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USER EXPERIENCE DESIGN AND EVALUATION OF PERSUASIVE SOCIAL ROBOT AS LANGUAGE TUTOR AT UNIVERSITY

Design and Learning Experiences from Design Research

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ABSTRACT

Tamilselvi Gnanasekar: User Experience and Evaluation of Persuasive Social Robot Language Tutor at University
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Human Robot Interaction (HRI) is a developing field where research and innovation are progressing. One domain where Human Robot Interaction has focused is in the educational sector. Various research has been conducted in education field to design social robots with appropriate design guidelines derived from user preferences, context, and technology to help students and teachers to foster their learning and teaching experience. Language learning has become popular in education due to students receiving opportunities to study and learn any interested subjects in any language in their preferred universities around the world. Thus, being the reason behind the research of using social robots in language learning and teaching in education field. To this context this thesis explored the design of language tutoring robot for students learning Finnish language at university. In language learning, motivation, the learning experience, context, and user preferences are important to be considered. This thesis focuses on the Finnish language learning students through language tutoring social robot at Tampere University. The design research methodology is used to design the persuasive language tutoring social robot teaching Finnish language to the international students at Tampere University. The design guidelines and the future language tutoring robot design with their benefits are formed using Design Research methodology.

Elias Robot, a language tutoring application designed by Curious Technologies, Finnish EdTech company was used in the explorative user study. The user study involved Pepper, Social robot along with the Elias robot application using Mobile device technology. The user study was conducted in university, the students include three male participants and four female participants. The aim of the study was to gather the design requirements based on learning experiences from social robot tutor. Based on this study findings and the design research findings, the future language tutoring social robot was co-created through co design workshop. Based on the findings from Field study, user study, technology acceptance model findings, design research findings, student interviews, the persuasive social robot language tutor was designed. The findings revealed all the multi modalities are required for the efficient tutoring of persuasive social robots and the social robots persuade motivation with students to learn the language. The design implications were discussed, and the design of social robot tutor are created through design scenarios.

Keywords: Design Research, Human Centered Design, Persuasive Design, Robot Assisted Language Learning, Social Robot, User Experience

PREFACE

I thank my supervisor Respected University Lecturer Aino Ahtinen, PhD, Tampere University for supporting me through the project by providing me with a research topic in persuasive social robot domain. She provided me knowledge around social robots. The social robot design project provided me a possibility to learn about the whole design process of a product design from research, field interview and product design. This thesis helped me in learning time management, project management, project ethics, design process, motivation. I thank from my bottom of my heart to my supervisor for giving me possibility to design a social robot for university. During this time my supervisor guided me all through the process in completing the project successfully. The project involved design of persuasive technology for language learning social robot. The learning resources and supervision instructions provided in social robot canvas was followed in the thesis. The findings and research are designed and published with the supervision and support from the university. I thank my supervisor for her support and trust in me to handle this project individually through which I gained an experience on how valuable time and life during our studies. Thank you, Aino Ahtinen, for motivating me every time and providing deep trust with my work. I thank you so much for all the learning experiences I have received through this project and the teachings I have gained from our university. Aino Ahtinen inspired me in all the work I had undergone through this project. She is my inspiration for the success of the project. She motivated and developed me as a good time manager and work life balance.

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List of Abbreviations and Symbols

CALL - Computer Assisted Language Learning

HCD - Human Centred Design

HRI - Human Robot Interaction

PD- Persuasive Design

RALL - Robot Assisted Language Learning

RAS - Robot Attitude Survey

TAM - Technology Acceptance Model

UEQ - User Experience Questionnaire

UX - User Experience

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1.INTRODUCTION

Learning a language has become an essential part of the current era. Evidence from Eurostat (2022) shows that the percentage of pupils interested in learning foreign languages increases yearly. Learning language is a complex process which can be learned utilizing various resources such as Computer Assisted Language Learning (CALL), Mobile Assisted Language Learning (MALL), Robot Assisted Language Learning (RALL) and from a Language Tutor at educational institutions. Computer Assisted Language Learning (CALL) concept terms are designed for tutoring and/or learning languages through computer (Higgins J, 1983) One example of CALL is Speech recognition, commonly known as voice recognition to recognize speech. It transfers human speech to written format and text to speech. In the research investigation, the use of speech recognition technology in language learning practice was found beneficial among language two learners (Yueh-Min Huang, 2016).

Acquiring a language requires motivation, social communication, practice, and several other factors. It relies on several factors, and one is a long-term motivation. Humans from various age groups have different learning strategies and different language learning preferences. According to Eurostat 2023, half the population of upper secondary educational pupils learn two or more foreign languages. Learning a language is becoming common in this era. Research by Abbott (2018) discloses the benefits of language learning as increasing the problem-solving skills among students. Amid other benefits it contributes optimistic effect to their brain and potential to focusing and multitasking. Thus, being a reason for the development of various Learning Applications and devices.

Over a few decades, tremendous research has progressed at high speed in the Human-Robot Interaction (HRI). Human-Robot Interaction (HRI) is the study of intercommunication between human and robots. HRI focuses on the design of social robots to foster experiences in human life. The social robots are defined as “A social robot is an autonomous or semi-autonomous robot that interacts and communicates with humans by following the behavioral norms expected by the people with whom the robot is intended to interact” (Bartneck, C., & Forlizzi, J., 2004, pg 2). Social robots are socially intelligent robots which eventually assist humans as collaborators and companions in our daily lives (Breazeal, 2009). Due to the various necessities of humans, these social robots are becoming a vital part of our daily lives. The study of social robots has become an important aspect in various fields and especially in educational context (Ahtinen, 2020) their research has shown significant growth. They are becoming one of the emerging platforms in educational society as a learning tool. Social robots are widely used in language learning in schools. The advantage of using social robots in peer learning is to foster learning of an individual. Thus, social robots are widely researched in learning various languages among various user groups and specifically earlier research findings use social robots in language learning to increase the learning capacity for children at school (Belpaeme, 2018). Social robots have been increasingly important in persuading language learning among students.

The embodiment feature of social robots provides a sense of being in person physically present with the user. The social engagement feature of the robot is another advantage to the user in learning context over mobile assisted learning devices. Moreover, social robots occupy physical space and provide relatedness with people in the environment enhancing the social communication lively. In language learning context, as it has access to all data of languages around the world, social robots can be used by students and teachers to relate the native language with the language two and utilize during the language tutoring. Language learning requires memory (Baddeley A.D., 1997) to remember and retrieve the words. Human memory functions through voice. Meaning practicing the words by speaking registers the words to the long-term memory. If a word or text is repeated multiple times, it registers to our memory. Within this context, social robots act as a suitable social companion to listen to human voices for long hours. Social robots can help through physical presence to learn the language by helping the person to remember and learn the language like teachers provide in the university. Moreover, learning language with secure access platform and privacy protected learning resources are provided in the University. Thus, this thesis explores the future use of the concept social robot tutoring Finnish as language two. To the scope of this thesis the research focuses with exploration of international students learning experiences of Finnish language as their language two at university.

A search of the literature on the potential benefits of social robots revealed a few studies which explored the use case of social robots in teaching a language among adult students in the university. Various design guidelines in designing social robots exist for children’s learning language and there is a space for exploring the use case of social robots in teaching the language among adult students. Also, the cognitive learning performance of children in school and adult students in university differs widely due to age factors. Questions have been raised whether the approaches that work well for children would work for adult learners (Belpaeme,

2018). To date, a few studies have investigated the utility of social robots for adult students learning a language two in university.

This thesis addresses the user perceptions on social robot tutors through conducting User Centered Design on international students studying Finnish as their language two at Tampere University, Finland. Finland's education system attracts non-EU applicants to Finnish universities due to its novel quality of top-notch education standards supplied equally to the university students. The mobility of international students to Finland increases every year.

According to EU statistics, the number of international students admitted during the academic year 2021 at Tampere university has increased by 20% compared to the previous year. To support social integration, Finnish Universities offer Finnish language courses as a language two to international students besides their studies to support their daily life during their stay as well as to expand their opportunities in the labor market. The language clubs and language practicing sessions are provided to students to improve their communication skills to support social inclusion and know more about the culture. These show the potential need for a language practice platform that would foster initial social interaction for language two learners to develop their language ability. In addition to the enormous facilities provided by the university, there is a need for a language tutoring assistant. This thesis aims to obtain data that will help to address these research gaps. One potential solution would be the use of social robots in language two learning for international students due to their cognitive capacity of being able to recognize various languages of international students and ability to manage with continuous communication many times.

The social robot is used as a research platform in this thesis and their use cases are studied. The social robot is customized based on the student’s language proficiency level. The study tries to find the students' perceptions on using a language two social robot tutor for international students in university. The findings are based on the requirements data collected from the design research methodologies. The goal of the thesis is to explore the learning experiences of university students with social robots as a tutor in practicing and learning the language two with the novel aim to foster social communication skills among international students.

This thesis focuses on the following research questions:

1. What are university student’s perceptions, learning experiences on Finnish language tutoring social robot for international students at university?

2. What are suitable use case scenarios for student robot interaction of Finnish language tutoring social robot?

3. What are the appropriate design guidelines suitable for social robot as language two tutor at the university?

This thesis generates a use case scenario and design guidelines of robot assisted language two learning for adult students in the university. The use case scenarios are evaluated to ensure how the social robots would foster language learning among students in university.

Thesis begins with developing theoretical dimensions of research and discussing the state of art on social robots and robot-assisted language learning in the context of human behavior, social robot behavior, and physical environment. Chapter two provides detailed literature review on what the research has already covered, what areas need future research, and the aim of thesis is discussed in the literature review. Then in chapter three, the research methodologies and research process are explained. Chapter four is concerned with the pre study which encapsulates the user needs from the study findings in the university context. In the fifth chapter formulation of user goals, use case scenario and design guidelines of student robot interaction are designed. Chapter six outlines co-design workshop and discusses the data gathered from evaluation of use case scenarios. Finally, the design implications and future scope of the topic are discussed.

2.LITERATURE REVIEW

2.1 Social Robots

Social robots are becoming ubiquitous in everyday life to enhance the way of living, such as uplifting the social inclusion of people in society (Nocentini, 2019). As defined by Bartneck (2004, p 2), “A social robot is an autonomous or semi-autonomous robot that interacts and communicates with humans by following the behavioral norms expected by the people with whom the robot is intended to interact.” These robots persuade human lives through social engagement. Fong (2003) defined the socially interactive robots as “robots for which social interaction plays a key role” (Fong, 2003, p 145)

According to Deng (2019), the social robot’s role is a major consideration as the user perceives it’s physical and behavioral characteristics and the interaction with the robot. Therefore, the design of the role and task of social robots plays significant importance during human-robot interaction as they directly affect the user's mental model. As described by Sinkkonen,I., (2006) mental model represents human's knowledge. The perceived unconscious, internal stimulation of real things, which are non-linguistic experiences, constitutes a mental model. The interactions emulated through robot tutoring impact the user's task achievement based on these mental models. Through the design of social robots’ roles and tasks, the positive learning experience of user’s mental model can be developed. Social robots are created by several HRI researchers with a motive to serve humans' unmet social needs.

With a social connectedness purpose and several other factors, social robots are used in diverse services such as in healthcare, industry and education. Some potential use of social robots in healthcare serves as a social companion and an assistive robot (Broekens, 2009), in education as tutoring social robot (Ahtinen, 2020) and peer robots (Leite, 2014). Assistive robots are those robots used as a peer and companion robot for adults needing support in enhancing their psychological well-being. Paro robot is a social robot used as a companion robot extensively in studies with elderly to measure the effects of robot therapy (Broekens, 2009). Also, social robots are used as an effective motivational companion for elderly people. The use of social robots with elderly people has shown that it increases their access and encourages behavior change, specifically on their physical activity. These are achieved through a motivational interview where the elders discuss their issues with the robots which also helps in self-reflection of their activities (Joana, 2018).

In another study, humanoid social robot Pepper is deployed in home to explore the requirements of elderly care at home and needs of children with education. The social robots provide natural interaction to communicate with users utilizing their multi modalities and behavioral autonomy. Through such activities they serve adults and children as assistive and social companions. Recently Kwon, K (2022) conducted a quasi-experimental study to explore embodied learning, an emerging theory. Embodied learning experiences have been explored for decades with humanoid social robots (Breazeal,2002). Embodied learning is a theory which utilizes the complete body locomotion which stimulates robot’s spatial information. They are widely used in education to support children’s learning and development as a co learner (Kennedy,2015). The students who participated in the study were examined on embodied learning experience utilize the agent bee along with programmer teacher as wizard of Oz technique using their locomotion resulted in contextual spatial information shared with the agent.

In recent decade, Researchers from MIT designed a social companion robot Jibo to study the design considerations of social robots with elder adults. The study explored the user's social, emotional, and related needs through robots copresence, physical embodiment, and verbal and non-verbal social modalities. The study result showed that the robot fosters social connectedness to the remote users in guiding digital assistance, providing coaching support in managing their diseases and assisting with healthy routines. The study findings suggest that through activating interaction and initiating social connectedness in social robots, the social robot can act as a social companionship and by evoking engagement it decreases social isolation in elder people (Breazeal, 2019).

Recent Netnographic analysis during the COVID-19 pandemic by Odekerken-Schröder (2020) has shown that robots have reached as in-home companion robots. The study analysis focuses on the role of companion robot vector. The study postulated that those robots could mitigate feelings of loneliness through social support. Robot Vector has been used as a personal assistant in the kitchen to track timers, relational

peers to perform hedonic activities such as fun games, and as an intimate buddy reducing emotional loneliness.

Social robots are used as tutors in the educational field which enhances learners' cognitive engagement (Zaga, 2015). In a study conducted by Leite (2014), Robot iCat is used as a tutoring robot with an empathic model. The empathic model comprised of esteem support such as a compliment, validation, reassurance, relief of blame designed within it. The third-grade children were allowed to play electronic chessboard with robot tutors to examine children's long-term interaction with the robot. The social support identified in the study were categorized as information support, tangible assistance, esteem support and emotional support (Leite, 2014). The support behaviors were implemented in the iRobot to evaluate the long-term interaction of the users.

