phase. Participants and groups were assigned unique codes for identification and referencing purposes. All the data was treated as confidential and they were stored in a secure drive provided by the Tampere University.

3.2 Research Platform

This research based study has been conducted on and around the Elias Robot language learning platform [26] developed by Utelias Technologies. Elias Robot is an artificial intelligence (AI) based language learning application, on which the learner can learn and practice multiple languages through lessons, listening and speaking with Elias in real time. There are numerous theme-based modules and lesson in the application to learn about fruits, food, colors, emotions etc. There is also a feature where teachers can freely create and modify their own lessons for their students to have a more customized and suited learning process. The application guides its learners to complete lessons and exercises which are designed with gamified elements and tries to encourage learning with fun. Currently, the application has fully made courses and support lessons for eight lan-

guages, such as Swedish, Chinese, English, German, French, Finnish, Italian and Spanish. On top of that, speech recognition more than 20 languages are available. The figure 2 represents an image of the Elias Robot language learning platform.

Figure 2. *Image of Elias Robot language learning platform* [26].

Previously, the platform only had voice based and visual interaction features. In relation to this study, it has been planned to introduce a virtual robot on the platform to make it more interactive and make the interactions more meaningful. In order to conduct the research and user studies in this thesis, the contents of the Elias language learning platform have been utilized for demonstration and scenario creation purposes.

3.3 Research Approach and Methods

The human-centred design (HCD) [27] approach has been used in this study. HCD is a process of creating design solutions by including humans and their perspectives in decision making. As example, if a product is going to be designed to be used by humans, then in HCD process, the design elements should come as suggestions or needs from humans, what they expect, how they expect it to be etc. Human involvement in such cases can be co-designing, observation, brainstorming, discussions, interviews and so on. This method has helped us understand the users' needs and preferences as well as their expectations towards the design factors.

3.3.1 Pre-study

3.3.1.1 Research Focus and Participants

The main element of this design study is a co-design workshop [61] with 25 language students, which focused on answering the three research question. The goal of this workshop was to understand the perception of potential users for the appearance, interactional behavior and rewarding of a virtual language learning companion robot. Later, theme interviews [62] were done with seven students who specialized in design and user experience (UX) to understand the design challenge from a designer's perspective. The participation in the co-design workshop and the theme interviews were voluntary and data consent was asked from all the participants. All the collected data was treated as confidential, hence no identification was kept, and the data was stored in a secure drive provided by the Tampere University. A qualitative analysis was then employed to analyze the data collected from the co-design workshop and theme interview sessions. Here, thematic coding [63] was done to divide the data into themes which were then analyzed to create design implications.

3.3.1.2 Data Collection Methods

Co-design Workshop: We conducted one co-design workshop where the participants were language students at the Tampere University. The workshop focused on understanding the perception of language students for a virtual language learning companion robot, specifically the robot's appearance, interactional behavior and it's rewarding schemes. The workshop was conducted online because of the covid-19 restrictions. Zoom online meeting tool was used to facilitate the workshop and the session was recorded. An online collaboration tool Mural was used for proper documentation, idea generation and discussion tracking. The participants were given three major tasks to complete, related to 1) the appearance 2) interactional behavior and 3) rewarding schemes of the virtual robot. Each task contained four questions to trigger discussions and insightful thinking. The total duration of the co-design workshop was two hours and 30 minutes.

A total of 25 participants took part in the co-design workshop. They were studying different languages at the Tampere University. The gender and age of the participants were not tracked. Among the participants, only one participant reported to have some previous experience of interacting with robots while the others had never interacted with robots despite strong interest. At the beginning of the workshop, the participants were given a short demonstration of the current Elias [26] learning platform to give them an idea about how it works without a virtual robot. Then, the participants were divided into five groups where each group consisted of five participants. The room division feature of Zoom was used here to create virtual rooms where each group was assigned to a room.

The Mural canvas was constructed with questions, which were designed to ignite critical thinking among participants, leading to discussions in the group. Some of the questions were as follows: "*What kind of behavior/interaction with the virtual robot can keep up your interest and motivation?*", "*What bodily or visual features of a robot can make you think that it's useful or fun?*", "*How do you think a virtual robot can appreciate your efforts? What things can a robot do that will make you feel good and motivate you to keep on interacting with it?*". Based the questions on the Mural canvas, each group discussed and documented their thoughts and discussion summaries on the Mural canvas. The participants were encouraged to speak their mind and document every idea even if they seemed unreasonable. Figure 2 is a screenshot of a small part of the Mural canvas where group members documented their ideas by answering specific questions related to the design of the virtual robot.

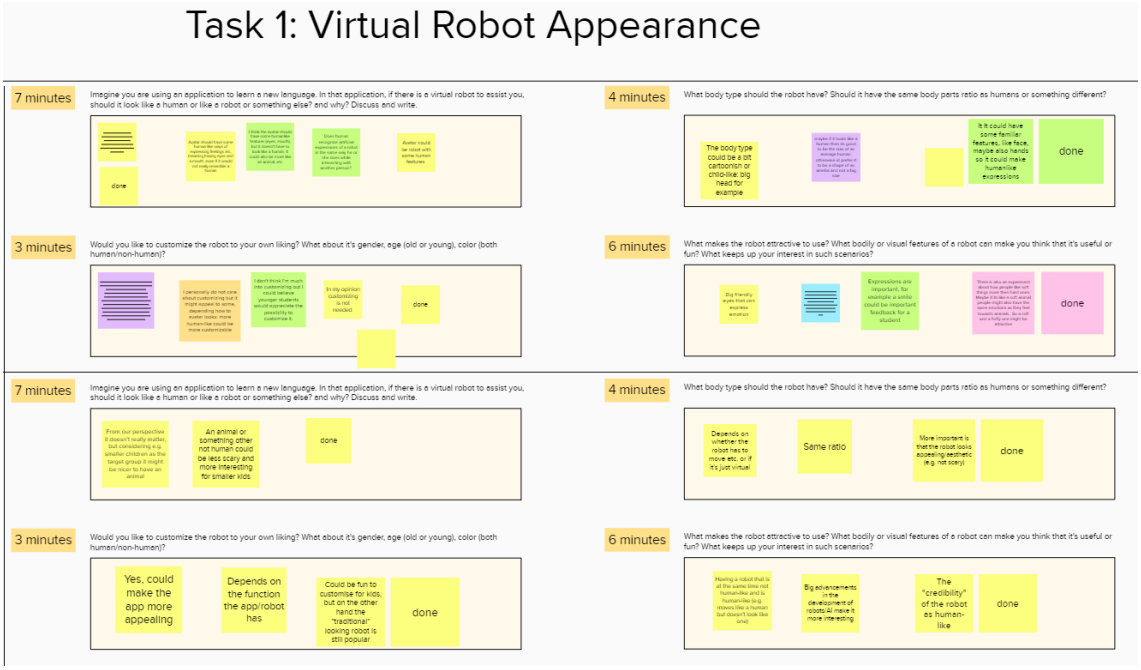

Figure 3. *A section of Mural canvas where the groups have documented their ideas based on the questions asked.*

Theme Interviews: As the language students did not have a design background and almost none of them had previous experience with robots let alone user experience in robotics, we decided to conduct one on one theme interviews with design students having previous experience with robots and user experience. These participants were considered competent in design and as a result, their insights and opinions added a designer's perspective to the data. For these interviews, the questions were kept the same

to keep the data aligned. The same tools, Zoom and Mural were used for these interviews and each session took around one hour and 30 minutes.

There was a total of seven participants for the theme interviews, among them five were second year masters students from design and user experience background. They also had previous experience in user experience in robotics. The other two students were first year master's students of Human Technology Interaction (HTI) with substantial experience in user experience in robotics.

3.3.1.3 Data Analysis

Data from both the co-design workshop and theme interview sessions were discussion notes triggered by the same questions and discussion cues. For this reason, all the data was collected to a common repository for analysis. At first, all the data fragments were copied into an Excel sheet under task categories. After collecting all the data into one sheet, thematic coding [64] was done. Based on the task categories (one task each for robot's appearance, interaction behavior and rewarding schemes), the data was already automatically divided into three themes (appearance, interactional behavior and rewards). However, as there were multiple questions for each major task fragment, there were multi-themed data under each category. As example, the task two was discussion on interactional behavior of the virtual robot when questions were asked about both verbal and non-verbal communication, different types of feedback as well as movements and gestures. As it was an open-ended discussion, several factors also came out that were not originally documented as structured questions. This way, one high level task gathered multiple themes of data and were needed to be divided into different categories. As a result, we divided the data further by identifying multiple themes from one major task. Finally, the data was distributed into five major themes where each thematic category represented a major part of the virtual robot's design. The categories are 1) appearance and visual features, 2) gestures and movements, 3) feedback, 4) sound, voice and tones, and 5) rewards and motivation. Under each theme, the data were analyzed in a qualitative process. Participants' opinions and needs were filtered out for each theme with this analysis.

3.3.2 Evaluation Study

3.3.2.1 Research Focus and Participants

As part of the HCD process, the findings from the pre-study with target users are needed to be evaluated. The findings from the pre-study with target groups resulted in some solid design suggestions which are in the process of implementation in the Elias language learning platform. The platform being under preparation led to choosing storyboarding

[65] and scenario development [66] for the evaluation study. Storyboarding is a widely used technique in the HCD process which is used for demonstrating product interfaces as well as usage context of it. For the designing of new products or systems, storyboards usually try to explain a possible usage scenario of how the features of an application work. This method is used in the design phase when there is enough data about how the product or system is envisioned. It helps the designers demonstrate the scenario on how the potential users will use a product and how the experience could be.

In line with the research questions, three storyboards were designed, 1) interaction and behavior of the robot, 2) constructive feedback and 3) rewarding for performance. The storyboards were created in image format and then they were used to create videos to demonstrate the scenarios. As the platform was yet to be published with the virtual robot included, still images of the virtual robot were collected to show and evaluate with the participants.

A total of seven participants were recruited for evaluating the scenario storyboards and the avatars. Six out of the seven participants were students from either Human Technology Interaction (HTI) or Information Technology (IT) background while the other participant was a service holder from the IT industry. Two out of seven participants were from the age range 20 to 25, two participants were from 26 to 30 and the other three participants belonged to the 30 to 35 age group. All of the participants reported that they had previously used digital applications or platforms for learning a second language.

3.3.2.2 Data Collection

For evaluating the scenario storyboards as well as the avatars of the virtual robot, semi-structured interviews were conducted. The scenario storyboards were created in a video format for convenience of demonstration. During the interviews, the participants were first introduced to the platform and its principles. Then they were shown the scenario videos one by one followed by questions for each specific scenario. Also, the newly designed appearance of the virtual robot in different scenarios was shown for evaluation purposes.

