# University Language Instructors Programming Robotic Learning Applications

Design and implementation of encouraging programming workshop experiences

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## ABSTRACT

Educational robots serve multiple purposes, including language learning, social skills development for students with autism, and improving communication skills. This research emphasizes the role of educational professionals in designing robotic learning activities, highlighting their understanding of pedagogy and student needs. Two language instructors co-designed programming workshops which aimed to teach them how to program the social robot NAO. They implemented robotic language learning activities that were used by 35 students in Finnish language courses. The results of this research suggested that hands-on programming workshops are an effective way to learn robot programming. Maintaining motivation during the sessions is facilitated by setting clear and concrete goals, monitoring progress, acquiring new knowledge, and following a precise schedule. The instructors faced challenges such as unexpected responses from the robots, the initial complexity of the programming software, and apprehensions about programming based on prior knowledge of text-based programming languages.

## CCS CONCEPTS

• **Human-centered computing** → Human computer interaction (HCI); Interaction paradigms; Collaborative and social computing; Collaborative and social computing design.

## KEYWORDS

Social Robots, Robot-Assisted Language Learning, Service Design, End-User Programming

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## 1 INTRODUCTION

Technology, including social robots, is increasingly prevalent in education. Social robots exhibit social behavior and have an appearance that enables interaction with users [26]. In addition, they interact with humans or with other robots in a way that looks similar to human-human social interaction [22].

Educational robots, used to enhance students' interest, engagement, and academic achievement [7], have been utilized to support language learning [10], improve social skills for students with autism [47], and develop verbal communication abilities [53]. These robots serve as tutors, peer learners, or novice learners [8], providing direct support, motivation, and opportunities for interaction. Although lately social robots have been used in education, educational professionals with no programming knowledge have been involved in programming robotic applications in fewer studies [33, 34], compared to educators with programming knowledge [14, 38, 42, 43, 58]. This research highlights the importance of involving all kinds of educational professionals in programming social robots, since they possess pedagogical knowledge and a better understanding of students' needs. Motivational programming workshops, that foster collaboration and guidance, can help educators overcome programming challenges stemming from various programming languages and robot possibilities.

This research aimed to design and implement programming workshops, where university language instructors learned to program the NAO robot [5] for language teaching activities. The instructors designed and implemented robotic applications that were tested with international students taking Finnish language courses. NAO, chosen as the research platform, can be programmed using visual-based programming languages that do not require prior programming experience [11]. In this research, NAO acted as a robot-assisted language learning (RALL) robot [37], facilitating language learning through verbal and non-verbal communication modalities [48].

The research aimed to answer three questions:

***RQ1****: What are the expectations and needs of university language instructors towards programming a social robot for teaching languages?*

***RQ2****: What are the university language instructors' perceptions of the benefits and challenges of programming a social robot by themselves?*

***RQ3****: What are the university language instructors' experiences of the programming workshops?*

Data collection employed qualitative and quantitative methods, including observations and interviews during the workshops, along with student questionnaires.



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# 2 RELATED WORK

## 2.1 Robot-Assisted Language Learning

RALL, which stands for robot-assisted language learning, is a research field that focuses on the use of social robots to support language learning in various contexts [37]. RALL is part of the broader research field of robot-assisted learning (RAL or r-learning), which involves educational robots for general teaching purposes [48]. RALL robots are designed to engage learners in oral interactions and can assist in tasks such as teaching vocabulary [30], practicing reading and writing skills, teaching grammar, and even sign language [56]. The presence of a robot in language learning environments often motivates students, leading to improved learning outcomes [25, 31].

Previous studies indicate that the most popular methods for RALL robots' oral interactions are communicative language [50], which emphasizes communication as the primary function of language, and teaching proficiency through reading and storytelling [46], where engaging stories are used for language learning. Additionally, the total physical response method [21] involves speech and physical actions, with learners actively following teacher instructions.

