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DESIGNING FOR AUTONOMY, COMPETENCE AND RELATEDNESS IN ROBOT-ASSISTED LANGUAGE LEARNING

Faculty of Information Technology and Communication Sciences
M. Sc. Thesis
April 2023

ABSTRACT

Luu Phan Dao: Designing for Autonomy, Competence, and Relatedness in Robot-Assisted Language Learning
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Master's Degree Programme in Human-Technology Interaction
April 2023

The current number of immigrants has risen quickly in recent years due to globalization. People move to another country for economic, educational, emotional, and other reasons. As a result, immigrants need to learn the host language to integrate into their new living environment. However, the process of learning the host language for adult immigrants faces many challenges. Among those challenges, maintaining intrinsic motivation is critical for a long-term language study process and the well-being of adult immigrants.

Self-Determination Theory (SDT) is a popular theoretical framework that explains human motivation, especially intrinsic motivation, through a psychological approach to understand its nature. According to SDT, humans are intrinsically motivated through the satisfaction of the three basic needs of Autonomy, Competence, and Relatedness. Many researchers have applied the theory to different topics and directions, including language learning. On the other hand, social robots have been used extensively in the language learning context due to their physical embodiments and the application of artificial intelligence in robotics. Furthermore, research has proven that social robots can create a relaxed and engaging learning environment, thus motivating language learners.

The thesis designs and implements a RALL application called SAMQ using QTrobot, a humanoid social robot capable of producing body gestures, displaying different facial expressions, and multilingual communication. The study aims to investigate SAMQ's ability to evoke intrinsic motivations of adult immigrants in learning the Finnish language. While previous research focuses on English as the second language (L2) and targets children, this thesis's L2 is Finnish, and the learners are adult immigrants.

The thesis conducts semi-structured interviews during the Pre-study phase (N=6) to gather real insights from adult immigrants living in Finland, to understand demotivating factors in their language learning experience and the unsatisfied aspects of the three basic needs. The qualitative findings from the Pre-study contribute to the design and implementation of two versions of SAMQ, aiming at evoking intrinsic motivations through satisfying unmet needs. The first version is a Quiz-only program that tests several assumptions regarding human-robot interaction (HRI). The final version of SAMQ is a more comprehensive language learning application that supports two modes of study: Learning and Quizzes. It consists of multiple modifications that address all adult immigrants' basic needs while additionally promoting intrinsic motivation through media. The final Evaluation of SAMQ (N=6) includes a questionnaire and a semi-structured interview. The quantitative results of the questionnaire validated the ability of using social robots to evoke adult learners' intrinsic motivation in the RALL context. The qualitative findings from the research highlight the importance of social robots' physical embodiments in eliciting intrinsic motivation for adult learners through satisfying Relatedness. In addition, the use of voice modality creates a genuine HRI for adult learners, fulfilling both Autonomy and Competence, resulting in an engaging and smooth learning experience. Besides that, the use of adult learners' L1 plays a crucial role in facilitating a relaxed and familiar learning environment, supplying both Competence and Relatedness. Moreover, multimedia learning materials make the learning experience more vivid and attractive. Ultimately, the result shows that accessibility and flexibility are essential attributes for adult learners to maintain their motivation for long-term language study through the satisfaction of Autonomy.

Finally, the thesis proposes a design guideline for the RALL context. It consists of five design implications for evoking intrinsic motivation in adult learners through satisfying the three basic psychological needs of Autonomy, Competence, and Relatedness. The design guideline acts as a proposal for future design and implementation of RALL programs for adults and contributes to developing the human-robot interaction field.

Keywords: User Experience, Self-Determination Theory, Robot-Assisted Language Learning, Social Robots, Human-Robot Interaction, Human-Centred Design
The originality of this thesis has been checked using the Turnitin OriginalityCheck service.

PREFACE

I have developed a genuine interest in robots since I was a kid, mostly through comics and fictional movies. However, in the country where I used to live, people did not have many chances to interact or learn with robots. I was luckier than many people in that sense, having an opportunity to work with robots in a co-learning session organized by Dr. Aino Ahtinen during my master's degree. The exciting experience really motivated me to work with robots, leading to my decision to work with them for my thesis. I appreciate that Aino has patiently waited and given me a chance to research human-robot interaction.

The thesis has challenged me in many different ways. I have learned many new things during the research, strengthening my knowledge as well as my ability to cope with stress and pressure. These challenges are precious for my personal growth as a working professiona.

First, I would like to express my deep gratitude to my supervisor, Dr. Aino Ahtinen, who gave me all the guidance needed through the thesis process. Her valuable support, pieces of advice, feedback, and comments have helped me a lot with my research. Her encouragement and trust have inspired me all along the way. Also, her new way of organizing a thesis group provided many additional benefits to the students who participated. We could share, learn, and grow together as friends and classmates. I am also thankful to Aparajita Chowdhury for her continuous support and cheerful attitude that always bring positive vibes to work.

Finally, I would like to thank my family and wife, who have always loved, trusted in and encouraged me unconditionally. I could not complete this without your help.

Tampere, 22 April 2023

Luu Phan Dao

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LIST OF SYMBOLS AND ABBREVIATIONS

AI	Artificial Intelligence
ASR	Automatic Speech Recognition
F1	Finnish 1 or equivalent course (Target CEFR Level A1.1)
F2	Finnish 2 or equivalent course (Target CEFR Level A1.2)
F3	Finnish 3 or equivalent course (Target CEFR Level A2.1)
HCD	Human-Centred Design
HRI	Human-Robot Interaction
ISO	International Organization for Standardization
L2	Second-Language
NLP	Natural Language Processing
RALL	Robot-Assisted Language Learning
SDT	Self-Determination Theory
TTS	Text-To-Speech
WOz	Wizard of Oz

1. INTRODUCTION

This chapter presents the topic of the thesis, basically the background of the research background and its motivational rationale. The chapter then introduces the research objectives, highlighted with a set of research questions. Lastly, the chapter reveals the thesis structure to put in place an outline of the study.

1.1. Research Background and Motivation

Due to the current trend of globalization and advancements in transportation and mobility, it is much easier for people to move to foreign countries to seek better-paying jobs, higher living standards, and many other reasons. As a result, the rise in the number of immigrants worldwide has increased the need to learn a second language (L2). For immigrants, mastering the host country's language is critical to integrate themselves with the new country. Research has shown that language proficiency is an essential factor in cultural integration. It allows immigrants to understand the norms and customs of their new community better, and to participate more fully in social and cultural activities (Phinney & Devich-Navarro, 1997). Immigrants also experience a better chance of entering the host country's labor market if they have proper L2 training (Sarvimäki & Hämäläinen, 2016; Lochmann et al., 2019) and earn higher salaries (Dustmann & Fabbri, 2003). However, the L2 learning process of immigrants often faces various challenges, e.g., the distance between immigrants' native language and host language, native language proficiency, age and development factors, cultural differences, and language learning context. These challenges result in a long and tiring L2 learning process for immigrants, where motivation, patience, perseverance, and support are essential.

In L2 learning, studies have shown that motivation is instrumental by different means. Motivated learners have a greater chance to be active in the learning process, have more positive attitudes towards the language and the learning process, and participate actively in class, which has been shown to impact language development positively (Dörnyei, 2001). Motivated learners are also inclined to practice and use the target language outside of class, which strongly predicts L2 success (Gardner & Lambert, 1972). Motivation can

also help overcome challenges and obstacles that may arise during the learning process, providing the learner with the necessary drive to persist in their efforts to acquire the language (Noels et al., 2000) while also supporting them in maintaining language skills over the long-term (Gardner & MacIntyre, 1993). Many researchers have focused on investigating human motivation and proposed different theories to explain the nature of motivation and its construct.

Among different theories of motivation, Self-Determination Theory (SDT) (Deci & Ryan, 2018) is a well-established, extensively researched, validated psychological theory of human motivation. It posits that the three inherent psychological needs—autonomy, competence, and relatedness—are vital for optimal growth, well-being, and happiness. SDT suggests that when these needs are supported and fulfilled, it leads to more intrinsic motivation, which is driven by personal interest and enjoyment, and ultimately results in greater well-being. In the language learning context, SDT suggests that supporting the innate psychological needs of learners can enhance their motivation, engagement, and language outcomes. Research has shown that providing learners with autonomy in their language learning process, opportunities to practice and receive feedback on their language abilities, and opportunities for social interaction can lead to greater intrinsic motivation, engagement, and better language outcomes (Dörnyei, 2013). However, it is essential to note that the relationships between motivation and L2 acquisition are complex and context dependent. Further research is needed to understand the nature of this relationship altogether.

The surging need for L2 learning and the challenges during the process has led to a greater effort in supporting and enhancing the process through technology adaptation. Among many innovations in L2 acquisition, Robot-Assisted Language Learning (RALL) is a field of study that uses robots and artificial intelligence (AI) technologies to help language learners acquire and improve their language skills. It has developed rapidly in recent years due to advancements in Natural Language Processing (NLP), machine learning, and robotics. RALL systems typically use conversational agents, social robots, interactive games, and simulations to provide learners with engaging and personalized language practice. RALL has been shown to be effective for various languages and levels and is being increasingly used in both formal and informal learning contexts (Alemi et al., 2014;

Mavilidi et al., 2015; Toumpaniari et al., 2015). Specifically, the utilization of social humanoid robots's non-verbal cues in RALL provides many positive effects on the learning environment. The body language of social robots may include eye gaze, pointing, and several other physical signs. Studies have found that people considered these social robots supportive, trustful, communicative, and pleasant to engage with (Kidd & Breazeal, 2004; Wainer et al., 2007; Alemi et al., 2017). Additionally, these robots can serve as a source of motivation for students in the classroom, as they create a relaxed yet focused atmosphere (Ahtinen & Kaipainen, 2020). As technology advances, the potential applications of RALL will only continue to grow, leading to more effective and immersive learning experiences.

Considering previous research in RALL and the effectiveness of SDT in explaining human motivation, this thesis aims to evoke intrinsic motivation in adult immigrants while learning the Finnish language by providing three positive experiences of SDT: autonomy, competence, and relatedness in the context of RALL. In this study, we used a social humanoid robot named QTrobot[1] as a facilitator to provide language practices for learners to evoke intrinsic motivation. QTrobot can display human-like emotions through its digital face and communicate with people in many languages through speech and a tablet (Learner Tablet). In addition, teachers or moderators can also give different commands to QTrobot through the Educator tablet during learning sessions.

The thesis employs the Human-Centered Design (HCD) process as its primary research approach. The first principle of HCD states that *"the design is based upon an explicit understanding of users, tasks and environments"* (International Organization for Standardization [ISO], 2019), explicitly emphasizing the importance of understanding users, especially their needs, goals, and the context of use. Thus, the first principle of HCD truly supports the study's exploratory nature. Furthermore, the HCD approach's ability to understand user needs also fulfills the primary goal of the current study, which is to foster intrinsic motivation through the satisfaction of the three basic psychological needs. In addition, the third principle of HCD presents that *"the design is driven and refined by*

[1] https://luxai.com/

user-centred evaluation" (ISO, 2019). By understanding the user experience in this setting through evaluation, the thesis provides a set of design guidelines for autonomy, competence, and relatedness in the RALL context.

1.2. Research Objectives & Questions

Research on learner motivation in RALL has been explored many times in the past, but most research focused on children learning English as L2. The thesis aims to use social robots to motivate adult immigrants to learn the Finnish language and foster long-term language study while promoting well-being through intrinsic motivation, thus facilitating a smoother and faster integration process.

1.2.1. Research Objectives

The universal objective of the thesis is to explore social robots as tutors in teaching or practicing the Finnish language with adult immigrants in Finland. More specifically, the aim is to evaluate how social robots can satisfy the psychological needs of Autonomy, Competence, and Relatedness of adult immigrants in language learning by fostering positive experiences. The ultimate goal is to design robotic programs that suit users' needs and expectations, producing a set of design guidelines for future usage in HRI and RALL.

1.2.2. Research Questions

1. What are the unsatisfied aspects of the needs of Autonomy, Competence, and Relatedness of adult immigrants while learning the Finnish language?

2. How can the robot facilitate Autonomy, Competence, and Relatedness for adult immigrants to further foster intrinsic motivation?

3. What can be considered as the design guidelines in designing for L2 adult learners' intrinsic motivation in the RALL context?

1.3. Thesis Structure

This section presents the overall structure of the thesis. The Literature Review chapter investigates all themes related to the main topic: (1) SDT and its application in language learning, (2) theory and examples of social robots, and (3) RALL and its shown benefits

in previous research. This chapter supports the thesis in creating the research questions through the understanding of the connection between research topics. It also gathers validated design attributes from previous RALL experiments. Chapter 3 introduces the research approach, different phases of the research process, and all methodologies involved, including the justification for their selection. Chapter 3 also mentions the information regarding the participants, the robotic platform of the thesis, and some ethical practices. The following chapter reports the Pre-study phase of the research, more specifically, its procedure and findings. The findings of Chapter 4 summarizes the qualitative insights from adult immigrants regarding their unsatisfied needs while learning the Finnish language. Chapter 5, Design & Implementation, forms the design goals and describes the iterative process of implementing the learning experience with QTrobot, namely Suomen Aikuiset Maahanmuuttajat ja QTrobot (SAMQ), given the design goals and design implications. Chapter 6 explains the Evaluation stage of the thesis, focusing on the assessment of SAMQ with its target users against the design goals, and reports the findings during the evaluation process. Chapter 7 synthesizes all the design implications and findings from the previous chapters to create a set of design guidelines to evoke the intrinsic motivation of adult immigrants in RALL. Chapter 8 finishes the thesis with conclusions and discussions, providing solutions to the research questions and mentioning the limitations of the thesis.

2. LITERATURE REVIEW

This chapter first examines the Self-Determination Theory (SDT) and its effectiveness in enhancing intrinsic motivation. This section also investigates the benefits of applying SDT in the language learning context. Secondly, the chapter covers the theory of social robots and their applications in some notable contexts, such as healthcare and, in more detail, education. The chapter then explores the topic of robot-assisted language learning (RALL), the results of using social robots for learning outcomes in RALL, and the affective changes that social robots produce for language learners. The last part examines the human-robot interaction in previous RALL studies by analyzing their educational approaches and the role of the robots.

2.1. Self-Determination Theory

This section introduces the Self-Determination Theory and its application in education for the purpose of fostering intrinsic motivation for engagement and well-being. In addition, the section summarizes important research that investigated the effect of three psychological needs in the context of language learning.

2.1.1. Theory and Examples

Self-Determination Theory (SDT) is a theoretical framework that explains human motivation and behavior that has gained widespread attention and recognition in recent years. According to Ryan and Deci (2018), SDT classifies motivation into two primary types: intrinsic and extrinsic motivation. Intrinsic motivation happens when people perform an activity for pure satisfaction and enjoyment. In contrast, extrinsic motivation is the reason why people perform an activity to achieve a specific outcome or reward. Extrinsic motivation includes four regulatory subtypes: external, introjected, identified, and integrated regulation. The four subtypes of extrinsic motivation describe the internalization process of humans regarding extrinsic motivation, in which external values and beliefs gradually become one's own identity. External regulation is the kind of motivation that people have when engaging in an activity solely for external rewards or avoiding punishment. Introjected regulation involves engaging in an activity to evade humiliation or embarrassment or, in contrast, doing an activity to feel prideful or morally righteous. Identified regulation

motivates people to participate in activities related to their personal beliefs or the perceived value of the activities. However, people motivated by identified regulation may not investigate the relationship between the activity's value and personal identity. Finally, integrated regulation, is extrinsic motivation's most self-initiated subtype. It motivates people to act based on the full integration of new values and their current identity, sometimes involving changes in their personal values or attitudes (Ryan & Deci, 2017). Recently, Ryan and Deci (2020) have expanded the classification of motivation with a new variety, namely amotivation. This kind of motivation implies a person lacking motivation or interest in the activity.

Numerous studies have explored the effects of different types of motivation on outcomes such as performance, engagement, and well-being. For example, Vallerand et al. (2003) found that student-athletes who had a higher self-determined form of motivation (intrinsic motivation and identified regulation) were more likely to experience greater engagement in sports and better performance than those who had a more controlled form of motivation (external regulation and introjected regulation). Another study by Grolnick et al. (1997) learned that children who experienced greater autonomy support from their parents were more likely to experience intrinsic motivation and better academic performance than those who experienced more controlling parenting practices. Generally, these studies suggest that more volitional forms of motivation are strongly correlated to higher achievements of related activities. In contrast, more involuntary forms of motivation can lead to adverse consequences like burnout and disengagement. In summary, SDT provides a framework for understanding the different types of motivation and their impacts on outcomes, e.g., performance, engagement, and well-being. It highlights the importance of fostering volitional types of motivation namely identified regulation and intrinsic motivation to a greater extent, for optimal functioning and well-being.

According to SDT, humans have three inborn psychological needs essential to facilitate intrinsic motivation: autonomy, competence, and relatedness (Ryan & Deci, 2017). Autonomy is the need for humans to feel in control of their own lives and to be able to make decisions that align with their values and interests. Autonomy is crucial in helping people feel more motivated, engaged, and fulfilled in their pursuits. The need for competence implies that people want to experience the feeling of being accomplished and effective in

their actions and activities. Competence is essential because it helps people build confidence and self-esteem, allowing them to engage more fully in challenging tasks and activities. Relatedness touches upon the need for individuals to feel a sense of togetherness by belonging to a community and seeking social support. Relatedness is vital because it helps individuals feel validated and understood and can provide a source of motivation and encouragement through a sense of connectedness.

2.1.2. Self-Determination Theory and Language Learning

According to SDT, in the context of learning, learners feel intrinsically motivated when they enjoy learning, find it attractive and valuable, and achieve the feeling of fulfillment from the learning process (Ryan & Deci, 2018).

Research on SDT and language learning has shown that intrinsic motivation is positively associated with various aspects of language learning, such as language proficiency, language attitudes, and language learning strategies (Noels et al., 2000; Dörnyei, 2001; Deci & Ryan, 2002). For instance, the study by Noels et al. (2000) found that intrinsically motivated language learners of the French language had a greater chance to use effective language learning strategies and had a more favorable mindset towards the language. Similarly, Dörnyei (2001) found that learners who were intrinsically motivated to learn English were more likely to engage in extensive reading and listening, leading to higher language proficiency.

Moreover, research has shown that autonomy, one of the basic psychological needs according to SDT, is also crucial for language learning (Ryan & Deci, 2020). Autonomy refers to the sense of volition and self-determination in one's actions and choices. In the context of language learning, autonomy involves having control over one's learning process, choosing learning materials and strategies, and setting learning goals (Deci & Ryan, 2002). Studies have shown that learners who perceive themselves as autonomous in their learning process have higher possibility of commitment to learning activities, overcoming obstacles, and accomplishing their learning targets (Assor et al., 2002; Gao et al., 2013).

However, achieving intrinsic motivation and autonomy in language learning is not always easy, and it requires a supportive learning environment that satisfies the three basic psychological needs according to SDT: autonomy, competence, and relatedness (Ryan & Deci, 2020). Autonomy-supportive environments are those that provide learners with

choices and opportunities to make decisions about their learning process and acknowledge their perspectives and feelings (Jang et al., 2010). Competence-supportive environments are those that provide learners with feedback, resources, and support that help them develop their language skills and achieve their learning goals (Ryan & Deci, 2020). Relatedness-supportive environments are those that provide learners with opportunities to interact with peers and instructors, helping them develop positive social relationships in the learning context (Ryan & Deci, 2020).

2.2. Social Robots

This section presents a definition of social robots and their important characteristics. The content also investigates popular applications of social robots in current research landscape, and how researchers utilized the social robots' attributes in the education setting.

2.2.1. Theory and Examples

Bartneck and Forlizzi (2004) defined a social robot as *"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"* (p. 592). Unlike traditional factory robots, many social robots can engage with humans through Automatic Speech Recognition (ASR) or facial recognition. Because people favor robots that can interact in a social manner (Goetz & Kiesler, 2002; J. Goetz et al., 2003), social robots have recently been integrated with advanced sensors and cameras for advanced environment perception to better understand human speech and emotions. In addition, social robots are programmed with robust AI algorithms to process and analyze the data collected in order to interact with humans more naturally and intuitively. To respond to people, social robots can use body language and display facial expressions and emotions to mimic natural human interaction. Exploring social interactions between humans and robots has been the focus of different research (Breazeal & Scassellati, 1999; Scheeff et al., 2002; Moyle et al., 2013). In Breazeal and Scassellati's (1999) research project, the social robot Kismet used motor actions and facial expressions to interact with humans. By presenting intentions through its behaviors and emotion-based facial expressions, the robot can foster social interactions with a human caregiver. Another experiment by Lee et al. (2006) indicated that a social robot's physical embodiment enhances its social presence, leading to positive social responses from the people it interacts with. The research

also concluded that people value social agents with physical embodiment more than disembodied ones.