Participants were invited to take part in a semi-structured interview for the evaluation phase data collection. In the interview sessions, each participant was made aware of the research process and consent was taken for recording the sessions. For each scenario, the participants were shown the storyboard scenario video and all of the questions were answered to make the ideas clear to them. After demonstration, participants were asked open ended questions about their opinion on the scenario storyboards. The answers of the participants were followed up by more questions on the go.

3.3.2.3 Data Analysis

All the evaluation interview sessions were recorded for the data analysis purpose. Participants were asked general questions about the idea as well as specific questions about the scenarios. The recorded sessions were transcribed into an excel sheet under four categories, 1) appearance, 2) interaction and behavior, 3) constructive feedback and 4) rewarding. After that, qualitative analysis was done for each category of data and were reported. The data was qualitatively reported under themes such as, positive feedback on the scenario, negative feedback on the scenario, and improvement suggestions.

4. PRE- STUDY FINDINGS

This chapter documents the findings gathered from the user needs study consisting of a co-design workshop and theme interviews. There were five groups in the co-design workshop and we refer to them as G1, G2, G3, G4 and G5. All the co-design workshop participants were language students at the Tampere University and had little to no previous experience with robotics and design. There were seven participants in the one on one theme interview sessions, and they are referred to as P1, P2, P3 and so on. These participants were design students with significant previous experience in robotics and user experience. The following section is the theme-based reporting of findings.

4.1 Appearance and Visual Features

In the co-design workshop, all the groups (5/5) said that they would prefer the appearance should not fully resemble a human, rather it should have a robot-like appearance. Some groups (2/5) said that it should be anything but human-like. One of the groups documented that it could be scary if there's too much resemblance with a human: "*It could resemble a human, but not in an uncanny way*" (G4). four out of the five groups suggested that the robot could be more impactful if it resembles an animal: "*An animal or something other than human, could be less scary and more interesting for smaller kids*" (G2). When asked about gender or colors, two out of five groups reported that it can be gender neutral with neutral colors while other groups did not report anything. From the theme interviews, some (3/7) participants reported that the appearance should be robot-like, not human-like: "*NOT A HUMAN, human-like virtual robots or agents are creepy and unnecessary*" (P3). "*To reduce the human expectations on what the robot can do.*" (P4). "*I would have robot-like form as a basis since it makes clear for the user that the function behind the agent is based on robot.*" (P3). two participants said that they would prefer humanoid robots. two out of seven participants wanted the robot to be either a human-like cartoon or a superhero. The other participant said that a female avatar would be preferred.

When asked about more specific visual features, three out of five groups reported that the robot should have body parts like humans such as eyes, mouth, hands and legs: "*It should have humanlike features like eyes, mouth but not necessarily human*" (G1). One group said that they would prefer a bigger head than usual and big friendly eyes that can express emotions. two out of five groups said that they would like something that looks soft and fluffy. One group said that round shapes make the robot more likable. Some

(3/7) of the participants in the theme interviews said that the robot should have human-like body parts and ratio while others did not report anything in this regard. two out of seven participants thought that the appearance should be based on specific cultures of the user so that they can connect to it better. One participant suggested that the virtual robot can have only an upper body form (no legs) and should float while two other participants said that it should have legs as humans: "*no need of legs. not necessary to have legs can have wheels or float in air*" (P4).

To summarize, majority of the participants preferred more of a robot-like appearance rather than a human-like one. However, they think that the robot should have human-like body parts. Some of them thought that the eyes or the head could be a bit bigger than normal while round shaped body parts were preferred. Some of the participants mentioned they would like to have the appearance customizable as well. They mentioned that it can look different for different age groups such as soft looking and cartoonish for kids while adults can choose from multiple options.

4.2 Gestures and Movements

Three out of five groups suggested that human-like gestures are more relatable when it comes to interaction. One of these groups delved more into it and said that there should be some robotic twist to the gestures: "*still there could be a robotic twist to the human-like gestures; some fun attached to it*" (G3). Another group said that they would prefer smooth movements: "*Smooth movements preferred, contrasted to "traditional" jolting robotic movement*" (G2). One of the groups said that human-like gestures might be distracting and partial movement of body would work. There were some suggested gestures such as thumbs up (G3, G4), high fives (G4) and head tilt (G4). One of the participants (P1) of themed interviews said that changing gestures, expressions and movement can highly impact the success of such a robot. Four out of seven participants said that the virtual robot should have human-like gestures or behave partly like a human. They think gestures are a very integral part of the robot: "*gestures are important to stand as a feedback from the performance or as a support for verbal message. They make the robot more interesting.*" (P3). Three participants suggested that there should be visual movements and the robot should not be static all the time, they should react to every action of the users, gaze at the users and other elements on the screen, point to objects when teaching about them and make facial and hand gestures while talking: "*Body movements like moving hands while communication, verbal or physical gestures, sense of humor*

while talking can make the interaction robot more fun and attractive." (P6). One participant (P7) thought that gestures and movements should be related to the topic of teaching as well as the cultural context.

When asked about facial features, two of the groups suggested that it needs to be done very carefully as there is a very fine line between proper expressions and creepy ones: "*Facial impressions combined to glassy eyes might be creepy. So, I'd go for visual effects and not facial expressions.*" (G1). "There's a thin line between facial expression feedback and 'getting it wrong' or creepy" (G3). Two of the seven participants think that there should be some kind of facial expression but not negative expressions like anger or disgust, rather happiness and surprise. One other participant (P5) thought it should not smile too much and should behave according to the situation, such as be neutral or caring when the user is not doing well with the learning.

To summarize, all the participants wanted either partial or human-like movement from the virtual robot, however, human-like facial expressions did not seem to be a good idea. Participants had divided opinion on types of movement as some preferred smooth human-like movements while others preferred robot-like movements. Majority of the participants thought that the robot can perform some well-known gestures like hi five or thumbs up.

4.3 Behavior and Feedback

All the groups in the co-design workshop (5/5) thought that the virtual robot should have varied reaction and behavior depending on the situation. "*Varying expressions depending on how to tasks are going can make it more interesting to interact with*" (G1). One of the five groups mentioned that the behavior should never be on an extreme level: "*Affects motivation negatively if the robot is always over-positive*" (G2). "*It can change its voice a bit when the performance is not up to the mark, but not so rudely, or maybe can use different color in eyes*" (P2). "*it should show the difference in behavior but not negative and not extreme positive.*" (P4). Two out of seven participants from the theme interviews thought that the robot should have short or medium length of speech so that the user does not have any problem understanding and following the instructions: "*short interaction so that the users know when they can start speaking, no long lectures, turn taking*" (P5).

Two out of the 5 groups (G1, G3) mentioned that there should be visual feedback as well as voice feedback for every interaction. All the groups (5/5) have said that the robot should have positive feedback for doing well but neutral or constructive feedback for bad

performance. One of the groups mentioned that negative feedback can be explored as long as they are constructive and not too extreme. Also, if everything is positive and neutral, the robot should be able to point out what went wrong. "*positive feedback when doing well and positive encouragement when not doing well*" (G1). "*Too much positivity and unnatural laughter and smiling might become annoying. Kindness, neutral approach would work instead.*" (G1). "*Affects motivation negatively if the robot is always over-positive*" (G2). One of the groups (1/5) thought that the type of feedback should be customizable. All seven out of seven participants from the theme interviews thought that positive feedback is the way to go but it should not be over positive. Five out of seven mentioned about constructive feedback while the other two mentioned that it should have a proper way to point out the lackings in a humble way: "*It is good to let learner know that they need to improve or try again. In some very clear way. Still it should not be done so that person feels humiliated.*" (P3). Three out of seven participants strongly opposed having negative emotions while the other did not mention it explicitly. One of the participants mentioned about surprise moves: "*It could also have some surprise moments, for example different variating funny moves or ways of giving feedback*" (P3).

To summarize, majority of participants thought they should be able to visualize their progress and there should be feedback about stage by stage progress of the learning. There should be variable reactions to different activities of users while the reaction should not be negative or over-positive. The feedback should be neutral or constructive for unsatisfactory learning performance. Some of the participants have mentioned that the robot could change its shape or color as a form of feedback.

4.4 Sound, Voice and Tones

All five out of five groups thought that having voice interaction along with text can make the understanding process easier and make the interaction better as a result. Three out of five groups mentioned that the voice of the robot should be human-like with varying tone for different situations while the one group (G4) said that the voice should not mimic a human voice. Three out of five groups said that different accents to choose from would be good, as example, for people from different parts of the world, adults, kids etc. Two of the groups said that the voice should sound appealing, not harsh: "*Not an over the top voice that only aims to be funny or entertaining*" (G2). Two out of seven participants mentioned that the robot could have different tones for different types of words: "*Using a tone of joy for achievement, sad tone for sad words are example*" (P1). One of the participants said that the voice should represent the appearance of the robot, as example, if the robot looks like a male person, the voice should complement that. Adding voices

of celebrities or known characters were also suggested: "*The idea of putting the voice of some known people or celebrities can be great. or the robot looks like some animal than we can use our favorite cartoon voice.*" (P2). Four out of seven participants thought that voice should be changed depending on the user: "*motivative voice for children might be a bit different than for adults. At least, I get irritated of voices in children's tv shows.*" (P3). Three out of seven participants thought that there should be multiple voice options to choose from.

To summarize, all the participants thought that the virtual robot should have voice features and it should vary according to context, such as, funny or happy voice for task completions or achievements while neutral voice for the opposite. Some of the participants think that the voice should be customizable, and the users should be able to choose from multiple options.

4.5 Motivation and Rewards

Three out of five groups mentioned that seeing a proper progress map and traceability of the learning process can play a very important role in keeping the users motivated. "*might motivate by telling me facts about my learning like how I am doing, how do people do it averagely, what helps, what does not*" (G1). Appropriate and precise reaction for the activities can improve motivation. Four out of five groups and five out of seven theme interview participants said that positive and constructive feedback is very important and some of them mentioned specific feedback types: "*positive sounds: hands clapping, positive words*" (G3). "*the robot could change its color when you advance, use different light effects while communicating*" (G4). "*Audio-visual feedback, pretty lights and sounds*" (G5). Two out of five groups and two out of seven participants mentioned competition as a motivation to keep going: "*Competition, being able to see how other users are doing.*" (G2). One of the groups said that it would be more fun and motivational if they can connect and use what they have learned with the real world through the platform and the robot. Another group (G4) mentioned, if the robot can recognize the user in some way and call the user by their name, this will give a more personalized experience, hence increasing motivation. Three out of the seven participants mentioned that learning progress needs to be available which might include some statistical analysis of the users' performance. Varying the type and degree of feedback has also been mentioned: "*some simple reaction for every action e.g. happy face when finished one sentence, important actions can get a longer reaction e.g. "well done" when we finish one lesson of 20 minutes*" (P5).