Social robots are also used as assistive robots (P.Christodoulou, 2020) in educational research to benefit student's learnability through adaptation and individualization. In their recent research with the emerging field of socially assistive robots explored to identify the potential benefits of social robots in education. The participatory design of Stimey robot design was used in primary STEM education. The robot was integrated with collaborative teaching learning sequence (TLS). The novel aspects of the socially assistive robots' design comprised the appearance, non-verbal communication, evaluation, and methodology. The robot was designed with gestures, facial expressions and various lights intended to elicit emotional expressions and behaviors. Their gestures were utilized to support nonverbal behaviors. The voice is genderless, and it is designed to be chosen based on the user's preference. The robot provides a haptic response through which the tactile responses are elicited by the users by touching their head and hand. Their results highlight the physical appearance of the robot influenced the user's acceptance of the social robot. The physical appearance and eye of the robot was the most appealing feature. The robot's physical appearance was endorsed differently by male and female users. The female participants favored eye as the appealing feature, whereas the male participants adapted to the social robot displayed and less concerned with the human like appearance. The resemblance of robots to the social identity of the users has a influence in users' response. This study provides various design features of social robots that could be adapted and explored in other studies as it integrated common design features such as social robot's role, appearance, verbal, and nonverbal behaviors.

Another study with persuasive social robot Nao showed that use of peer robots enhances a child's cognitive engagement with the task and the robot. The children's play with the peer robot showed attention and solved the puzzle quicker than the novice tutor robot (Zaga, 2015). Similarly, another study with a personalized Nao robot revealed that learners' performance improved significantly during the training with the robot tutor in the game 'I spy with my little eyes game' (Saerbeck, 2010). Thus, it is visible that social robots could provide an exceptional role as companion robots in enhancing social interaction with humans. Designing such a social robot is unique and includes various integral factors.

According to Deng (2019), the design framework of socially interactive robots must be defined in a way that integrates physical, behavioral, interactive, and contextual factors. Physical factors of the social robot are considered as one of the design aspects in socially interactive robot design (Leite, 2013). Further discussion in the next paragraph will be the justification of choosing physically embodied social robots over virtual social robots and their advantages to the context of thesis.

2.1.1 Role of Physical embodiment in socially interactive robots

Physical embodiment of social robots is a main feature in the design of social robots. Gratch (2007), considers social robots and virtual agents as ubiquitous connectivity as they share several technologies such as speech, Artificial intelligence, machine learning and vision. Even though these technologies are shared by social robots there are considerable differences in their performance based on their role provided by the physically embodied social robots.

Deng (2019) proposes that social robots provide a role of colocation which initiates collaboration in their performance. One advantage of embodied agents is the face-to-face communication feature they provide with their users are unique when compared to that of interactive systems such as speech to text applications. Mead (2017), suggests such communication between physically embodied agents enables social interaction.

According to Heerink (2010), the physically embodied agents provide social presence which is another advantage over virtual agents. In a research by Vygotski (1978), it was found that the robot's social presence provides better communication than virtual agents. Wainer (2006), notes using physically embodied agents based on their performance can improve the perception on social agent's tasks and capabilities as well as user's perceptions with social robot's task.

For instance, a study by Leyzberg (2012) compared physically present robot tutor, screen tutor, voice-only tutor using Keep on a robot with undergraduate and graduate students. The social robots refereed the logic puzzle game with participant students. The study revealed that the students who played with a physically present social robot with personalized lessons showed better learning gains than on-screen or voice-only tutors. This ensures the importance of physically embodied social robots would benefit us to a wider extent. Therefore, it is noteworthy to consider embodiment as part of the design while designing the social robot based on the context of use (Leite, 2013).

The role of robots and their feedback also influences the user's actions which is examined by Ham (2014). The social feedback of the persuasive social robotic agents has shown that social robots might be a powerful technology in persuading a user to achieve their goals. The persuasive robots are designed with persuasive technology to change user behaviors through interactive technology (Oinas-Kukkonen, 2009).

The researchers Ham (2014) conducted an experiment using persuasive social robot, iCat to find the results of persuasiveness among the users of washing machine. The iCat was designed with physical embodiment like a cat with eyes, lips, eyebrows, eyelashes. It can play a speech file and show social expressions. The experiment was conducted to find the results of persuasiveness among the users of washing machine and their contribution to energy consumption. By exploring the effect of persuasive social feedback of robotic agents they discovered the robotic agents have the capability in persuading the change with user behaviors. Also, the changes in behavior were observed to be large when compared to the factual feedback. They compared two experiments where the participants observed the result of positive and negative social feedback provided by the robot and their results in energy consumption reduction. The experiment had two goals for the users, the first goal was energy saving and second goal was to clean the laundry. The robot provided positive energy consumption feedback to inform the user about their achievement. The study result showed that when users have several goals to achieve while using the appliances, they tend to decrease their energy saving and they start using the electricity more as observed from the positive feedback provided by persuasive social robot. They observed this finding with one type of feedback with a goal of energy consumption. When multiple goals are considered the social robots feedback feature also varies depending on the context and goal of the social robot. The researchers propose the positive social feedback by the social agent would encourage the users to concentrate with their secondary goals as in the study the users strived to achieve laundry to be clean rather than focusing on low electric consumption, whereas from their observation persuasive effects in users were more when there was negative social feedback through persuasive social embodied agent, iCat. Therefore, the feedback provided by persuasive social robot agents varies depending on the user goals and they proposed future research if multiple goals are to be considered in the design.

Leite (2013) had proposed a summary on social robot design based on the theoretical research on human robot social interaction for long term interaction. In an initial specification of the social robot design, the embodiment is one of the designs to be considered while designing a social robot and the embodiment should be selected based on the aim of robot's design and robots' potency as well as the embodiment should be chosen that is well suited for the environment. Regular behaviours (routine) need to be considered like greeting etc. One another important design feature is incremental and continuity behaviors of social robots that help in recalling previous activities and self-disclosure. To remember aspects of past interaction the robot must possess a high level of memory and adaptation which can identify new and repeated users and recall them appropriately. Personalized interaction, Affective interactions and empathy are also important design features to understand the user's affective state and respond based on the user's reaction. They are also considered to possess displaying the contextualized affective reactions.

2.1.2 Role of Social Robot's Behavior during interaction

The behavioral design of social robots in human-robot interaction acquaints human-human interaction and multi-modal communication patterns (Deng, 2019). Human language encompasses non-verbal cues such as gestures and facial expressions (Saerbeck, 2010). A study of human behavioral analysis with social robots Nao and icub, examined the importance of non-verbal cues during the interaction with the robot that measured social intelligence (Anzalone, 2015). As noted by (Breazeal, 2009), humans infer social cues while interacting with robots.

In one study by Goeham (1988), the university students were observed and suggested that for student-centered learning verbal immediacy of the teacher is supportive of cognitive learning. Sanders (1990) studied on a mass university student, it suggested that verbal and nonverbal immediacy of teacher immediacy is important for student learning.

This study highlights the importance of social cues in humans during an interaction, especially in the educational context. Deng (2019) states while designing a socially intelligible robot the task the users are intended to perform and the role the robot intended to perform, and their task shapes the user's mental modals of the robot's interaction, physical and behavioural characteristics.

According to the previous studies, socially interactive robots must be able to provide feedback about their states as well as allow humans to interact with them transparently one possible way would be showing expressions through gestures and voice feedback (Deng, 2019). For example, the study by Kirby (2010) examined how emotional expressions foster natural interaction between robots and human research.

In a study conducted by Kirby (2010) designed a social robot with emotional expressions which interacted with humans daily as a receptionist. The study examined those emotional expressions influenced the people it interacted with, also the robots' expressions influenced how the people perceive and interact with the robot (Kirby, 2010). Also, Leite (2014) suggests that robot design suggests that utilizing effective interactions and empathy in design will aid to understand the user's affective state and respond based on the user's reaction.

To perform such tasks the robot would require possessing a prominent level of memory which can be achievable in the future (Leite, 2014). Therefore, it is evident that how important emotion is to achieve natural interaction in human-robot interaction. One possible way used in studies to increase the natural interaction in robots is the use of vocal prosody and by utilizing the vocal prosody the emotion is expressed in robots (Crumpton, 2016).

While designing the social robot, the expressive behavior of robots such as expressive cues and instrumental actions play a significant role in how humans perceive the robot (Breazeal, 2009). Regular *behavior* such as greeting, continuity, and incremental behaviors are to be considered in behavioral design (Kirby, 2010).

The robot's task is intertwined with the role of the social robot based on various situations (Deng, 2019). Satake (2009) used the robot as a service robot at the shopping mall and examined the importance of interaction in the robot's role. The robots in the field proactively used nonverbal interaction with humans. The results showed that people enjoyed receiving information from robots. The system must be able to adapt to the real-time changes and should be capable of learning from the user as knowledge and people's preferences change over time (Nocentini, 2019). The adaptive interaction of a robot is considered to provide many benefits based on the role and task of the robot. Kanero (2018) in their review on the previous research performed with language tutoring social robot they found that the robots can provide reliable feedback when the users speech is recognized reliably. Deng (2019) states that the physical embodiment of social robot benefits in learning.

In a study done by Saerbeck (2010), the adaptive condition of the robot was used with children for learning. It showed that the children learned better with the adaptive condition of the robot. Likewise, according to Breazeal (2016), using personalized interaction by utilizing the state of the user's information could be considered in the design (Leite, 2013). However, to avoid communication failures in robots it is evident to consider a consistent set of behaviors in robots (Bartneck, 2004).

One major factor needed to be considered among social robot's successful implementation is the long-term interaction they enable with the users. This feature in social robots also depends on various other factors. Kertesz, C (2017) conducted a long-term study with 75 participants aged 40-60 years using Sony Aibo to

evaluate the user acceptance of social robots for long term interaction. For a long-term interaction, the user's major expectation was the conversation skills and interaction between the robots and humans. Another main expectation was the integration of AI agents and Internet services. Robots' physical appearance is expected to be attractive to keep the users in long term use. Repeated behavior of robots is considered to bore the user and they expect new features. Therefore, their results highlight long term interaction with the social robot adhering to features meeting user need and context are to be considered in the robot's design.

On the whole social robots with social intelligence embodies sensing the user's environment, managing the dialogue with the human, recognizing the emotions and moods of the user (Malerba, 2019). In the design of social robots defining the social robot's role, it is important to select appropriate behavioral design despite its physical appearance (Deng, 2019).

When looking back to the origin of research for social robots, it is noted that several unknown factors like how people accept and perceive interaction and cooperation with intelligent systems have led to various research (Nocentini, 2019). Likewise, to the context of this thesis to design an effective social robot it is important to know how the users perceive the use of social robots in an educational environment and how robot behavior should be designed to enhance users' expectations.

2.2 Robot Assisted Language Learning

Robot Assisted Language Learning (RALL) has been explored in recent years. As defined by Natasha (2019, pg 1), "Robot assisted language learning as the use of robots to teach people language expression or comprehensive skills- such as speaking, writing, reading, or listening." Learning language includes instruction of native and non-native language instruction with verbal and non-verbal languages through robots. According to their review on previous research, social robots aid the learners in learning a language. Based on their evidence the positive effects of robot assisted learning were found. The design of social robots such as robots form, social role, verbal, and non-verbal cues were considered as important. Their key findings circulated around the robot's physical embodiment and graphical user interface feedback to the students. The design guidelines include providing natural voice communication from robot, displaying verbal and non-verbal immediacy while learning, personalizing to the learner's difficulty level.

One major aspect of robot assisted language learning is to engage users in language learning and support their motivation. Similarly, Persuasive technology fosters users' motivation in achieving their goals through persuasive techniques. As defined by Fogg (2003, pg 32), "A persuasive technology tool is an interactive product designed to change attitudes or behaviors or both by making desired outcomes easier to achieve." Therefore, persuasive technology is developed to help in motivation and change the user's behaviors based on their need and context through interactive information technology. The persuasive system development (Oinas-Kukkonen, 2009) includes primary tasks, dialogue, system credibility and social support. Multiple aspects while designing a persuasive system are postulated by the researchers which includes, responsiveness, error-freeness, positive user experience, ease of access, ease of use, convenience, information quality, attractiveness, simplicity, user loyalty, precise user requirements for software quality. From the Persuasive System Design (PSD) model designed by Oinas-Kukkonen (2009), the persuasive and motivation principles are considered as preliminary features in language learning. System dialogue support such as praise, rewards, reminders, suggestion, similarity, and social role are provided as an implemented dialogue support to keep moving the user towards their target behavior. The system credibility support from PSD model includes trustworthiness, expertise, surface credibility, rea world feel, authority, third party endorsements, verifiability. The principle of social support includes social learning, social comparison, normative influence, social facilitation, cooperation, competition, and recognition. The persuasive features such as social learning, cooperation, competition, and motivation are considered as major discussion aspects in the persuading language learning in the scope of this thesis.

Robot assisted language learning utilizes various persuasive social robotic agents in helping the language learners of various age groups specifically among children language learners with Nao, humanoid persuasive social robot (Ahtinen, 2020). In the Natural studies conducted by Ahtinen (2020), long term field studies were conducted in authentic context of use of social robots for language learning with 9-10years children's and collaboration of parents and teachers in a primary school setting. The research focused on the design framework of socially interactive robots specifically on robot's role, task and their behavior and interaction. The robots' tasks were typically based on the teaching contents used by the teachers in the

actual learning environment rather than defining by researchers. The Elias mobile based app was used as a platform together with Nao robot for teaching children. The wizard of oz technique was utilized with the help of teachers operating the robot platform. The study has shown that the social robot played an important role of encourager, motivator and learning companion and was able to create a positive atmosphere, their physical appearance was well accepted and considered as important factor due to its various modalities such as speech, gestures, gaze, movements, and touch.

Similar explorative study was conducted by Kouri (2020) with 10 immigrants as participants learning Finnish through social robot Nao. The user study was conducted to explore the potential of customized language robots. The study revealed that the user's attitude with language tutor is positive. The findings reveal the importance of robot feedback. The repetition of words seemed important in customized language learning. This feature in RALL is found to increase and strengthen professional vocabulary. The personalization of the robot seemed to influence positively on motivation. The learner's perception also correlated to the environment. Two of the participants considered they learned and remembered more effectively in a classroom environment. In addition, with customized lessons and an aspect of easy- going learning session the participant also expects to learn at a slower pace of learning. With the Finnish language trainer, most of the learners communicated naturally and fluently. There were also considerations for support from language trainers in understanding the robot's pronunciation and understanding the robot's questions and instructions. Thereby, the findings call for the need for the human support during the language training with students as the students consider human teacher has proficient language knowledge and can facilitate if there will be a need to fulfill the competencies of students from robot. The support of facilitator role is considered as an encouraging factor through the learning process. Thus, the novelty of robot assisted language learning is considered to rely on the context, role of the robot, robot's basic behavior, language learning program and many other factors.