With the recent rapid development of robotics technology, the application of social robots nowadays ranges in more diverse areas, such as education, entertainment, customer service, and healthcare. In the educational context, social robots have played the role of teachers, tutors, and learning companions. People also viewed social robots as toys, companions, and performers in the entertainment industry. Social robots are also frequently seen as receptionists, information providers, and personal assistants. Specifically, social robots have emerged as a promising technology to improve healthcare services. They can be used in a variety of healthcare settings to enhance patient care, improve patient outcomes, and reduce healthcare costs. Social robots are designed to engage and interact with patients in a human-like manner, which can help to reduce patient anxiety and promote feelings of comfort and well-being.

Examples of Social Robots in Healthcare

One of the primary advantages of using social robots in healthcare is that they can provide continuous support to patients. Social robots can monitor patients' vital signs and other health indicators (McCarthy et al., 2015; Al-Taee et al., 2016), provide instructions (Alemi et al., 2016; Cañamero & Lewis, 2016), and offer assistance with daily activities (Graf et al., 2004). This can help to improve patient adherence to treatment regimens, reduce hospital readmissions, and lower healthcare costs. In the research by Graf et al. (2004), a robotic assistant named Care-O-Bot (**Figure 1**) continuously provided support to senior people in multiple contexts, especially in healthcare. Besides monitoring patients' health and communicating with their families and medical staff, the robot can even help elders collect different items or use the microwave. Lastly, Care-O-Bot's ability for home security and environment control provides another layer of safety to the life of senior people. Other than that, social robots can also be used to assist healthcare providers in various tasks, such as taking patient histories, conducting physical exams, and collecting patient data. This can help reduce healthcare providers' workload and free up time for them to focus on other essential tasks, such as patient education and counselling.

Figure 1. *Care-O-Bot*

(Source: https://www.care-o-bot.de/en/care-o-bot-3/history/care-o-bot-ii.html)

Another benefit of using social robots in healthcare is providing patients with emotional support. Social robots can offer companionship and comfort to patients experiencing loneliness or anxiety, particularly when they may be isolated from friends and family due to illness or hospitalization. A study by Banks et al. (2008) suggested that the use of zoomorphic social robots can have the same effect as a companion pet in terms of providing companionship and reducing the feeling of loneliness. The study utilized a robot dog named AIBO, which was designed and manufactured by Sony. In this study, 38 participants joined a one-on-one session with AIBO, a natural dog, or did not have any companion. The results showed that the participants with companionship felt significantly less lonely than participants in the remaining group. Other studies (Kanamori et al., 2003; Robinson et al., 2013) also displayed promising results in mitigating the feeling of social isolation in group settings. In the first study by Kanamori et al. (2003), 11 elderly participants joined an experiment to explore the ability to reduce loneliness using the AIBO (ERS-210 model) (**Figure 2**) robot. The results indicated that elders who interacted with the robot had their sense of isolation significantly decreased. The experiment suggested

that utilizing robotic therapy sessions could lead to improved communication between elders from different backgrounds, thus reducing the feeling of being alone.

Figure 2. *AIBO (ERS-210 model) robot*
(Source: https://www.sony-aibo.com/aibo-models/sony-aibo-ers-210/)

The second study by Robinson et al. (2013) was a larger study consisting of 40 participants divided into two groups, with one group having the companionship of a Paro robot (**Figure 3**). Utilizing the UCLA loneliness scale to evaluate the effectiveness of interacting with the robot, the results after 12 weeks of investigation indicated that the subjects in the Paro group felt less lonely than subjects in the group that did not have the presence of Paro. This result also showed that the social robot could reduce elders' loneliness after a long period.

Figure 3. *Paro robot*
(Source: https://www.verywellhealth.com/paro-the-therapeutic-robot-seal-1123855)

Another field that has seen a wide range of applications of social robots is education. The ability to expand the capacity of teaching and learning through robotic technology has led to numerous research using social robots. The following section focuses on research and implementation of social robots for educational purposes.

2.2.2. The Application of Social Robots in the Education Context

Recent developments in robotics and AI have brought the application of social robots to the education context. The ability to communicate through verbal and nonverbal means of social robots provides many opportunities for improving teaching and learning quality. In addition, social robots can support a higher level of personalization and customization with their programmability and advanced algorithms.

With the rapid development of robotics technology, social robots have been applied to various educational settings. The physical presence of a social robot is a distinct trait that separates it from other kinds of digital services. Such a presence is beneficial when the robot works as a tutoring agent. For example, in a study by Leyzberg et al. (2012), a social robot named Keepon (**Figure 4**) was used to evaluate how its physical presence affected puzzle solving skills of students. Keepon was a small robot in yellow color with a shape of a snowman. In the experiment, participants were divided into 5 groups with different settings. The first group did not receive any advice for the task. The second group received

random direction from the physically present robot, while participants from the third group received personalized guidance from the robot's voice only. In the fourth group, the participants also received personalized advice through a video version of the robot. Finally, the last group received personalized advice directly from the robot itself. The puzzle was selected in a field where the participants had minimal knowledge to reduce the effect of experience. The results showed that participants who received advice from a physically present robot solved the puzzles faster than participants in the other groups. It indicates that the robot's physical embodiment directly affects the learning achieved. The results also showed higher social acceptance among participants about the robot's physical embodiment compared to its virtual versions.

Figure 4. *Keepon robot*
(Source: https://robots.ieee.org/robots/keepon/)

The behavioral aspect of social robots also plays a critical role in social robots performing well in educational settings. For example, the study by Saerbeck et al. (2010) validated that a social robot in the role of tutor utilizing socially supportive behaviors helped students learn more efficiently. In the research, the social robot iCat (**Figure 5**) was implemented with supportive gestures such as nodding or shaking head for non-verbal feedback, gazing behavior for attention guiding, displaying corresponding emotions for empathy, and a combination of dynamic motions, lights, and sound effects for communicativeness. The result is the comparison of the post-study learning performance of primary school pupils between two groups: students who received maximum social support from

the robot and students who only received basic help. The data showed that the test score of the support-receiving group was remarkably higher than the other one, thus confirming that socially supportive behaviors of robot tutors boost learning competence. In some other studies, the implementation of empathetic facial expressions and encouraging gestures (Leite et al., 2014) or conforming gaze behavior (Huang & Mutlu, 2013) not only yielded better learning results but also invoked positive feelings.

Figure 5. *iCat robot*
(Source: https://www.abotdatabase.info/assets/images/43_iCat.jpg)

From the user needs perspective, social robots' programmability and adaptability through advanced development in computer science, especially AI, have equipped them with the ability to provide personalized learning experiences. This feature brings another dimension to the application of social robots in education by detailing the learning content to suit learners' abilities, performance, and needs. An experiment by Janssen et al. (2011) compared the degree of motivation and learning outcomes of primary school students doing regular and personalized tasks. Utilizing the NAO robot[2] (**Figure 6**), the study applied *"learning by playing"* principles to create a robotic game for the children, combining an arithmetic assignment with a fun imitation challenge. The children experienced the personalization features by testing their own arithmetic capabilities, meaning the game did not end until its difficulty surpassed the child's ability. The game mechanics also allowed self-adjustable, increasing its difficulty if no mistakes were made. In contrast,

[2] https://www.aldebaran.com/en/nao

the game's difficulty level decreased if a mistake was made. Finally, the research applied a free-choice period after the main study, in which the children could either choose to: continue playing with the robot, read comics, or play computer games, to evaluate the degree of motivation of the children towards learning with the robot. Results showed that the students who belonged to the personalization group had stronger motivation and managed to reach higher levels in the arithmetic task. Even though the effectiveness of supportive and emotional verbal feedback on children's motivation was not evaluated, its benefits were indisputable.

Figure 6. *NAO robot*
(Source: https://www.aldebaran.com/en/nao)

In conclusion, social robots have the potential to revolutionize education by providing new opportunities for learning and engagement. They can support students with special needs, enhance language learning, encourage student participation, provide individualized learning experiences, and support students' social and emotional learning. While there are still some limitations to the use of social robots in education, such as their high cost, unreliable ASR (Kennedy et al., 2017), and the need for further research on their effectiveness, they are a promising tool for improving students' learning experiences and outcomes.

The following section focuses on the application of social robots in language learning, which has become a recent trend due to the robust development in ASR, NLP, and Text-To-Speech (TTS) technology.

2.3. Robot-Assisted Language Learning

This section introduces the topic of Robot-Assisted Language Learning (RALL) and the use of technology along with social robots in previous RALL research. It also covers the main approaches and the role of social robots in providing affective and cognitive benefits for language learners. The summary of previous studies provides directions for designing the RALL session of the thesis.

2.3.1. Theory and Examples

Robot-Assisted Language Learning (RALL) is the approach of using social robots to teach and learn different kinds of language for both native and non-native speakers (Randall, 2019). Specifically, RALL could provide education for comprehension skills of spoken languages, such as listening, speaking, reading, and writing, or expressions of non-verbal languages. This thesis focuses on applying social robots in L2 teaching, supporting adult immigrants in Finland to learn the Finnish language.

Social robots have been widely applied in RALL with a large variety of purposes, and in different functional settings. For instance, both autonomous and remotely controlled robots have been applied in RALL, sometimes in Wizard of Oz experiments, for teaching specific language skills, evaluating language ability (Gordon & Breazeal, 2015), or for affective purposes (Shin & Shin, 2015; Wu et al., 2015).

One important characteristic of social robots is their physical embodiments. In the RALL context, social robots' physical embodiments supported real-world interactions. In the research by Alemi et al. (2014), the NAO robot performed various gestures to teach Iranian junior-high students English vocabulary. Also, in the same study, the researchers designed various conversational scenarios and dialogs, which employed physical object manipulations and real-life situations, to explore vocabulary learning. Other studies have shown that incorporating whole-body movement and gestures can significantly enhance children's vocabulary learning (Mavilidi et al., 2015; Rowe & Goldin-Meadow, 2009; Toumpaniari et al., 2015). By allowing learners to interact with the physical environment, the use of social robots in education can contribute to creating a more dynamic and effective learning environment better suited to the needs and interests of today's students.

With the development of TTS software in recent years, the voice of the social robots in the RALL context can employ many identities, representing different age groups, genders, and, more often, languages. Various research has combined these voice attributes to create a wide range of characters for social robots, especially in storytelling tasks (Wu et al., 2015; Chang et al., 2010). However, the low quality of TTS can affect the learning gains regarding learners' listening comprehension (Lee et al., 2011). An alternative to TTS is to provide social robots with a pre-recorded voice. This strategy offers several advantages over TTS, such as offering the naturalness of native speakers' voices to the learning session or encapsulating emotions (Westlund et al., 2015). However, synthesized speech still provides important customizations adjusting volume and speaking rate to support divergent users' needs.

In addition, people have a tendency to ascribe human-like qualities and behaviors to robots. Due to this anthropomorphizing process, people often identified social robots with specific role such as teachers, teacher's assistants, peers, or friends rather than mere machines. This phenomenon has been observed in both children and adults, as confirmed by various studies, including Bartneck et al. (2009), Beran et al. (2011), and Duffy (2003). Consequently, robots can be programmed to assume a particular role, such as that of a teacher or friend, depending on the learning objectives of the task. Social robots can act as a teacher to guide and deliver corrective feedback to language students or undertake the role of a peer to facilitate the practice of language learners' recently obtained knowledge.

In the RALL context, a large body of research focused on exploring the effect of social robots in teaching L2 to children. However, the subject of the current thesis is adult immigrants. The following section examines several RALL research on cognitive and affective gains with adult language learners.

2.3.2. The effectiveness of RALL on learning outcomes for adults

Many studies have presented the positive effects of RALL on the learning outcomes of adult L2 learners. For example, Ishida et al. (2016) developed a RALL system that combined two NAO robots with language learning to enhance language acquisition. The study collected data from a group of 61 adult Japanese learners of English as L2 who used the RALL system for a period of six months. The data analysis process focused on identifying

the linguistic features of the learners, including vocabulary, grammar, and fluency. Results of the study exhibited that the use of the RALL system improved the learners' language skills in all areas, with notable improvements in vocabulary and grammar. The study also found that the learners' proficiency level influenced the type of language errors they made. Overall, the research demonstrates that the RALL system is an effective tool for language learning, and the analysis of the learner corpus—a collection of written or spoken texts produced by language learners—can provide valuable insights into the linguistic features of the learners.

In another study, Wedenborn et al. (2019) set up an experiment to compare the vocabulary learning ability of L2 adult learners in three different conditions: in the first, the learner received instructions from a disembodied voice; in the second, a vibrant on-screen avatar acted as the tutor for the participant, and in the third condition, the tutor was a social robot named Furhat[3] with a 3D animated face mask (**Figure 7**). The L2 in this study was Russian. All 15 subjects of the experiment had yet to gain prior L2 skills before the exercises. In the first phase of the experiment, all participants practiced with nine words among three conditions in random order. During the second phase, the participants were requested to recall the words that they had practiced in the previous step. According to the findings, practicing words with a physical robot significantly improved the participant's ability to remember, compared to practicing them with an avatar on a screen or a disembodied voice.

[3] https://furhatrobotics.com/

Figure 7. *Furhat robot*
(Source: https://furhatrobotics.com/about-us/)

While vocabulary and grammar were the focal learning points of considerable research, improving face-to-face communication for L2 adult learners was the focus of the study by Khalifa et al. (2017). The researchers designed a scenario to teach English expressions to Japanese university students. In the experiment, the RALL system consisted of two NAO robots, one serving as a teacher and the other as an advanced peer learner. The teaching method applied was implicit learning, meaning that the advanced peer learner robot responded first when asked by the robot teacher. The answer from the peer robot acted as guidance so the human learner could refer to it while forming their own response. The study quantitatively measured the effects of implicit learning with repetitive queries on 37 learners, dividing into two groups. Only the participants in the second group experienced the implicit learning method. The results indicated that repetitive questions of specific grammatical expressions improved the correct use of these expressions. Furthermore, the researchers observed that the supportive answer from the peer learner robot during implicit learning significantly improved the phenomenon, compared with the situation when no assistance was provided.

2.3.3. Affective Benefits of Robot-Assisted Language Learning

Learning a new language is challenging for many individuals as it requires significant cognitive effort and persistence. Positive affective states, which refer to positive emotions

and moods, increase motivation and engagement in the learning process. Learners in a positive mood are more likely to approach language learning with enthusiasm and energy, leading to tremendous effort and persistence in studying and practicing the language. As research has confirmed the positive effect of motivation on learning outcomes (Dörnyei, 1994; Pekrun et al., 2002), many RALL-related studies have attempted to improve learners' motivation using social robots (Alemi et al., 2014; Alemi et al., 2017; Lee et al., 2011). According to the research results from Alemi et al. (2017) and Lee et al. (2011), the effect even lasted after a long-term period of usage (one to two months), suggesting that the significant increment in motivation came from the RALL experience altogether, not only by the novelty aspect of social robots.

In the study by Alemi et al. (2017), researchers observed the attitude of 19 Iranian preschool students toward the NAO robot for one month during 10 English language sessions. The research inspected the children's thoughts and feelings toward the robot through three variables: anxiety, motivation, and interaction. The reported result on pressure showed a positive effect of the robot on reducing children's reluctance, fear, and boredom during classes. The robot also helped the preschoolers understand that they should not feel embarrassed by making mistakes, lowering their concern about right or wrong. In addition, a personalization strategy was applied with the robot calling children using their names, making the kids more motivated. Throughout the language course, the children developed a strong bond with the robot by touching and kissing the robot, even when uninstructed and without permission. As a result, the NAO robot became the children's friend after a while, and they were extremely engaged when interacting with the robot. Observation revealed that the children were highly motivated to learn English with the robot. They enjoyed spending time with NAO and did not want to stop using the robot at the end of class. In summary, the study displayed social robots' ability to motivate children by satisfying their needs for Competence (reducing anxiety and not being afraid of making mistakes) and Relatedness (bonding, collaboration, companionship).

Social robots also displayed similar results in the study by Lee et al. (2011), with the participation of 21 South Korean elementary students in the RALL setting. The participants joined a 2-month-long English course with multiple sessions per week, learning English as L2 with the help of two social robots: Mero and Engkey. The students in the study displayed a substantial boost in their self-confidence after learning with the robots.

The ability to create a relaxed environment for repetitive training of the robots resulted in the affective gain of the participants. Additionally, the robots could extrinsically motivate the children in the study, helping them realize the importance of learning English through conversational practices. In the end, the result of the research reported a considerable improvement in students' interest in the English language and learning experience. It meant that the robots improved students' intrinsic motivation through learning the language. The result also revealed that the robot's physical appearance, body gestures, and facial expressions made the student feel more enjoyable than before learning with the robots.

Many researchers have targeted the older audience in their RALL experiments (Ishida et al., 2016; Khalifa et al., 2017; Perlmutter et al., 2016; Wedenborn et al., 2019), focused on investigating the cognitive gains of learners rather than the ability to evoke positive affective states. In contrast, most research on RALL regarding affective improvements in this section was conducted mainly with children. As a result, the current research landscape of RALL regarding different age groups presents a need for more research on the affective gains of adult learners. Furthermore, other aspects such as educational methods as well as the role of the robot also have a particular influence on learners' motivation and affective condition. Therefore, the upcoming section examined some popular instructional approaches for language learning applied in previous RALL research and the robot role applied in accordance. Even though these features highly depend on the robot's software and hardware, the inspection provided some guidance for the Design and Implementation part of the research.

2.3.4. Teaching Strategies and Robot Roles in RALL

In the RALL context, the association of educational methods and the robot's role largely contributed to the design of interactions between humans and robots. However, the teaching strategies and robot roles are often based on the robot's capabilities unless researchers use in-house robots. Therefore, the exploration of educational methods and the robot's role based on the robot used provided practical suggestions for the choice of robot interaction for the thesis.

Multimedia-based education (MBE)

Multimedia-based education (MBE) is the application of media into the learning environment along with social robots, acting as a supportive tool to significantly improve learners' study experience. Multimedia learning environments fosters positive emotions, which make the learning experience more satisfactory, increase learner's motivation and perception toward the learning materials (Um et al., 2012). Many researchers have applied text, video, sound, graphics, and animation to support language learners in the RALL context further (Alemi et al., 2014; Schodde et al., 2017; Wedenborn et al., 2019). Specifically, in the study by Wedenborn et al. (2019), the researchers also used a tablet to provide learners with images, supporting the Furhat robot in the RALL experiment. Schodde et al. (2017) also took advantage of the tablet to display pictures and provide answers to the robot during the interaction process.

Alemi et al. (2014) combined MBE with NAO robots to improve young learners' engagement. Even though the primary purpose of the research was to study social robots and RALL, the researchers utilized a setup consisting of a laptop and a video projector to display images of objects for more intuitive learning. In the study, the robot employed the role of an assistant to the human teacher, presenting the learning material while teaching English vocabulary to the children. The application of MBE also contributed to the success of intrinsically motivating language learners.

Audio-lingual Method (ALM)

In ALM settings, the student learns correct grammar structures through realizing patterns in the learning material and repetitive practice. In other words, the teacher did not explicitly teach the grammar rules. The main reason for using the ALM approach in RALL was to improve students' oral comprehension through practicing with the robot. While applying ALM to RALL experiments, the robots often acted as teachers or tutors in this setting to instruct the students on pronunciation, speaking, and listening skills. ALM is highly dependent on the robot's TTS capability, as the study by Lee et al. (2011) showed that the limitation in the robot's TTS could be a critical factor in hindering students' improvement in listening skills. The use of ALM also improved the students' confidence in focused topics, thus leading to more language usage and higher intrinsic motivation to continue learning.

Total Physical Response (TPR)

This method utilizes the social robots' ability to demonstrate body gestures to explain ideas and concepts. TRP is best suited to humanoid robots that possess a certain degree of freedom in their motion because the complexity and diversity of the learning content are entirely subjected to the trait mentioned above. The study by Wu et al. (2015) employed TPR in one of its experiments to teach English vocabulary regarding body parts and body movements to Taiwanese elementary school pupils. For this study, Wu and colleagues developed their own robot named PET to serve the requirements of the experiment. The robot taught children English words by pointing at the corresponding body part, uttering the word through the speaker, and displaying the word on a screen at the chest. The study also incorporated dances and aerobic movements as other means of TPR instruction. The robots usually acted as teacher assistants or tutors since they were the main in charge of teaching activities. The students said the robot's body movements created an engaging and exciting learning experience. They also felt more motivated to learn the English language.