As for more tangible rewards, two out of five groups and four out of seven participants mentioned game like rewards, such as achievements, emblems, trophies, diamonds, points, new levels unlocking, robot look upgrades etc.: "*games: gaining "coins" etc. when you do well and when you do, you can unlock new levels / upgrade the robot looks*" (G3). Two out of five groups mentioned about something surprising and crazy such as fire-works or the robot turning into a disco ball. Two out of seven participants mentioned about a cool robot dance in the event of good performance. Rewards can also be related to the lesson and very specific: "*if the user finishes fruit exercise, the robot gets a fruit in its hands*" (P5). Unlocking new robot avatars and new accessories have been mentioned by three participants.

For maintaining motivation, majority of the participants mentioned about traceability of the learning process as well as competition between users. As rewards, participants suggested game-like rewards such as coins, emblems, level unlocks etc. while clapping or other appreciative gestures were also mentioned. Surprising the users by changing shape and color of the robot was also mentioned by some of the participants.

5. SCENARIO DEVELOPMENT AND EVALUATION

This chapter explains the process of developing scenarios from user needs study findings. Furthermore, each scenario has been described including the design elements supported by the pre-study and the related works.

5.1 Scenario Design

In the co-design workshop and theme interviews, participants were asked specific questions to understand their expectations for a language learning companion robot. In the previous chapter, those findings were analyzed and categorized. At time of the evaluation of the findings, the Elias platform was not yet ready, hence we decided to create storyboard scenarios based on the findings. The three research questions which are discussed in section 1.2, were taken into account while designing the scenarios.

The goal of the storyboard scenarios was to give the potential users some idea about how the interaction would be when interacting with a virtual language learning robot. Three scenarios were designed to demonstrate positive feedback, constructive feedback and performance-based rewarding. For creating the scenarios, an online storyboarding tool was used, named Storyboardthat [67]. These scenarios were low fidelity and did not have interactivity in them, rather sample interaction examples. The designed scenarios, their design process and link to research questions are discussed on the following section.

5.2 Scenario Description

5.2.1 Scenario 1: Interactional Behavior and Positive Feedback

It was apparent from the co-design workshop and theme interviews that positive behavior and feedback is very important for the virtual robot to create the best learning experience. Specific design elements were chosen to help portray a positive feedback scenario. Table 1 contains the design elements used in creating this scenario as well as their justification from the user studies and literature. Additionally, it's also mentioned how these design elements have been incorporated in the storyboard. Among the design elements, the backgrounds and the characters are property of StoryboardThat [67]. The images of the Elias platform are property of Utelias Technologies [26].

The storyboard video has been uploaded to YouTube: https://youtu.be/Wkxkesaemr4

Table 1. *Interactional Behavior and Positive Feedback scenario elements and justification*

Design element	Justification	Implementation
Body movement of robot	User study indicated that the robot should have movement and it should change based on context	The virtual robot has different hand gestures as well as facial expressions created by eyes
Positive words and comments	User study findings support that positive words and feedback creates motivation	Positive encouraging words, such as *great, brilliant* etc.
Neutral feedback	When the user is not performing as expected, neutral feedback is desirable rather than negative	The robot does not provide any negative feedback
Statistical view of performance	The potential users expect to have a statistical view of their progress	Letting the user know how well they did compared to other learners

Keeping the design elements in mind, the storyboard based scenario was designed. Figure 3 and 4 are the designed storyboard scenarios in comic format.

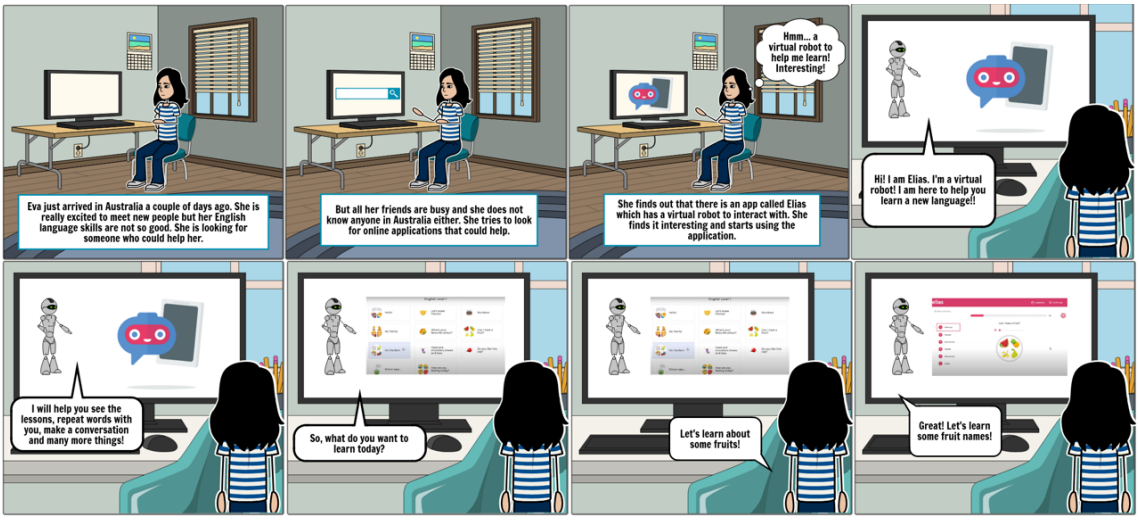

Figure 4. *Part 1 of interaction and behavior scenario; using design elements from Utelias Technologies* [26] *and Storyboardthat* [67].

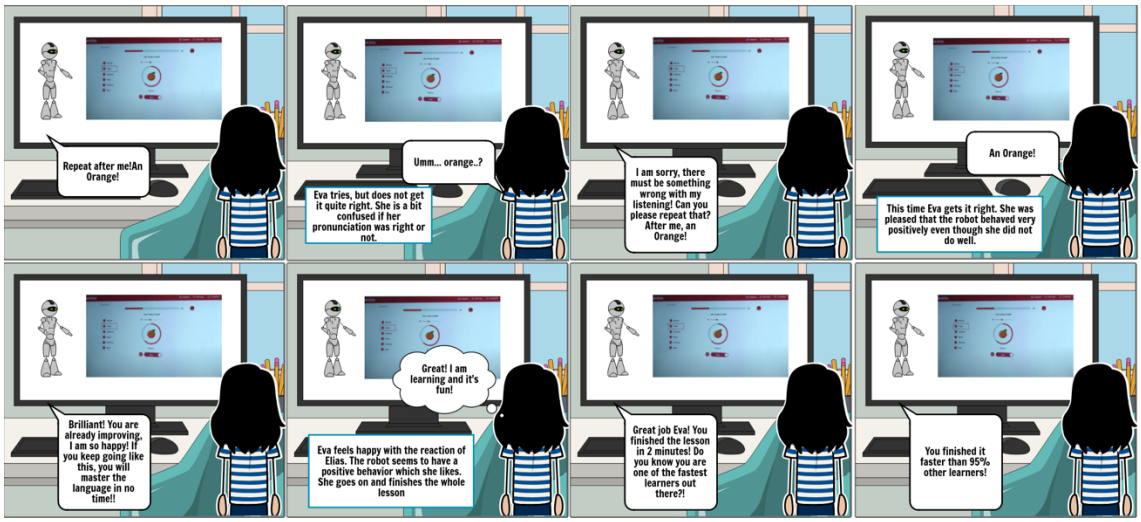

Figure 5. *Part 2 of interaction and behavior scenario; using design elements from Utelias Technologies* [26] *and Storyboardthat* [67].

This scenario introduces the character of the story, Eva and her interaction with the virtual language learning robot. The robot introduces itself to Eva and described what it can do. Then Eva starts a lesson to help her learn some fruit names. Here, initially Eva finds it difficult to correctly pronounce a fruit name but Elias does not provide any negative feedback, rather stays neutral and asks again. When Eva gets it right, Elias this time gives positive feedback. Additionally, Elias provides some statistical view for Eva's learning progress.

5.2.2 Scenario 2: Constructive Feedback

The user studies suggest that the virtual language learning robot should provide constructive feedback especially when the user is not performing well. To portray constructive feedback in the scenarios, design elements were agreed upon from the findings of the user studies which are listed and justified along with their implementation in table 2. Among the design elements, the backgrounds and the characters are property of StoryboardThat [67]. The images of the Elias platform are property of Utelias Technologies [26].

The storyboard video has been uploaded to YouTube: https://youtu.be/tGCsKanj6-k

Table 2. *Constructive feedback scenario design elements and justification*

Design element	Justification	Implementation
Users' condition recognition	According to the user study, the robot should recognize states of learning and difficulties	Robot recognizes the difficulties of the learner and responds accordingly
Specific comments on learning	User study findings say, the robot should be able to point out specific problem pointers to solve them	Robot pinpoint problem pointers

Statistical view for motivation	The robot should point out to statistical views of other users to make users feel associated	Robot gives a statistical view to console the user and motivate
Patience	The robot should behave patiently when the user is not performing well	The robot does not show any negative behavior and patiently handles the situation

The aforementioned design elements were considered for designing the constructive feedback scenario storyboard. The storyboard is shown in figures 5.

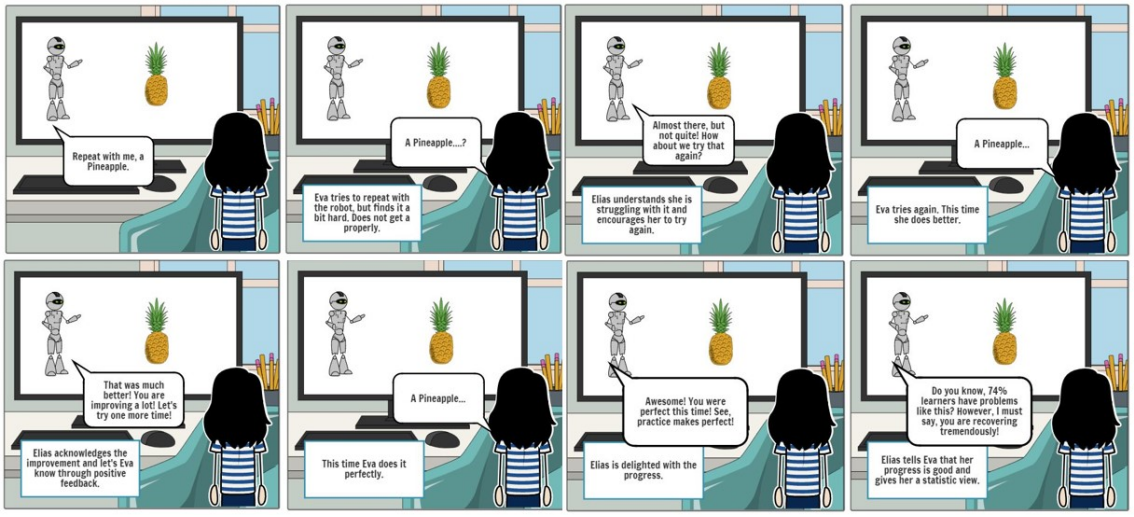

Figure 6. *Constructive feedback scenario storyboard; using design elements from Utelias Technologies* [26] *and Storyboardthat* [67].