The study findings by Ahtinen (2020) designed various feedback for the language tutors to encourage the learners and motivate in language sessions. Their findings were based on the user's choice and their inferences on the robot's use in their context. The robot's role was found out to be encourager and learning companion.The robot's verbal feedback along with gestures such as cheering, nodding, clapping and movements were used as rewarding features. From the pupil's observation the robots gestural award was perceived as enjoyable experience at the end of learning task. In addition, the robot's eye was perceived as attractive and strongest rewarding element for the robot in motivating the students to learn. The multimodal features representing the motivation behavior in robots are used with need basis to keep the students active with the engagement and not letting them to get bored with continued use. In addition to various features utilized in social robots, the movements of the robots during the learning supported the students learning. The social role of the robot initiated the collaboration with the children and the interaction worked well working in teams. Students learning experiences through robot assistance are found to be unique and motivational. Also, the users showed empathy and played with social robot which shows the potential of social skills the robots possess.

Other findings from their study include the robot should create a learner friendly environment to keep the students stay focused. The teachers involved in the study along with robots perceived that the robot was able to create motivation in learning based on student's actions with robot tutor. There were also frustrations evoked in participants due to imperfect speech recognition which calls for precise speech recognition in social robots for language tutoring. Besides, the speech recognition seemed to be natural with adult learners than with children's users. The robot's nonverbal communication provided a rewarding and interesting learning experience through persuasive interactions. The robots gaze attracted most of the students which served as a reward from robot as feedback. The persuasive social feedback provided by the social robot agent has persuaded the children's motivation in language learning as discussed earlier in the findings from Ham (2014).

In a recent study conducted by Engwall,O., & Lopes, J. (2022), the language learning with the robot assisted language learning is analyzed. A user study with 33 adult second language learners practicing Swedish language with Furhat, anthropomorphic robot was analyzed. The study findings showed that the robot's interaction with the students was positive. The need for adaptation of robot's behavior based on students' interaction is found to be important. Also, collaboration with the peer during the conversation practice is

important in managing the linguistic difficulties and to overcome the communication hindrances with the robot.

Engwall (2022) produced an overview of teaching strategies and robot's roles used in previous RALL studies. Based on their comparative study findings on various social robots used in the robot assisted language learning (RALL), Engwall (2022) suggests the role of robot could vary based on the robot's type, interaction, students age, context and their proficiency level. Social robots are perceived to be beneficial in listening and pronunciation practice. Their implications highlight that for adult language learners' combination of teaching strategy may increase realism of communication. Also, robot type with verbal and nonverbal interaction promotes learners own intrinsic motivation specifically with social exchange. The importance of the need for accurate voice recognition and feedback is highlighted in the paper. For an enhanced engagement the social robot's appearance, verbal and nonverbal behaviors are important. With the light of language tutoring robot's role, personalizing the robot improved the interaction with the robot. They also proposed the behavior of the language tutoring robot should adapt based on the learner's proficiency, language familiarity, age and gender. Based on their findings and their thorough analysis various robotic features influence the learner's interaction with robots.

Another study by Saerbeck (2010) evaluated the social behavior of the robots with the social robots iCat in English language tutoring to find the students learning performance with expressive robots. The robot behaviors such as role model, non-verbal feedback, attention building, empathy and communicativeness are considered in a design. Their findings convey that the robots designed with social supportive expressive behavior significantly motivated the students. The robots designed with socially supportive behavior are expected to be supportive in learning for long term.

According to Engwall (2021), to create a social relationship interpersonal and collaborative learning is found to help the learners in a social dimension. The conversation of the social robot should also support extrovert concrete learners. Their study reveals the embodiment of the social robot impacts the learners and the learning software. Therefore, it is evident that the robot software chosen in design of social robot has influence with the usage environment and context to provide potential learning benefits to the learners. As the learning style of the users varies the design of social robots' interaction strategies need to be considered based on user's preferences.

The researchers Schodde,T (2020) investigated the learning outcome of social robots in second language learning among the young children around 4-7years. They focussed on the adapt and explain approach meaning adaptation of the learning task to the user's knowledge, providing explanations on their adaptation decision and their actions would support during users dis engagement in learning. Their data revealed the robot's adaptation of learning tasks based on the learner's state had effect on learning gains for students in need. This was beneficial among the slow learners than fast learners. They propose the zone of proximal development occurs based on the individual knowledge state of the learners. Through adapting the behaviour of robot and their course of interaction with the cognitive and engagement state of the learner and providing the explanation of their adaptations supports the users struggling with learning task and dis engaged in learning. They also highlighted such adaptation systems can be exploited when a social robot can know the individual learner's potential and distinguish the differences among the users. To make the learners engaged in learning meaning for affective learning(motivation) with the social robot they found the robots actions such as stretching and standing could support concentration which is required in cognitive learning. However, they do not guarantee their influence and side effects of the combination of robotic strategies, and they propose for validation of such strategies are still required and opened to future research. Therefore, the social robot's interaction strategies vary based on individual differences thus the task of robot relies on users' needs and preferences.

In an extensive literature review conducted by Van Den Berghe (2019) the use of robot assisted language learning was analyzed specifically on the effect of robotic behaviors and their learning outcomes were discussed. They addressed the topics word learning, reading, grammar, speaking skills and sign language based on the mixed results of research papers on language 1 and language 2 learners. The findings suggest the effectiveness of robot tutors in learning needs more exploration due to their technological limitations and considerations, the fully autonomous robot was not explored widely. Also, in most of the research robot assisted language learning was conducted with the support of teachers through teleoperation. Therefore, designing robot behaviors for effective language learning based on semi-autonomous and fully autonomous

robots will differ based on their interactions. Hence, due to these technological limitations further research will be required in the design on effective robotic behaviors.

In their discussion (Van Den Berghe, 2019) on effectiveness of robot's adaptation feature, the result of adaptive learning could be measured if the user's knowledge is known by the social robot. The aspects that may affect users learning in an unexpected manner are specific learning materials, the difficulty of tasks and robot's behavior. Another aspect is the robot's speech system also affects the second language learning and pronunciation of words the user learns. As the robot's text to speech is inferior quality when compared to human speech the alignment of robot's text to speech system to the human speech is important. In the design of robot's speech system, careful consideration is needed for an effective language learning as there is no explicit evidence on how the learning outcomes would be if user prefers the alignment of robot's text to speech, prerecorded human speech or to an advanced speech system. The physical interaction of robot benefits language learning depending on the learning situations. In grammar and sign language learning the robot Robovie R3 utilized 5 fingered hands and the Nao robot used 3 finger hands. The learning gains were seen in both robots but there was more learning gain with the robot Robovie R3 due to its physical possibilities it used in the interaction. It is clearly visible that the importance of physical embodiment during interaction is also a key aspect during language learning in various contexts.

Other findings related to social robots providing reading support suggest that the children in the robot assisted classroom outperformed well and were highly motivated in learning. After multiple interactions with robots the students were highly engaged and highly motivated in learning from robots with less anxiety. However, more investigation on the effects of robots as motivators in language learning needs discovery to make a distinction whether students are intrinsically motivated to learn a language through social robot. If the robot motivates in language learning, clear findings are needed whether the users are motivated due to its novelty or the motivational actions it provides to the users (Van Den Berghe, 2019).

Based on their state of art discussions the students stay motivated in the beginning with the robot and this effect has faded eventually after several attempts. One possible solution for long term interaction suggested was increasing the social behaviour of the robot or involving working around tele-operating the robot. In short, for a long-term interaction with social robot, guidelines such as robots' appearance, behaviours, affect, adaptation and memory are recommended by the researchers (Van Den Berghe, 2019).

With respect to robots' behaviour, it is recommended that the robot should have both new and routine behaviour with personalization feature, and it should be focussed on their users. The adaptivity of the robot's social behavior depends on the various factors it should optimize with. One aspect is learning tasks such as grammar learning, speaking skills, sign language, reading skills and word learning. Another factor it should consider is the diverse group of language learners such as children from various age groups and adults. Adaptivity and feedback should be designed based on the users and the target learning. They highlighted the interactional possibilities of robots and their advantages in language learning. Another advantage of social robots in language learning are the robot's social behavior and personalization of the learner-robot interaction. Based on the progress of learners the tutoring strategies are adapted. For a robot to behave as an effective language tutor it is important to consider the robots way of interaction with users and its social behaviors for effective language learning. The researchers suggest the need for advanced speech recognition systems to recognize the state of learners to perform effective language tutoring (Van Den Berghe, 2019).

It's evident from previous studies, for a long-term interaction the robot's physical appearance, robot's features, conversational and interactional features, robotic behaviors need to be supportive to the targeted audience (Kertesz, C, 2019).

The social robots being novel and emerging field its use in various context relies on the user's acceptance. This is evident from the study conducted by Mäkelä, 2019) on the user's acceptance and perceptions of location tracking displays. The Simsense system is a creative location tracking system which can transfer content from public display to personal devices through mid-air gestures. It utilizes Kinect sensor and Bluetooth beacons for the location of mobile devices. It allows the user to pull the information to their mobile device from the display. Their study with 25 participants revealed the users are willing and feeling excited to adopt the use the novel-tracking system, also prefers control over the system to be what, when and where they are tracked. The results highlight the users want the information to be transparent with regards to data

collection and ownership. As the social robots utilize various sensors for users' location tracking, object tracking to avoid obstacles when used with humans, usage of data collection, appropriate software choices based on users' acceptance and perceptions need to be considered in the design of social robot to create positive learning experiences with the students. The willingness of using the social robots in the learning environment and their deployment is based on the consent from the users. The social aspects of security and privacy need to be considered in future research before the deployment.

To the context of this thesis, based on the above literature review the idea of language two tutoring social robot at university context has been chosen and evaluated through explorative user study has shown potential use case with the Finnish language learning international students. The study explored the use case of social robots in university. The social robot used is a humanoid robot, Pepper. The role of the robot is language two tutor. The context of use of robot is in university premises. The lessons are designed by language teachers from university. The concept is designed with social robot, Nao as proposed in user study and considering the above research articles.

2.3 Social robots and Technology

Several social robots are used in the education and research in various context. Most common persuasive robotics used in the language learning and their technology aspects are discussed in this section.

Furhat, Humanoid social robot:

Furhat robot is a humanoid robot designed to intuitively interact like interacting with the humans. It differentiates from other social robots around the market through its anthropomorphism and natural conversation. It is used in various use cases; one potential use is with children to practise social skills. It also serves as a multilingual robot assistant in enhancing travel experiences. The Furhat features include: displaying digital face through ingenious back-projection system, using real voices and synthesised voices, mimicking human behaviour with expressions and movements, providing natural facial expressions, head movements and eye gaze, automatic face movements to produce illusion of life, advanced face engine enables highly expressive animations, face and voice recognition to enable precise verbal and non-verbal feedback, advanced computer vision to track face and estimate the engagement, audio visual inputs for multiuser interaction feature, natural interactions to maintain eye contact and return smiles. The technologies used on Furhat include NLU engine which manages the speech through turn taking, error handling and speech recogniser for expected utterances. To provide efficient interaction it utilises powerful stereo speakers with USB microphone. It can produce various representations of human appearance through the back projection. It can exhibit humanlike appearance through animated projections. The robot behaviours include natural verbal interaction through nodding, headshaking and raising eyebrows. It also can lip sync and express characters in numerous languages around the world with cutting-edge speech recognition.

Elias Robot, The Language Learning Robot:

Elias robot is designed by Utelias Technologies/ Curious Technologies Ltd to coach languages to language learners in various languages through positive feedback. The lessons can be programmed by teachers and used in the classroom practices with students. It is also possible for individual coaching around the classroom. Elias's robot has thematically pedagogically designed language lessons. It creates a fun and interactive learning environment. The Elias robot application consists of five exercise sessions. The thematic sessions consist of warm up exercises with encouraging features such as songs, dances, stories, memory exercises and games. Another feature consists of adaptive speech training lessons, allowing the students to interact multiple times without a fear of making mistakes. It helps students to learn a language through natural interaction with speaking practice sessions. The language lessons can be practiced by repeating and remembering features in the application. It accurately produces feedback on the words pronounced through the progress visual shown in the screen. The students can learn words with flashcard-based vocabulary learning through repeat and remember feature. It can modify lessons based on students' needs and can adapt to students learning capabilities with real-life conversation situation. The students can practice for an exam through playful quiz exercises.

Nao, Social robot:

Nao, humanoid social robot is designed by Aldebaran united robotics group and an open-source programmable robot. It has 25 degrees of freedom for adapting with the environment. It has seven touch sensors to get aware of the environment. For speech recognition four directional microphones are used and the dialogues are used in various languages. To recognise the person and objects around the space, it utilises 2D cameras.

Pepper, Social robot:

Various social robots and their technology information are explored in this section. Pepper (Fig 1) as a telepresence robot used in various services. One example is pepper used in the company reception area. Pepper is a humanoid robot designed by Softbank Robotics (Aldebaran) operates through programmable platform. Pepper has feature in recognising face and human emotions. Pepper has 20 degrees of freedom to express natural movements, speech recognition and dialogues in several languages, perception modules which recognises the person discussing with, multimodal interactions are produced using touch sensors, LED's and microphones. It uses infrared sensors, bumpers, an inertial unit, 2D and 3D cameras, and sonars are used for autonomous navigation. The robot provides a space to connect with the users through secure audio and video encryptions. It can automatically detect the objects to avoid the obstacles. The pepper robot can be operated remotely using browser-based interface. The user can walk with the robot due to its self-navigation feature and technology.

Summary of Literature Review

As a summary this section discusses the findings from the literature review. The user experience of social robot language tutor depends on the embodiment, collaboration of teacher with the robot in integrating the language teaching efficiently (Ahtinen, 2020). The features such as social robots' speech, gestures, gaze, movements, and touch designed in the robot impacts the learner's experiences. The robot's state of process needs to be addressed such that the learners are aware of robot's actions. The robots verbal and non-verbal cues could be utilized as reward and surprise elements to enhance students learning.

According to Leite (2013) the social robot's embodiment should be considered in design. The embodiment of the social robot is chosen based on the task, role, and environment they perform. While designing a social robot its memory is considered to possess such that it can identify new and repeated users to remember aspects of past interactions and recall them appropriately such that they adapt to the users in identifying new and repeated users. Continuity and incremental behaviors need to be considered which addresses strategic behaviors to recall previous behaviors and activity of the users. Socially personalized interaction with the user utilizing the user information was also proposed in their studies. Socially affective interactions and empathy were in the summary of social robot design.

The social robot tutor applications should be designed such that they support specific users in learning. The design feature should consider the environment of the user to support in learning which is related to the voice recognition of the social robot. The multi modalities of the social robot should be selected based on their use case. The social behavior of the robots should support the student's behavior with a human friendly environment. The learners attitude affects the learning experience therefore it is important to choose the role of robot based on their context.