Communicative Language Teaching (CLT)

The CLT method focuses on developing language ability through social interaction. It is also the general aim of learning a language: communicating with others. Therefore, this method applies oral activities such as role-play, interviews, and group work to foster student interactions. The study by Alemi et al. (2014) implemented CLT into the RALL experiment, where a NAO robot not just taught children vocabulary through questions and answers but also participated as a learner during the class by replying to the human teacher's inquiries. In the study, the NAO robot sometimes played the role of different professions and taught English vocabulary related. The structured conversation was the CLT approach in one experiment in Wu et al. (2015)'s research, where the robot's role was an assistant to support the language teacher in teaching conversational statements. The physical appearance of the PET robot in the study effectively boosted students' confidence and generated more social interactions, thus suiting the ultimate goal of the CLT method.

Several other language educational approaches have been applied in RALL research, e.g., Collaborative Language Learning (CLL) and Task-based Language Teaching (TBLL). However, the section focuses on applicable methods for the Design and Implementation

phase, given the hardware and software of the robot chosen for the thesis. These methods are also proven effective in increasing the intrinsic motivation of language learners in the RALL settings.

2.4. Summary

The first part of the Literature Review explains the SDT, human motivation theory, and intrinsic motivation's benefits. The body of research on SDT on intrinsic motivation lays the foundation for the thesis by introducing the three psychological needs of Autonomy, Competence, and Relatedness. As the thesis topic revolves around language learning and SDT, it is critical to understand the implications of Autonomy, Competence, and Relatedness from research in the same context. More specifically, the Literature Review inspected previous research that applied SDT to the language teaching and learning context, gathering valuable hints to design for the three needs in the RALL context.

With the use of QTrobot in the thesis, human-robot interaction is key in the design process. Therefore, understanding social robots and their primary characteristics is an essential prerequisite. It is also vital to investigate previous applications of social robots in language learning to study the utilization of the robots' traits and capabilities and the effectiveness of RALL on both cognitive and affective outcomes. Furthermore, several aspects contributing to the quality of human-robot interactions, such as teaching methods and the robot's role, are also carefully examined. To sum up, the findings from reviewing previous research inform the design process of the thesis.

3. RESEARCH APPROACH & METHODOLOGY

This chapter presents a comprehensive overview of the research approach, methodologies used, and all stages of this thesis. The beginning part discusses the approach and overall process of the study, providing an overview of the different research phases involved. Furthermore, this chapter provides an in-depth look at the choice of data collection and analysis methods and their usage during various stages of the research. The following part of the chapter introduces the research platform—the robotic system and its programming language. Finally, the chapter highlights all essential ethical considerations applied throughout the research.

3.1. Research Approach

The thesis applies the Human-Centred Design (HCD) process as the general approach for the research. The first principle of HCD in the ISO standard mentioned that design is based on an explicit understanding of users, tasks, and the environment. The second principle emphasizes the heavy involvement of users through the whole design and implementation process. In addition, the third principle states that design is driven and refined by user-centered evaluation (ISO, 2019). To sum up, the HCD process involves understanding users' needs and designing products and services that meet those needs in a user-friendly and efficient manner. Furthermore, the process is iterative to continuously develop a solution that meets the user's requirements. In recent years, HCD has become increasingly popular as it has been shown to lead to greater user satisfaction, engagement, and loyalty.

One of the main benefits of HCD is that it ensures that products and services meet users' needs and preferences. By involving users in the design process and soliciting their feedback and input, designers can create products and services tailored to users' specific needs and preferences. This can lead to greater user satisfaction and engagement, as users are more likely to use and enjoy products and services that are designed with their needs in mind.

HCD can also lead to greater efficiency and productivity. By designing products and services that are easy to use and navigate, designers can reduce user frustration and errors,

leading to greater efficiency and productivity. This can be particularly beneficial in the workplace, where productivity and efficiency are often top priorities.

HCD also has the potential to promote social and environmental sustainability. By designing products and services that are easy to use and understand, designers can reduce waste and encourage more sustainable consumption patterns. Additionally, by involving users in the design process, designers can promote greater social engagement and community involvement, leading to greater social sustainability.

3.2. Research Process & Phases

The thesis consists of five phases in its process. Figure 8 displays all the phases of the research with their goals and outcomes.

Phase	Goal	Activity
Literature Review	Formulating Research Questions	• Identifying existing knowledge • Investigating theoretical framework and previous research approaches • Summarizing findings to plan the Pre-study and Design phases.
Pre-study	Collecting User Insights	• Understanding unsatisfied user needs • Analyzing qualitative data to produce user insights for design & implementation
Design & Implementation	Transforming Insights to Design	• Ideating different design ideas based on user insights • Implementing final design decisions
Evaluation	Testing and Validating Design Assumptions	• Iterative design and test the implementation • Analyze the qualitative and quantitative data
Design Guidelines	Synthesize Findings	• Synthesize findings with previous research • Conclude the design process with discussion and limitations

Figure 8. *Thesis research phases with goals and detailed activities*

Phase 1 - Literature Review

The Literature Review phase of the thesis extensively investigated the scientific research related to the thesis topic. Firstly, it focused on SDT and examples of SDT implementa-

tion in the language learning context. Secondly, the phase explored the theory and examples of social robots, emphasizing healthcare and education contexts. Moreover, the research phase also examined the topic of RALL, especially the characteristics of social robots that benefit RALL, several cognitive and affective benefits of RALL, and applied instructional methods. Most importantly, the Literature Review phase strengthens the case for choosing autonomy, competence, and relatedness as the primary target user needs for the research. Furthermore, the coverage of different RALL educational approaches contributes to the design and implementation of the human-robot interaction during SAMQ.

Phase 2 - Pre-study

The Pre-study phase conducted in-depth user interviews (N=6) in both online and in-person to gather qualitative data following appropriate research ethics guidelines. Zoom Meetings were the platform for conducting online interviews, whereas offline interviews occurred at participants' preferred locations such as their apartment or the Robostudio of Tampere University. The phase aimed to understand the unsatisfied users' needs in learning the Finnish language through analyzing the qualitative data. The insights from the user studies during this phase helped create a set of design implications for the design & implementation phase.

Phase 3 - Design & Implementation of SAMQ

The third phase of the thesis presented a RALL session named SAMQ using QTrobot. The language learning session focused on enhancing adult learners' intrinsic motivation through the fulfillment of the three needs of autonomy, competence, and relatedness. The interactive technique for input included haptic and speech, while visual and audio were the output channels of SAMQ. The choice of interaction techniques and output methods relied on the literature review regarding instructional strategies and the learners' insights from the Pre-study phase. Learning content was chosen based on learners' preferences during the semi-structured interviews of the previous phase. The QTrobot Studio is the programming platform for the learning session.

Phase 4 - Evaluation of SAMQ

The fourth phase conducted prototype evaluation with adult immigrants (N=6) in the laboratory environment. The goal of the evaluation is to validate the design attributes of the

prototype based on the concrete UX goals defined in Phase 2 and obtain feedback for future improvements. Additionally, the prototype evaluation focused on learners' learning experience with QTrobot, especially the feeling of interest/enjoyment. The result helped to examine whether SAMQ can motivate learners to learn the Finnish language.

Phase 5 - Design guidelines for invoking competence, autonomy, and relatedness in RALL

The last phase introduced a set of design guidelines for invoking the feeling of competence, autonomy, and relatedness in the RALL context. Based on the synthesis of findings in previous phases, the thesis generated a design guideline consists of several design implications to consider while designing motivational strategies for RALL programs.

3.3. Data Collection Methods

This section describes the methods for data collection process during the Pre-study and the Evaluation phase of the thesis. The Semi-structured Interview and UX Laddering are utilized in both phases, while the Customized IMI Questionnaire is developed for the Evaluation phase only.

3.3.1. Semi-structured Interviews and UX Laddering

In the project's exploratory phase, the semi-structured user interview is the primary approach for conducting user inquiries. A semi-structured interview is a qualitative research method that utilizes the advantages of both structured and unstructured interviews. As a result, semi-structured interviews inherited the organized and focus nature of structured interviews while also being flexible as unstructured interviews. In a semi-structured interview, the interviewer has a set of open-ended questions to guide the conversation but is also free to deviate from the script and follow up on exciting or unexpected responses from the interviewee, allowing for a more nuanced and detailed understanding of the research topic than structured interviews, while still maintaining some degree of consistency and structure. Additionally, because the interviewee has more freedom to share their thoughts and ideas, semi-structured interviews can be more engaging and interactive than structured interviews. Due to the sensitive nature of personal difficulties in learning the Finnish language, the participants may feel uncomfortable answering open-ended

questions about the topic if they join a focus group (Adams, 2005). Therefore, semi-structured interviews have more advantages over group inquiries in this study.

The second method used in the pre-study phase of the thesis is UX Laddering (Vanden Abeele & Zaman, 2009). This method is an adaptation of Laddering in consumer research, commonly known as an in-depth interview technique (Reynolds & Gutman, 2001). It involves an interviewing process that begins with broad, open-ended questions and gradually narrows to more specific, detailed inquiries. The term "laddering" refers to the process of progressively "climbing up" the ladder of abstraction from concrete product features to more abstract personal values and beliefs. As a result, UX researchers can better understand the emotional and psychological factors that influence user behavior by asking users questions that dive deeper into their thought processes and decision-making. Many researchers have used the laddering interview technique as a research method in the Human-Computer Interaction context to develop design recommendations (Subramony, 2002; Jans & Calvi, 2006; Vanden Abeele & Zaman, 2008).

In practice, the semi-structured interview begins with broad, open-ended questions such as *"Could you please tell me about your past experience of learning the Finnish language since you came to Finland?"* or some alternative versions to explore the participant's history of learning the language. The following part contains a series of more focused questions to identify the participant's needs, desires, and goals in learning the Finnish language. This stage also focuses on learning about the participant's positive and negative experiences in the context of learning the Finnish language in Finland. Finally, the study applies "laddering" to connect the participant's needs, difficulties, feelings, and emotions to broader, more abstract values and beliefs. This technique helps to uncover the underlying motivations and emotional drivers that influence the participant's behavior and evaluate the connection between these data and the three needs of Autonomy, Competence, and Relatedness. The list of all main questions is in Appendix B – Pre-study Interview Primary Questions.

In the research's evaluation phase, semi-structured interviews and UX Laddering aim to understand the participants' perspectives on SAMQ, explaining the rationale behind the participants' choices and finding room for improvement.

3.3.2. Customized Intrinsic Motivation Inventory (IMI)

The Intrinsic Motivation Inventory (IMI)[4] is a compound questionnaire designed to measure participants' subjective experience in laboratory experiments regarding intrinsic motivation and self-regulation (*Intrinsic Motivation Inventory (IMI) – selfdeterminationtheory.org*, n.d.). Many experiments (e.g., Ryan, 1982; Ryan et al., 1983; Plant & Ryan, 1985; Ryan et al., 1991; Deci et al., 1994) have used different versions of the scale to measure essential factors of intrinsic motivation.

The inventory comprises of 45 items across seven sub-scales: Interest/Enjoyment, Perceived Competence, Effort, Value/Usefulness, Pressure/Tension, Perceived Choice, and Relatedness. Among these dimensions, the Interest/Enjoyment subscale is considered the self-report measurement for intrinsic motivation, whereas Pressure/Tension is believed to be an obstructive indicator of intrinsic motivation.

The thesis developed a customized version of the original IMI consisting of 11 items (Appendix C – Customized IMI Questionnaire), focusing on assessing Perceived Competence, Perceived Choice, Relatedness, and Interest/Enjoyment of the participants after experiencing SAMQ. These aforementioned subscales represents the three basic needs of Competence, Autonomy, Relatedness and Intrinsic Motivation. Each subscale consists of two items to ensure their external validity. Additionally, the Customized IMI Questionnaire also includes two items to evaluate the Pressure/Tension subscale to strengthen the validity of Interest/Enjoyment. Finally, the questionnaire assesses whether users found the learning activity valuable for learning the vocabulary and listening skills for the Finnish language using one item from the Value/Usefulness subscale. In the evaluation phase, the participants give answers to the questionnaire after participating in the learning session with QTrobot.

3.4. Data Analysis Methods

The Affinity Diagram is a data analysis method used in UX design to help designers organize, connect, and combine large amounts of unstructured data (Lucero, 2015), such as user feedback, observations, and ideas. It was developed in the 1960s by Jiro Kawakita, a Japanese anthropologist, and is also known as the KJ method (after its creator's initials).

[4] https://selfdeterminationtheory.org/intrinsic-motivation-inventory/

Due to the exploratory nature of the thesis, a lot of qualitative data is collected through observations and semi-structured interviews.

In the Pre-study phase, the qualitative data collected is analyzed and organized into four main groups: Autonomy, Competence, Relatedness, and Usefulness. The former three groups represent the findings that strongly connect with the three unmet needs of adult immigrants. The three groups included another layer of categorization: Enhancement and Blocking. Data in Enhancement are positive events or attributes that inspire adult immigrants to continue learning the Finnish language—a sign of intrinsic motivation. In contrast, Blocking contains adverse incidents or phenomena that reduce the drive or joy of expatriates in their language-learning journey. While the former three focused on the hedonic aspect of the learners' experience, the latter, Usefulness, accumulated the pragmatic side of the experience, the learning content. Information such as important grammar structures, preferred skills to focus on, and topics of interest are parts of the classification. The practice of categorizing and organizing notes helps detect patterns and themes in participants' thoughts and expectations for the language learning process, linking the data with the three unmet needs. Consequently, the combination of detected themes and UX goals guides the ideation process and generates design ideas for the prototype.

During the evaluation phase, the thesis collected the participants' opinions regarding the overall intrinsic motivation, the three unmet needs, and their ideas for improvements. This qualitative data is summarized and analyzed with the quantitative data from the IMI questionnaire to produce the design guidelines for designing future RALL sessions.

Finally, the quantitative data collected by the customized IMI questionnaire were analyzed using basic statistical analysis methods in Microsoft Excel. Even though the research focuses on qualitative data, having a quantitative measurement to evaluate the prototype supports the qualitative research findings and helps detect points for improvements.

3.5. The Wizard of Oz Method

The thesis employed the Wizard of Oz (WOz) method to support the evaluation of SAMQ. According to Nielsen Norman Group[5], WOz is a user-research approach in which a person interacts with an interface controlled by a human operator to manage the system's responses (*The Wizard of Oz Method in UX*, n.d.). The method was introduced by Kelley (1984), where the system made the users believe that the system understands human language. In order for robots to understand human language, they must be able to convert speeches to texts through ASR and then process the texts to interpret the meaning with NLP. In the HRI context, multiple research has utilized WOz due to limitations in robotics and AI technology regarding the ability of robots to autonomously communicate with humans verbally, especially to simulate ASR (Funakoshi et al., 2008; Iwamura et al., 2011) and furthermore, NLP.

Given the limited time and technical resources of the thesis, we could not implement the ASR and NLP modules of QTrobot for the Finnish language during the thesis's timeline. Therefore, choosing WOz was an appropriate selection since the setup could simulate the ASR feature of QTrobot to support natural HRI during the evaluation phase by providing an impression that QTrobot can recognize the participants' utterances in Finnish. In addition, a scenario was designed to constrain the complexity of the conversation between the robot and the human, simulating the NLP module. Therefore, the WOz setup allowed us to quickly explore different conversational strategies for satisfying users' needs without having to actually implement ASR and NLP features, thus benefiting the design process.

3.6. Research Platform

3.6.1. QTrobot

This study utilized QTrobot (Figure 9), a humanoid robot designed to serve as a tool for therapists and educators in both research and educational contexts. The robot is specifically designed to support researchers and teachers in guiding children diagnosed with autism spectrum disorder about communication, emotions, and social skills by employing

[5] https://www.nngroup.com/

various non-verbal means, including facial expressions, gestures, and games. (*QTrobot - ROBOTS: Your Guide to the World of Robotics*, n.d.)

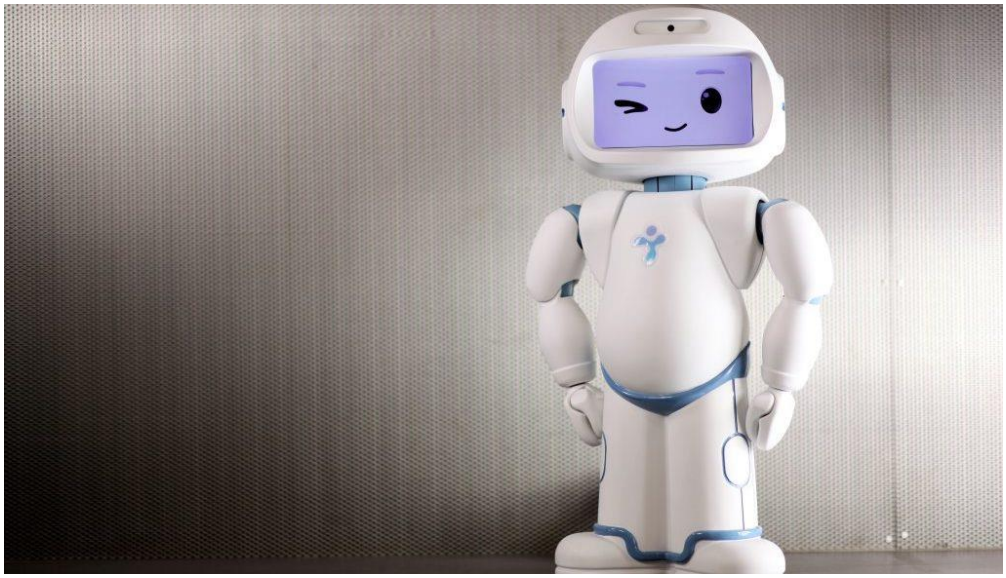

Figure 9. *QTrobot*
(Source: https://luxai.com/blog/validating-clinical-effectiveness-of-at-home-early-intervention-for-autistic-children-by-social-robot-qtrobot/)

The robot has an integrated 800x480 standard display in the head that can display a diverse range of built-in facial emotions. In addition, the robot's display can also exhibit any custom-generated emotions in the form of a video file. Furthermore, QTrobot has double speakers powered by a 2.8W stereo amplifier, working as an audio device for speech-based output and playing different sound effects. The robot also comes with TTS software from Acapela, enabling multi-language communication during human-robot interaction. QTrobot's software architecture also allows researchers to install different language models that support ASR, further enhancing its conversational ability. On top of that, QTrobot has two tablets, allowing the teacher and student to interact with it through touch-based gestures.

The research objective was to explore how social robots can facilitate positive experiences, specifically autonomy, competence, and relatedness, to motivate adult immigrants to learn the Finnish language. Therefore, we selected QTrobot as the research platform for RALL because of its emotionally rich digital face, its attractiveness and child-like appearance, its ability to participate in multi-language conversations, and its use of its

tablet to provide additional autonomy support. Those attributes of QTrobot are valuable for positive human-robot interaction and user experiences.

3.6.2. Block Programming with QTrobot Studio

The programming of SAMQ using QTrobot was performed on QTrobot Studio, a web-based visual programming interface with user-friendly commands and interactions (Figure 10). The tool offers a wide range of blocks for both generic purposes and QTrobot-specific. The supported standard programming blocks are loops, conditions, lists, variables, and functions. Additionally, QTrobot-specific blocks support features like speaking multiple languages, playing head and arm gestures, and displaying facial emotions in sync through the robot's digital face. The dedicated control-flow blocks enable the creation of interactive applications where one user (the learner) can interact via the Learner Tablet while another user (the educator) can control the program flow in real time from another tablet (the Educator Tablet). The QTrobot online studio also allows uploading custom images, animations, and audio to enhance the application. The webtool's intuitive design and features help researchers with limited programming ability to create simple yet interactive robotic experiences.