The story in this scenario continues from the interaction and behavior scenario. Here, the user is trying to learn a rather difficult word and finds it difficult to get it the first time. The robot understands the struggle of the user and remains patient. It repeats the process again and encourages the user to try again. When the user improves upon previous attempts, the robot recognizes and acknowledges the improvement. Also, the robot provides some statistical facts about the lesson being a hard one and mentions that majority of learners have difficulties, resulting in creating a sense of association. Through the whole process, the robot stays positive and does not give any negative feedback.

5.2.3 Scenario 3: Rewards for learning performance

The idea of having reward based learning has been supported by both the literature and the user studies we have conducted. Different forms of rewards can play a significant role in increasing learning motivation and make it sustainable. For the rewards scenario, the design elements are shown in table 3 along with their justifications and their implementations into the storyboard. Among the design elements, the backgrounds and the characters are property of StoryboardThat [67]. The images of the Elias platform are property of Utelias Technologies [26].

The storyboard video has been uploaded to YouTube: https://youtu.be/wNAxDLySJaY

Table 3. *Rewards for learning performance scenario design elements and justification*

Design element	Justification	Implementation
Statistics and points based feedback	Precise statistics about the learning performance, users' position compared to other learners can be rewarding	Statistics about how other users do in difficult lessons
Topic related rewards	The rewards should be related to the topic	After finishing the vegetables lesson, the user is rewarded a vegetable bouquet with many types of vegetables
Unlocking new lessons	Based on performance, the users should be able to unlock new lessons	The food items lesson unlocks itself when the user finishes the vegetables lesson
Surprise factor	Unexpected and surprising rewards can create interest in the user	The robot catches fire and turns into fireworks is portrayed as a surprising factor
Positivity	The robot should use positive words and feedback even when the user is not performing well	The robot uses positive words and expressions, such as "*you are an inspiration!*"

Figure 6 shows the rewards scenario storyboard in a comic format.

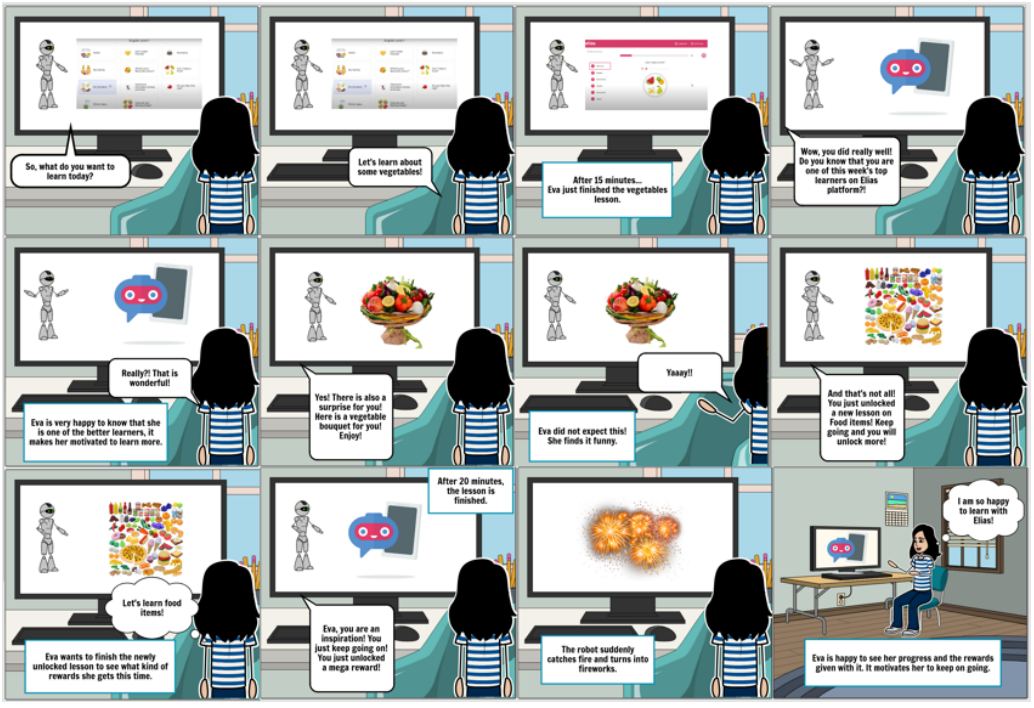

Figure 7. *Constructive feedback scenario storyboard; using design elements from Utelias Technologies* [26] *and Storyboardthat* [67].

In this scenario, several types of rewards have been demonstrated, such as topic related rewards, positive statistics, new lesson unlocking and surprise. The statistics and topic

related rewards are initial or more common rewards. The lesson unlocking depends on the performance of learners while the surprise rewards are a bit rare and they are given for continuous successful effort.

5.2.4 Virtual robot avatar

An avatar was designed by Utelias Technologies [26] which took inspiration and suggestions from the findings of our co-design workshop and theme interviews. This avatar was also a part of the evaluation process. Figure 7 shows the neutral mood of the virtual robot which is shown when it's having a normal conversation. Figure 8 shows the delighted state of the virtual robot which triggers when the user is performing very well. Figure 9 shows the sad state of the robot when something goes wrong. Figure 10 shows the robot on the platform, interacting with the users and asking questions. Figure 11 shows the state where the user has completed a lesson, performed well and achieved good points. This also demonstrates the statistical feedback of the performance for each lesson.

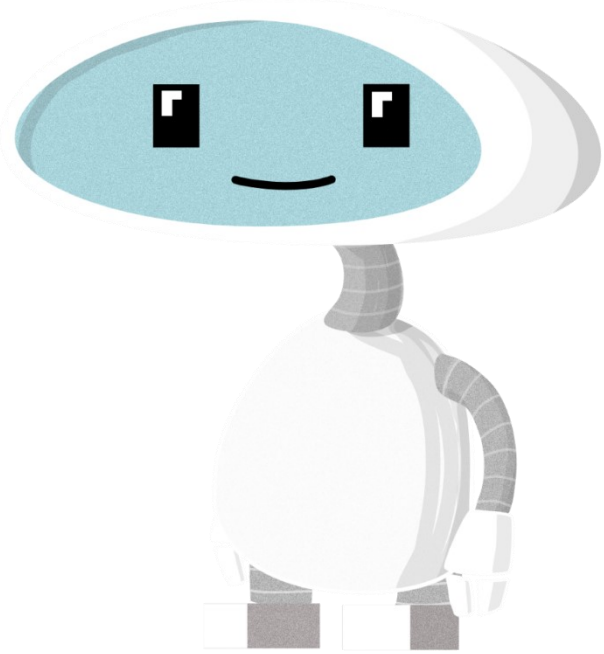

Figure 8. *Virtual Elias avatar, when neutral* [26].

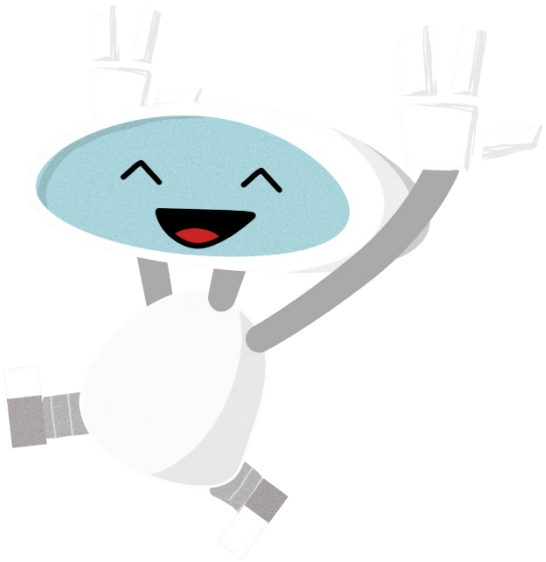

Figure 9. *Virtual Elias avatar, when very happy* [26].

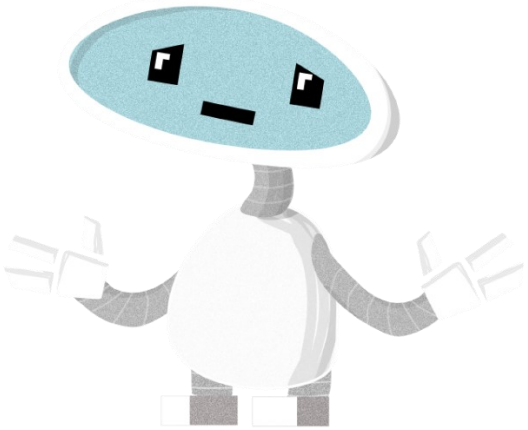

Figure 10. *Virtual Elias avatar, when sad* [26].