3.RESEARCH PROCESS AND METHODOLOGY

The research utilized various methodologies in the thesis. The explorative user study findings are gathered to evaluate the concept of language two tutor at university context. The thesis approaches, phases and process are described in this chapter.

3.1 Research approach

The research approach included design research methodology. Constructive Design Approach (Koskinen, 2011) is followed in this research process. According to Koskinen (2011), Design research is a construction of prototypes, products, and models through defining the problem that might be unexplored. Exploring the new materials and constructing the product intentionally for the future is an advantage of this approach. It provides an imaginative space to explore the future scenarios of the product instead of limiting with their present and past research analysis. Utilizing this design approach, we implemented the language two tutoring robot concept in the beginning for the purpose of pre-studies user trials.

Next, Design Research methodology (Cross, 2006) is also adapted in the thesis to design and evaluate the social robot, tutoring language two to the university students with international group. According to Cross (2006), the design research is “Designerly ways of knowing”. Knowing means the designer delves into designing a product through researching about the people (Design Epistemology), the design processes and practices (Design Praxiology), the products configuration and form (Design Phenomenology). The author of this thesis followed all the three design taxonomies to communicate the acquired design knowledge and circulate those for the future research, design and development of the novel artefacts among the researchers in the design field.

Firstly, the context users, university’s international students learning Finnish as their language two were explored in a naturalistic environment at the University premises. Based on Cross (2006) taxonomy, the people are the first participants in the research process. Exploring user’s actions in the context enhanced the thesis authors knowledge to contribute the data of user’s actions with the social robots in the learning environment. The collected knowledge served as a feed to the design of artefacts. The preliminary design implications were drawn based on Design Epistemology process.

Lastly, the researcher gathered product knowledge from the related field to produce product trends specifically on the social robot's form and interaction configurations. Appropriate literatures were selected to utilise prosaic form of products based on recent technology trends. Thus, following Design Phenomenology with product information served as potential ingredient to the design of language two tutor.

The data collected through three taxonomies of design research (Cross, 2006) evolved in the creation of novel artefacts of Social Robot at university context.

Another approach followed in this research is Human Centred Design process and practices (ISO 9241-210:2019). This methodology benefitted as a guideline to follow the user centred practices. The practices include adhering to the ethical considerations in the design process. The participants involved in the study were informed about the study and the data privacy of the users are strictly followed in the design process. All the data’s are securely handled with ethical design considerations. The interviews were conducted based on the HCD guidelines. The interview questions followed Semi structured Thematic questionnaire, open ended questionnaire. The evaluation method of design Artefacts are carefully chosen based on knowledge gained from previous literature research in HCI and HRI, user study and feedback from co design workshop. The evaluation process adapted the cocreation canvas designed by Axelsson, M.(2022) to involve the context users and gather product information. This provided significant knowledge in producing design implications of the social robot. The evaluation question was partly carefully chosen from the experience design cards of Islam, M. S. (2021) to identify the purpose the students intend to use the product.

The robotic canvas designed by supervisor Aino Ahtinen was utilised in the design of language two tutor which served as a supportive guide all through the thesis process.

3.2 Data Gathering Methods

The Grounded Theory (Charmaz, 2014; Glaser & Strauss, 1967) is adapted to develop the concepts and theory from the data collected from field study and literature findings. The line-by-line coding technique is utilised to analyse the data gathered from the pilot study and field trial interviews. Glaser (1978) defined the line-by-line coding technique as naming each line of the gathered data. This coding technique helps in finding the undetected patterns in students learning process while using the robot in the interview. Overall, the grounded theory technique helps in gaining a closer look towards what participants say to that of their activities performed during the interview. This helps in identifying and understanding if there will be any underlying task-related problems faced by the participants while interacting with the robots.

The *explorative context study* is conducted at the beginning of the project to know the semantic differential about the physical appearance of the robot and the feelings of the users. Consent for the data processing and background details is collected informing the participants about the data processing will be anonymised. A semi-structured interview is used to collect the information that reflects the actions performed by students with social robot tutors. Naturalistic explorative field studies are emerging trend in HRI field which was adapted to provide rich data to serve as a potential finding for future research and design of language two social robot tutor.

Technology Acceptance Model (TAM) intends to determine technology acceptance from two perspectives such as ease of use and effectiveness. To evaluate the important aspects of the language tutoring robot such as trust with social robot tutor and learning experience of students, during the explorative study, TAM is utilised in the design process (M.Heerink, 2010). The semi structured questionnaire to evaluate various hedonic and pragmatic qualities are used in the user study.

The Robot Attitude Scale (RAS) (Broadbent, 2009) is utilised in the user context study to evaluate the user's attitude towards the social robot tutor. RAS scale survey questions were altered from previous research to match the context study. The robot attitude scale was asked to students at the end to measure the robot acceptance as a tutor in language learning.

User Experience Questionnaire (UEQ) was utilized during the user study. The user experience was utilized in the semi structured questionnaire. The participants were asked questions post explorative session to know their learning experiences with the social robot. However, the author adopted question-based evaluation of UEQ to gather more information on their product experience.

Co design is used in this design process to find the real needs and wants of users and for latent opportunities and to design together with all the stakeholders. The Co-Design is defined as "The process of designing with people that will use or deliver a product or service" (Design Council, UK). As the users are participating in the design process, it is also a participatory design which describes co-operative approaches in the process. Co-Design includes workshop in the development process where tools are provided to the users encouraging and guiding the users through facilitation. A co-design framework designed by the research team (Axelsson, 2021) is adapted in the design of the Personalised Socially Intelligent Tutoring Robot. The aim is to involve designers and users to share their perspectives to progress towards a shared goal of designing a language tutoring robot with an idea that this will lead to improvements and innovation. The Minimum Viable Product design canvas from the framework is utilised for the codesign workshop. With regards to development of social robots, UX is considered as a central issue (Lindblom, 2016). Therefore, to evoke a positive user experience UX design needs to be considered in the evaluation of social robots. The findings from pre study were utilized to implement the concept prototype.

3.3 Research Process

The thesis process comprises of five phases utilizing the methods mentioned in the previous section.

The first phase is the literature review process. The research gap was found and the future trends in the design of social robots in human robot interaction are explored. The grounded theory approach was utilized in the research based on the research requirements in each phase of the research.

The second phase is explorative user study, which included preliminary user study and first field trial. The study was conducted in a naturalistic qualitative approach. The learning experiences and their perceptions on use case of social robot as language tutor were explored based on the qualitative interview. The data are analyzed and utilized for the design phase.

The third phase is the concept design phase. The Constructive Design Approach methodology was utilized in the design to develop the future artifacts based on the information retrieved from literature and user study.

The fourth phase is the evaluation of the concept scenarios with codesign canvas designed by Axelsson (2022) and was evaluated with the university students.

The fifth phase of the thesis is the formulation of design implications based on the findings from the literature and user study.

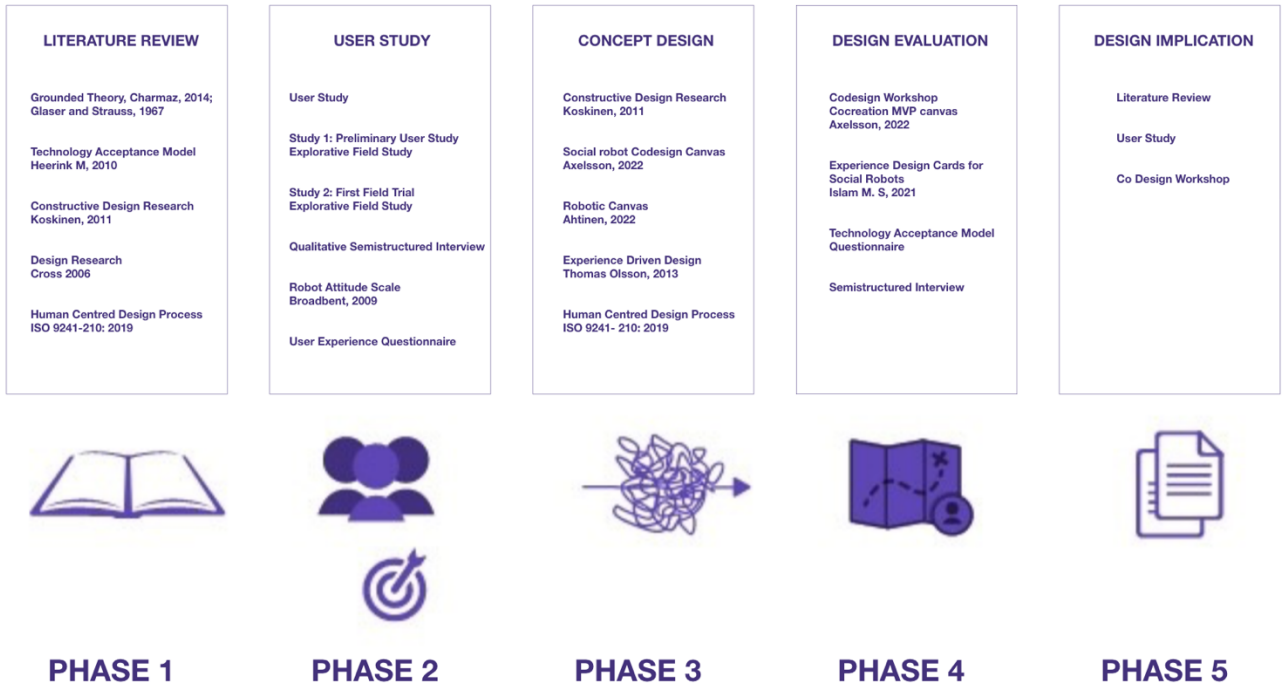


Figure 1: Research process

4.USER STUDY

The contextual Inquiry was conducted at the beginning of the thesis to reveal the user needs as well as to observe the user actions in the natural environment. The qualitative explorative field study methodology is adapted.

The participants are invited through the language courses at university and the participation were voluntary. The context study comprised of two phases: Preliminary User Study and Pilot study. The findings are described in study 1 and study 2.

4.1 Study 1

Methods

The preliminary user study conducted in the language center at the university during Dec 2019. The preliminary user study plan was initiated by supervisor Aino Ahtinen, University Lecturer in collaboration with University Language center teachers, Laura Pihkala – Posti, Project Manager and Pirjo Litmanen, University Instructor and Utelias Technologies to study the initial concept idea of social robot teaching language two to international students learning Finnish language as their language two. During the initial phase of the project, German language learning and Finnish language learning concept was initiated. The design of social robot tutor for German language tutoring was explored by Sanna Auri. This thesis focuses on Finnish language learning.

The humanoid social robot, Pepper was used to explore the initial concept. Pepper robot is a semi humanoid social robot designed by Softbank Robotics (Aldeberan Robotics). Due to logistical constraints with humanoid social robot, Pepper, the study was conducted in the University premises where the concept was initiated. The Elias language learning application designed by Utelias Technologies was used as a source of language learning platform along with humanoid social robot. The tablet was used to learn the language through the humanoid robot.

The Participants were invited to the study with the help of my supervisor, by circulating the mail to language teachers which was efficient to recruit the volunteering participants. The participants registered for the study through the doodle shared link.

Three participants enrolled in the preliminary user study. The male participants were from diverse demographic locations from Europe and Asia. The participants had a different schedule. The study was conducted in the room next to the language center and in the computing science building. The allocated time for each participant is 20-30 minutes. When the pilot study was conducted, all the enrolled students were learning Finnish at stage 1.

At the beginning of the study, the students filled in the background information regarding their age, origin, Finnish language skill, and study information. The students signed the consent form confirming their agreement with the Preliminary user study recordings and interview data acquisition for the thesis. The observations were made with note taking and consented video recording. The students explored practicing the Finnish language with the pre-programmed social robot. In the end, the participants answered the semi-structured, open-ended interview questions and filled in the Robot Attitude Scale (RAS). RAS scale supplies student's ratings on robots while practicing Finnish language. The reason for choosing the RAS scale is to assess the students' positive and negative attitude towards the social robot. The quality of participants' interaction with social robots was measured. The selected attributes measured in the survey were (friendly-unfriendly, useful-useless, trustworthy-untrustworthy, easy to use-hard to use, reliable-unreliable, safe-dangerous, helpful-unhelpful, interesting-boring, basic-advanced, complicated-simple)

4.2. Study 2

Methods

Study 2 was conducted as the second phase of the context study with a few more participants to gather the insights from the context and users. The study was conducted at the university during January 2020. The study approach was an exploratory field study that aimed to observe the student actions and first experience with the social robot as a language tutor. The participation enrollment was completely voluntary. The students are invited with the help of the language center and my supervisor, Aino Ahtinen's reference. This way it was more convenient to recruit the right participant who was learning the Finnish language at the beginning level. The field study information is presented in Finnish class to the students and the invite is shared to students through email through my supervisor and language center teachers. The students were invited to enroll in the field study based on their voluntary interests.

Four female participants enrolled in the field study from Europe and Asia. The participants had a different schedule for the study. The study was conducted in the room opposite the current Robot lab and the Lecturer's library room. The allocated time for each participant is 20-30 minutes. When the field study is conducted, the students were learning Finnish at stage 1. The humanoid social robot Pepper was used in the pilot study along with the Elias language application. The Finnish lessons are designed in collaboration with language teacher Pirjo Litmanen. The robots dialogue system for the lessons were curated by the language teacher based on predicting the user's response.

At the beginning of the field study, the students filled in the background information regarding their age, origin, Finnish language skill, and study information. The students signed the consent form confirming their agreement with the field study recordings and interview data acquisition for the thesis. In this study all the participants were instructed on the process of using the robot application and the feedback of the robot. Then the students explored practicing the Finnish language with the pre-programmed social robot. In the end, the participants answered the semi-structured, open-ended interview questions and filled in the Robot Attitude Scale (RAS) survey. RAS scale supplies student's ratings on robots while practicing Finnish language. User Experience Questionnaire (UEQ) was used as a part of qualitative interview. The adapted questions related to hedonic quality aspect are stimulating and novelty. Other aspects of pragmatic quality such as perspicuity, efficiency and dependability are asked as a question.