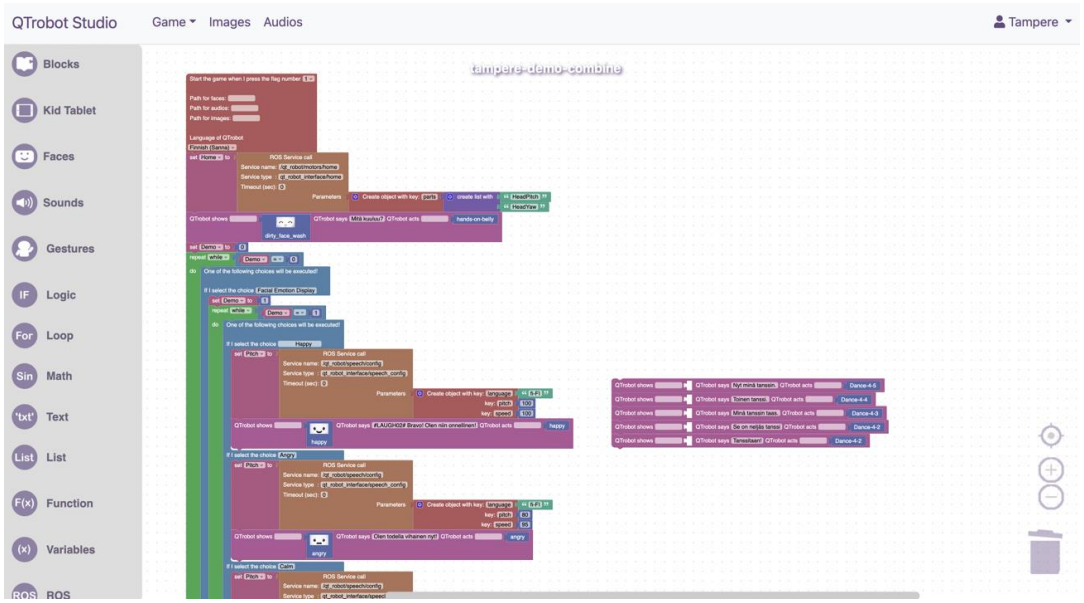

Figure 10. *QTrobot Studio for block programming*

3.7. Participants & Ethical Considerations

For the Pre-study phase, six semi-structured interviews were conducted, with a length of 30 to 45 minutes, starting from September to October 2022. The participant group (N=6) consisted of immigrants from Vietnam and China, two countries in Asia. The participants' age ranged from 25 to 36.

The informed consent and the information sheet about the research were provided to the participants before their official participation in the interviews (Appendix A – Research Info & User Study Consent Form). All interviews were conducted at locations that the participants preferred. The interviewer conducted the interviews in a relaxed manner, allowing the participants to freely report their Finnish language learning history without facing any pressure or stress. During the interviews of the Pre-study, no identification information of the participants (name) was asked or mentioned. The consent forms are stored separately from the research data, in a locked cabinet at the author's home. The videos regarding the online interviews conducted through Zoom Meetings have been deleted. Only the recorded audio of the meetings is stored in the researcher's personal computer, which requires a password to access and it will be deleted the thesis's submission. The researcher used participant codes to identify the participants in research data, which was only understandable to the researcher.

During the evaluation phase, the study did not collect personal information about the participants except their names in the consent form. However, the names of the participants were not connected to the research data. The researcher took handwritten notes from interviews and observations, but all the information was anonymized. The consent forms were presented to the participants before the evaluation, and are stored in a locked cabinet at the author's home. As many have mentioned ethical concerns regarding the use of the WOz method or similar approaches when participants were deceived (Fraser & Gilbert, 1991), the thesis mitigated these problems by exposing the actual setup to the participants after finishing all activities of the Evaluation phase. We explicitly admitted to the participants the current limited capability of QTrobot's software in recognizing the Finnish language.

Other research data regarding the thesis were stored digitally in a password-protected folder on the researcher's personal computer. No other person has access to this computer or folder except the researcher of the study. The research data did not include any identifying information, and no other person has permission to access these data. During the thesis, surveys, and responses from the participants have been stored online in the university's private cloud services under the researcher's account for analysis purposes and are deleted. All research data will be deleted after the thesis's submission.

4. PRE-STUDY

This chapter covers the Pre-study phase of the research, including the purposes of conducting the Pre-study and generic information about the participants. The chapter also explains the data collection and analysis processes in detail. Finally, the chapter reports the summary of the findings in the Pre-study.

4.1. Goals of the study

The Pre-study phase of the thesis focused on synthesizing qualitative data about the participants' past experiences of learning the Finnish language, focusing on the unsatisfied aspects of the three basic psychological needs. Through the collection and analysis of this factual data, the Pre-study phase aimed to understand the meaning of adult immigrants' needs on autonomy, competence, and relatedness. Moreover, the user study in this phase highlighted the positive attributes of SAMQ that supported the satisfaction of the three needs while also considering the negative features that undermined those needs. In addition, the Pre-study phase also learned about the subjects' preferences regarding the learning content and the context where the learning happened. Finally, the synthesized data from the Pre-study phase served as the input for the Design and Implementation phase of the thesis.

4.2. Participants and Recruitment

The participants were six adult immigrants living in Finland for around two years. Among the participants, three were male, and three were female. All the participants studied the Finnish language for at least six consecutive months. Therefore, even though their Finnish language skills were at the beginner level, they have already obtained a basic vocabulary and grammar knowledge equivalent to the A1 level of language proficiency according to the Common European Framework of Reference for Languages: Learning, Teaching, Assessment (CEFR). Furthermore, some of them are still learning in different Finnish language courses, and others have studied in courses in the past six months. Consequently, the ability to remember important details of their learning experiences were still in good condition. Four of the six participants were immigrants from Vietnam, while the remaining two originated from China. Regarding the profession, four of the participants were

students at Tampere University, while the other two were employees of Finnish companies. The thesis's recruitment process utilized the author's personal network.

4.3. Data Collection and Analysis

The Data Collection and Analysis section of the Pre-study phase focuses on the details of those related activities during the study. The method for data inquiry was Semi-structured Interviews, while the Affinity Diagram method served as the technique for data analysis. The description of the methods and the rationale for their choice was provided in the Chapter 3 - Research Approach & Methodology.

4.3.1. Semi-structured Interviews

The primary method for soliciting L2 adult learners' insight for the thesis is semi-structured interviews combined with UX Laddering, as introduced in Chapter 3. The structure and primary questions of the semi-structured interviews is in Appendix B – Pre-study Interview Primary Questions. All the interviews were conducted at pre-negotiated times and locations that suited the preferences of the interviewees to create a relaxed atmosphere. For instance, two interviews were implemented online through Zoom Meetings[6] per the request of the participants, while two interviews were conducted face-to-face at the subjects' apartments. Lastly, two remaining interviews were organized in Robostudio—a co-learning workspace in Hervanta Campus, Tampere University.

During the pre-negotiation phase prior to the interviews, verbal consent was obtained for each participant of the Pre-study phase. Before the start of the interviews, participants received the information sheet regarding the study and a consent form for collecting information.

The interviews of the Pre-study phase started with information sharing regarding the participant's backgrounds, consisting of age, amount of Finnish language study time, and length of the living period in Finland. This initial phase of the interview helped ease the participants, acting as an ice-breaker tool to make the participants comfortable in sharing more personal details. The interviewer started by asking the central question: *"Could you*

[6] https://zoom.us/

please tell me about your story of learning the Finnish language?". Sometimes, the interviewer needed to explain more or use an alternative version of the primary question if the original version was unclear to the participant. A different version of the main question could be: *"How many times have you studied Finnish? How long have you been studying the Finnish language, and how was your experience?".* Initially, all the answers of the participants mentioned the surface data about their process of learning the Finnish language, such as the number of courses that they have participated in, the study frequency every week, and the length of each study session. Sometimes, the interviewer repeated a piece of information so that the subject could elaborate on that by giving more details. For instance, after a participant mentioned that she studied the Finnish 1 (F1) [7] course again in the last year of her bachelor's degree, the interviewer iterated, *"So you mentioned that you studied the Finnish 1 course again?"*. The participant continued right away with additional information regarding the decision *"Yeah! Because I felt that I had forgotten everything I'd learned. And because I feel like with different teachers, even when they teach the same thing, they give you different techniques. And now I feel like I have really understood the basics"*. Some participants just answered with relatively short responses, and the interviewer had to ask a sequence of questions to collect the information as a whole. For example, in one interview, the interviewer needed to ask again, *"So could you please tell me about the experience of studying in the Finnish courses that you have joined?"*, and the participant started to tell the story focusing on the feelings and emotions that she had during those courses. The answer would be authentic by asking the participants to tell their stories. As the thesis aims to design for a real-world issue; therefore, collecting real insights and problems was critical. Various research found that when people experience high arousal and negative affects, they tend to remember better the central aspects of events (Christianson & Loftus, 1991; Reisberg & Heuer, 2004), while the positive affects improve their ability to recollect the secondary details (Talarico et al., 2009). The following section of the interviews helped the participants remember the correct details of their previous experiences by recalling the emotions involved.

[7] An introductory Finnish course with a target CEFR level of A1.1

The next part of the interview focused on gathering all the memorable moments of the participants in their language-learning process in Finland, including both positive experiences and negative encounters. Research has shown that positive feelings and emotions foster intrinsic motivation (Løvoll et al., 2017), especially learning (MacIntyre & Vincze, 2017; Um et al., 2012). Therefore, detecting positive experiences from the participants helped generate ideas when designing for intrinsic motivation during the Design & Implementation phase of the study. In contrast, noticing negative experiences helped avoid creating similar situations for the learners while designing for intrinsic motivation. In this interview section, the interviewer applied the UX Laddering method to uncover the underlying reasons and values of the participant's thoughts and emotions while learning the Finnish language. For example, when a participant mentioned, *"I like contact teaching more than online"*, the interviewer asked, *"Why?"* or *"How so?"* so the underlying reasons for the choice could be revealed. The participant replied, *"I feel like I learned better"*, and the interviewer again climbed the ladder with the question *"Like how?"* to understand the reason for the corresponding feeling. Until then, the participant would clearly explain why she preferred the contact teaching method over online classes because *"the environment or the atmosphere in the classroom is better"*, *"it's easier for the teacher to help you in the class", "if you have a question, you can just ask, it's very convenient"*, and *"you can interact with other students"*.

The collection of positive emotions and their underlying causes helped us understand the connection between the positive emotions and the participants' motivation to learn the Finnish language. On the other hand, the adult immigrants who participated in the Pre-study phase often lost the learning inspiration after going through negative experiences.

The last part of the semi-structured interviews explored the participant's perspectives on using robots for language learning. Firstly, the interviewer touched upon the topic of using robots for general purposes, asking the participants about their experiences of interacting with any robot through a sequence of questions, *"Have you ever used any kind of robot before? Could you please tell me about that experience? What do you think about that experience?"*. Participants who do not have any prior encounters with robots would continue answering other questions regarding their opinions on humanoid robots in general, such as *"What do you think about humanoid robots or robots that look like humans?".* Finally, the interviewer again applied the UX Laddering technique to understand

the hidden logic behind the participant's thoughts and opinions on humanoid social robots. Adult learners must embrace social robots in order to make RALL a successful learning method (Kouri et al., 2020). As a result, these questions aimed to understand the adult immigrants' level of acceptance of social robots.

4.3.2. Affinity Diagram

Figure 11 displays the main part of the Affinity Diagram, which consists of the main findings of the Pre-study phase. These findings are factors that either enhance or reduce the satisfaction of the three basic needs.

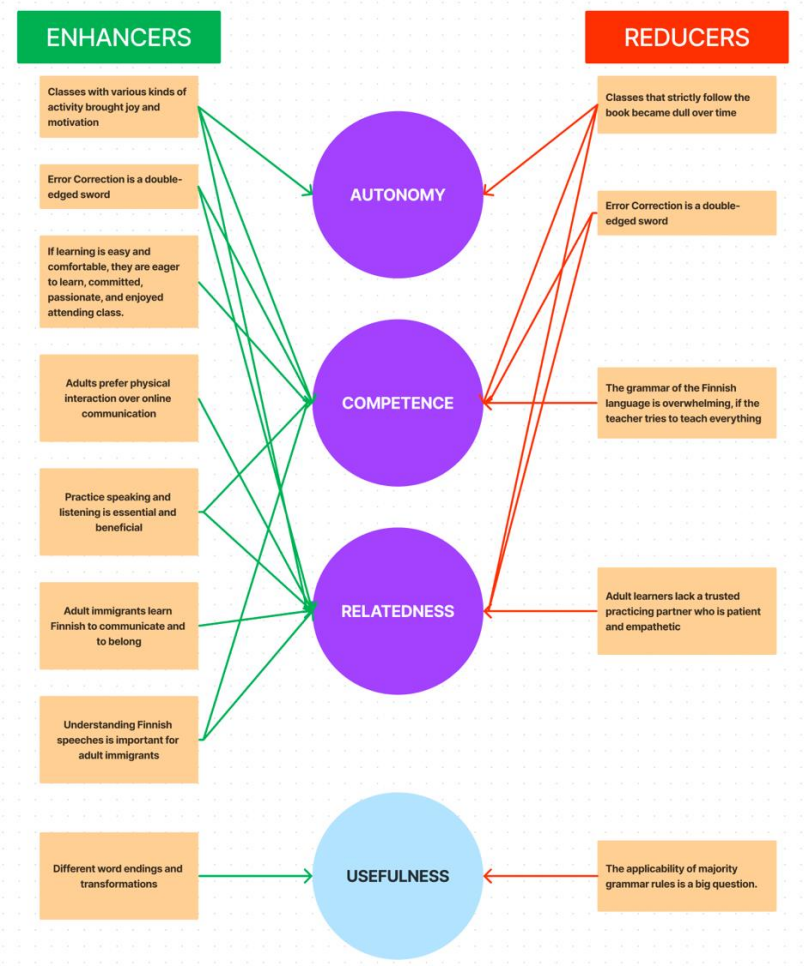

Figure 11. *Affinity Diagram of the Pre-study phase*

4.4. Findings

This section explains all the findings of the Pre-study phase after the data analysis process using the Affinity Diagram method. The findings were organized into several themes and

analyzed their effect on learners' intrinsic motivation through connection to the three psychological needs of Autonomy, Competence, and Relatedness.

4.4.1. Main Findings

Classes that strictly follow the book became dull over time, while classes with various kinds of activity brought joy and motivation.

Several participants demonstrated a distaste for classes that stuck with one agenda for an extended period. For example, P3 described the same learning schedule for a whole course, *"It seems like they're way too fixed in their methods and agenda. Everytime before the course the teacher wrote the schedule for the day. But every time it was the same*". She elaborated more, *"First we reviewed something, then we read the paragraph. Then we practiced. Breakout rooms. Finish. All the time"*. P3 also mentioned limited learning materials as another reason for her to feel bored, *"Yeah we just used only one book. Just one book."*. Regarding games or gamification activities, P3 never had any chances to play games during classes that she recognized as boring, *"No, the teacher never used game. Maybe we did some listening tests, but they're not games. Not anything like Bingo or Kahoot"*.

On the contrary, other participants said they felt delighted and enjoyable during language classes with activities such as games and supportive applications. Although they did not stress the importance of creative and novel teaching methods, using Bingo, Kahoot, and several interactive tools increased adult students' engagement and participation during the class. P2 liked how the teacher applied different games to his F1 class: *"I really liked playing games during the class. Kahoot, Bingo, and some other puzzle-like games are all very fun and amusing to play. I felt that time flew really fast"*. P6 mentioned Booklet and some competitive games as the source of joy and happiness while learning the Finnish language, *"Yeah the teacher used Booklet and some other games. It was really fun. We competed with each other. I think they really helped in recalling the knowledge, especially vocabulary"*. According to P4, her most memorable course was F3, where the teacher also used different games for repetitive language practice and recall. For her, being the winner was also a source of motivation for learning the language during the course, *"I was so competitive. I really wanted to win those games. I even studied before classes to win games"*. Even though this type of motivation was extrinsic, the ability of games to

drive recurring language exercises without evoking boredom and monotony is worth noticing, as these negative feelings are signals of lacking intrinsic motivation for the activity. P1 directly mentioned the ability of games to make the class more fun and interactive, *"Yeah, the games were fun. They really helped in a way that the class was not boring"*. Although thinking that games did not provide much new learning, he really liked to play games during language classes, *"I really liked to play games such as Kahoot, Booklet during the class. But I think they're more like a small test to see my current expertise. I still prefer real study using books"*.

Citing cultural elements as critical features for reducing language study weariness, P5 told the story of her teacher organizing a baking day for the adult immigrants on the Independence Day of Finland, *"Yeah the teacher told us to purchase the ingredients beforehand so we can make Joulutorttu, a special pastry in the Finnish culture. It was so much fun and pleasurable. We learned how to make a new kind of pastry while practicing language at the same time"*. Even though the class was fully remote, P5 still found precious and unforgettable moments during her study through creative approaches from the teacher.

P3 remembered that when she studied English during her bachelor's degree, music helped improve the learning mood among students in the class, *"There was one part that I really liked. The teacher put on some pop music, it's not too fast. She gave the whole lyrics to us, but some words are removed. So it's another interesting method to practice while also enjoy the music. Something like that"*. The novel method reduced pressure and made her learning experience more comfortable.

In summary, using different activities during class can improve language learning in many ways. Cultural events bring people together and deliver a stronger sense of belonging and Relatedness, while well-designed games can satisfy various psychological needs of learners. Games that offer language learners choices and the ability to play at their own pace provide the feeling of control and Autonomy. Adaptive and personalization games that could tailor the gameplay according to the player's skill and ability support players' confidence and Competence. Collaborative games with societal elements can enhance an individual's connection with society and the people involved. All these innovative methods significantly increased the joy and happiness of adult immigrants during their language classes, intrinsically motivating them to continue their language expedition.

Error Correction is a double-edged sword.

Error Correction is a pedagogical strategy to enhance learners' linguistic Competence in a second or foreign language. Its primary purpose is to foster the acquisition of explicit knowledge of L2 and its grammar rules. The technique entails identifying and correcting learners' spoken and written language errors, providing them immediate feedback on their linguistic performance. Even though Error Correction is believed to be an effective approach to language teaching and is widely applied in language teaching nowadays, not every language learner is fond of this technique. For the participants in the Pre-study, making mistakes while learning L2 is quite common. According to Participant 3 (P3), her Finnish friends found that it is typical even among locals, *"I talked about this with my Finnish friends, and they said that even Finnish people made mistakes when they speak"*. Participant 4 (P4) strongly agreed with this belief, *"Yeah! I'm a foreigner. Even local people make mistakes"*. P4 stated, *"I'm not scared of making mistakes. Nobody knows you even if you make mistakes in public"*. Participant 6 (P6) happily commented, *"No pressure at all. Mistakes happened all the time during class. But that's how I learn a language"*.

Therefore, P3 felt demotivated when she was corrected all the time. Making minor mistakes while speaking and practicing a language is normal for her. She mentioned, *"The teacher always tried to correct you whenever you make mistakes. I think it's not good for daily conversation. They were too much emphasis on grammar"*. The situation was getting even worse for P3 as she felt stressed, *"When the teacher focused too much on correcting our grammar mistakes during speaking, I felt so stressed."* These events led to a hesitation to speak Finnish, *"I don't like to speak because I'm afraid that I will make mistakes"*. P3 displayed a negative feeling related to Competence. She also lost trust in the teacher, which reduced her sense of Relatedness. She thought that her skill was not good enough.

In contrast, Participant 5 (P5) noted that *"the teacher did correct us sometimes. But she encouraged us to speak. We did not worry about mistakes at all"*. P5 felt a sense of empathy from the teacher while also gaining confidence, and this was a sign of enhancement in Competence and Relatedness for P5. Thus, the method for delivering Error Correction is the critical difference between P3's and P5's situation.

Other participants felt that Error Correction is needed during class, as they had no issues receiving teachers' feedback. P1, P2, and P6 said that they did not have any fear or anxiety when the teacher corrected them during class, while P4 explicitly mentioned the importance of corrective feedback, *"without the feedback, in the end, I'm not sure if I'm correct, for example, my pronunciation".* The common ground among participants was that Error Correction is needed, but the teacher's approach to giving feedback is critical. It could either enhance the feeling of Competence and Relatedness among adult learners or diminish those affections.

The grammar of the Finnish language is overwhelming, if the teacher tries to teach everything.

The adult learners mentioned that grammar was the focal point of their in-class study. In their opinion, the amount of knowledge of grammar was tremendous. Therefore, it was hard for adult learners to remember all of them. P4 stated: *"If the teacher focused on grammar, it's too boring. There are so many cases and logic. And sometimes even the teacher didn't know why the rule is like that"*. P1 admitted he was overloaded with the new knowledge, *"I was overwhelmed with learning that huge amount of grammar during my course in Sampola"*. For P2, *"The grammar was too complicated for me. I forgot all the grammar that I've learned"*. Among the participants of the Pre-study phase, only P5 acknowledged the importance of grammar, *"You need to know the grammar to understand the meaning of the words and endings. Vocabulary and grammar are very important. I really like to learn grammar".* The reason behind this outlier was that *"I didn't feel tired at all while learning grammar because the teacher did not teach too many things during a session."*, P2 clearly explained.