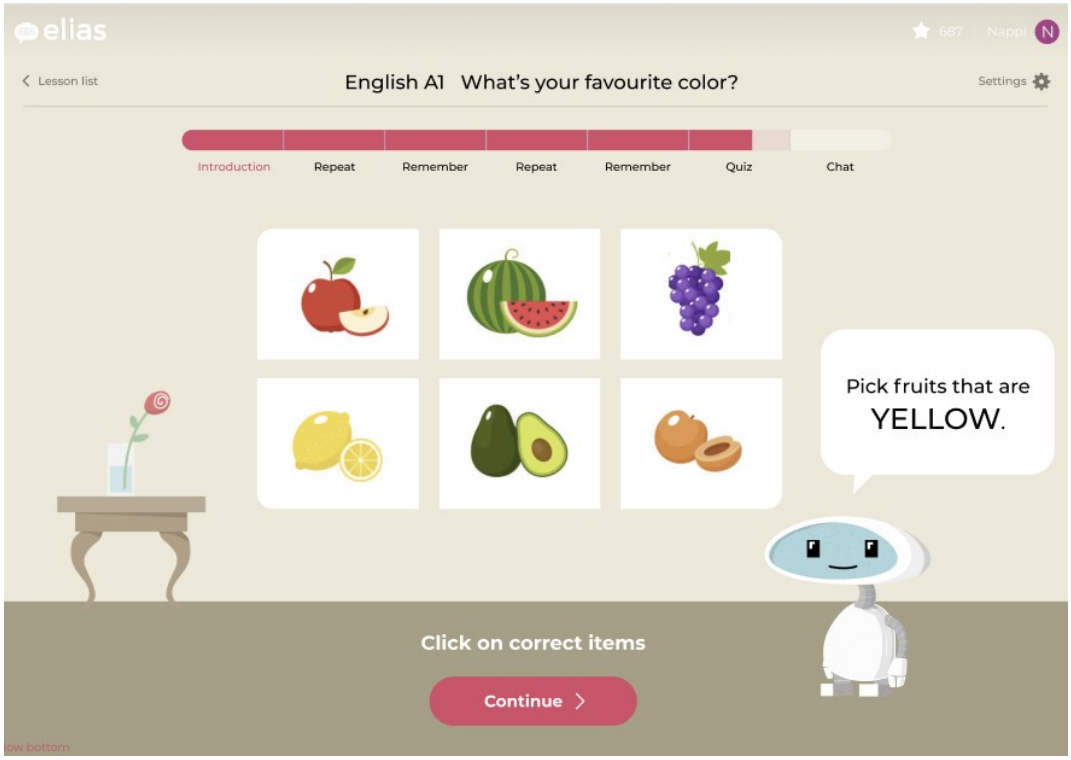

Figure 11. *Virtual Elias avatar interacting with the user, asking question* [26].

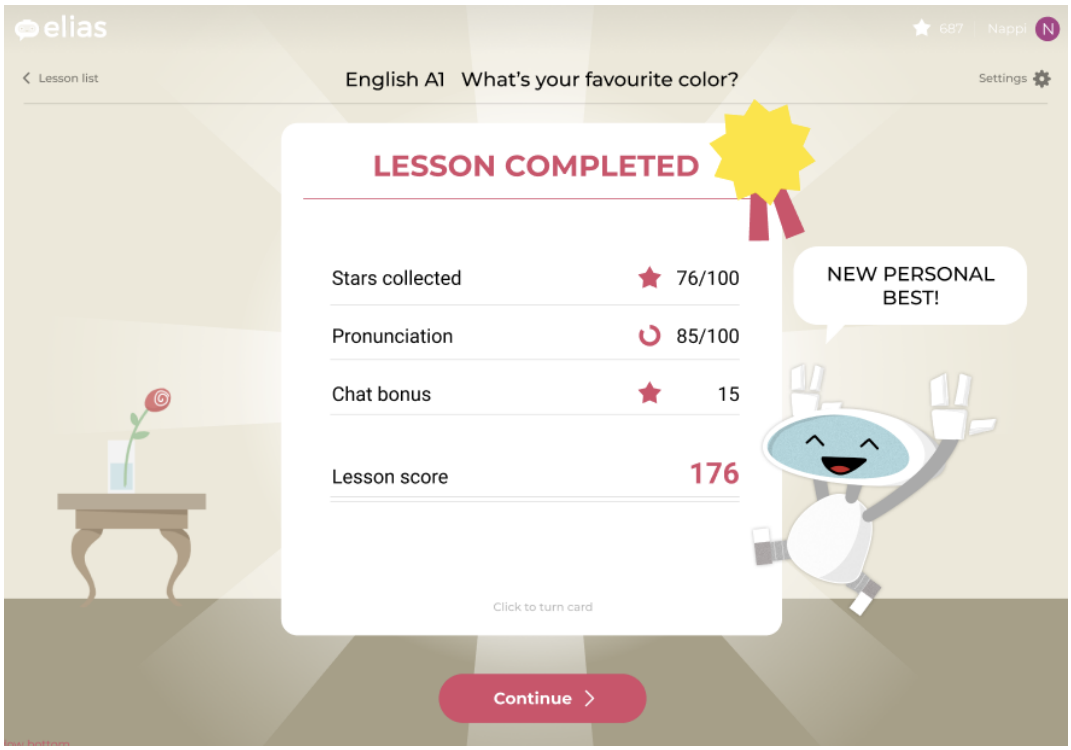

Figure 12. *Virtual Elias avatar very happy with performance and statistics* [26].

6. EVALUATION FINDINGS

In this chapter, the storyboard scenario evaluation findings are discussed for the categories appearance, interactions and behavior, constructive feedback and rewarding. Additionally, some general findings are reported. Finally, the design implications are stated and discussed.

6.1 Appearance

All seven out of seven participants felt positively about the appearance of the robot. The avatar seemed to be funny, cute and entertaining to them: "*It looks calm and friendly, colors are nice*" (P3). "*It's funny and cute and looks very lovely to interact with*" (P5). "*The robot looks very positive and happy, it's nice!*" (P7). Three out of seven participants explicitly mentioned the facial expressions to nice: "*I really like the avatar, especially the facial expression, expressions are really precise and natural*" (P1). "*The expressions are really good; I was saddened to see the sad expression!*" (P4). "*The face structure and the expressions were nice*" (P6). Two out of seven participants mentioned about the eyes of the robot being very expressive and effective: "*I like the hands and the eyes well really expressive*" (P4). "*It shows how it feels and emotions with the eyes*" (P5). One of the participants liked how the avatar was shown on the platform: "*I like the way the avatar is shown and how it greets the users*" (P1).

One of the participants suggested that the expressions should change during interactions rather than becoming monotonous: "*I hope the expressions change during interactions*" (P1). Three out of seven participants mentioned that the robot should have a more colorful appearance as well as some kind of story to it: "*Body, hand and leg color looks like it's covered in band aid; I would like a more colorful body*" (P6). "*For the body, I would change the colors, I want more colorful robot*" (P4). Two out of seven participants expressed their concerns about expressions being redundant: "*It needs to be animated, not static*". "*Emotion/expression/animation should not be redundant; The robot should come close depending on the interaction situation*" (P7).

Participants were asked to rate the appearance of the robot on a scale of one to five where higher number represents their fondness to the avatar. Five out of seven participants rated the appearance as 4 and the other two participants rated it as 5. The figure 12 shows a graph representing this.

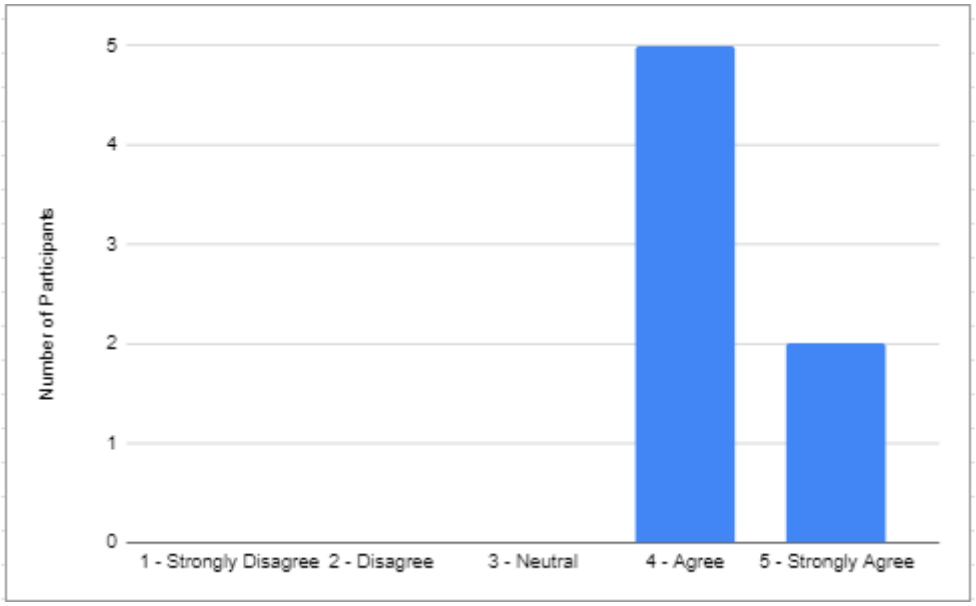

Figure 13. *Participants' rating for the virtual robot's appearance.*

6.2 Interaction and Behavior

All seven out of seven participants liked the feedback mechanism of the virtual robot as well as the way it responds to each interaction: "*When the user is not doing well, it stays positive and takes it upon itself, that is really nice*" (P1). "*Detecting that you are not doing good and recognizing it, seeing the robot there, having text with voice, conversation was really nice*" (P3). "*I was really impressed with the behavior, friendly, optimistic and encouraging which are best qualities that I expect from it*" (P4). "*The girl was confused, but the robot managed it very well and positively*" (P6). "Nice to see Elias trying to make Eva do better pronunciation by repeating" (P7). "*It's nice that the robot gives the user chance to improve*" (P1).

When asked about things to improve on the scenarios and things they did agree with, three out of seven participants said about having more dynamic facial expressions and animation while interacting: "*some kind of animation, there has to be some kind of story and gamification*" (P2). "It would be good to have better facial features or emotions" (P6). One of the participants (P3) wanted to have customizability: "*Can I personalize the robot?*

Can I tweak it to my liking?". One of the participants said that the robot should not give explicit feedback every time the user interacts with it: "*Do not give feedback every time, it should vary, can it adapt to the learning speed*" (P2). One other participant said it would be good to be able to interact with the robot in different languages: "*Interaction with the robot, could it be done in the native language of the user?*" (P4).

Participants were asked to rate the interaction and behavior scenario of the robot on a scale of 1 to 5 where higher number represents high level of agreement. six out of seven participants rated the appearance as 4 and the other one participant rated it as 5. The figure 13 shows a graph representing this.