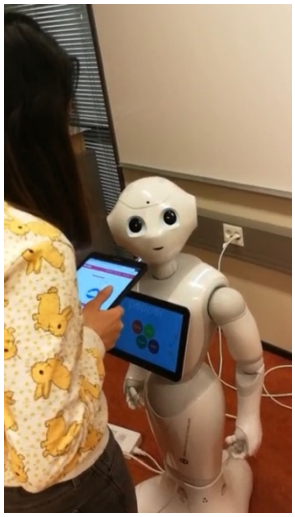


Figure 2: User study with social robot Pepper and Elias Robot learning program

4.3 Findings: Study 1 and Study 2

The findings from the pre-studies are comprised in this chapter. The study observed the student actions and first experience with the social robot as language two tutor. Most of the participants revealed that the learning experience through the humanoid social robot was interesting, helpful, and motivating in language learning. Based on the semi structured interview, the pragmatic qualities of the social robot and hedonic aspects were perceived by most of the students positively. Both the male and female students liked the idea of using social robot as language tutor in the university. One of the female participants was impressed from nonverbal

gestures of robot features and considered as enjoyable and pleasing. All the male participants among the three considered the social robot is easy to use and understand and the learning application is easy to use with the social robot and found potential benefit for future.

Physical Appearance:

The physical appearance of the robot was sufficient and friendly among all the participants. Participant 1 expected the height of the robot to be considered while designing the humanoid robot as the user needs to adjust his seating position according to the robot's feedback. The voice quality differs from user to user, and the robot must adapt to the user's voice. The proximity of the robot and the user must be considered, which depends on the position of user and the height and voice recognition of the robot. However, to the study's context, the participant accepted the robot's current design as the students will be seated in the classroom. For participant 2, the robots candy eyes raised his motivation. Whereas for participant 3, the physical appearance was professional and aesthetic.

Robot's Gesture:

The robot's gesture should be based on the environment. One of the participants felt the use of gestures sense humanness. *"It makes it more human as it has gestures, so using pepper with tablet is fun".* This highlights the importance of the use of gestural communication plays a vital role for an engaged interaction.

Robots Gaze:

The robot's eye was considered positively by most of the participants. Most of the female participants felt the eyes of the robot as beautiful and attractive. One participant considered the robots' eyes as a motivating factor. "*Maybe it could provide some candy eyes for low motivated students.*"

The eyes in the context of user study were also connected as a feedback element based on the design. The robot used in the study produced green light as feedback through eyes which also served as an information transmitter between the conversation. We observed the feedback through eyes with attractive colorful eyes as a part of the robot's feedback helped the students. It showed the state of robot's action during the learning progress as in this case the green light indicated as a signal to correct answer. This also expresses that the persuasion could also be initiated through such novel social robotic interactions. Therefore, this feedback by students highlights the importance of machine vision and light usage among persuasive social robots.

Robot's Speech:

The study findings resulted with the major expectation based on the recognition of student's speech by robots and its response to the users. One participant expected *"It requires the student to speak loudly and closely to the microphone but then again in a classroom setting students are probably expected to be naturally seated so this might not be a problem."* The robot's vocal feedback should be designed based on the user's context of use such that the feedback is audible to users and the users voice are sensed by the robot tutor. While using in classroom various other factors could influence in recognizing students voice and delivering the output to the users. The parsing of noise and providing precise feedback would be a concern in such scenarios. To the study context as the students interacted with the robot individually, there is a freedom of adjusting the volume of the robot and naturally converse with the social robot tutor.

Most of the participants considered robots could be used in the speaking and listening practice session of a language. One of the participants said, "*it would help with speaking, listening practice*". Therefore, it is significant that the robot's speech is delivered in a user's understandable language. Another participant says "*The robot's pronunciation differs as it combines two words and pronounces. If the words are pronounced correctly, it would be very useful for new learners.*" Here, it is visible that the participants expect the language tutor robot to deliver the speech precisely as a human teacher would do. As the students are from diverse language backgrounds there are circumstances where students can relate the pronounced words to their own learnt experiences and relate those words with the listened words. Hence, the use of different language examples in the user's context by the robot is also one of the requirements which could be considered. Most of the students understood the robot's speech, yet one participant considered "*The pronunciation of robot was clearer, but the pronunciation was different when compared to our lecture*". This indicates the users relate to their real-life lecture scenarios and expect similar performance while learning from the language tutor.

However, most of the students understood the robot's speech while exploring the language lesson with the social robot tutor. In general, students expect natural conversation with the social robot. Therefore, while designing a social robot, precise information delivery of social robot's voice is expected by the students to understand the language as desired. Considering the autonomous voice adaptation and correction of the processed voice would enhance the conversation between the user and the robot tutor.

Robots Touch:

The students expected the robots' feedback on their learning outcome can encourage their study progress. For example, like candy eye feedback considered as motivating factor for language learning during the process, robot can encourage the students through various waving gestures through their hands as a positive and encouraging feedback to the students based on their learning performance. The touch interaction among social robot is important feature as all the text input entered to the persuasive social robot's device is through touch interaction, therefore touch and visual interaction are major features considered in the design of social robots.

Language tutor's feedback:

The robot's speech was understood clearly by all the participants. The participants expected spontaneous reaction from the robot. Participant 1 expected the robot to provide prompt response to the queries raised along with constructive feedback. The tutoring robot should provide clear pronunciation to the language learners to learn the words correctly. Participant 3 considered these kinds of social robot tutors can be beneficial in learning language if the robot could decipher the words and provide precise syllabic lessons to the new learners. The voice of the robot tutor is important to be considered in language learning process, especially to the beginner learners as the users need to understand and pronounce rightly. Participant conveyed *"To the present social robot, Various accent lessons through videos could be beneficial to learn the words.*"

Students Learning Experience:

Learning language through humanoid social robots was perceived to be beneficial and motivating among all the participants. Participant 1 perceived learning completely through a functional language tutoring robot is beneficial and could be used in assisting with important tasks. Also, he recommended the concept idea of using social robot as a language tutor. According to participant 2, learning the vocabulary repeat and remember feature of language tutor was beneficial in learning words. One of the male participants considered "*The app was like flash card method which is very useful to learn for freshers and beginners.*" Learning language through visuals was found to be beneficial to adult learners as well. The important use of image and visual representation in the language lessons is represented through the user's comment.

Motivating Language tutor

The study revealed that the use of social robots in learning a language two is beneficial. Participant 1 stated *"It proves to be efficient in delivering language instruction and it will be a supportive means in teaching, also with futuristic aspect that it brings to the classroom and the learning process could be very exciting and motivating to students and language learners."*

Engaging methods in language tutoring were expected from the students as a motivating factor in language learning. One of the female participants says, "It is boring just learning with apps with no rewards, so including reward will motivate student." Motivating elements such as game-based learning, gestural dance from the robot tutor, music was expected which can be considered as a reward factor to increase engagement and motivation in the students' progress. While one other participant considered *"Some more encouragement word when finishes the lesson would be really interesting*." Providing encouraging and positive feedback based on user's learning progress is another motivating element in language learning.

Another motivating factor considered by one participant is robots' attention during language learning. "*Attention which you could get from robot motivates to learn, because you know that someone listens you."* The student expects the robot tutor to listen to their practicing and provide feedback on their language. Robot feedback is an important concern in this scenario which will make the student continue in the language learning.

One participant considered repeating the word is useful in learning a language. "*As I repeat some more time to accept my word, it would be really useful.*" The repetition of words while practicing with robots were found to be beneficial. As the students learn through practice, the Elias robots feature "repeat and remember" is useful for memorizing the words learned through the robot in a long term. The motivation factors in language learning varies from student to student based on their preferences which need to be considered.

Information sharing in Language Learning application.

The lesson presented in the humanoid robot's tablet was easily understandable by all the students who participated in the study. The major expectations from the language tutor interface are it should display the information regarding the robot's process. If there exists a delay in the transformation of information, they expect the interface to display the instructions to the users. Another expectation is about the robot tutors processing such that the user perceives what information the robot processes and the next action of robots. This information could be displayed in the display.

For example, if there would be any technical issues the students expect these should be automatically displayed on the screen, if such action is going to happen during the process. Also, if the robot processes user's information, the processing action are expected to be displayed in the screen. In this way the user can be aware of the informed robot's actions and the user can proceed with the next process accordingly. As an ethical consideration, the user should know the limitations and robot's capabilities of producing the information during the learning. The data processing of users should be informed at the beginning of the interaction such that the learner proceeds based on the informed consent. Such information could be beneficial to the users in effectively utilising the robots during the language learning. In brief, the students expect the robot to provide the visual information of the mutual actions performed during the learning process.

Potential use case scenarios:

The participant provided suggestions on the use of social robot tutor in various environments. Participant 1 suggested "*The social robots will be useful to assist teacher in the classroom as a primary source of language instruction*", "*I can picture that it could probably be useful during classroom exercises and workshop tasks to assist the teacher in responding to students' inquiry and teaching the required skills.*" Here, the student foresees the use case of social robot tutor serving as a teacher's assistant in classroom.

Participant 2 proposed that the robots could be beneficial to users from non-robot environment, learning vocabulary and to the idle language learners. "*It will be beneficial to users who want to learn vocabulary, "It will be easy to learn vocabulary rather than with paper and pen as the robot provides repeat and remember"*. Also, the participants preferred to communicate with real people face to face.

Participant 3 considered the robot assisted language learning will benefit the environments where the authentic teaching could not be conducted such as remote teaching. The participant also considered the use of pronunciation lessons in the language tutor would benefit the beginner level language learners.

Another participant thought "for real conversation, it would be still better to communicate with other people face to face." Here the participant sense to converse with the other person and connect while learning the language like remote learning. The social connectedness with humans through social robot tutor.

Some of the participants consider using the social robot in-situ context. The participant inferred and suggested to use in classroom. "It can be brought to language classroom to create interest among students practicing vocabulary, pronunciation, and conversation."

One participant considered using the social robot individually rather than in a group or with friends and preferred to use it only in university context. *"I will use it for myself. If I use with friends, the communication will be different so I will use this at university alone"*. The user's privacy while practicing a new language is explicitly visible in this statement. Like this participant says, *"It is useful in a good and positive way as I don't feel embarrassed when I make a mistake*". The student prefers to practice the language in a space where the language could be learned in self-space through freedom and does not think of external factors such as

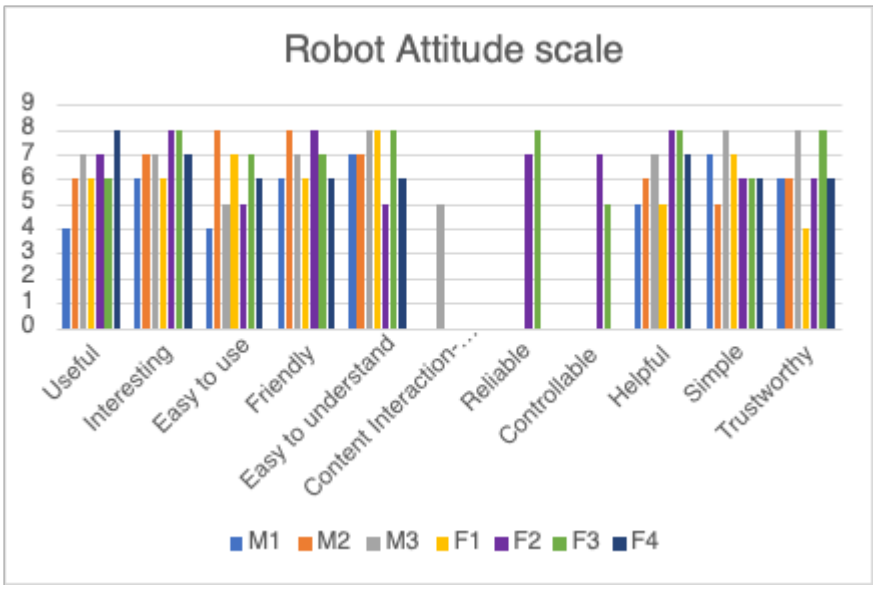
unease circumstances to practice in public fearing for others listening to their voice during their practice time. This allows the participant to learn the language more efficiently.

Summary of User Study

Most of the participants provided positive feedback on their learning experience with the social robot as interesting to learn the language, helpful to learn with flashcards, trustworthy to interact with the social robot and considered that learning language with the help of robot will be beneficial when some more gamified features are included in the lessons. One of the participants considered that providing videos for pronunciation would help beginners to learn the language with right prosody.

Language learning requires motivation, time, resources, memory, and other sources depending on the student's requirement. Language learning requires memory to remember unfamiliar words and utilize the words in practice. The feature of repeat and remember displayed in social robot was perceived as beneficial by the students in remembering unfamiliar words. This was accepted by most of the students. Thus, social robots also benefit the students in remembering which satisfies the pedagogical considerations.

The RAS scale received from seven participants of pilot study and field trial is shown in the figure 1.



F1-F4: Female participants

M1-M3: Male Participants

Figure 3: Robot Attitude Scale (RAS) of User Study

5.DESIGN AND EVALUATION OF PERSUASIVE SOCIAL ROBOT TUTORING FINNISH AS LANGUAGE TWO AT THE UNIVERSITY

This chapter discusses the findings from the user study and literature review in a light of design and evaluation of persuasive social robot as a language tutoring robot at university and discusses the findings considering both qualitative and quantitative data gatherings. In the first section interaction design scenarios of persuasive robot is explained followed by co design workshop of the design of social robot in the second section. In the third section ethical considerations and design guidelines of persuasive social robot are derived. In the fourth section the evaluation and features adhering to current technologies is explained. Finally in the discussion section the overall findings of data considering literature review are discussed.

The design of persuasive social robot language tutor consists of three scenarios. The scenarios are created based on the user experience goals derived from user study. The UX goals are as follows:

1. To provide efficient language learning sessions and facilitate connectedness between students at university in a novel and creative way.

2. To create a motivating, fun and engaging interaction concept with social robot for international students to persuade language learning at the university.

3. To create a new experience, user-friendly and pleasurable learning environment for students with persuasive robot assisted language learning.