Diving deeper into the issue with the insight from P5, all other participants felt very comfortable and motivated when the amount of new knowledge was adequate. For P2, it was easy for him when he started learning the language in F1, "*It was quite simple. I really liked it. It's not many new things, so it's easy to remember"*. P1 also agreed while mentioning the positive atmosphere of the class, *"It was quite an easy learning. It was also relaxed. I didn't have to do a lot of homework, but I still managed to remember easily"*. According to P6, the course was also his most memorable because *"It's the most basic things. Nothing complicated"*. Although the introductory Finnish course did not impress

them, P3 and P4 had no learning difficulties. The problem of the participants only appeared during higher-level classes. The lack of proper practice time and real-life examples led to the overwhelming sentiment while studying non-beginner grammar. P1 openly said that *"I was overwhelmed with the amount of knowledge"* while talking about his experience in the Finnish 3 (F3) [8] course*"*. The difficulties already happened for P2 during Finnish 2 (F2)[9], as he mentioned *"too many verb types with different things to remember. It was too hard for me"*. The same situation applied to P6 since he also felt that learning was much more difficult in F2 and F3, *"It was much more complicated. The grammar was very difficult to learn and to remember, especially verbs, verb types and word transformation"*. Moreover, the same problem happened to P5, who likes to learn grammar when a large amount of new information is presented, *"Recently, a young teacher has started to teach us three times a week, and studying with her was very exhausting and stressful because she always tried to provide us as much knowledge as possible"*. The heavy cognitive load required from the class led to physical and mental tiredness, resulting in a reduced feeling of Competence. Thus, this diminished intrinsic motivation, making the learning *"more of a responsibility than a positive experience"*, according to P1. P2 also confirmed, *"I tried to memorize by heart to pass the course, not by the joy of learning"*. P5 mentioned that *"I didn't like to study with that young teacher at all. I feel like I'm not good enough. There's still a lot to be learned. It's so tired."*

In conclusion, when adult learners felt that learning was too overwhelming, they lost the sense of Competence, and this affection significantly diminished their intrinsic motivation for learning the Finnish language. In contrast, mature immigrants were confident and assured when the amount of knowledge was appropriate. Furthermore, as learning was easy and comfortable, they were eager to learn, committed, passionate, and enjoyed attending class. These are all signs of a higher feeling of Competence and an intrinsically motivated person.

[8] A Finnish course with a target CEFR level of A2.1
[9] A Finnish course with a target CEFR level of A1.2

The applicability of majority grammar rules is a big question. There are multiple causes for that problem.

Almost every participant questioned the relevance of many grammar rules when they told their story. They said that many of the grammar rules they had learned were quite challenging to use for casual purposes. During the interview, P1 said: *"I felt that it was really hard to use the knowledge that I learned. I don't know how to use them in casual conversations"*. P2 also expressed the same opinion: *"Most grammar rules were not practical for me. I can't use them in real life"*. For P4, there was a period that *"I didn't study Finnish because I felt it's useless. When I go to the supermarket, I only used simple greeting sentences"*. Although P5 did not vigorously challenge the practicality of grammar, she admitted that *"I can only use a very limited amount of language knowledge that I have learned. For now I can only use them when I go to the supermarket, communicating with the cashier"*. P6 simply said that *"They're so boring. I didn't use them much"*.

To find the root cause for the problem, P3 put some thought into it, stating that *"I need to learn how to use the grammar in real situations. I don't want to think for a long time before saying a sentence. Finnish people don't think when they speak"*. P3 emphasized the ability to promptly produce sentences or responses without much thinking to feel she was having a conversation. For P2, he believed that he needed practice, *"you must use the language in order to remember it"*, but the problem was that he could not create sentences, *"I could not form sentences for conversation"*. The idea came from his thought that using incorrect Finnish sentences costs people time, *"I don't want to avoid wasting people's time, so I switched to English. It was much more convenient. Most Finnish people speak English really well"*. Forming sentences was also mentioned by P1 and P6 when talking about different reasons for not being able to practice the Finnish language. P1 and P4 also concurred with P2's opinion about using English to save time and, even more importantly, having a precise conversation instead of going back and forth on the meaning of words.

Relating to the problem, P6 mentioned the effectiveness of Duolingo[10] in teaching vocabulary and simple yet practical sentences after using the app, *"I think Duolingo is very effective in teaching simple sentences. It didn't teach me any grammar, but I still can use*

[10] https://www.duolingo.com/ - a mobile application that helps people learn languages, including Finnish

some of the sentences". P4 agreed with this opinion about Duolingo, *"It helped. It didn't teach you the same thing in normal classes. It taught me the daily conversation, and that helped me a lot. I understand more what people are saying"*.

In summary, forming practical and useful sentences is crucial for adult immigrants in the Pre-study phase. They see this as necessary before they can confidently join a conversation using Finnish. Since learning in class could not provide immediate help, adult learners sought assistance from other solutions, such as language learning applications. Even though this is a complex problem that is unsolvable in a short time, the adult learners in this user study already pointed out a weakness of the teaching method applied widely in Finnish language classes regarding the ability to construct sentences.

Different word endings and transformations are a critical part of the Finnish language.

During the interviews, adult immigrants considered many grammar rules as inapplicable or very hard to use in real-life situations by adult immigrants. However, they still highlighted some essential syntax and principles of the Finnish language. For instance, they all concluded that several word endings and transformations combined with their usage examples must be mastered to understand the language better. P4 developed a sense of Competence after starting to comprehend the inflection of nouns regarding location cases, *"Yeah, those words endings like -lla, -lle, -ssa, etc..... are everywhere and you need to understand them first"*. P6 also agreed that the inflection of nouns is the initial step to grasping the Finnish language, *"After understanding and use some of the endings, other things are starting to be easier for me"*. Other participants also acknowledged the importance of becoming proficient in word endings to move further on their language-learning journey. Again, adult immigrants based their judgment on the practicality of grammar principles when choosing what to learn. In other words, adult immigrants always considered the Usefulness aspect of learning content while studying the Finnish language.

Adults people prefer physical interaction over online communication in language learning.

Most participants shared the same preference when asked to compare contact teaching and online classes. P4 mentioned that she remembered her F3 class the most among the courses that she studied. P4 assured that by saying: *"The one that I like most is Finnish*

3. I didn't have any negative experiences during Finnish 3. I enjoyed going to classes, I was expecting the classes. I met good classmates and a good teacher". Another benefit of studying in the physical environment for her was the ability to practice speaking, *"I have a lot of chances to practice speaking"*. In contrast, this was her statement when talking about her F2 course, citing the boredom of a self-study course, *"It was a self-learning course. I just watch the video and do the exam. It was kind of boring"*. Even though he did not clearly say that he preferred contact teaching, P2 only remembered the negative aspects of online language classes regarding social interactions, *"I was studying in Zoom, and nobody turned on their camera. After a while, I saw myself also hiding behind the black screen, spilling out answer when asked".* P3 listed out many benefits of physical class, such as *"When you have a question, you can just ask. In the Zoom meeting, it was very hard for the teacher to find all the people who want to ask"*, or *"It's also easier for the students to have conversations, face-to-face talk with each other"*. She felt that *"the atmosphere of the contact teaching is different. It's always better"*. P3 also mentioned a similar idea to P2, *"If you go to the classroom, you will need to prepare before class, and it will help you get better. When you study online, you can hide behind the camera and just searching for the answer"*. Even though P5's studied in a remote setting, the teacher arranged a small gathering once in a while at the public library or to a sauna to bring the students closer to others and closer to the Finnish culture, *"Last week we met outside at Metso Library, and after that we went to the sauna. It was very relaxed and comfortable. Wonderful moment!"*.

For the adult learners in the Pre-study, social interactions during real-life classes triumph over the freedom feelings of remote study. They want to communicate and connect with peers and instructors in the physical world. These activities brought a sense of Relatedness to their learning experience, making it more meaningful and memorable. However, lacking physical interchanges during classes created a feeling of isolation, thus reducing their sense of belonging and negatively affecting their intrinsic motivation toward their learning experience.

Practice speaking and listening is essential and beneficial. But adult learners lack a trusted practicing partner who is patient and empathetic.

Most participants shared a need to have a peer to practice the language knowledge that they have learned, focusing on oral skills. P1 mentioned the problem while telling his

story, *"I had no chance of practice speaking outside the class. Back then, I lived in Kokkola which is a small town, and there were not many Finnish people where I lived. It was very hard to find someone to practice the Finnish language, who could patiently listen to what I say. Therefore, it was easy to forget everything I learned"*. For P6, he was motivated when talking about practicing speaking Finnish, *"I really like speaking. I think it's quite flexible. There's no hard grammar restrictions, so I did not feel any pressure at all. It was comfortable, I had a lot of freedom"*. In his story, he recalled an event when he took his second Corona vaccination, and the nurse did not use English, *"Yeah it was an interesting encounter. I went to take my second Corona vaccination and the nurse could not speak English. I had to use my limited Finnish language capital, but it turned out fine at the end. Just like a small challenge. There was nothing negative. It was a rare opportunity for me where I can practice Finnish. I really like it"*. He cited the nurse's patience, empathy, and friendliness as the main factor that made the experience comfortable and pleasurable. He displayed a glimpse of confidence while recalling details of the event. For P2, it was an exciting and attractive learning experience when he practiced speaking with his language teacher, *"Yeah, it was great. The teacher asked us to say a sentence in Finnish. She gave us some hints, using the vocabulary that we studied before. That made us think. It's way more interactive"*. However, he had no chance to practice the language when he was not in the class, *"Yeah, I could not practice at all. I didn't have anyone to practice speaking and listening together without feeling awkward. I think I was also a bit shy"*.

The practicing partners of P3 were the badminton club members she was joining. They were mostly elderly Finnish people who were fun, patient, and friendly. P3 smiled while talking about the elders, saying, *"They always spoke to me in Finnish. I think they didn't know English at all, or they have very limited English. Of course, they knew that I could only speak very little Finnish, but they kept speaking Finnish to me and smiling and it was really encouraging me to learn more".* To add more to the story, P3 mentioned that even though she barely produced complete sentences, the elders were still happy listening and answering, *"I can only babble in words, but they were very focus on listening and try to understand me. That made me feel very happy and heart-warming"*.

The only participant who had regular practicing partners was P5. She has been joining a long and intensive language training program organized by TE office[11] that would last for nine months. The course consists of five-weekday study sessions from 9 AM to 2 PM, focusing only on the Finnish language. During the class, the teachers organized practicing sessions daily for learners to practice speaking with each other. Since the students have studied together for two months, they have built rapport and trust. Even though it was a remote course, having practicing partners for regular exercises helped P5, *"Yeah we practiced speaking and listening every day. The teacher put random people together, so we spoke about different topics. I think it forced us to start speaking, forming sentences. And we were not scared of making mistakes. We are all learners."*

In conclusion, the ability to communicate with even small success leads to a sense of Competence, intrinsically motivating adult learners to learn the language. Having a peer partner who can patiently listen to their unfinished language output without displaying negative emotions is truly important to achieve those small victories. Some participants already mentioned that they did not scare of making mistakes in front of their peers, compared with speaking to the teachers. The presence of an uncomplaining and calm peer partner eliminated the inherent pressure on teachers and improved the feeling of Competence for adult immigrants. Furthermore, when the peer was considered equal to a Finnish person, the learning experience also delivered a sense of Relatedness, as the learners felt accepted by local residents.

Adult immigrants learn Finnish to communicate and to belong, not for certificates.

All participants wanted to learn the Finnish combinations they could use daily, not for tests or examinations. None of them mentioned any goal for passing a specific language examination. For instance, all participants would like to learn valuable sentences while purchasing groceries and other essential goods at the supermarket. P2 mentioned that asking for discount items is his crucial question since he is a student, "*Yes! I really want to just ask if the chicken breast is on sale or not. Or where can I find the ice cream that is being discounted"*. For P4, having a short conversation with the cashier was meaningful enough, *"It would be very valuable for me if I can understand what the cashier was saying, even if it's just the total amount of money that I need to pay, in Finnish!"*. Although

[11] https://toimistot.te-palvelut.fi/ - a Finnish government agency that supports job search and employment

not explicitly mention the topics of interest, P2 said, "*I prefer learning something that I can use frequently"*. P6 straightforwardly mentioned communication as his most important goal, *"I want to learn Finnish to have basic communication with people"*. P3 yearned for simple conversations, *"I really really want to talk to people using Finnish"*. She explicitly mentioned the importance of learning how to use the language in real-life situations, *"I think the teachers can really help if they give more examples or teach more about the real situation that you can meet in your daily life"*. Then P3 recalled a story when using the language on the bus that helped her remember the related vocabulary and grammar structures, *"The teacher used to say Hetkinen, and we didn't know what that means or how to use that until there's one time we were on the bus. I was with some of my classmates, and the monitor had some problems. So it showed Hetkinen on the screen. And someone explained to us that it means Wait for a moment. After that, I can easily remember the word and how to use it."*

Eventually, the adult immigrants' goal for learning Finnish is to have a sense of belonging and desire the feeling of Relatedness. They preferred having meaningful talks, even though only short ones, over the success of passing language tests. Learning grammar was essential, but not their ultimate goal for studying the Finnish language, as their desire was reflected through their favorite topics for learning and practicing the language. These are practical words, phrases, and sentences useful for grocery shopping, buying clothes and shoes, asking for directions, or domestic travel. The customs and traditions of the Finnish culture are also critical features that they want to understand through language learning, which also displayed a craving for Relatedness.

Understanding Finnish speeches is important for adult immigrants, and it could be the first step in mastering the language.

Regarding the ability to communicate with local people using the Finnish language, almost every adult in the Pre-study interviews showed a need to understand what others share using Finnish. For them, being able to understand others' messages strengthened their confidence, offering them a glimpse of hope in mastering the language. In contrast, they lost their composure and comfort if they could not recognize the meaning of others' speeches. P1 felt overwhelmed even when he studied in his F3 class because the teacher only used Finnish for communication, *"Yeah, it was very overwhelming for me. Finnish was used 100% of time, and I can only manage to understand maybe half of it"*. As a

result, he gradually lost his confidence during his language course. For P3, it was problematic even when she watched children's programs on Finnish channels, "*In some cartoons, they speak very slow. But the program has no subtitles, so it's very hard for me. Sometimes I can listen to the word, but most of the time I don't understand what they mean"*. P4 mentioned the reality of Finnish people speaking the Finnish language, *"They speak too fast. I don't get the meaning. For me, I stopped processing it in my brain if I could not understand"*. P6 said that he wanted to understand the messages himself, "*I want to practice listening the most. I want to understand the language; I don't want to ask someone to help me translate"*.To solve the problem herself, P4 concluded, "*I feel like when you study a language, you need to learn something first before you can produce something. It's also easier to study input than output, for example, listening and reading are easier than writing and speaking"*. Her opinion makes sense because to understand speeches, one must be able to: one, recognize the words or phrases uttered by the opposite person in the conversation, and two, understand the meaning of those words and phrases. The required language skills for this thorough understanding are listening and vocabulary. All participants displayed strong confidence when talking about vocabulary. For them, it was the easiest thing to study during language classes because the teachers used many multimedia means to support vocabulary learning, such as games and applications.

To sum up, adult immigrants' need to understand Finnish led to the obvious choice of favorite skills to learn: listening and vocabulary. In addition, understanding Finnish can significantly boost adult immigrants' sense of Competence and Relatedness. They feel more confident by recognizing what others are saying, understanding the meaning of the messages that make them feel they belong. These sentiments immensely drive their intrinsic motivation for learning the Finnish language.

Adults' perspectives on social robots.

P1 was relatively straightforward when asked about his opinions on social robots, *"I don't have high expectations in robots. I don't think it could totally replace a person. It could provide some help for sure"*. Citing his previous encounters with robots as the basis of his opinion, he mentioned an experience with a robot working as a receptionist at a museum, *"Yeah, it can answer some of my questions, provide information on the tablet and say some sentences. But in general, it was not very smart as in the movie"*. He further explained his acceptance of social robots, *"If it has some awkward or stupid actions, I*

still accept it. I know that it's something expectable". For P2, it was not intimidating, *"I think it's not scary or anything negative. I kind of like them. I think they're fine to work with. If they're not too smart, it's ok. It depends a lot on the technology, and sometimes you can't control that part"*. P4 had high expectations over social robots, *"I think the current robots are mostly stupid. I still feel them as machines. They're not teachers. They're not even as smart as Duolingo"*. After several rounds of UX Laddering, she revealed the reason behind her opinions, *"The responding time of the robot is very slow. I think he took too much time to think. Besides, my phone can do many things already, such as translating, or I can practice using Duolingo"*. However, she still had some expectations about robots, *"It will be nice if the robot can practice speaking with me"*. P5 and P6 thought it would be an exciting experience to interact with the robot since they had no previous encounters with them. They did not have specific expectations over the robots, mentioning that anything can happen with technology.

4.5. Summary

To summarize the findings in the Pre-study phase, learning a new language can be challenging, especially for adult immigrants unfamiliar with the language's grammar and vocabulary. Based on the opinions of adult immigrants interviewed, several aspects can hugely affect their intrinsic motivation. These insights are valuable input for the Design and Implementation phase of the thesis.

One of the critical aspects of making learning Finnish enjoyable is to avoid a fixed agenda that becomes tedious over time. Adult students tend to lose interest in the material, and the course becomes less effective when they find it monotonous. In addition, organizing different kinds of class activities and providing learners with more study options and choices yield a strong sense of Autonomy, leading to higher intrinsic motivation. Providing learners with Autonomy through more alternatives and possibilities while studying is an essential attribute of the intended experience.

Another essential issue in teaching Finnish to adult immigrants is finding the balance in error correction. While it is necessary to identify and correct mistakes, doing it too often can discourage mature students and make them feel demotivated. The key is to reach a middle ground between correcting errors and providing encouragement. If done right, the technique would enormously boost Competence, drastically increasing learners' intrinsic

motivation to learn the language. In addition, timely and positive encouragement also exhibits empathy, thus developing the feeling of Relatedness in language learners. Otherwise, error correction can considerably diminish Competence and Relatedness, ruining adult immigrants' joy and inner drive and becoming a massive impediment to their language-learning journey. Hence, balancing between detecting mistakes and corrective feedback is vital while designing SAMQ in the following phase.

Moreover, the grammar of the Finnish language can be overwhelming if the teacher tries to cram the knowledge, as learners can only remember everything by heart if they practice. It is essential to understand that adult immigrants learn Finnish to communicate, not for certificates. While certificates can be helpful for employment or further education, they are not the primary motivation for most adult immigrants. Therefore, the prioritization here is the most commonly used grammar rules, focusing on practical applications and topics that students can use daily. Some common topics mentioned by the participants included grocery shopping, asking for directions, traveling and scenic places, and fashion shopping. According to the immigrants, essential grammar rules, e.g., the inflection of nouns, popular verbs, and their transformation, are critical in learning Finnish. However, they can be confusing, especially for students whose native language does not have similar structures. Therefore, the focal point for learning is to provide ample practice and clear explanations to help students understand the patterns. An adequate amount of practical language knowledge leads to more real-life applications, which increase the Usefulness of SAMQ. In addition, the more the adult immigrants practice, the better their command of the Finnish language becomes. They feel a powerful sense of Competence due to their improved language capability and a stronger feeling of Relatedness through the ability to communicate with local people. The higher satisfaction of two psychological needs brings happiness and joy to adult learners and dramatically enhances their intrinsic motivation. In the end, insights about grammar rules and topics of interest are the primary influencers for the content of SAMQ.

Regarding language comprehension, all participants agreed that input-oriented skills, e.g., listening, reading, and vocabulary, are primary skills to master before being able to produce meaningful language components in speaking and writing. Those input-oriented skills also intrinsically motivated adult immigrants to learn the Finnish language since

they helped people understand each other, improving their confidence and social connection.

Adult immigrants also expressed a neutral stance over social robots. They did not have too high expectations for social robots, which could lead to disappointment if the robots did not satisfy their needs. Besides, they did not have any strong prejudices over social robots or scare them, avoiding any wrong impressions at the beginning of the evaluation.

5. DESIGN & IMPLEMENTATION OF SAMQ

This chapter presents the design & implementation of the robotic application named Suomen Aikuiset Maahanmuuttajat ja QTrobot (SAMQ) using the QTrobot Studio. The name is a Finnish phrase and its meaning in English is "Finnish Adult Immigrants and QTrobot". The application is a program that supports adult immigrants in learning the Finnish language with the help of QTrobot as a tutor. The first section discusses the main educational approaches of SAMQ and the robot roles with appropriate rationale. The second section describes the main functionalities of SAMQ, focusing on satisfying the adult immigrants' three basic psychological needs of Autonomy, Competence, and Relatedness.