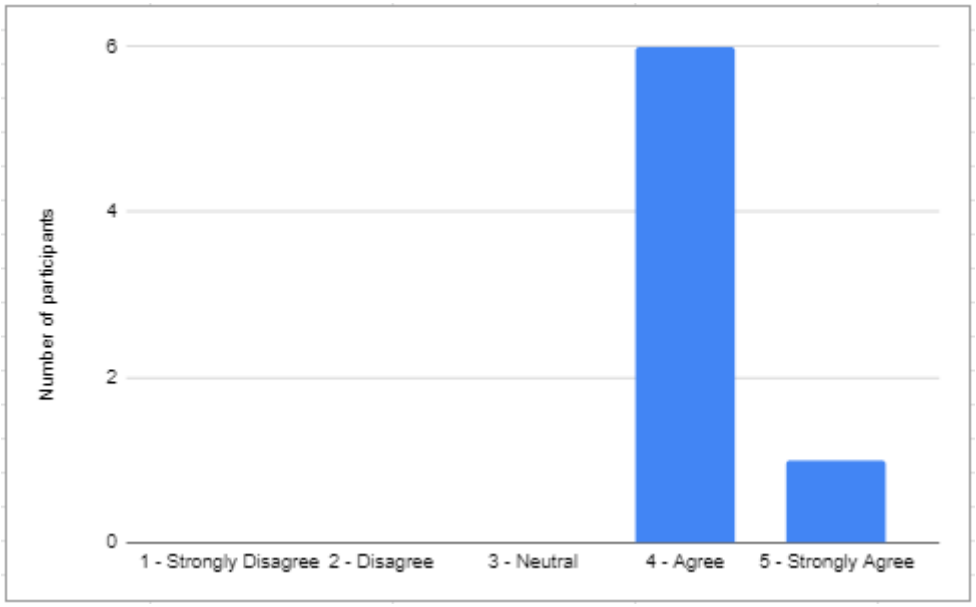

Figure 14. *Participants' rating for the virtual robot's interaction and behavior.*

6.3 Constructive Feedback

Five out of seven participants liked that the robot could understand the situation of the user and act accordingly: "Understanding the user's situation (struggling) is important" (P1). "The robot understanding and explains the situation creates really good feedback" (P3). "The robot acknowledges that the learner is trying, and it creates a sense of comfort, not shame, encourages to try at least once more, that's a good thing" (P4). "The robot is very active in listening and giving feedback". "It's nice that the robot is understanding the users' learning stage and giving feedback" (P5). Three out of seven participants felt that statistics are helpful to make the user feel more confident and motivated

to learn: “It’s good to have some statistics to show that you are not alone/behind many people” (P7).

Two out of seven participants did not agree with the fact of giving statistical views as feedback: “I do not agree with the way how the feedback should be, I do not care about statistics, it's not very good for motivation” (P2). “I do not like the statistical view, do not compare with people, do not say percentage, say better that previous... these will only work when you are doing horrible, not in normal scenarios” (P3). One participant thought that the feedback sentences from the robot were sometimes too big and it should be more precise and casual: “Too many words and too big sentences, can be more casual. It should motivate in another way, find easier words, speak less. The robot is talking too much” (P3). Two participants suggested that the robot should be able to pinpoint to specific problems in learning and should divide bigger words into small ones to make the user understand: “The robot could understand specific pronunciation problems, then divide the word in different parts” (P3). “Break words into fragments - pine and apple makes Pineapple” (P7)

Participants were asked to rate the constructive feedback scenario of the robot on a scale of 1 to 5 where higher number represents high level of agreement. Four out of seven participants rated the appearance as 3, one participant rated it as 4 and the other two participants rates it as 5. The figure 14 shows a graph representing this.

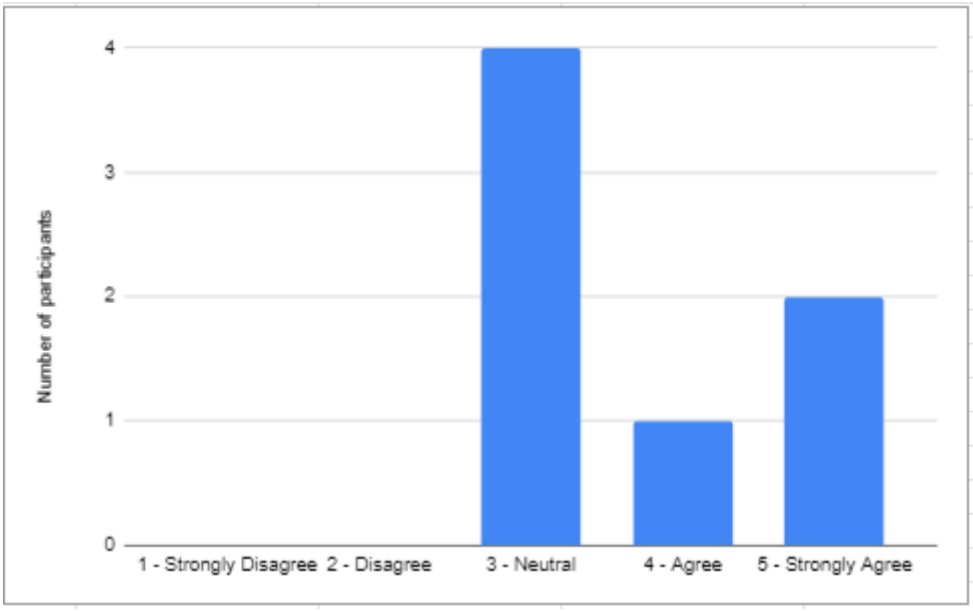

Figure 15. *Participants' rating for the virtual robot's constructive feedback.*

6.4 Rewarding

Three out of seven participants mentioned that the way of having a surprise factor in rewards can work very well to make the learning interesting: "*I really like the mega reward – fireworks, it works as a nice surprise factor*" (P1). "*The surprise element makes it very interesting*" (P7). Two out of seven participants liked the incremental rewards such as unlocking new levels and increased reward volume: "*Lesson unlocking, getting better rewards incremental*" (P4). Two out of seven participants liked the statistical feedback from the robot: "*The statistics parts are very encouraging to a learner*" (P4). Three out of seven participants thought that the robot's feedback on progress of learning can increase motivation: "*It's nice to see the robot recognizing the learning and progress*" (P6).

Four out of seven participants suggested different types of rewards to go with the existing ones: "Other rewards - online gift cards, currency, coins, unlocking a different course" (P1). "There could be more digital rewards, new animations, short animated clips (adventures with veggies), select rewards from options" (P3). "The robot could reward the user with more colorful things" (P5). "Maybe traditional rewards like receiving of tokens, new robot avatar, new platform UI. Maybe add something more, show some rankings of the user and statistics" (P6). Three out of seven participants did not agree with fireworks as the mega reward: "Catching fire might be shocking (different for diff age groups). Maybe Different types of surprises" (P1). "I do not like the mega reward, may be a robotic dancing could work as a better surprise" (P5). One of the participants suggested that there should be a proper hierarchy of rewards: "When there are a lot of rewards, there should be some kind of barrier, not jumping to mega rewards straight away. It should give smaller rewards first" (P4). One other participant suggested that the rewards should be advertised so that the user feels more motivated during the lessons: "The robot can talk about the reward before the lesson, so that the learner feels more interested/engaged" (P7).

Participants were asked to rate the performance based rewarding scenario of the robot on a scale of 1 to 5 where higher number represents high level of agreement. Four out of seven participants rated the appearance as 4, one participant rated it as 3, one participant rated 5 and the other participant rated it as a 2. The figure 15 shows a graph representing this.

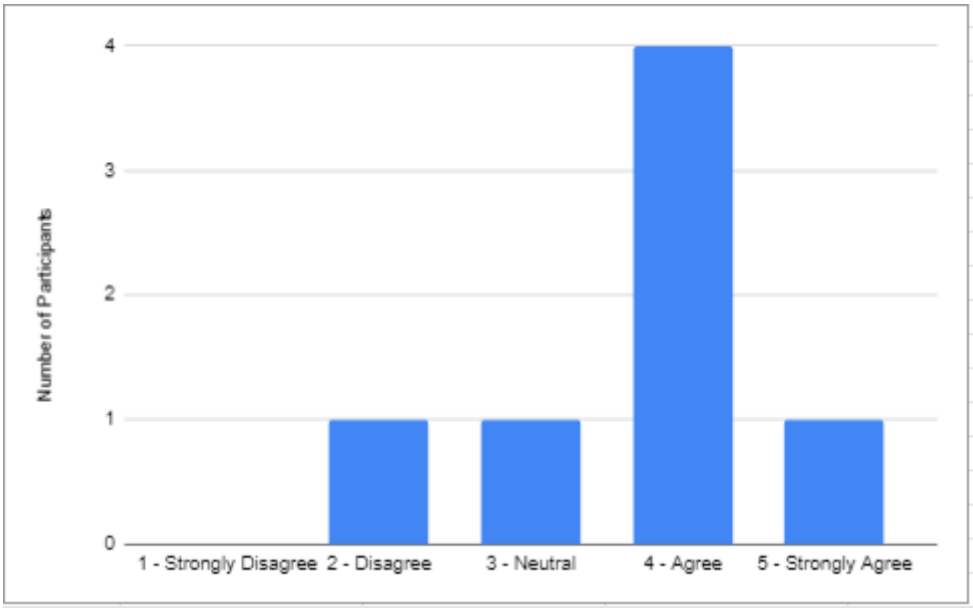

Figure 16. *Participants' rating for the virtual robot's rewarding.*

6.5 Overall Evaluation of the Storyboard Scenarios

When asked about their experience of using the digital platforms for second language learning, five out of seven participants reported that their usage spell was short-lived. Six out of seven participants reported that they liked the lessons while three of them reported that the lessons were not engaging enough to keep them motivated: "*I liked it initially, especially the exercises, but it was not engaging enough for me*" (P2). "*My motivation was somehow reduced, and I forgot to continue*" (P5). Two out of seven participants said that the features and lessons were good and had some gamified elements. One participant felt the need to interact with other users and desired more peer support. One other participant wanted more of conversational learning, but the lessons are more focused on teaching words only: "*It focused on words only, I needed more conversational things*" (P4). Two out of seven participants mentioned the lack of an instructor or peers which causes problem while having problems with learning: "*tough to solve if something is wrong, there is no one to interact*" (P1).

When asked about having a virtual robot on the language learning platform as a companion, all the seven participants thought it was a good idea and it can make the platforms much more fun to interact with. Five out of seven participants expressed that it would be great and interesting at the same time to have company on the platform: "*It's good to have someone to guide through the process*" (P1). "*It will not be lonely anymore, I can have some interaction, it can participate with me and improve my experience*" (P4). "*It kind of makes you more motivated to keep learning if someone is interacting with you*"

(P5). "*Learning a new language is tough, it's interesting that there is a robot to interact with you, makes it easier*" (P6). Two out of seven participants were confused between the roles of the robot as teacher or companion. One participant raised a concern about raising the expectation of the users with human-like features and then failing to live up to it.

All seven participants agreed on the fact that the idea of having a virtual robot on a language learning platform can result into better learning outcomes. None of them faced any difficulty to understand the idea through the storyboard, however there were significant suggestions on how to improve the demonstration. Three out of seven participants though that it would be better if the they could interact with the actual platform with the robot present: "*Using the actual robot on the platform would be great, or maybe a video of the actual interaction would work better for demonstration*" (P1). "*Experiencing the application will help*" (P4). Two out of seven participants suggested having something other than a storyboard as there is too much text: "*Verbally explain the scenarios would make it better, show 5 important scenes and explain them instead of playing the video*" (P2). "*Not a storyboard, too much to read, an actual scenario video would be better*" (P3).