5.1 Interaction Concept Design of persuasive social robot

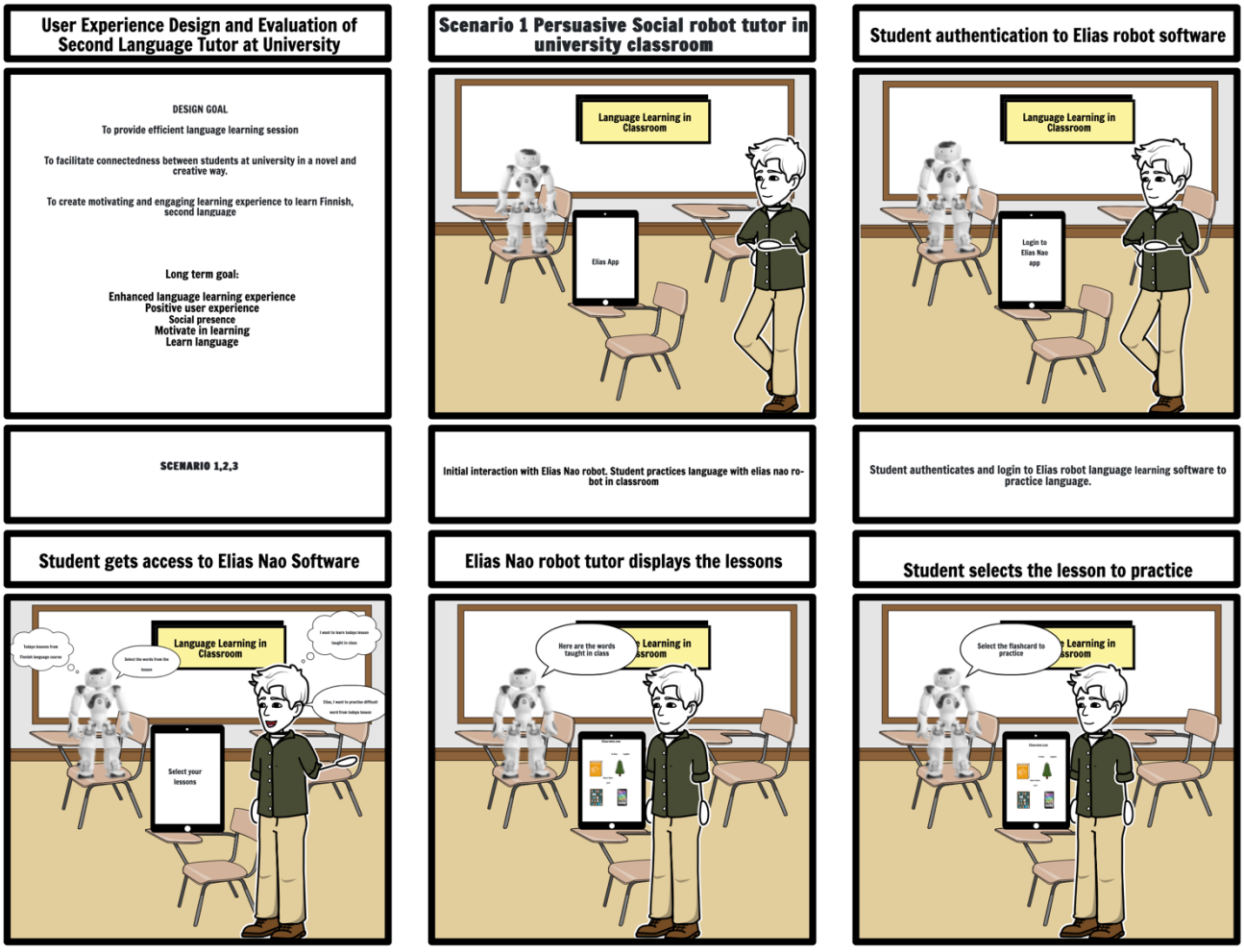
5.1.1 Use scenario

The social robot Elias helping students learn Finnish Language. The user experience goal is **social** and **motivating** language tutor. The user experience goal is derived based on user study. The first scenario chosen is based on the user study to collect more feedback on the user's acceptance and trust with social robot tutor in university. The social robot is used in the university as an assistant with language teacher in the classroom to help students by providing real-time examples of the words produced by teachers. The language two social robot tutor teaches Finnish through flashcard method. The student is allowed to repeat the word multiple times until complete proficiency is achieved which the robot displays in screen. The robot provides social presence like a teacher would provide to student through practice session and individual feedback. The social robot persuades language learning in students through repeating and remembering features.

The concept design of Elias social robot teaching Finnish as a language two at university context is designed based on the data retrieved from the user study and literature findings. The interaction scenario involves design of social robot Nao using Elias's language application. The Elias social robot act as a language tutor teaching students learning Finnish language as their language two. The language lessons are accessed through the language application designed by language teachers. The student's login to access the language learning software. The social robot displays the lessons. The student chooses the word and repeats them. The Elias robot detects the mispronounced word. As the robot has access to multiple language dictionaries it can help the students efficiently to produce various language examples. Thus, adapting to the student's language. The social robot provides real-time examples and feedback based on the student's practiced words. If the students are learning nature-oriented lessons, it connects through the web

and presents live scenario examples. It provides constructive feedback if the student did not manage to learn successfully. The robotic social cues and gestures such as candy eyes, hand gestures, movements and music are produced as feedback based on student's learning progress. Those nonverbal feedback from persuasive social robot tutors serves as a surprise reward element in the learning process.

The experience goal social characteristics of robot is utilized in this scenario as the robot connects with live environment, students and teachers, to help the students in social engagement. The concept is novel as the social robot helps students to improve in language through persuasive behaviors, adapting to students' language proficiency through suitable lessons and creates a social environment with student to practice the learned language with self-confidence without fear of making language mistakes during speech. Repeating the words helps the student in remembering. The behavior of robot's attention to student during learning and patience in listening to students practice session are considered as an additional novel feature. It helps students overcome the feeling of social isolation and helps with focused learning. The social robot also acts as motivator and encourager as it produces constructive social feedback through gestures and social cues. The UX goal Social and Nurture is utilized to reinforce language learning.



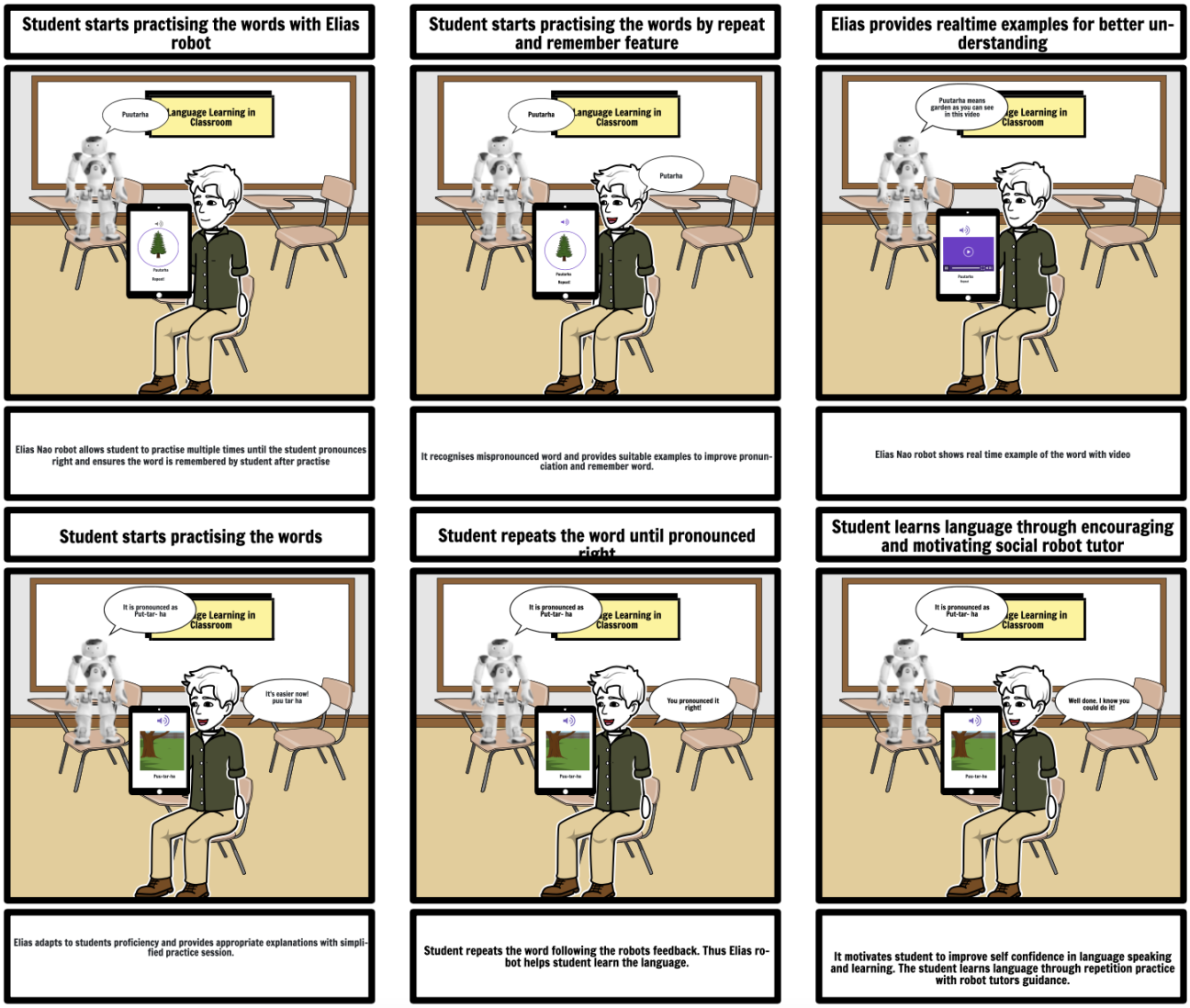


Figure 4: Use Case Scenario 1: Social robot language tutor as encourager at university classroom

The second scenario is a language tutoring robot with social engagement. The robot elicits the real examples of the words used in the lessons utilizing the resources shared in the university server. The social robot provides access to connect with other students to practice language with each other through live chat. It can also connect with other social robots to access suitable data to help the students learn better. The social robot tutor also provides access to connect with their teachers and native Finnish language speaking persons to chat in language café through social robot. The adaptation occurs as the shared data of other robots can be utilized by the social robot to help with language learning. Here the social robot acts as a peer language supporter in communication. It facilitates communication and helps the student to know which aspects of a language need more practice and adapts the lesson according to students language skill and displays the personalized lesson for language practice.. Students can practice with each other through social robots. Thus, language tutoring social robot enhances the student's language proficiency. The result of connecting with other native students and teachers through social robot tutor is it provides an experience of friendliness, community, bonding and intimacy thereby enhancing social connectedness and students perceives a feel of being a part of Finnish community as well as getting learned a language. The user experience goal is social, fellowship and submission are utilized.

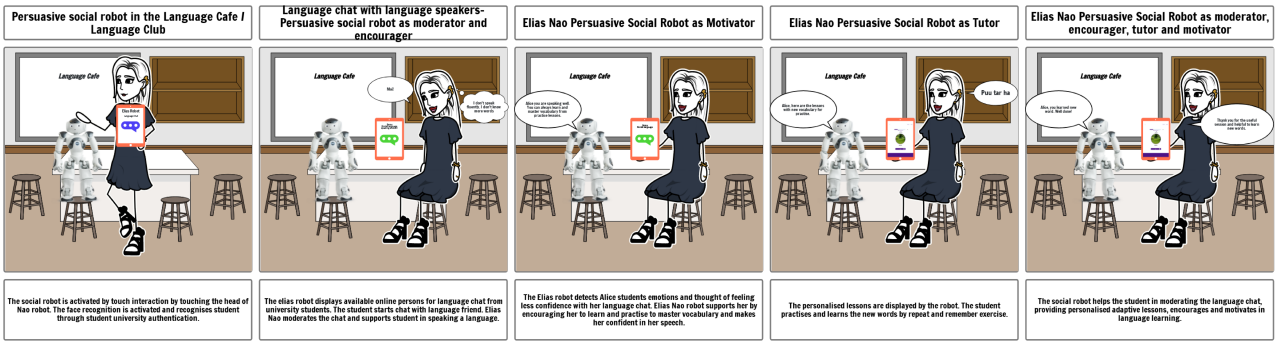


Figure 5: Use Case Scenario 2: Social robot language tutor at university language center

The third scenario is as a university language tutor robot where the robot can be used in the university campus as a peer tutor and companion. The student can practice the language in their own space by walking and practicing. This concept was derived from the co creation workshop. The student also prefers to learn and practice language through physical movement such as walking. The language tutor provides challenging quiz features adapted to students learning progress and encourages the student through social praise and compliments with nonverbal gestural movements. This feature is adapted from user study as the students explicitly conveyed, they also prefer to learn language through gamed based approach through fun and engaging learning experience. The persuasive social robot provides nonverbal gestures as a reward for the achieved student. Thus, encouraging the student to continue with the learning process. Thereby social robot tutor provides the student to self-test their abilities, challenge and learn more from self-competing tasks to excel in their language. The experience goal challenge, relaxation, completion and excel in language is utilized. Virtual agents can be used to provide guidance with pronunciation videos to help the students learn the language accurately.

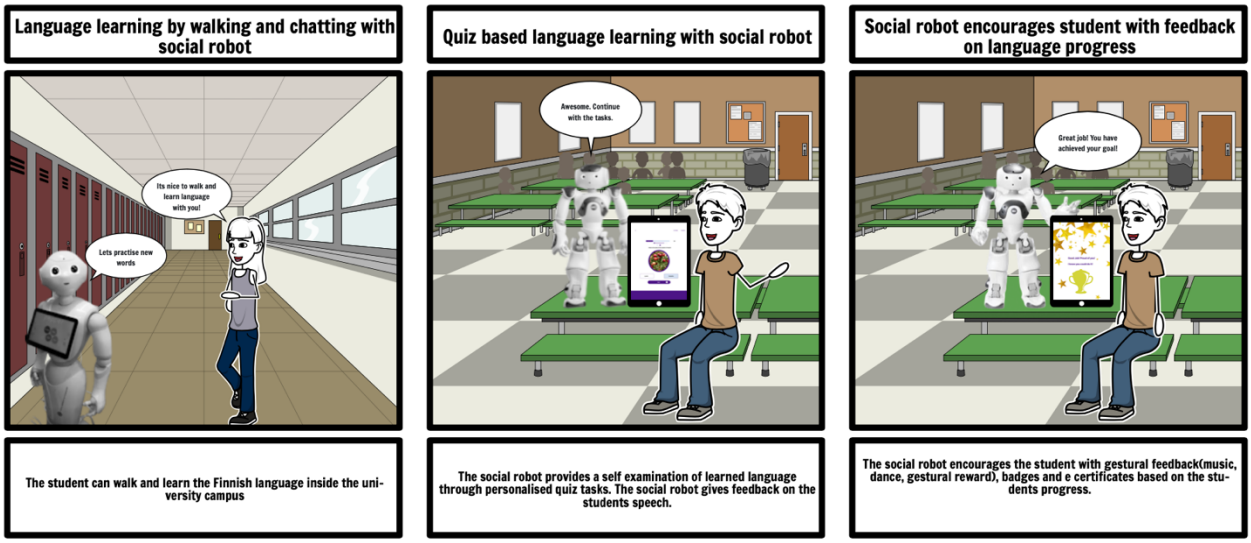


Figure 6: Use Case Scenario 3: Social robot language tutor at university campus

The use case scenario four is designed based on codesign workshop. The students can access the robot through university and use the robot for learning a language remotely from home. The UX goal is social companion. As it is accessed and available to learn from home through physical and virtual robot it acts as a companion robot.