The design process started with summarizing findings in the Literature Review and Prestudy phases. Then, by combining valuable insights from previous research and an explicit understanding of user needs, the thesis generated a set of practical and achievable design goals for the conceptual design. Finally, based on the concrete design goals, the research conducted an ideation process to produce design implications for SAMQ. The purpose of creating the design implications is to further clarify the design goals by attaching them to the contextual attributes of RALL. In other words, the design implications of a design goal are the detailed explanation for its meaning in the target user's context of use. For example, the design implications for Autonomy can help translate the design goal of *"evoke the feelings of Autonomy"* to *"what does the concept of Autonomy means and how to design for it in the context of adult immigrants learning the Finnish language with QTrobot"*, given all the details about user preferences and QTrobot's capabilities.

The next step in the design process was to select the educational methods and robot roles. The selection process for these features began with an in-depth inspection of QTrobot's software and hardware capabilities, a recap on previous applications of language teaching strategies in RALL, and the target users' preferences on topics and language skills of interest. The selection process generated a combination of methods for implementing SAMQ: MBE (Alemi et al., 2014), CLT (Wu et al., 2015), and ALM (Lee et al., 2011) to satisfy all the requirements. In addition, the robot would act as a tutor for the learners in SAMQ.

Based on the design implications and teaching approaches, the thesis switched to implementing all features of SAMQ.

5.1. Design Goals

The fifth principle of HCD states that the design needs to fulfill the users' experience as a complete entity (ISO, 2019). Based on the findings of the Pre-study and the fifth principle of HCD, the thesis came up with three design goals that satisfy the primary user needs, provide good usability, and create a positive overall user experience. The design goals of the thesis are presented below,

1. Evoke feelings of Autonomy, Competence, and Relatedness in adult immigrants during SAMQ.

2. Provide learners with practical and useful learning materials that align with their topics of interest.

3. The design aims for a smooth and natural human-robot interaction, making SAMQ easy to use.

5.2. Pedagogical Approaches and Robot's Role

The thesis utilized several educational approaches examined in the previous chapter to apply to the design process. The choice of educational practices for the SAMQ was based on the combination of multiple elements, e.g., the software and hardware capabilities of the QTrobot, the findings from the Pre-study phase regarding the adult immigrants' preferred skill and topics of interest, and the literature review on previous application of popular teaching methods in RALL.

First, the built-in features of QTrobot highly support the MBE method by providing different means to add media elements such as text, graphics, and sound, as the benefits of using media in RALL settings have been validated in previous research (Alemi et al., 2014; Schodde et al., 2017; Wedenborn et al., 2019). QTrobot's speaker and software allow researchers to play any MP3 files, while its Learner Tablet supports graphical components of the learning content, such as texts or images. The supportive effect of texts and pictures also dramatically improves the vocabulary learning experience, making it

more fascinating and intuitive. Since vocabulary is vital for L2 learning, especially for adult immigrants in the Pre-study, using MBE makes the language more memorable.

In addition, QTrobot's integrated TTS software allows learners to practice oral comprehension skills such as listening and pronunciation. Therefore, the CLT approach is a proper choice because it teaches L2 through interaction (Alemi et al., 2014; Wu et al., 2015). The ability to practice listening also aligns with the need of adult immigrants in the Pre-study phase since they mentioned the demand to understand what others are saying. By applying the CLT method, adult learners can also focus on learning the authentic language to communicate in specific situations or meaningful tasks, e.g., grocery shopping, asking for directions, fashion shopping, ordering in the cafeteria, and many more. The method perfectly complements the need to learn practical aspects of the Finnish language for the daily communication of adult immigrants.

The ALM method is a proper choice in combination with MBE and CLT. An essential aspect of ALM is that it teaches learners the correct rule of grammar based on repetitive training (Lee et al., 2011). Learners of the ALM method acquire the new grammar structures through memorization and practical examples rather than by studying the syntaxes. This feature of ALM complements another critical finding in the Pre-study, where adult immigrants wanted to learn grammar using different methods, not just by the book. Instead, ALM can help them learn grammar through real-world examples of CLT. Although the focus of teaching in ALM is grammar, the practice of ALM does not require learners to study all the rules perfectly but to realize the primary patterns in those grammar rules.

With the selected educational approach, an appropriate role for QTrobot would be a tutor or superior peer learner. Acting in this role helps remove the intimidation feeling generated by a teacher, while the role also matches the physical appearance of QTrobot—a childlike face and body. In addition, social robots as a tutor provide many benefits, as previous research showed that learners displayed higher motivation in learning a language with a robot than without it (Lee et al., 2011; Wu et al., 2015), achieved better comprehension of vocabulary (Schodde et al., 2017; Wedenborn et al., 2019) and speaking (Lee et al., 2011; Wu et al., 2015).

Also, SAMQ is a one-on-one tutoring session between QTrobot and an adult immigrant. Given that adult learners already had different opportunities to learn in a classroom with

multiple students, SAMQ provides adult learners a unique opportunity to learn and practice the Finnish language with a skilled instructor, as this method is believed to be the most effective learning approach for an L2 language (Long, 1981; Bloom, 1984). Another reason for conducting SAMQ as a one-on-one session is that the goal of the thesis is to evoke different personal learning experiences of the learner by using the QTrobot. Having another learner in the session could affect those experiences and lead to an incorrect evaluation of SAMQ.

5.3. Design & Implementation

The design stage utilized the design goals and their implications to ideate possible features of SAMQ through an iterative process consisting of two phases following the HCD approach. After the first iteration, we conducted a quick evaluation session with two adult immigrants to hear their opinions regarding SAMQ, uncover problems, and find room for improvement.

The final version of the SAMQ setup consists of one QTrobot and its two tablets: Learner and Educator. During SAMQ, QTrobot is put on a table with its face toward the participant while the participant also sits in front of the robot. The participant interacts with the robot through speech commands and the Learner Tablet. Again, the setup utilizes WOz, with the moderator acting as the "Wizard" sitting in the same room but behind a curtain to operate QTrobot, giving the command when the participant issues some command.

5.3.1. First Iteration – Initial Functionalities

The first iteration of conceptual design explored various ideas that satisfy the needs of Autonomy, Competence, and Relatedness. The main idea of the concept was practice-based learning, where the adult immigrants improved their language capabilities through playing quizzes with QTrobot. In this concept, QTrobot started the session by introducing the SAMQ to the learner. Then, QTrobot presented the learner with a set of 10 quizzes, with each one a multiple-choice question. Through the Learner Tablet, the adult immigrant had to choose the correct English version of a Finnish word among four options. After the learner finished all ten quizzes, QTrobot gave motivational feedback to encourage the learner based on the result of the practice session. All speeches of QTrobot were in Finnish. The Finnish and English subtitles of QTrobot's speeches were simultaneously

displayed on the Learner Tablet while QTrobot spoke. The first concept utilized the MBE teaching approach by providing learning content through media.

In this version, SAMQ satisfied the user's need for Autonomy by providing learners with multiple topics to practice, e.g., grocery shopping, asking for directions, fashion shopping, and travel. In addition, SAMQ also allowed the user to adjust multiple settings for the learning session, including English Subtitles and Pace of Speech. Because listening comprehension varies among adult learners, we decided that the system should provide adjustability to these features. The subtitles supported novice learners in understanding what QTrobot was saying, and the reduced pace of speech may benefit them in recognizing Finnish words in the speeches of QTrobot. Adult learners can increase or reduce QTrobot's rate of speech according to their preference and choose to display the subtitles or not.

The verbal and non-verbal elements of the motivational feedback brought a sense of Competence to the learner. Verbal feedback was Finnish sentences such as: *"Bravo! Olet vastannut oikein kaikkiin 10 kysymykseen! Bravo! Bravo!"*. The TTS feature of Acapela provided multiple exclamations like *"Bravo!"* or *"Hurraa!"* to convey human emotions in the audio messages. As a result, the output resulted in a more appealing and inspiring message for the learner. During the utterance of verbal statements, QTrobot concurrently displayed non-verbal cues, e.g., head nods, clapping hands, and different emotions through its digital face to produce more human-like interactions, bringing a positive experience to the learner.

The first version of SAMQ was quickly evaluated with two adult immigrants who also joined during the Pre-study phase. According to the verbal feedback from the participants, the first iteration had several positive notes. The participants loved the physical appearance of QTrobot and its ability to communicate in both verbal and non-verbal means. The participants also highly appreciated the signature trait of QTrobot—its digital face. These characteristics produced positive feelings, thus making the adult learners feel more relaxed and motivated. The participants also praised the usefulness of the learning topics.

An important finding in the evaluation was the ability to build trust toward QTrobot of the subtitles. Because QTrobot only used Finnish, the instructional messages were challenging to recognize for novice learners. The participants felt that the Finnish subtitles

made them believe what QTrobot was saying because they matched the robot's speeches. The English subtitles also provided a sense of Competence because the user understood everything and could do anything according to the guidance. In addition, the learners felt that the robot was an expert in Finnish because it only spoke in Finnish, and the messages seemed correct.

However, the participants of the first design iteration also mentioned some critical weaknesses of the concept. First, it only had one usage mode, and this limitation diminished the ability to choose and control their learning mode, thus restraining their satisfaction with the need for Autonomy. Secondly, the learning focus was vocabulary only, which was insufficient for their demand. They would feel a stronger sense of accomplishment and competence if SAMQ offered more practice on different skills. In other words, the participants were not satisfied with Competence. Lastly, the participants wanted more interaction with QTrobot. In the first concept, they felt that QTrobot only acted as a moderator who provided instructions at the beginning and motivational messages at the end with little involvement in their learning experience. The participants displayed a weak emotional connection with QTrobot, a sign of unsatisfied with Relatedness.

During the evaluation, we also observed some usability issues regarding human-robot interaction. For instance, though the adjustability Settings provided a stronger sense of Autonomy, they created a complicated interaction process and provided little benefits to the learner. For example, a human tutor or teacher would automatically adjust their speaking rate or offer more material to make it easier for the students to understand their speeches. Therefore, to create an authentic HRI that mimics human interactions in this situation, QTrobot must be able to self-adjust according to the learner's level. Other than that, none of the participants chose to disable the subtitles, citing their importance in helping learners understand QTrobot's Finnish speeches.

Considering all the insights from the first iteration, the thesis continued with the second design iteration to improve SAMQ.

5.3.2. Second Iteration – Final Functionalities

The second iteration continued building on the features from the first iteration, addressing the weaknesses while exploring new ideas for Autonomy, Competence, and Relatedness.

Based on the feedback from real users in the previous iteration, the second version of SAMQ provided several enhancements.

Learning Mode

The second version of SAMQ introduced a new study mode, namely Learning, to further satisfy adult learners' need for Autonomy. Through utilizing the CLT method, learners can learn short, practical conversations for real-life situations in all similar topics of the first concept (grocery shopping, asking for directions, fashion shopping, and travel) in the new Learning mode. This mode also applies the ACM teaching approach, in which adult learners can practice their listening skills while learning grammar structures by realizing patterns in the learning content. Therefore, the conversations were usually structured in the Questions and Answers format to teach the learners the essential grammar to ask and reply in the corresponding situations.

In addition, the second concept intended to give adult learners more control and autonomy than the first. After each lesson in Learning mode, adult learners can choose among three options: (1) continue with the same topic, (2) change to learn another topic and (3) switch to Quiz. The same navigation logic applied to Quiz—where learners can continue or change the study mode at the end of each lesson—created a simple yet powerful navigation model for the users. To sum up, adult learners were free to change their study mode. Figure 12 displayes the primary user flow of SAMQ, showing the interaction points of learners with the main program.

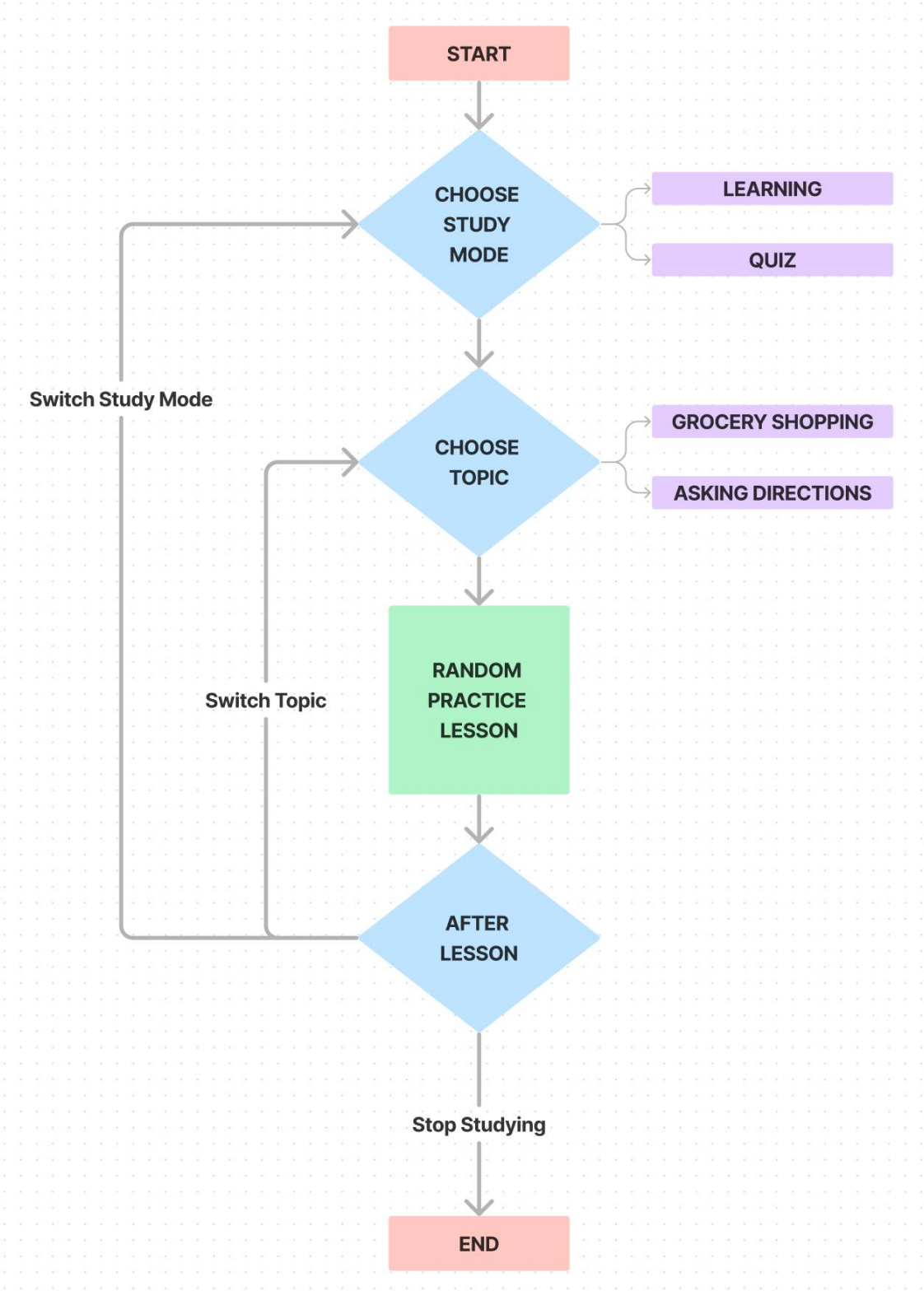

Figure 12. *SAMQ's user flow*

To strengthen the feeling of Competence for adult immigrants, each lesson of the Learning mode was designed to consist of one to three sentences, following the law suggested by Miller (1956), to reduce the required cognitive load while processing new knowledge

by organizing them into smaller chunks. Adult learners are presented with two steps for learning a sentence: Vocabulary and Listening. The Vocabulary step introduced essential vocabulary and phrases of the sentence. The learner could also decide to practice the Listening steps right away if they were already familiar with the vocabulary and phrases presented (Figure 13). Preparing the learners with vocabulary beforehand made it easier for them to recognize words in the following Listening step.

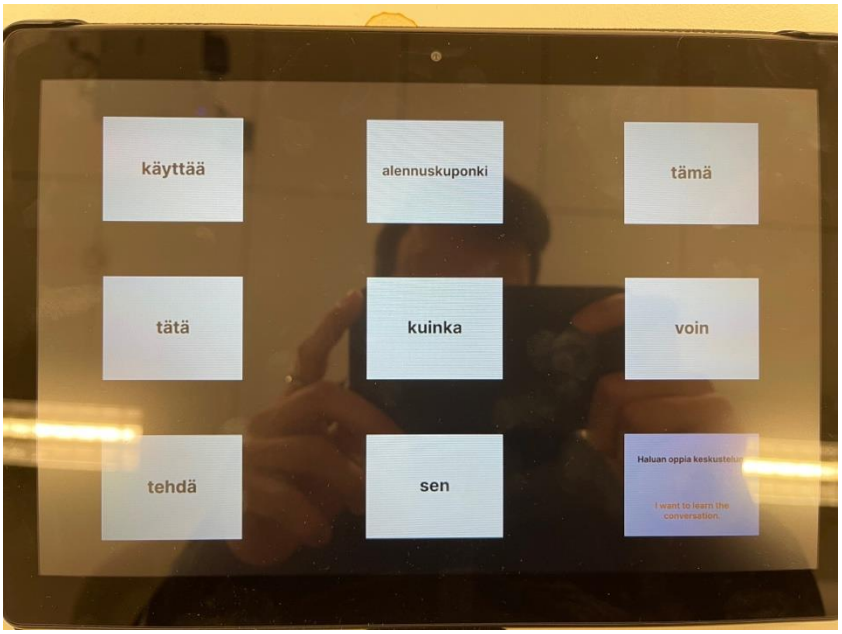

Figure 13. *Vocabulary Learning with the option to start practice Listening*

The Listening step focused on listening to QTrobot's speech and choosing the correct sentence the robot said. QTrobot carefully prompted the learner before playing the conversation, so the learner had more time to prepare. We believed that the timely preparation can lead to better results, which in turn improved learner's confidence and their sense of Competence. Figure 14 displayed the flow of QTrobot's prompts before and after learners listening to the conversation in the Listening step.

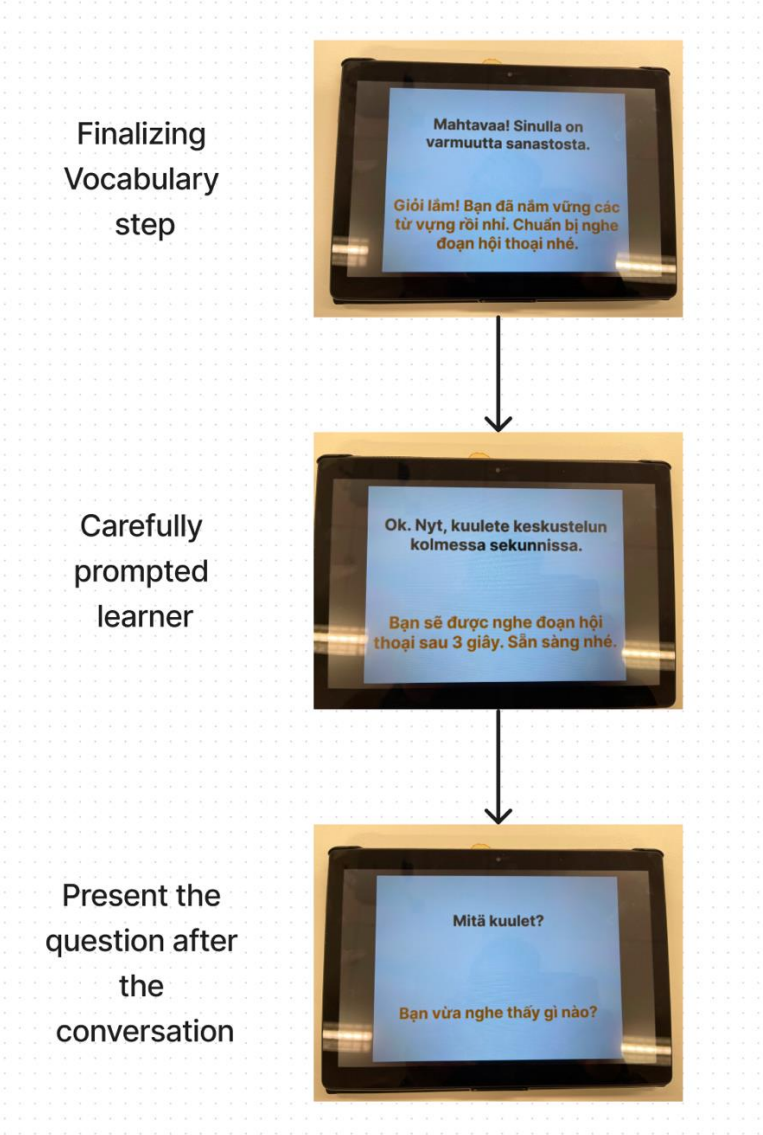

Figure 14. *QTrobot's prompts in Listening step*

This step presented another vital improvement aimed at boosting learners' sense of Competence was the Listen Again function. Adult learners could listen to the sentence again if they could not hear it for the first time, as this option will be displayed together with the answers (Figure 15). During Listen Again, QTrobot automatically reduced its pace of speech, uttering a slower sentence, making it much easier for the learner to recognize and choose the correct answer. Thus, the improvement made QTrobot more intelligent and strengthen its role as an experienced tutor because it created an impression that QTrobot could adjust the difficulty of the knowledge based on the learner level. In general, the change made the HRI of SAMQ more human-like.