Participants were asked to rate the whole scenario demonstration and storyboards on a scale of 1 to 5 where higher number represents high level of agreement. Four out of seven participants rated the appearance as 5, two participants rated it as 4 and the other participant rated it as a 3. The figure 16 shows a graph representing this.

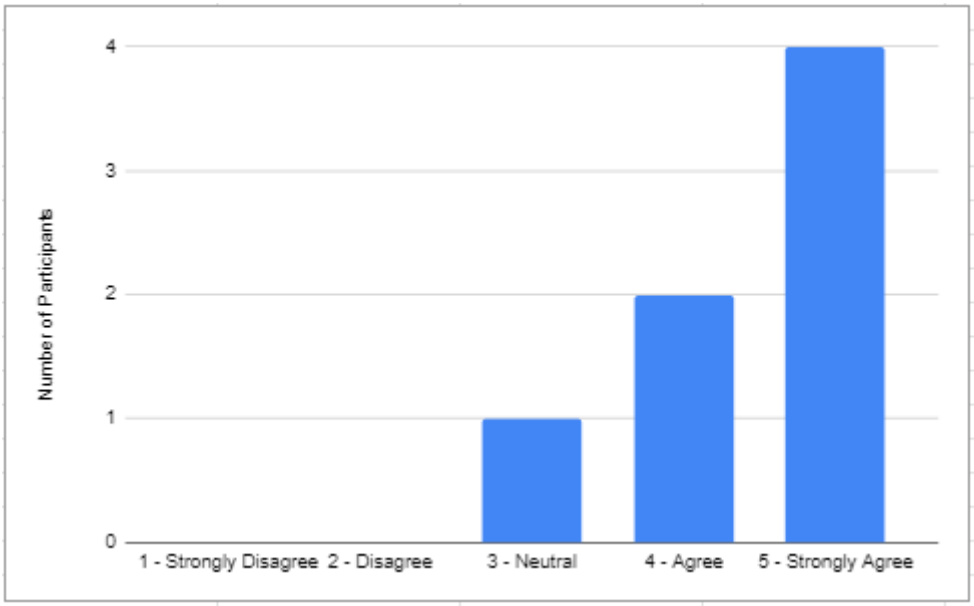

Figure 17. *Participants' rating for the virtual robot's rewarding.*

6.6 Design Implications

According to the related work, there are no existing proper guidelines for designing a virtual language learning robot. No studies were found to report the process of designing such a robot as well. Based on the findings gathered from the co-design workshop, theme interviews and scenario evaluations, a good number of design suggestion were gathered. In this study we have created 7 design implications, which can help future virtual agent designers especially for language learning.

These design implications reflect the need of new knowledge considering the research questions presented in section 1.2. The design implications for a virtual language learning companion robot are discussed below in light of the research questions and related works.

1. **The appearance of the virtual robot should not fully resemble a human**. Too much similarity with a human could create several problems, such as increased expectation from the robot as well as risk of getting it wrong and making it creepy as a result. Also, human features like facial expression are very challenging to mimic fully in a robot, making it a risk factor. A robot like or even an animal like appearance should work better. Similar findings were made in [51]. This design implication attempts to answer the RQ1 which is concerned about the appearance of the virtual language learning companion robot.
2. **Human-like movements and gestures are preferable**. While the robot should not exactly like a human, it can sure move like one. Human gestures such as hand movements, nodding, waving can add to the interaction and make it more engaging. This implication is also mentioned in [56]. This design implication partially answers the RQ2 concerning the movements and gestures.
3. **Facial features should be handled very carefully**. Eye movements as well as other moving parts of the face such as jaws and mouth can be done wrong very easily, making it creepy as a result. This implication partially answers the RQ2 concerning meaningful and engaging interaction.
4. **Positive feedback with constructive criticism**. For keeping the motivation up for learning positive feedback is necessary while negative feedback is not desirable. However, for poor performance, there should not always be positive feedback, rather constructive criticism along with suggestions to improve. This

design implication partially answers the RQ2 concerning the feedback mechanism, feedback type and behavior.

5. **Voice based interaction in line with movements and gestures has a positive effect**. Voice of the virtual robot should not be over the top and should sync with its physical movements. Also, voice and tone should be different for different situations such as a happy tone for positive feedback and neutral for criticism [59] has reported similar findings. This design implication partially answers RQ2 concerning engaging interaction.

6. **The robot should have some reaction to every action of the user**. There should always be some kind of feedback from the robot for everything the user does. A simple nod, sparkling eyes, sounds or hand movement etc. can create a proper interactive environment. This design implication partially answers RQ2 and RQ3 considering feedback and motivation.

7. **Rewards should be incremental and should have a surprise factor to increase interest**. Robot can turn into funny attractive characters as reward. As it's a virtual robot, it can turn into a disco ball, or create fireworks for the user when performing well. The element of surprise works very well in this regard. This design implication tries to answer the RQ3 which concerns about motivation and rewarding based on performance.

7. DISCUSSION AND CONCLUSION

This chapter discusses the findings of this research in light of the related works to find similarities and novelty of the findings. Furthermore, the limitations and challenges of the study is discussed along with possible future work directions.

7.1 Discussion

From previous works, several terms have been found that can be related to virtual language learning companion robots, such as, virtual agents, embodied agents, and embodied virtual agents. From the definition and usage of such terms, we have concluded that these terms in fact represent agents with similar characteristics. All of them have embodiment and some social features. The difference between these agents can be found in their implementation in different contexts which does not reflect in their definition. As a result, all these terms are considered similar in this research and referred to as virtual social robots. Additionally, in the context of this study, they are named as virtual language learning companion robot.

At the beginning of this thesis research, we set three high level research questions. The RQ1 concerns about the appearance of the virtual robot, the RQ2 concerns about the interaction, beahvior, feedback and movements of the virtual robot and the RQ3 concerns about the rewarding and motivation factors of the virtual robot. Through the pre-study with the target users who are university students for this research, we tried to gather design suggestions. Based on those design suggestions, we created the scenario storyboards and evaluated them with our target user group. At the same time, the suggestions were taken into account by Utelias Technologies while designing the avatar of the virtual language learning companion robot. Finally, based on the pre-study, evaluation as well as the related works, design implications were formulated. By completing this whole HCD process, we attempted to answer the three research questions. In the following subsections, the research questions are analyzed in terms of the related works as well as the research findings.

RQ1. What type of physical appearance should a virtual language learning robot have?

This high-level question consisted of several specific questions, such as, should the robot resemble a human or any other animal? Should the robot have a robotic appearance instead? Should the robot have similar body features to humans? How can the robot look attractive?

Previous studies [52][53][55] emphasized a lot on the importance of embodiment for a virtual agent. Our research study findings suggest that embodiment of a virtual robot is very important. While asked about embodiment, all of the participants from either the co-design workshop or the theme interviews mentioned that the virtual robot needs to have an appearance and they delved into more detail such as, if it should be human-like or robot-like or animal-like, making the necessity of embodiment very clear. However, previous studies did not go into detail about the embodiment of virtual robots and there is a knowledge gap here. The findings of this research question tries to bridge that gap.

After becoming certain about the embodiment, we tried to get into more specific details of the robot's appearance. The findings suggest that majority of the pre-study participants agreed to the fact that the virtual robot should not fully resemble a human appearance. According to them, the robot should have more of a robotic appearance, however, it can have the bodily features of a human, so it can have two legs, two hands, a body, head and eyes. Participants were worried about raised expectations from users if the robot appears too much like a human. They also mentioned that facial features should be handled very carefully as there is a very fine line between correct and creepy expressions.

These findings add new knowledge to the domain of virtual robot's appearance as no previous study has investigated such questions and none have reported such findings. These implications can be used to design virtual robots, especially for language learning purposes. Another factor that came into light is the customizability of the virtual robot's appearance. Once build, it's almost impossible to customize physical robots while virtual robots can be programmed to any type of customized shape which can give the end users a lot of options to modify it to their own liking.

RQ2. How a virtual language learning robot should react and behave to create meaningful and engaging interaction? What type of movements and gestures should be included?

This research question can be divided into several more specific questions, such as, what type of behavior makes the learning interesting? What types of gestures can have a positive impact in creating meaningful interaction and how? Should the robot have facial features and expressions and how should they differ? How important is the voice and tone of the robot?

Previous research [19][56] suggest that gestures and movements play a very important role in making the interaction more interesting and engaging. Gestures work as a feedback mechanism to all the activities by the user which creates a feeling that all the input from the users are recognized and accounted for. Based on these, gestures and movements of the virtual robot have been explored extensively in this study to make more

precise design suggestions and implications. The results show that user prefer human-like movements and gestures such as, hand movements, nodding, waving etc. It was found that these gestures and movements can add liveliness to the robot and make the interaction more contextual and meaningful. However, facial features and expressions should be handles with care.

The feedback mechanism of the virtual language learning appeared to be one of the most important aspects of the design. Strong emphasis was given on this in the findings. It was found that the robot should have either positive or non-negative feedback and should not have negative feedback. So, in neutral or positive scenarios, the robot can behave as per the situation, but in a negative scenario like lack of effort or bad performance should not lead to negative feedback. Instead, the robot should have constructive feedback which can help make the situation better for the user in terms of mindset and learning motivation. This is consistent with prior research [37], where positive and constructive feedback has been encouraged.

Another aspect that came to light about the behavior is the adaptiveness of it. Related works [44][57] have suggested that learning companion robots should be designed in such a manner that it can adapt to the diverse nature of learners, understand their approach and act accordingly. This goes in line with the findings of this research as contextual behavior have been marked very important in the findings. Results suggest that the robot should be able to understand the learning state and situation of the user and act accordingly. As example, if a user is struggling with learning a specific word, the robot should understand this struggle and change its approach. It can divide the word in several fragments, it can keep pushing the user to try again until perfected and being positive the whole time.

These findings add more specific knowledge about how the behavior and interaction should be of the virtual language learning companion robot. The findings are in line with prior research, and this validates these findings in questions of virtual robots which were previously for physical social robots.

RQ3. What type of rewards can motivate the users in a virtual language learning platform?

This high-level research question can be divided into more specific questions, such as, What factors can maintain or increase motivation in online learning? How can a virtual robot appreciate the effort of the users? How should a virtual robot react when the user is performing well? How should a virtual robot react when the user is not performing well?