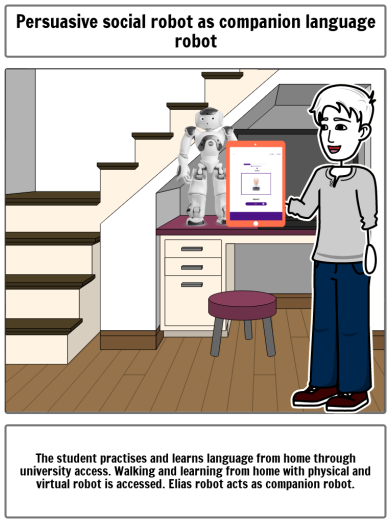


Figure 7: Social robot language tutor as companion robot of university from student home- remote learning

Concept Video

Link to concept video created from Storyboardthat: concept video.mp4

Novelty of the concept

The concept of persuasive social robot tutor in a classroom context is implemented with two goals Social and Nurture. The social robot connects with other social robots and shares the knowledge of language to help the users. The students can connect with each other through Elias robot to practice language. Thereby increasing the social connectedness with the users in enhancing social reinforcement. The social robot tutor can perceive the voice of them and adapt to the student's state pronunciation. It corrects the students voice by identifying the mispronunciation and suggesting the solutions through relating it to other similar language examples user knows. Thereby the user learns the words with the right pronunciation. The social robot encourages with gestural movements, clapping and a dance based on users learning progress.

Another novelty of the concept is Nurture. This goal was chosen as it helps students by showing real-time examples of the learnings. In the concept a word is chosen by student to practice, the social robot displays the video example of that word as an explanation. The user can see the realtime scenarios and perceive better learning experiences. The videos can be natural scenarios connected by social robots, teachers' vocal videos, virtual assistants. Thus, the social robot helps students in fostering their language learning.

5.2 Co-design workshop

The codesign workshop is conducted to evaluate the concept idea of language two tutoring robot. The participants were recruited through my supervisor Aino Ahtinen. Two female students with Human robot interaction design background enrolled to the co design workshop. The emails with consent form and background questionnaire were shared with the participants. The students were aware of the design of social robots. All the participants found potential use of social robot tutor teaching Finnish language at university. The students also preferred to consider the language two tutoring social robot as peer, companion, or friend besides the role tutor. The background information and signed consents of participants are shared in university drive with supervisors and teachers view. The co design workshop utilized Minimum Viable Product design canvas designed by Axelsson (2021) to evaluate the user's perceptions with social robot tutor concept at university. The idea of using social robots as Finnish language tutor was found beneficial to the students. The ethical design canvas was not utilized in this thesis which is left for future researchers for evaluation. The findings from codesign workshop provide the potential benefit of using the language two social robot tutor Elias at university will help them to learn language and serves various purposes.

Findings in light of Co-Design workshop

The learning experience of the language two tutoring social robot and feedback received from two participants are discussed in this section. The concept of Finnish language tutoring social robot for university students was welcomed by two female international Finnish learning students. The students perceived the potential benefits in learning with social robot language tutor due to its social feature. One participant considered the utilitarian aspect as beneficial in learning. The freedom of communicating easily and learning privately by making mistakes is beneficial to the student. The role of social robot tutor was based on students' preference. They perceived roles such as tutor, peer, companion in the university context would benefit in language practice with the social robots. Personalization aspect of social robot and the hedonic aspect of friendly looking physical appearance such as empathetic, cute, social are accepted by both the students. Feedback from social robot tutor is expected during their conversation. Constructive feedback needs to be delivered by the social robots to the student's tasks. The design of dialogue responses of social robots also relies on user's feedback.

The Finnish language is practiced by foreign language students, they preferred features of how the words to be pronounced could be provided through audio examples and expects to correct the pronunciation. The students preferred emotional feedback from the robot could be happy, welcoming, not happy, but neutral. The social robots can access the connected databaseThe students considered the emotional intelligence the robot could stimulate is better to be able to identify and map potential solutions to students in a way they can understand. This concept is evaluated online, and the ethical guidelines and software choice are not considered, based on user feedback the concept scenarios are created.

5.3 Design Guidelines and Ethical Considerations

Easily approachable

The advantage of social robot perceived was the freedom to ask anything to the social language tutor in getting instant and proper answers. One student considered it a focused learning feature and the attention it would provide to students would help in language learning.

Provide focused practice lessons

The social robot language tutor is expected to give focused revisions and invest specifically in progress of student. They prefer the lessons not burden or feel missing something during the language learning. For

example, Repeat and Remember feature from the Elias robot trains the vocabulary learning through flashcard approach. Adaptive lessons are interpreted to benefit the student as proposed by the student: pronouns, sentence structure, adjective, nouns picture-based quiz. In the continuous conversation the natural response from social robot was proposed. Such focussed learning is considered to support in language learning.

Multimodalities of social robot language tutor

The student proposed the importance of interactive modality. The interactivity the social robot language tutor could provide to student can provide the sense of connection with the student to initiate their willingness to learn through tutor. The multimodalities such as voice, sound, gesture and movements of robots are interpreted as beneficial during language learning.

Improving Progress

The students considered the motivational factors such as encouragement through verbal and nonverbal expressions by social robot language tutor could be used to improve their progress.

Adapt with multi language users

The student considered learning Finnish language through English is easier to learn Finnish language due to language similarities they perceived. Also, they suggested considering multi language users and their preferences in learning.

Users' privacy

The student considered data sharing should be securely handled. The student inferred it would have its own data to connect with any person.

Social engagement role

The language tutoring robot was perceived as a socially engaging role. The social robot's multimodal interaction and behaviour of robot helped the students as an encouraging feature and perceived as learning companion. The students were motivated in learning with the persuasive and motivational principles it provided through practising with language tutoring robot (Ahtinen, 2020). The social role aspects-initiated collaboration and supporting as a peer created positive learning experience. The language tutoring robot was also considered to be used in multiple projects.

The students show interest with interaction when social cues and verbal non-verbal communicative features are used with social language tutors.(Deng, 2019; Malerba, 2019 ;Kennedy, 2015 ;Kanda, 2004). Also, design with careful consideration to features enabling emotional intelligence (Breazeal, 2019).

Unique language learning program

The social robot's program in the language learning context was perceived as motivational. The persuasive learning strategies through exercises are found to be beneficial to the robots. Consider utilising multiple resources for enhanced learning. For a long-term interaction, consider the robotic features that support flawless connection with internet services and AI features and User expectations on fully autonomous robots(Kertész, C., & Turunen, M., 2017 ; User study). Consider use of social robots with human(teacher) monitoring (Kouri, 2020). Implement ethically supportive software for social language tutor

Consider social robot tutors' software supportive to users (Engwall, 2021)

Repeating and learning features relate to memory and human knowledge (Baddeley,A.D. 1997). Repetition motivates and help in vocabulary learning with flashcards and precise feedback (User study).

Practise language with robots through constructive feedback creates positive learning experience and Implement robot specific ways of persuasion in language learning and ethical aspects as well as consider persuasive and motivational features to benefit in language learning. (Ahtinen, 2022). Provide language

learners performance feedback (User Study). Utilize game-based language learning feature that motivates users and Providing surprise elements as reward motivates users in learning and consider a relaxed and focused atmosphere (Ahtinen et al,. 2020 & User study).

The language tutoring program utilized English language with diverse language speaking users which is considered as beneficial and easier to learn. Providing such adaptable language features are expected by students (Kouri .S, 2020).

The student expects the social robot actions to be visible through verbal or non-verbal communication or visuals based in a way user understands its actions. Also design the persuasive social robotic features role and task supporting users mental model (Sinkkonen, 2006).

Verbal communication

The user study revealed the students prefer various real-time examples included in the language learning lessons, teacher's pronunciation examples, help during pronunciation (Engwall, 2022) mistakes with constructive feedback on user's progress. The voice interaction is expected to be smooth to reduce the frustrations in the conversation practise. The social robot's verbal communication is expected to be supportive during learning for smooth practise session. Implementing adjustable voice interaction based on user's preferences and environment (Leite et al., 2014). Such implementations require more dataset in exploring various uses and user acceptance (Mäkelä, V., Linna, J., Keskinen, T., Hakulinen, J., & Turunen, M. (2019)). Consider designing adaptable instructional design based on user goals (Schodde, T et al,. (2020) & User study & Van Den Berghe et al. 2019).

Physical embodiment

The physical embodiment of the language tutoring robots based on its role are considered as encouraging feature. The unique feature of language tutors attractive eye feedback helped the student learning attention (Kouri, 2020 ; Ahtinen, 2020). The physical embodiment benefits in learning (Engwall, 2022). Their social embodiment benefits in face-to-face communication and social engagement and considered to provide emotional support (Leite, 2014; Heerink, 2010; Mead, 2017).

Designing aesthetic physical persuasive social robot based on users should be considered. The physical presence of social robot provides support as social companion (Vygotski, 1978). Therefore physical embodiment and appearance impact acceptance of persuasive social robot among users (Kanda, T., Hirano, T., Eaton, D., & Ishiguro, H. , 2004). The social robot's physical appearance, form and behavior should be based on users' preference and environment (Breazeal, C., Dautenhahn, K., & Kanda, T., 2016).

The social robot features verbal and non-verbal immediacies in social robots results in positively associated cognitive learning (Goeham , 1988). The expressive cues help in attention and engagement (Breazeal, 2009). Gestural and voice feedback features such as greeting enhances students' social engagement (Kirby, 2010). The unique gestural feedback through attractive candy eyes supports in language learning (Ahtinen, 2020).

Implementing better conversational and interactional skills need to be considered in design of persuasive social robot. The robot should provide socially personalisable features (Engwall, 2022; Kertész, C., & Turunen, M., 2017). The design should also include persuasive social feedback based on user goals and preferences (Ham, 2014). The negative behavior feature of social robot should be minimised and Implementing features adhering to ethical considerations should be considered (Axelsson, 2022).

Implementing features supporting utility value should be considered. New and rich features should be considered in design of persuasive social robot. The users get engaged through new features(Kertész, C., & Turunen, M. (2017). Students expect new features benefitting their language learning (user study). Therefore, Language Learning students get motivated through utility features provided by robots which need to be considered in the design of persuasive social robot tutor.

5.3.1 Ethical Considerations

The ethical considerations are discussed in this section based on findings from codesign canvas designed by Axelsson (2022).

Physical safety Aspect

The social robot language tutors are designed with physical safety. As the machinery has a potential to enable malfunctioning to the users when operated without careful consideration. For psychological safety the touch protocols should be used with appropriate design guidelines. The authentications such as password security, face recognition, voice and finger-based touch authentications which are already in the current technology could be considered based on user and context preferences. To the concept of language tutoring persuasive social robot, university authentication can be used based on students' feedback from user study for secure authentication.

Data Security Aspect

The data collection by social robots should be ethically considered. According to (Axelsson, 2022) due to unique nature of social robot, collecting data from users is considered to elicit emotional responses. It is recommended to switch off the device after the practice due to the data collected through social robots like if the social robots used in various contexts where the users would be vulnerable. They are considered to collect large data from users. Matching the form of the social robot with their ability and adhering to transparency of the robot's capabilities are two main proposed aspects related to data. The functionality and privacy need to be carefully considered. To create an accurate mental model of social robot with user's secure perceptions on social robots need to be considered. Therefore, to this concept the consented authentication from the university is designed.

Axelsson (2022) findings suggest the importance of mentioning the accurate internal state communication of robots. Considering transparency with robot's intention and constraints will support the users in secure task performance. The robot should be honest to users and the person operating the social robot.

Behaviour implementation aspect

The findings from the researcher (Axelsson, 2022) suggest the robot's negative behavior may impact the behavior of humans from positive to negative. Social robots may be treated in an abusive manner by both adults and children when unsupervised. Minimizing the negative behavior toward the robot should be considered in design. Discouraging words and unacceptable behavior of body language towards the user should be minimized. In this user study the lessons designed by Finnish language teachers with pedagogical concerns is considered.

Emotional Aspect

The authors (Axelsson, 2022) propose the social robot's anthropomorphism should be considered carefully as it evokes human emotions therefore the designers should consider where to encourage the emotional feedback and where not to evoke. The evaluation of robot's interactions before and after use and over several interactions whether it is beneficial or not. The concept idea of using the robot as Finnish language tutor was beneficial by all the students. The language tutor emotion is neutral based on user study.

Equality Aspect with users

Ethical aspect of user equality is another aspect in ethical consideration. The researchers (Axelsson, 2022) propose while designing a social robot avoiding racism, sexism and harmful or other unequal qualities in the form and its behavior of robot. Constructing gender identity is important as it can be biased based on gender.

During the user study the students perceived as tutors and the friendly nature of robot and called the name of robot, Pepper, and Elias's robot. Some students prefer to use the same name and some other he or she and others prefer to name themselves as they would with their peers and friend. If the datasets are biased in training, inequality can appear in machine learning software to control the robot's behavior. The developers and users of robotic technology may unnotice the harmful racial and gender biases, it is advised to consider equality across users of social robots.

Ethical learning outcomes of the Thesis

Ethical Aspects of Robot Assisted Language Learning and Persuasion, possibilities of haptic interaction as a modality in child robot interaction need to be considered as touching and being close are being natural to children. The ethical aspects were not evaluated in this thesis. The ethical evaluation and the learning outcome are considered with students learning finnish as language two and data evaluations are from user study and background research. There is a possibility for future researchers to evaluate the ethical and learning outcomes of social robots for various disciplines. These are for future research.

Behaviour implementation aspect

The findings from the researcher (Axelsson, 2022) suggest the robot's negative behavior may traumatize or desensitize humans to negative behavior. Social robots may be treated in an abusive manner by both adults and children when unsupervised. Minimizing the negative behavior toward the robot should be considered in design. Discouraging words and unacceptable behavior of body language towards the user should be minimized. In this user study the lessons designed by Finnish language teachers with pedagogical concerns is considered.