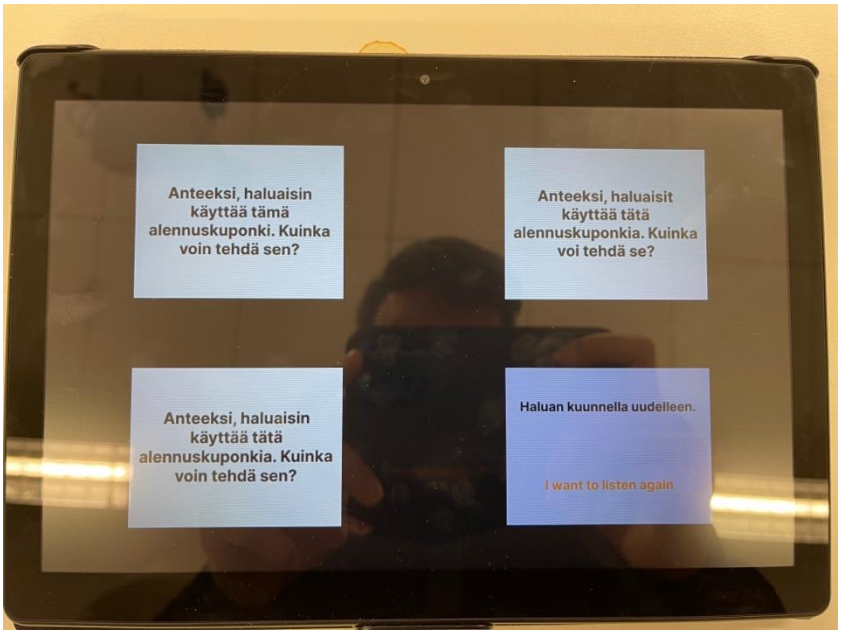

Figure 15. *Choose the answer or Listen Again*

We also employed positive sound effects that brought the feeling of victory or congratulation whenever the learner chose the correct answer or finish a lesson. Our assumption was that the combination of sound, supportive verbal messages, and QTrobot's funny gestures and facial expressions would create a fun and engaging experience for the learners. Figure 16 shows the flow of a typical conversational lesson in the Learning mode of SAMQ, with detailed description for a single sentence in the lesson.

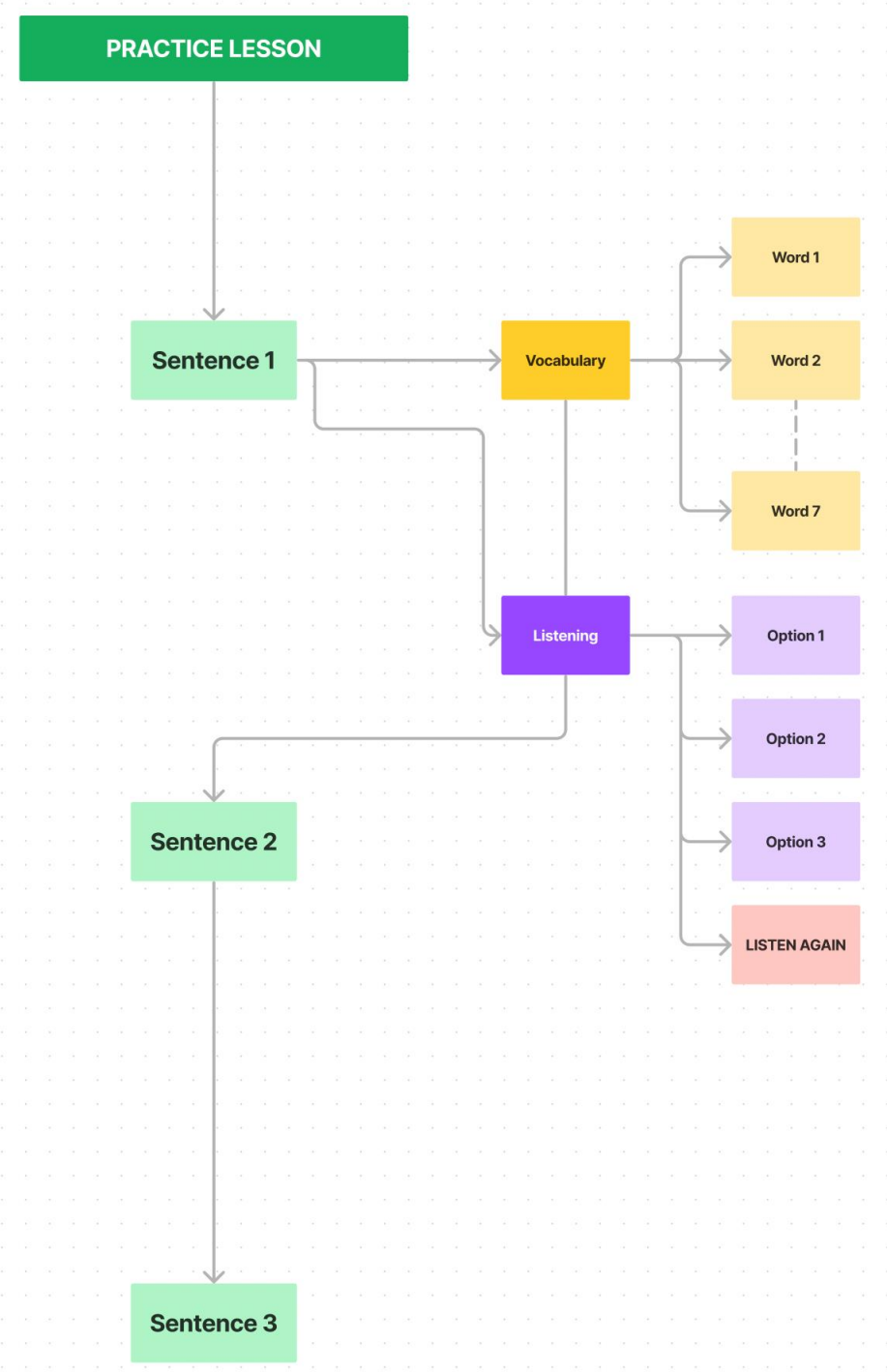

Figure 16. *Single lesson flow in SAMQ*

Quizzes Mode

The Quizzes Mode was kept based on the idea from the first iteration. This study mode was modified to become an interactive quiz for adult learners to practice their vocabulary after studying in Learning mode. Adult learners can test their vocabulary skills through answering multiple choice questions. For the scope of the study, the quiz has maximum

10 levels, and the starting level is zero. The quiz continues if the learner chooses the correct answer, and stops if the learner is wrong. In stead of being silent as in the first SAMQ, QTrobot cheered if the participant chose the correct answer, presenting each question in a social manner, and summarize the quiz session when it ends, providing supportive feedback. The goal of the Quizzes mode is that learners can improve their level after practicing and learning.

General Human-Robot Interaction

In the second implementation, besides providing instructions at the beginning and giving motivational feedback at the end of each lesson, QTrobot continuously interacted with the learner during the whole process by guiding the learner through different steps of studying and practicing. With this change, we planned to create a stronger bond between the adult learner and QTrobot. Also, in this version, the subtitles were displayed all the time on the Learner Tablet, and the Learner's L1 subtitles replaced the English subtitles. The modification simplified the learner's task during SAMQ, letting them focus on learning the Finnish language while adding another layer of Competence. In addition, adult immigrants would feel comfortable reading subtitles in their native language instead of having to translate again from English.

To create a genuine HRI, we programmed that each utterance of the robot has three to four different versions that convey the same meaning. QTrobot would randomly choose a version of the message to say out loud. For instance, to congratulate learners for a correct answer, QTrobot would say *"Bravo! Oikea vastaus!"* or *"Jess! Mahtava!"* or *"Juu! Hyva!"* to make the message less boring over time.

In addition, the second version of SAMQ also allowed learners to navigate through different states of the system using voice commands. Learners can choose different study modes, choose learning topics, or decide to stop the learning session based on their preferences. Given that people usually interact with each other in a multimodal manner (Quek et al., 2002), providing multiple modalities for humans during the interaction process enriches the human-robot interaction in the learning experience, making it more natural and sufficient. We assume that the change would make the HRI more similar to human-human interaction, thus strengthening the bond between QTrobot and the learner. The improved robot-learner connection would lead to a stronger sense of Relatedness, enhancing the role of QTrobot as a tutor.

WOz scenario

Due to limited resources, we decided to apply the WOz method to simulate the ASR and NLP features of QTrobot. With the moderator operating QTrobot, we wanted the participants to believe that QTrobot could understand Finnish human speeches and respond accordingly. Specifically, the moderator sat "behind the curtain" to give direct commands to QTrobot through the Educator tablet after hearing the voice commands from the participants.

However, communicating in human language presents a huge challenge in HRI. As humans can use different syntaxes and vocabulary to convey the same meaning, it is really important to construct scenarios to constraint the number of utterances that the robot should be able to recognize. According to Green et al. (2004), a scenario for the Wizard of Oz in HRI consists of three parts: (1) user instruction, (2) behavior hypotheses, and (3) robot behavior. The first part provides participants with the appropriate guidance to execute the intended tasks. The behavior hypotheses are the assumptions for the human participant's behaviors. The last part, robot behavior, explains what the robot would do in response. To apply this structure to SAMQ, we designed that QTrobot would provide instructions to the adult learners before the actual study. The instructions include basic information regarding SAMQ's study modes and how to interact with the robot during SAMQ through uttering Finnish words for the options that the learner would choose. By providing the users explicit and obvious options for the decision making steps, the behaviors of the learners are clearly defined. QTrobot's behaviors were designed to follow the scenario through the moderator's control, based on the choice given by the learners.

For instance, when asked to choose the study mode, QTrobot presented two options to the learners: Oppiminen (Learning) and Tietokipailut (Quizzes) as in Figure 17. The same logic applied when QTrobot displayed different learning topics for learners (Figure 18). Because QTrobot already introduced on how to choose an option, the learner would pronounce the word and the robot would continue with the learner's choice. By creating simple and short words or phrases for the options, it was also easier for the moderator to listen to the pronunciation of the learner and control QTrobot accordingly.

Figure 17. *Options for choosing Study Mode*

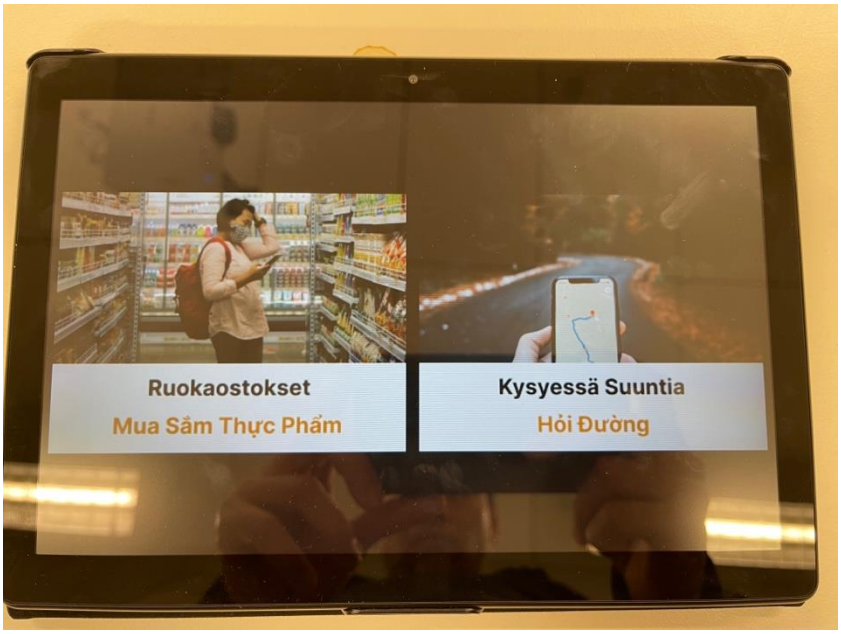

Figure 18. *Options for choosing Learning Topics*

6. EVALUATION OF THE DESIGN, SAMQ

This chapter covers details of the evaluation phase of the research study. First, it presents the methodology and the participants of the evaluation process. The next part describes the procedure of the research phase, focusing on the activities during the evaluation session. Finally, the chapter summarizes the findings by analyzing the results. The goal of the design evaluation is to measure the effectiveness of the design in driving the intrinsic motivation of the target users.

6.1. Procedure

According to ISO (2019), the user evaluation process of the design or prototype produced during the design phase is a mandatory step in HCD. Therefore, we conducted the evaluation to assess the success of delivering the design goals of the SAMQ under the format of a laboratory experiment at Robostudio, Hervanta Campus, Tampere University. All participants (N=6) of the evaluation were adult immigrants from Vietnam who have lived in Finland for at least one year and studied Finnish for more than three months. The age of the participants ranges between 20 and 40 years old.

The evaluation process consisted of three main parts: participants experiencing SAMQ, answering a questionnaire, and answering questions in a semi-structured interview. The whole process lasted for one hour. In SAMQ, the participants used QTrobot to learn the Finnish language for a session that lasted from 15 to 30 minutes. Following the ethical research guidelines, the participants could stop SAMQ whenever they wanted, resulting in a varied session length between participants. At the beginning of the evaluation, we briefly introduced the goal and the procedure of the study. Then the participants started freely exploring and using QTrobot to practice and learn the Finnish language during SAMQ.

6.2. Methodology

This section introduces the methods used for the Evaluation phase of the thesis. The methodologies included techniques for data collection and analysis.

6.2.1. Data Collection

In reference to Chapter 3, the primary methods for gathering evaluation results are the Customized IMI Questionnaire (Appendix C – Customized IMI Questionnaire) and Semi-structured Interview. Before SAMQ, the participants gave consent to the evaluation study. The participants also provided their basic information (age, gender, profession) through basic questions.

After the participants finished with SAMQ, they provided their assessment of SAMQ through the questions in the customized IMI. We developed the customized IMI to reduce the total number of questions for the questionnaire from 45 to 11, as we focused on evaluating five main subscales of perceived competence, perceived choice, relatedness, interest/enjoyment, and pressure/tension. In addition, the questionnaire has one item to evaluate the value/usefulness of SAMQ.

After calculating the result regarding the six subscales, we organized a semi-structured interview to ask the participants about the rationale behind their choices for each subscale. Because each subscale consists of two items to strengthen the validity, the semi-structured interview supported validating the participants' results. For instance, we asked the participants the reason behind their ratings for a subscale. We also asked them what could be improved so that they would give a higher rating for the subscale. The insights from the participants contributed to the future development of SAMQ. Other than that, when participants gave different values for two items in the same subscale, we asked them for the reasons behind their choice. The interview questions of the Evaluation phase is in Appendix D – Evaluation Interview Questions.

6.2.2. Data Analysis

The data analysis process of the evaluation phase utilized the Affinity Diagram method and basic statistical methods of Microsoft Excel. More specifically, we calculated the mean and sample standard deviation values of the quantitative data from the Customized IMI Questionnaire.

The qualitative insights from the interviews were analyzed using the Affinity Diagram and categorized into several groups regarding Autonomy, Competence, Relatedness, and

Usefulness. The themes either contributed to the design guidelines or became the input for the future design and development of SAMQ.

6.3. Findings

6.3.1. Results of Customized IMI Questionnaire

The structure of the Customized IMI Questionnaire is described in Appendix C – Customized IMI Questionnaire. There were eleven 7-point Likert scale statements covering six subscales that affect intrinsic motivation of adult learners. The responses are ranging from 1-*not at all true* to 7-*very true*, representing the opinion of the learner regarding the statement. After the combination of results of all statements, the mean and standard deviation values of six subscales are presented in Table 1. The higher score specified the higher sense of the concept described in the subscale's name. Therefore, a higher score for Perceived Competence means the participant felt more competence, while a lower score for Pressure/Tension means the participant felt less pressure or tension during SAMQ.

Table 1. *The mean and standard deviation value of the Customized IMI Questionnaire (N=6)*

Perceived Competence		**Perceived Choice**		**Relatedness**		**Interest /Enjoyment**		**Pressure/Tension**		**Value/Usefulness**	
Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
6.33	0.65	6.25	0.62	5.92	0.67	5.75	0.45	2.00	0.85	6.50	0.84

The participants of the evaluation reported a high degree of satisfaction over Competence (M=6.33, SD=0.65), Autonomy (M=6.25, SD=0.62), and Relatedness (M=5.92, SD=0.67). The result of the three needs correlated with the result of Interest/Enjoyment and Pressure/Tension, as participants displayed a higher score for Interest/Enjoyment (M=5.75, SD=0.45) and a lower score for Pressure/Tension (M=2.00, SD=0.85). It meant that the participants felt motivated and did not perceive pressure or tension during SAMQ.

The participants also highly valued SAMQ regarding learning vocabulary and listening, as the result of Value/Usefulness is also high (M=6.5, SD=0.84). Following the questionnaire, the thesis conducted the interviews to uncover reasons behind the participants' choices.

6.3.2. Important Findings from the Interviews

The support of L1 is heavily important in language learning for adult immigrants.

Even though adult immigrants in the Evaluation were capable in English, the use of their native language (L1) in learning Finnish really helped adult immigrants in the process. They showed confidence and engagement when seeing their native language in SAMQ. P5 said, *"Wow! It's Vietnamese language! This is the first time that I see Vietnamese in learning for a long time!"*. As they're adults who have developed their native language skill at a high level, using it felt very comfortable for them. The use of L1 improved their learning experience through the connection to their home language, and helped them to feel more engaged. Thus, this feature satisfied both adult immigrants' need of Competence and Relatedness.

Robot gestures and facial expressions are essential even for adult learners.

Even though QTrobot's appearance is more childlike, adult learners really liked the cheerful gestures and expressions of QTrobot. They surprised when seeing that QTrobot could produce many different body movements and showing different digital faces. According to P1, *"Yeah I think it was fun seeing the robot cheering me like that! Even though it's a bit slow, I still find it helpful and feel a positive vibe"*. They even asked for more exhibition of these physical embodiments, suggested that we should employ more of those during SAMQ. Most participants emphasized that QTrobot appearance and behaviors were their main source of joy while learning language in SAMQ. These characteristics also created a relaxed environment that supported learning.

Subtitles could build trust in RALL, if the robot communicates mainly in L2 language.

According to the participants, the subtitles really helped them following QTrobot's speech during SAMQ. They felt more confident and also they saw that the QTrobot's speech matched with the subtitles, meaning that QTrobot was telling them what's on the

tablet, not something fictional. This feature improved learners' degree of trust toward the robot, strengthening the role of QTrobot as a tutor. This feature contributed to the satisfaction of both Competence and Relatedness of the adult learners.

Media materials are essential, as in learning language with a human teacher.

All participants mentioned the need for more pictures and images, and multimedia in general, during SAMQ. They believed that those graphical and audio elements would support them in learning the Finnish language. For instance, P4 said, *"It would be very easy if there's a picture showing the meaning of the word, and the text next to it. So it's super easy for me to see what it is. And I don't even need to read the translation"*. They compared SAMQ to Duolingo, in which the latter provides a huge set of multimedia elements for the learners. They mentioned engagement and joy as the main reason for the comparison, with P2 saying that, *"It would be a lot more interesting and fun if you can add more graphical items to the program"*.

The sense of control in SAMQ motivates adult learners in different ways.

According to the learners, being able to start and stop the learning session by themselves was interesting. They never had the chance to do that in previous language courses while learning with human teacher. The ability to study and stop whenever they want really motivated them, and they felt that they were in total control. Even though QTrobot was their tutor with superior language skill, QTrobot accepted their request of ending the learning session when asked. According to the participants, learning the language only happened to them during the late afternoon or evening, when they were exhausted after a long working day. Adult learners believed that they know when they should stop, citing tiredness or saturation as the main reason for ending the session. Therefore, being able to control the learning period was critical, it made the participant felt a stronger sense of Autonomy. In addition, the easy-going manner of QTrobot was a sign of empathy and it satisfied adult learners' Relatedness.

Learners prefers verbal communication over touch-based gestures.