Previous research [58][59] on rewards and motivation in virtual learning platforms suggest that digital badges, reward points, ranking systems etc. can create motivation in users which is in line with our findings. The results of this research support this statement as the participants have suggested digital rewards to be effective and competitiveness makes learning more fun and appealing. In addition to the similarities found in the findings with previous research, there also additional findings that adds new knowledge. We found that rewards should be incremental to keep the users motivated. Instead of giving the users some stars after they complete every lesson, the volume of value of the reward should be varied, increased for continuous betterment in performance and might be decreased in case of worsened performance. As example, initial rewards can be simple stars or badges and after more learning the reward could be bigger like paid lesson unlocking etc. Then after continuous good performance, there could be bigger rewards. Also, it was mentioned that rewards related to the lesson topics can be more interesting and motivating.

The results indicate a need for continuous interaction with the robot as well as consistent feedback. Here in the platform, the robot-learner interaction can be considered as peer interaction. Peer interaction has been mentioned as an important factor based on the related work [6][7] where it's mentioned that that the learner should not be alone and should be able to interact with either the instructor or peers to ask questions and resolve confusions. Participants have also suggested that a clear learning process and traceability can lead to better engagement in virtual learning platforms which supports the findings in [28].

One new finding that has been appreciated in the evaluations is the surprise factor in performance-based rewarding. Surprise factor as mega rewards was perceived as very interesting according to the findings. Fireworks, robot dancing, robot turning into funny things are mentioned as surprise rewards. This finding adds value to the existing rewarding mechanisms and can have a great impact on increasing motivation.

While several previous studies have focused on different specific aspects of virtual agents for virtual learning platforms by introducing pre-designed agents to understand effects of specific characteristics, the process of designing those agents have not been reported in detail. This study focused on starting the design process from the very beginning of the design of a virtual language learning companion robot with a human-centred approach. To make the data more credible, we have included potential users already in the co-design phase. In short, the HCD process has been utilized to find and strengthen the design implications.

7.2 Limitations and Challenges

Due to the pandemic and distant working regulations we had to move to online platforms like Zoom for conducting the co-design workshops as well as the theme interviews. This might have created some complications in collecting data and conducting them in a normal way; we had to make changes to the setup of the workshops to match the online conduction scenarios.

The online workshop meetings had been recorded; however, the transcription was challenging as there were a mixture of English and Finnish languages. To compensate for this, participants were requested to document every idea they had as well as everything they talked about. This approach has made the data richer, however, it cannot be stated for certain that no data was lost or not documented.

The number of language students in the co-design workshop was quite good, however, we feel that some more design student theme interviews could have made the data richer and more balanced. Design students think more related to design principles and it provides a new dimension to the data. A future study with data collected from more design focused participants can create a significant improvement to the design implications.

The current study lacks the evaluation of the design implications provided which is already being planned as a future work. A full design of the virtual language learning companion robot needs to be done based on the findings and design implication presented in this study. Furthermore, a proper evaluation with a target group (language students) needs to be done as a future work to ensure credibility.

7.3 Conclusion

Virtual learning platforms are becoming more and more important these days and they are contributing significant knowledge for the learners. As a result, making these platforms more effective has become a need. Previous research has suggested that interactive virtual agents can improve the effectiveness by introducing meaningful interaction and raising motivation. In this qualitative study, we wanted to understand how potential users of a language learning platform perceive a virtual social robot to assist with their learning. We conducted a co-design workshop with language students and theme interviews with design students at the Tampere University. These workshops and interviews provided users' preferences and expectations for a virtual language learning companion robot focusing on its major characteristics, such as, appearance, interactional behavior, feedback styles, movements, gestures and rewarding. Based on the co-design workshop and theme interview data, we found significant design suggestions and used them to

create storyboard scenarios. These scenarios were then evaluated with the target group which are university students, through semi-structured interviews. Finally, seven design implications for a virtual language learning companion robot were formulated keeping the findings as well as the literature in mind.

There has been no previous work that has reported the design process of a virtual robot from the beginning and this study attempts to add to this lacking in the virtual robot research field. Although this study does not fully cover the whole design process, it starts from the very beginning by including potential users in the co-design process. These are the contributions of this research study. Design implications were formulated based on the findings from the literature and analyzed data. The design implications can be used to design a virtual robot that assists with online education. However, these design implications need to be further validated by applying into actual designs and evaluation studies which is expected to be an upcoming future work of this study.

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APPENDIX A: USER NEEDS STUDY MATERIALS

A.1 Mural canvas

Figure 18. *The Mural canvas where the groups have documented their ideas based on the questions asked.*

A.2 Questions to trigger discussion for co-design workshop and theme interviews

1. Imagine you are using an application to learn a new language. In that application, if there is a virtual robot to assist you, should it look like a human or like a robot or something else? and why? Discuss.
2. What body type should the robot have? Should it have the same body parts ratio as humans or something different?
3. Would you like to customize the robot to your own liking? What about it's gender, age (old or young), color (both human/non-human)?
4. What makes the robot attractive to use? What bodily or visual features of a robot can make you think that it's useful or fun? What keeps up your interest in such scenarios?
5. How do you think a robot can motivate you to learn and keep using it? What kind of behavior/interaction can keep up your interest and motivation? What makes you feel appreciated when performing well?

6. What do you think about facial expressions on the robot? Should it change based on the interaction? How do you feel about it? Should the robot behave differently in different contexts?
7. Should the virtual robot move like a human, use human-like gestures? What role can gestures play in the interaction with the robot?
8. How do you think the voice and tone should be for the virtual robot? Does this make any difference? Would you like to have it customized?
9. What motivates you to keep going when learning something new? Why?
10. Do you think the virtual robot should always be positive and jolly even if your learning performance is not up to the mark? Or should it behave differently?
11. How do you think a virtual robot can appreciate your efforts? What things can a robot do that will make you feel good and motivate you to keep on interacting with it?
12. When you are learning and performing well, what would make you feel good or well appreciated?

A.3 User needs study consent form

Invitation to participate in co-design workshop

You are invited to participate in a co-design workshop which will focus on several aspects of the design of a language learning robot. This study is part of an ongoing human-technology interaction MSc. thesis at the Tampere University. The workshop will be conducted in English via Zoom online meeting tool.

The whole workshop will be recorded for data analysis purposes. We would like to collect the following material from the workshop in order to develop a concept for a robot that will assist in language learning:

1. Video and audio of the whole workshop recorded in Zoom
2. Discussion points and findings posted on Mural

Showing your face on Zoom video meeting is recommended for better interaction and collaboration, however, it's in your right to decide whether you would want to show your face on the video. Participation is completely voluntary, and you can leave the workshop at any point of time without stating any reason.

About the workshop

The purpose of the workshop is to understand the perception and ideas of potential users for a language learning robot. The workshop is designed to collect in-depth information regarding the appearance, interactional behavior and rewarding schemes of a language learning robot. The collected information will be analyzed later to find meaningful design elements for the robot.

Confidentiality and data security

All data will be treated as confidential. The data will be stored in a secure drive provided by the Tampere University. In the analysis phase the data will be anonymized, i.e. all identification information will be removed. The data will only be utilized for research purposes. The data will be stored for two years and after that it will be deleted.

Results of the research

The results of this research may be written up for a MSc. thesis, conference papers or peer-reviewed journal articles. We may also show parts of the results in conferences and events.

Consent

Based on the information expressed above, I provide consent for using my data in the study.

[write your name here] [write the date here]

Contact information

If you have any further questions regarding this study, please do not hesitate to contact the responsible researchers:

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APPENDIX B: SCENARIO EVALUATION

B.1 Evaluation questions

Demographic questions: Occupation, Age group

General Questions:

- Have you ever used any digital application/platform for learning a second language?
- How was your experience of using such a platform or service?
- What things did you like about them?
- What were the things that you did not like?
- What kind of interaction methods did those platforms use?

Questions about Virtual robots:

- What do you think about the idea of having a virtual robot on a language learning platform?
- What do you expect from such a service?
- Do you think a virtual robot can make learning more interactive and fun if added to these kinds of platforms?

Interaction and Behavior questions

- On a scale of 1 to 5, how well does the scenario represent desired interaction and behavior?
- What were the things that you liked or agreed with in the scenario?
- Does the scenario reflect your own perception of how the virtual robot should behave and interact? If not, explain how it differs.
- How do you think these interaction scenarios can be improved?

Rewards questions

- On a scale of 1 to 5, how well does the scenario represent rewarding for learning performance?

- What were the things that you liked or agreed with in the scenario?
- Does the scenario reflect your own perception of how the virtual robot should reward the learners? If not, explain how it differs.
- How do you think these scenarios can be improved?

Constructive Feedback questions

- On a scale of 1 to 5, how well does the scenario represent constructive feedback of the virtual robot?
- What were the things that you liked or agreed with in the scenario?
- Does the scenario reflect your own perception of how the virtual robot should behave and interact in such situations? If not, explain how it differs.
- How do you think these scenarios can be improved?

Wrap up questions

- On a scale of 1 to 5, how easy were the storyboards to understand?
- What could be improved to make the demonstration more clear?
- What do you think about the overall scenarios and their representations?
- Do you think the demonstrated way of interaction and rewards can have a significant effect on learning?

B.2 Consent form

Invitation to participate in interview

You are invited to participate in an evaluation interview, which will focus on several aspects of the design of a language learning robot. This study is part of an ongoing Human-Technology Interaction MSc. thesis at the Tampere University. The workshop will be conducted in English via Zoom/Teams online meeting tool.

The whole workshop will be recorded for data analysis purposes. We would like to collect the following material from the workshop in order to understand your feedback and perception on the study findings for a robot that will assist in language learning:

- Video/audio of the whole session recorded in Zoom/Teams

Participation is completely voluntary, and you can leave the workshop at any point of time without stating any reason.

About the interview session

The purpose of the session is to understand the feedback of potential users on the findings for designing a virtual language learning robot. Ideally, the participant will be shown a number of scenarios and will then be asked about their feedback. The collected information will be analyzed later to solidify the design implications for the virtual robot.

Confidentiality and data security

All data will be treated as confidential. The data will be stored in a secure drive provided by the Tampere University. In the analysis phase the data will be anonymized, i.e. all identification information will be removed. The data will only be utilized for research purposes. The data will be stored for two years and after that it will be deleted.

Results of the research

The results of this research may be written up for a MSc. thesis, conference papers or peer-reviewed journal articles. We may also show parts of the results in conferences, online blogs and events.

Consent

Based on the information expressed above, I provide consent for using my data in the study.

[Your Name] [Date]

Contact information

If you have any further questions regarding this study, please do not hesitate to contact the responsible researchers:

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