5.4 Evaluation and features adhering new trends

The concept of using social robot as language tutor in Finnish language learning is considered to perceived to be beneficial due to its novelty it provides as social companion and repetitive language practicing (Ahtinen, 2020). The personalized lessons help the students to stay focused with the lesson along with the natural conversational feedback (Kouri, 2020). The robot assisted language learning with international students is unique as the learning program supports diverse language speakers within application. The uniqueness it provides is its training exercises in nurturing the memory through speech and visuals. The social robot's physical embodiment, task and role depends on the user's context. The social robot tutor and the user should provide empathy and tenderness (Ahtinen, 2020). The social robots task affects the user's mental model (Sinkkonen,I., 2006). To perceive user's acceptance of the social robot's various features, needs to be examined (Mäkelä, 2019).

The design of socially intelligible language tutor has various dimensional considerations with the student's learning language. The social cues, facial expressions and gestures of the social robot tutor impacts the user's perception (Broekens, 2009; P.Christodoulou, 2020; Saerbeck, 2010). Heerink, 2010 found the physically embodied agents poses social presence. Hence, the physical appearance form and behavior are based on users' preference and environment (Breazeal, C., Dautenhahn, K., & Kanda, T. , 2016). They can adapt the features inferring users (Nocentini, 2019; Deng, 2019).

The researchers study their potential use case based on the enjoyable experiences, robots' verbal feedback along with gestures and movements, gestural award and empathy(Nocentini, 2019, Deng, 2019). Multimodal patterns of social robots elicit collaboration (Deng, 2019). The robot's expression influences how they perceive the users (Kirby, 2010). The findings by Engwall (2022) proposes the robot type interaction varies based on students age context and their proficiency level. Therefore, for learners' intrinsic motivation, robots verbal and non-verbal interaction are considered. The conversation skills and interaction between robots and humans are another concern in long term interaction (Kertesz. C, 2017)

The willingness in using the software requires evaluation and data collection in a wider perspective. According to the study by Mäkelä (2019) balancing the control over systems also is a criterion mentioned in research. If the datasets are biased in training, inequality can appear in machine learning software to control the robot's behavior (Axelsson, 2022). Therefore, considering such unbiases are preferred in language learning.

In the codesign workshop, the multimodal interactions such as touch, voice, gesture, haptic, sound, light were useful from language tutoring social robots. Various technologies that could be adapted in the design of social robot language tutoring robot are discussed in the following section based on the students.

5.4.1 Current Technologies

The ethical considerations such as physical safety, data security aspect, emotional aspect, equality aspect, ethical learning outcome, behavioural implementation of social robot language two tutor is proposed to be considered with rigorous research before deployment of the concept design (Axellson, 2022). The user study revealed the students accept the use of social robot as their Finnish language tutor at university based on their one-one interactions with the robots which was with Elias's robot learning software and Pepper humanoid robot. In the codesign workshop the concept was perceived by students as novel and would accept using Nao and Elias robot as language two tutor in the university. Therefore, the pedagogical considerations are consented at the initial stage of the user study. However, to the concept idea created from codesign workshop, the language tutor poses socially adaptive and affective robot which was evaluated through online scenario. The socially affective robots have more dimensions to be considered in design (Eloranta, E. (2021)) to consider in the future research and implementation along with ethical evaluations.

The current technology of Furhat robot (Figure 1) as discussed in the section 2.2.3, the voice recognition and speech technology (Pieraccini, R., 2012; Yueh-Min Huang, Rustam Shadiev, and Wu-Yuin Hwang., 2016), emotional recognition (Sidorov, M., Brester, C., Ultes, S., Schmitt, A. , 2017; Thomas W. Jensen , 2014), facial recognition(Lee, S., Noh, H., Lee, J., Lee, K., Lee, G. G., Sagong, S., & Kim, M., 2011), eye tracking, gesture recognition, touch recognition, social persuasive feedback(Jaap Ham and Cees. J. H. Midden , 2013), creating virtual agents (Gratch, J., Wang, N., Gerten, J., Fast, E., & Duffy, R. , 2007), gamified motivational learning (Chan, E., Nah, F. F-H., Liu, Q., & Lu, Z., 2018), non verbal communication (Burgoon, J. K., Guerrero, L. K., & Floyd, K. , 2009), social and emotional communication (Buchanan, R., Gueldner, B., Tran, O. & Merrell, K. 2009) and various interactional modalities (Jinying He, Anouk van Maris, and Praminda Caleb-Solly. 2020; Engwall, O., & Lopes, J. , 2022; Engwall, O., Lopes, J., & Åhlund, A. 2021) are already possible for implementation based on the learnings gained from the research. Therefore all the interactional modalities are essential in implementing the design of persuasive social robot language tutor. The learning outcomes and ethical considerations are proposed to the future researchers.

5.5 Discussion

The thesis studied the university student's perceptions, language learning experiences through persuasive social robot and the suitable use case design scenarios with design guidelines were designed and explored. The findings from user study and codesign workshop are discussed in this section. According to students' perception all the multimodalities such as voice, sound, gestures, movement, touch, facial expressions, screens, light are required as input and output modalities of social robot design. The voice and sound are important modalities in social robot tutor design as the language tutoring and learning of a Finnish language happens through speech and practicing the language through repeating the word. Therefore, voice and sound modalities are key features that should be considered in design. Next gestures, movement, touch, facial expressions, screens and light are considered as a cohesive modality in the language tutoring robot design. These modalities are very important as they play significant role in proximity, emotion sensing and producing positive feedback appropriately and provide negative feedback when the students proximity is detected to safeguard the students from the unwanted collisions. The gestures and facial expressions are important as the students expressed, they are motivated through eye expression of social robot and the gestural feedback of the robot. Touch feedback is an essential modality as all the alphabet input and tactile input are accessed through touch interaction. The social robot was activated and deactivated through touch modality. The light and screen are essential to display the output feedback of the social robot. The candy eye

of the robot utilises light which persuades the students in language learning and increasing their learning curve which is conveyed by students during user study.
Regarding the use case scenarios, the social robots were perceived to be capable of listening to human voice for long hours as it has long term memory to speak with humans as it can remember and retrieve words from any language due to data sharing features. Thus, it meets the criteria, language learning requires memory (Baddeley A.D., 1997). Belpaeme (2018) raised a question whether teaching and learning approaches of adult and children language learners are same. From our user study findings, it is evident and clearly visible that adult language learners require different learning approaches and require utility-based learning and adaptive learning strategy to make learning persuasive language learning. Sinkkonen (2006), the mental model of unconscious experiences can be responded by social robots. The robots can identify the levels of self confidence in students learning a language and provide adaptive and personalized lessons. It supports the students through emotional support verbal and non-verbal modalities by evoking engagement to develop social relationships and overcome social isolation (Breazeal, 2019) also provide language coaching support to the university students. It can also act as personal tutor by reducing emotional loneliness and provides language support through adaptive teaching and learning experiences (Odekerken-Schröder, 2020). Adaptive learning based on users knowledge (Van Den Berghe(2019) leads to effective language learning which was also suggested by the students in the user study and co design workshop. The robot's physical embodiment and spoken interaction are key features seen as beneficial for learning a language and motivational aspects by students. The context of useage of persuasive social robot was perceived as useful in university and at students home to learn the language based on users context preference thus making it an adaptive language learning scenario.
Thus, the tutor role and adaptive, personalized lesson performance along with multimodalities of persuasive social robot play an important part at university context for an effective persuasive social robot language tutor.

6. CONCLUSION

The language tutoring social robot was initiated during the social distancing COVID 19 to fulfill the needs of students from community. The thesis gathered rich user study data for the creation of concept. At the time of research, the technologies were developing, the concept implementation feasibility depends on the various technology and softwares developers and implementers chosen based on universities preferences. By adapting the HCD and constructive design approach the data are collected and utilized in the thesis.

To answer the Research Question 1 (RQ1) What are university student's perceptions, learning experiences on Finnish language tutoring social robot for international students at university?, the learning experiences with social robot with students were perceived positively and the students found there are possible uses of social robots in language tutoring and learning. The participants thought the robots can act as a platform in persuading language learning at university. It can provide social connectedness through tutoring a language from various environment and roles. Multimodal interaction are required to fulfill the user needs in tutoring the language efficiently such that the language learning to be fluent and natural communication. Haptic, tactile, light sensors, candy eyes , gestural feedback were perceived as motivating factors of language learning in the tutoring sessions. Genderless naming the robot is preferred and most of the participants called the robot with the real name of the robot. Male participant showed more importance with the utility the social robot can provide in learning a language. Whereas female participants were also in need of motivating factors the social robots could provide in persuading the language learning performance. The non verbal and verbal behaviour's of social robots were highly appreciated while tutoring a language to keep the students motivated. All of the students found social robot as beneficial technology and perceived as it could serve as a language learning tool for students at university.

To answer research question 2 (RQ2) What are suitable use case scenarios for student robot interaction of Finnish language tutoring social robot?, Various use scenarios were proposed by students in addition to university and in situ context. All the scenarios proposed in the thesis were designed based on the data gathered from the explorative field study and from the co design workshop. The context, form, behaviour, appearance of the social robot were designed by students of university during the online co design workshop.

The research question 3 (RQ3), What are the appropriate design guidelines suitable for social robot as language two tutor at the university?, The results from the user study and co design workshop are documented. The design guidelines formulated from the quantitative and qualitative data gatherings from explorative field study, related work, co -design workshop and evaluation of social robot language tutor at university. The learning outcomes of the persuasive social robot are for the examination of future research purpose. However most of the students perceived that the social robot tutor are efficient and beneficial as language tutors and useful to language learners.

The social robot tutor for language is a novel concept which we found from the student's feedback. We found that students welcome the use of social robots as language tutor and has a potential benefit in persuading motivation in language learning.

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APPENDICES

Appendix A - User Study Consent Form

The following consent form from the human robot interaction course is adapted for the user study to get consent from the participants. Robot Attitude Scale is used after the participants tried using the social robot tutor to evaluate the user experience of robot tutor.

Study on Master's Thesis with Pepper Robot: Information regarding participation

Invitation to participate in research project

You are invited to participate in a preliminary user study to collect information for human-robot interaction design. This study is a part of the Master Thesis of Human Technology Interaction.

About the research

The overall aim of the master's thesis "User Experience Design and Evaluation of Pepper as Second Language Tutor at University" is to evaluate the social robot's design and potential uses of social robot as Language Tutor to the university students.

This study is to discover how better we could design social robots to serve the purpose of language learning in better possible way. ***This study does not test the skills/abilities of the participant.*** This research is done in collaboration with Tampere University's Language Center. The client is Utelias Technologies.

We would like to collect the following material from you to develop a concept for using social robot:

Audio-recorded interview

Videos will be taken during the evaluation to discover the usage of the robot.

Participation is ***completely voluntary*** & you can withdraw on any phase of the study.

Confidentiality and data security

All data will be treated as confidential. Recordings, written notes and photographs will not contain any identifying information about you. All collected data will be anonymized.

Results of the research

The results of this research, the methods and findings will be published on a master's Thesis of Human Technology Interaction.

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 thesis supervisors of the study:

Aino Ahtinen

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Tampere University

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Appendix B - User Study Background Information

Background Information:

Gender:

Age:

Nationality:

Name of your Study Program:

Current course in Finnish studies:

Years of Finnish learning:

Appendix C - User Study Questionnaire

User Study Questionnaire

Have you ever interacted with the robots? Would you write what kind of experience it was?

What are your expectations about the language learning robots?

How do you feel about the idea of a robot teaching languages?

How do you find the robot talking to you? Does it speak clearly and understandable way?

How motivating the robot seems based on this experience?

How useful it seems to learn language through robots? Why?

In your opinion, could it support Language learning?

Would you consider using this robot later for language learning at university? Why?

Kindly please provide the grade points to the robot based on experience with Social robot:

I think the robot is:

Useless	1	2	3	4	5	6	7	8	Useful
Boring	1	2	3	4	5	6	7	8	Interesting
Hard to use	1	2	3	4	5	6	7	8	Easy to use

Unfriendly	1	2	3	4	5	6	7	8	Friendly
Hard to understand	1	2	3	4	5	6	7	8	Easy to understand
Unhelpful	1	2	3	4	5	6	7	8	Helpful
Complicated	1	2	3	4	5	6	7	8	Simple
Untrustworthy	1	2	3	4	5	6	7	8	Trustworthy

Appendix D - Codesign workshop

Social robot codesign canvas, Robot Design MVP and Problem Space, designing a social robot (Axelsson ,2021) and Robotix supervision canvas(Ahtinen, 2021) is utilised in the workshop for the design of Social Robot Language Tutor.

Concept Evaluation and Co creation workshop Consent form, Background Questionnaire:

Study topic: Evaluation of concepts and Co-design workshop of Social Robot as a Second Language Tutor with international students learning Finnish

University: Tampere University

Master thesis: Part of ongoing project in Human Technology Interaction of Tampere University

Master's degree Student: Tamilselvi Jayavelu

Thesis Supervisor: Aino Ahtinen

The study is part of master thesis project designed to evaluate the concepts and co create the future social robot tutor for university students learning Finnish as their second language.

The study will be conducted online in zoom or teams through university access.

The study is voluntary. The students can withdraw from the study anytime based on their interest.

The study is not to evaluate participants skills or to test their language proficiency. The study is to collect feedback on the topic.

Confidentiality and Data Security:

The workshop will be recorded (audio and video) with students' permission to collect data on the perceptions of the displayed idea and their feedback. The personal identity of students will be anonymized and securely saved in the university drive.

The anonymized data is intended to be utilized in the master thesis and published through university.

Consent:

Based on the information above, I agree to consent for using my data in the study.

I agree to collect the information from the workshop. The data can be used for future publishing in journals or public websites if university requires it for research purposes. I do not have conflict in recording videos online. I understand the collected information is for the university research purpose.

Signature: Name: Date:

Contact information

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

Tamilselvi Jayavelu Aino Ahtinen Master Student in Human Technology Interaction University Lecturer

Tampere University Tampere University

Contact number: +358447470352 Email: Aino.Ahtinen@tuni.fi

Background Questionnaire:

The following information are collected for statistical and research purposes as a part of Master thesis project.

Thank you for your time in answering this survey.

1. Participant Background:

a. Age:

b. Gender:

c. Nationality:

d. Native Language:

e. Study Programme:

f. Enrolled course level in Finnish: Proficiency in Finnish: Beginner / Intermediate / Advance

2. What motivates you to learn the language in general?

3. In what language do you understand Finnish language?

4. Have you used any translators during language learning? a. If any kindly mention those: b. In what language do you translate?

5. How do you learn Finnish language in general?

6. What strategies help you in learning the language?

7. What resources/applications/language groups do you use to support your language learning?
a. What features from those resources do you think are beneficial to you in learning a language?