The adult immigrants also displayed a strong preference on the ability to use verbal commands with QTrobot instead of having to manually input everything through the Learner Tablet. Through the Evaluation phase's observation and interview, the adult learners displayed a strong boost in engagement when using voice modality to communicate with

QTrobot, compared with using the Leaner Tablet. During SAMQ, they showed eagerness and happiness on their face during verbal exchanges with QTrobot, and a neutral face while using Learner Tablet. P1 said, *"Yeah, I like to give the command like this, like talking to the robot. The tablet is boring and if I have to use it all the time, then I don't like it at all"*. P4 mentioned that it was obvious in expecting that the robot can listen, *"Yeah, the robot is quite similar to a kid. It supposed to be able to understand what I said"*. For them, QTrobot's capability of listening and understanding should match with its appearance.

6.4. Summary

From the result of the evaluation, QTrobot was successfully in fostering intrinsic motivation for adult immigrants in learning Finnish language. Adult learners really liked QTrobot's appearance, expressive digital faces and adorable body gestures. They were surprised by the capabilities of exhibiting emotions and speeches of QTrobot in SAMQ, felt engaged and enjoyable throughout the learning session. These traits built a strong connection between the adult learner and QTrobot, reinforced the role of the robot as an empathetic tutor, and satisfied adult learners' need of Relatedness. Besides, the ability to control the topic, mode, and length of the learning period satisfied adult immigrants' need of Autonomy. Finally, the comfortable learning pace, and relaxed atmosphere satisfied their need of Competence. In addition to the benefits provided by QTrobot, the application of media learning materials also played an important role in creating an engaging and attractive learning experience.

7. DESIGN GUIDELINE FOR INTRINSIC MOTIVATION IN ROBOT-ASSISTED LANGUAGE LEARNING

Through the Evaluation study, the thesis validated the design features that originated from Pre-study's insights and Literature Review's learnings. The findings from the Evaluation phase of the thesis created a design guideline for future RALL implementations regarding adult learners. The guideline provides five design implications focusing on motivating adult learners using robot and other supportive elements for the RALL context.

Robot behavior is the primary element for intrinsic motivation

The ability to engage adult learners through human-like behaviors of robot is critical in RALL context. They considered robot's appearance, gestures, facial expression, verbal and nonverbal messages as the primary cause for their intrinsic motivation in RALL session. For adult immigrants, relevant social interactions are more important than mere advanced technology in language learning. Therefore, they considered robots as human-like characters in RALL session so they could have meaningful learning experiences. By providing positive and productive interactions, social robots could intrinsically motivate adult learners in RALL through a strong emotional connection.

Voice modality is critical for humanoid robot

For adult learners, the capabilities of robot should complement its appearance. Therefore, their expectation for humanoid robot includes the ability to speak and understand simple language. During the evaluation, adult immigrants were highly engaged when they discovered that the robot can understand their L2 pronunciation. This characteristics of the robot intrinsically motivated them, as it brought surprise, joy, and excitement to the learning experience.

The use of media for language learning is a must

The benefits of media has been shown in traditional language learning with human as teacher or tutor. With the robot acting as a tutor, the use of media learning materials provided the same advantages. Positive sound and musical effects bring joy and entertain adult learners, while images and videos enhancing the learning experience through its attractive content. It is also worth noting that because adult immigrants are used to the

existence of media in language learning, it is unavoidable to exclude these materials in the RALL context.

Adult learner's L1 should be supported

Through the Pre-study and Evaluation stages, adult immigrants with highly developed L1 skills still learn L2 through the traditional translation method. They learn new knowledge by mapping them to their previous understanding of their native language. Using adult immigrant's L1 is an effective way in their L2 learning, as it follows their mental model. Therefore, the application of L1 would reduce the barrier of the new language, making it easier for adult immigrants to learn, thus motivating them for continuing the activity.

Design for accessible and flexible RALL

Adult learners were motivated in learning L2 language using robot. However, learning time, place and the cost of the robot are critical factors that hugely affect their learning experience. As adult immigrants are tied to many responsibilities, their requirements for time, place and cost are different with other user groups. While designing RALL sessions for adult immigrants, it is important to consider these attributes to improve the ability to participate of the learners. The improved accessibility of RALL would also motivate adult learners, foster a long-term language study process.

8. DISCUSSION & CONCLUSIONS

8.1. Summary of Findings

The thesis conducted in-depth Pre-study interviews with six adult immigrants living in Finland to discover elements that demotivated them in the language learning process, and how those elements related to their needs of Autonomy, Competence and Relatedness. The findings from the Pre-study answered the first research question of **What are the unsatisfied aspects of the needs of Autonomy, Competence, and Relatedness of adult immigrants while learning the Finnish language?** For instance, *too much Error Correction leads to the feeling of demotivated through the lack of Competence and Relatedness*. In addition, *the learners felt overwhelmed if the teacher taught too much knowledge, making them feel incapable of learning.* Other than that, the lack of Autonomy displayed through *lack of choices in learning activity due to teacher boring teaching methods*. The adult immigrants were also unsatisfied in Relatedness and Competence, because *they cannot use what they learned in real life situations.* For them, *learning language is for communicating and belonging, not for certificates*. However, *it was difficult to find someone who is patient and empathetic to practice with.* Aside from answering the first research question, the interviews also investigated the adult immigrants' level of acceptance over robots.

The findings from the Evaluation phase of the thesis responded to the second research question: **How can the robot facilitate Autonomy, Competence, and Relatedness for adult immigrants to further foster intrinsic motivation?** Eight adult immigrants participated in two rounds of evaluation study to experience SAMQ with QTrobot. The key finding of the Evaluation was that *robot's social interactions were the primary factor in fostering adult learners' intrinsic motivation*. Learners reported a higher engagement and joy during SAMQ, showing genuine interest in learning language with the robot. The findings also stressed *the use of adult learner's L1 during L2 learning motivated learners in many ways*. Learner felt easier learning the L2 while also remembering their native language, displaying a satisfied sense of Competence and Relatedness. *Using media as supportive learning materials were also a key component in improving learner's intrinsic motivation*, as adult immigrants believed that media could produce a more intuitive and stimulating learning. As *learners preferred verbal communication with the robot over*

gesture interactions, providing subtitles for them could enhance their intrinsic motivation through stronger sense of Competence and Relatedness. Finally, *the ability to decide when, where, and how long to study* greatly contributed to the improvement of intrinsic motivation, through a huge boost of Autonomy.

The findings from the Evaluation phase contributed to answer the final research question: **What can be considered as the design guideline in designing for L2 adult learnern's intrinsic motivation in the RALL context?** The five design implications from the guideline support future research and experiments in the RALL context with adult as target audience.

Table 2. *Design Implications for RALL with adults*

Design Implications	Summary
Robot behavior is the primary element for intrinsic motivation	Employ social interactions to provide positive experience is key to intrinsically motivate adult learners. They highly valued social interactions and the ability of the robot to evoke positive emotions.
Voice modality is critical for humanoid robot	Adult learners prefer voice modality while interacting with humanoid robot for a natural HRI. In addition, using speech in language learning also benefit learners in their speaking comprehension.
The use of media for language learning is a must	Media supports robot in creating an intuitive and appealing learning experience in RALL, providing benefits that not all robots can bring to the learners.
Adult learner's L1 should be supported	The design of RALL should also follow adult learner's mental model in language learning—

	translating the new language to their L1. Supporting their native language would motivate them in many ways.
Design for accessible and flexible RALL	Adult learners with other responsibilities should have higher accessibility and flexibility over their language study. Time, place, length, mode, and topics of the study are what they would like to control.

8.2. Discussion

This section synthesizes the findings of thesis and its novelty contribution. With the aim of strengthening the presented design guideline in the previous chapter, the section discusses each design implication of the guideline together with important and correlated findings from previous related research.

Robot behavior for intrinsic motivation

Previous studies in RALL already validated the benefits of social robots' physical embodiments in motivating language learners (Alemi et al., 2014; Wu et al., 2015). The ability of social robots in evoking positive emotions through body movements, facial expressions and other traits created an engaging and exciting learning experience. Although the large part of previous research in RALL focused on children, the finding from the thesis also shows similar results for adults. They also felt more motivated to learn the L2 by interacting with social robots, even though the robot's behavior was not playful but more task-oriented. This effect aligned with the finding from a study by Kouri et al. (2020). The human-like behaviors of social robots also strengthen their roles as teachers, tutors, or peer, maintaining and enhancing the relationship between robots and learners. This strong connection is also beneficial for long-term RALL research, as the novelty effect of social robots gradually disappears.

Genuine HRI requires voice modality

For more natural and genuine HRI in RALL context for adult learners, the voice modality is an essential component. Similar to the finding regarding robot's body movements and

facial expressions, providing a little verbal communication sparks a huge interest in adult learners during the language learning session. As adult learners desire social interactions in class, communicating through speech satisfies their need for Relatedness. Having more options to interact with robots improves their sense of Autonomy, while being able to exchange verbally with the robot enhances the feeling of Competence. The discovery of this effect among adult learners is similar to validated results from children in the long-term study by Alemi et al. (2017). In addition, the capability of using voice modal would supply many different teaching approaches and experiment designs in the RALL context, such as conversational practice and storytelling in the study by Wu et al. (2015) . Therefore, the use of voice supports future long-term studies in broadening the capability of RALL while preserving learner's intrinsic motivation.

The use of media in RALL

Even though robotics technology and AI have seen rapid development in recent years, using media in language learning seems inevitable. Considering all the options for the robot's role as teacher, tutor, or peer, media still plays a central part in improving the quality of the learning material. Given the fact that RALL happens in the physical world, social robots cannot provide all the benefits of using media at the same time. Media learning materials intrinsically motivate language learners by providing an engaging and appealing learning experience. This finding is in line with the studies by Alemi et al. (2014) and Wedenborn et al. (2019) in the RALL context and also aligns with the study by Um et al. (2012) for the education context in general. All in all, the use of multimedia in language learning provides a multimodal learning environment for learners regardless of age, widening their perception and creating a captivating experience.

L1 support in RALL

The use of L1 has not been the focus of previous research in the RALL context. It might be due to the reason that the target audience of those research was mainly children. Other than that, the main focus would be on the robot itself rather than the consideration of other attributes of RALL. This finding of the thesis aligns with studies in L2 teaching and learning regarding the role of L1 as a constructive attribute (Nazary, 2008) that greatly affects the learning outcome (De La Fuente & Goldenberg, 2020). Therefore, future designs of RALL's curriculum and activities for adults should involve L1. For adult immigrants, the use of L1 by social robots also creates intimate feelings and a strong sense of Relatedness.

This phenomenon is vital for maintaining long-term interest, motivation, and trust toward social robots in RALL.

Accessible and Flexible RALL

The design of SAMQ with enhanced controllability hugely supports the need for Autonomy of adult immigrants. In addition, the ability to decide the learning method, content, and length of study is critical to adult learners. This novel discovery contributes to future research and practical designs and implementations of RALL aiming at motivating adult participants. The feeling of control also mitigates any pressure or tension in learning L2. Because language learning is a lengthy and gradual process, providing adult learners with the needed flexibility is essential in maintaining their intrinsic motivation during their journey. Accessibility and flexibility also play an essential part in ethical considerations. They support adult immigrants' well-being and sustainable learning for the long-term learning process.

8.3. Limitations

There were several challenges that affected the research work during the conduct of the thesis. This section reports the main challenges and its limitations with their specific description.

8.3.1. Technical Limitations

The fact that QTrobot does not include a built-in language model of the Finnish language for ASR was a substantial technical limitation of the research. Other than that, the limitation in programming capabilities regarding ASR led to the apparent choice of applying WOz method as a replacement for QTrobot's speech recognition. Even though implementing ASR would present other technical issues, conducting the study without the WOz setup would uncover novel findings that hugely contribute to HRI and robotic technology development.

In addition, the ongoing development of QTrobot and its programming platform produced a significant challenge to the design and implementation of SAMQ. Due to the limitation of QTrobot Studio, the Learner Tablet can only display images. Therefore, to present textual information such as sentences, words, or phrases, we must convert those data into

image format. Given the amount of speech that QTrobot provided to the learner during SAMQ, we had to create a significant amount of images (more than 100) to display subtitles on the Learner Tablet for adult immigrants. Other than that, the design of SAMQ requires interactive buttons or similar items for navigation purposes, but QTrobot Studio could not provide this feature through Learner Tablet. As a result, any changes to QTrobot's speech or navigation choices would require an entirely new set of images. This laborious task required a considerable amount of time for execution, thus slower the design and implementation process of SAMQ. The documentation of QTrobot platform also had some minor mistakes, thus making the implementation more difficult.

Besides, the current design of the QTrobot platform requires synchronization with the Educator Tablet if there are any modifications to the program of SAMQ. During the syncing progress, the Educator tablet would disconnect from QTrobot, and connect to the Internet to retrieve the new updates. Then, if we want to run the newly updated application, the Educator Tablet would connect to QTrobot again. The procedure took a few minutes each time and required many manual input, thus obstructing the programming flow. Therefore, a smoother synchronization is critical for a straightforward development procedure, benefiting more complicated applications.

The hardware power of QTrobot platform was also a concern. Sometimes, QTrobot did not start even though there was no change to the application, and the previous execution was very smooth. This problem happened regularly during the study and making the implementation of SAMQ much more exhausting.

8.3.2. Research Procedure Limitations

The Evaluation phase of the study consists of only Vietnamese adult immigrants. Therefore, the participants' subjective opinions could be cultural bias. Implementing a wider range of participants from several countries would remove this problem and lead to more universal and inclusive ideas. Another limitation regarding the Evaluation phase of the study was the small number of participants. Due to a conflicting schedule, only six participants joined the Evaluation experiment. A more extensive set of subjects could bring more viewpoints to the collected data, thus delivering new patterns and findings. As this study is exploratory research, more participants are needed until we reach a saturation

point for findings. Other than that, the research followed the HCD approach, which emphasizes the iterative nature of the process. However, due to the time limit and the scope of the thesis, we only conducted two evaluations (one soft evaluation). More rounds of design and implementation would lead to a better design and a comprehensive solution for the target audience.

In addition, as language learning is a long-term process, it is also essential to study the long-term effect in evoking intrinsic motivation of QTrobot in SAMQ, given that the novelty aspect of learning with the robot could play a role in motivating adult learners. The number of learning topics for adult language learners must also be increased for long-term study purposes. As learners gradually improve themselves, they require more knowledge that matches their language proficiency and also provides usefulness.

8.4. Conclusion

The thesis followed the approach of Human-Centred Design (ISO, 2019) to perform an iterative process of research and design targeting at evoking adult immigrants' intrinsic motivation in the RALL context. The findings from the Pre-study contributed to the design and implementation of SAMQ. The Evaluation stage of the thesis assessed and validated our design assumptions with the participation of real target users in SAMQ. The result of the research displayed positive signals in evoking intrinsic motivation and satisfying the three psychological needs of Autonomy, Competence, and Relatedness in adult learners in RALL. Finally, the thesis presented a guideline consists of five design implications aiming at evoking intrinsic motivation for adult learners in RALL context.

Several findings of the research aligns with results from previous RALL research targeting children. For instance, social robots' physical embodiments is key in promoting learner's interest and intrinsic motivation for learning language with the robot. Moreover, the ability to create positive and permanent emotions of social robots through body gestures and facial expressions would form a strong human-robot connection, further maintain the sustainability for long-term study of adult learners. The use of voice modality in RALL creates a multimodal HRI, which makes it more natural and human-like. Furthermore, the voice modal expands the design space for RALL context, offering more options and choices in teaching methods and learning focus. Even though robotics technology has

developed rapidly, multimedia should always be considered when designing for an engaging and appealing RALL session, even for adult learners.

Novelty findings such as the effectiveness of L1 in RALL context for adults is important. The finding aligns with the mental model of adults who possess high L1 skill, and using L1 would positively impact learner's intrinsic motivation. In the end, future studies in RALL focusing on affective gains and motivation should also consider the aspects of accessibility and flexibility when considering adult learners, as these attributes are important to maintain long-term motivation.

Finally, the thesis suggested a design guideline consisted of five design implications for the facilitation of adults' intrinsic motivation in RALL context. The five design implications included: design natural robot behavior for intrinsic motivation, voice modality is critical for humanoid robots, multimedia is a must-have supporting tool, using adult immigrants' L1 in RALL, and designing for accessible and flexible RALL. The five design implications contributed to both future design and implementation of RALL programs regarding adult learners, as well as subsequent research regarding HRI focusing on adult users.

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APPENDICES

Appendix A – Research Info & User Study Consent Form

Research name: Design of a robotic service for adult immigrants in learning Finnish

The study collects your experiences related to learning the Finnish language while in Finland. The goal of the study is to motivate adult immigrants to learn the Finnish language.

The participation is entirely voluntary, and you can cancel the study later by notifing Luu Dao, the responsible researcher.

If you agree to join the study, consent and give permission to the researcher to record video/audio for the purpose of research. Your personal information and identity will be anonymized and not be shared with anyone.

Your name

Your signature

Appendix B – Pre-study Interview Primary Questions

1. Could you tell me about your experiences of learning the Finnish language since you moved to Finland?

2. What went well during your previous learning experiences? How did you feel during those positive moments? Why did you feel like that?

3. What were the challenges/difficulties during your study? What's the worst part about learning Finnish? Why did you think that it's the worst part? How did you feel? Why did you feel like that?

4. What do you want/expect for future Finnish classes/courses? Is there a particular reason for that expectation?

5. Have you ever had any experience with social robots? Could you describe about those experiences? What was your feeling toward the robot? Why was it like that?

    a. Which attribute of the robot made you like/dislike it? Why was it like that?

    b. What are your thoughts about them now? What do you expect when you interact with them? What are the reasons for those expectations?

Appendix C – Customized IMI Questionnaire

This is the simplified version of the complete IMI questionnaire. The subscales are organized at below, with each subscale consist of the question numbers:

Interest/Enjoyment: 1, 11

Pressure/Tension: 5, 10

Competence: 2, 7.

Autonomy: 3, 8.

Relatedness: 4, 9.

Usefulness: 6.

1. I enjoyed doing this activity very much.

1	2	3	4	5	6	7

Not at all true Very true

2. I think I am pretty good at this activity.

1	2	3	4	5	6	7

Not at all true Very true

3. I believe I had some choice about doing this activity.

1	2	3	4	5	6	7

Not at all true Very true

4. I felt like I could really trust this robot.

1	2	3	4	5	6	7

Not at all true Very true

5. I felt very tense while doing this activity.

1	2	3	4	5	6	7

Not at all true Very true

6. I think that doing this activity is useful for learning Finnish vocabulary and practice listening.

1	2	3	4	5	6	7

Not at all true Very true

7. I am satisfied with my performance at this activity.

1	2	3	4	5	6	7

Not at all true Very true

8. I felt like I had to do this activity.

1	2	3	4	5	6	7

Not at all true Very true

9. I'd really prefer not to interact with this robot in the future.

1	2	3	4	5	6	7

Not at all true Very true

10. I was very relaxed in doing this activity.

1	2	3	4	5	6	7

Not at all true Very true

11. I thought this was a boring activity.

1	2	3	4	5	6	7

Not at all true Very true

Appendix D – Evaluation Interview Questions

The interview questions of the Evaluation focus on gathering qualitative data based on the results of the Customized IMI Questionnaire regarding the six subscales: Intrinsic Motivation, Pressure/Tension, Competence, Autonomy, Relatedness, and Usefulness.

Questions for positive results regarding the subscales:

1. What were your enjoyable moments during the learning activity? What made you give the highest score? What still can be improved so you can feel more enjoyable?

2. What made you feel relaxed during the learning activity? What could be improved for a more relaxed learning experience?

3. What made you feel that you were good at this activity? What made you satisfied with your performance? What made you give the highest score? What still can be improved?

4. What made you feel that you had control while doing this activity? What is the decisive feature of this feeling? What can be improved so you can have your best sense of control?

5. Which features make you feel you can trust the robot and would like to interact with the robot in the future? Which can be done to make you feel more connected with the robot?

6. Which features make you feel that the activity is useful for learning Finnish? What could be improved?

Questions for negative results regarding the subscales:

1. What made you feel this was a boring activity? Why did you feel like that? What can be changed to make it less boring?

2. What made you feel that you were not good at this activity? What made you feel unsatisfied with your performance? What should be changed?

3. What made you feel that you did not have control while doing this activity? What should be changed so you can have your best feeling of control?

4. Which features make you feel you could not trust the robot and don't like to interact with the robot in the future? Which can be done to make you feel connected with the robot?

5. Which features make you feel that the activity is not useful for learning Finnish? What should be changed so it could be more useful?

Questions for conflicting results regarding the subscales:

These questions were asked to clarify the conflicting results of the Customized IMI questionnaire regarding each subscale. For example: *"Why do you think that you were not relaxed during the activity, but you did not feel tense at all?"*. Similar structure applies to this kind of question for all other subscales.