RALL robots in language learning assume different roles. The most common is as a dialogue partner, engaging learners with predefined phrases. They can also become role-play characters in interactive stories or serve as entertaining companions through activities like singing, dancing, and showing pictures to aid learning. Additionally, some robots assist teachers by offering skill training and emotional feedback. [41]

Using RALL robots offers advantages over other technologies [9]. Their physical presence, along with gestures and non-verbal communication, enhances language education [9, 39]. Research suggests that involving real objects [35] and incorporating body movements and gestures [44, 49, 55] benefits children's vocabulary learning. Robots also boost motivation in language learning, with studies showing higher student motivation compared to other technologies [28, 52, 57].

RALL robots are not limited to children but are valuable for adult learners too. Adults often prefer realistic and relevant interactions [20]. Studies indicate that conversational practice with robots benefits adult learners [29, 32, 37]. Robots can take on various roles, like interviewer, narrator, facilitator, or interlocutor, to meet specific learner needs [20]. Collaborative settings, where multiple learners interact with the robot simultaneously, emphasize the significance of learner-learner interaction in RALL [20].

While RALL robots offer advantages, challenges exist. Technical issues, like speech recognition problems, can frustrate teachers and learners [1]. Effective guidelines and models are needed for integrating robots into language classrooms, specifying activities and frequency of use [1]. Customizing robot behavior based on learner characteristics is crucial [20]. In summary, RALL research aims to enhance language learning through interactive and engaging interactions, communication skill promotion, and motivation [20]. All the literature reviewed helped to understand how RALL robots have been used in an educational context and the benefits of using them.

## 2.2 Educational Professionals Programming Robotic Applications

The use of robots in education has been a topic of interest for researchers, but the involvement of educational professionals with no programming knowledge in programming robotic applications has been limited [33, 34], compared to educators with programming knowledge [14, 38, 42, 43, 58]. This may be due to factors such as the lack of specialized training for educators in educational institutions or the insufficient content of available training programs [51].

Schina et al. [51] reviewed 38 scientific publications on educational robotics training, emphasizing collaborative learning. They highlighted the need for teaching material development, pedagogical approaches like constructivism, instructor support, and clear program details, including hours and attendance requirements, to create effective training programs.

When it comes to programming robots, text-based programming languages like Python, C++, and Java can pose challenges for non-programmer teachers [11]. Visual-based programming, an accessible alternative, involves dragging and dropping icons to create robot programs [11]. While it simplifies coding, it still demands basic programming skills like loops and conditional statements. Other end-user development methods, such as content authoring [18], interaction parameterization [6], and trigger-action programming [40], do not require such skills.

End-user programming [13, 36] is a concept that enables people with non-professional programming skills to customize and retask robots according to their needs. It allows users to modify and create robotic applications within their own contexts [3]. End-user programming not only increases the capabilities of robots but also provides an opportunity for users to learn programming while enjoying the process. Natural and user-friendly interfaces are crucial for making robotic programming enjoyable and engaging [24].

In conclusion, the concept of end-user programming supported the research objective of teaching educators to design and implement their own robotic applications. Moreover, the review of previous literature which highlighted the best practices when designing robotic teacher training, was beneficial when designing and implementing the robotic programming workshops, as all the considerations were contemplated to create and provide educators with meaningful learning experiences.

# 3 RESEARCH PROCESS AND METHODS

In our research, we focused on service design, which centers on users as vital stakeholders. It involves collaborative interdisciplinary efforts, including users and stakeholders, to co-design a service or product. This iterative process integrates user research, design prototyping, and evaluation, aiming to create a feasible and sustainable solution. [54].

The research platforms used in the research include:

***NAO Robot [*** 5 ***]:*** is an Aldebaran-designed bipedal social robot. It possesses diverse features such us speech recognition, walking, sound reproduction, and object and people recognition. It is equipped with sensors, cameras, microphones, and speakers for comprehensive environment interaction.

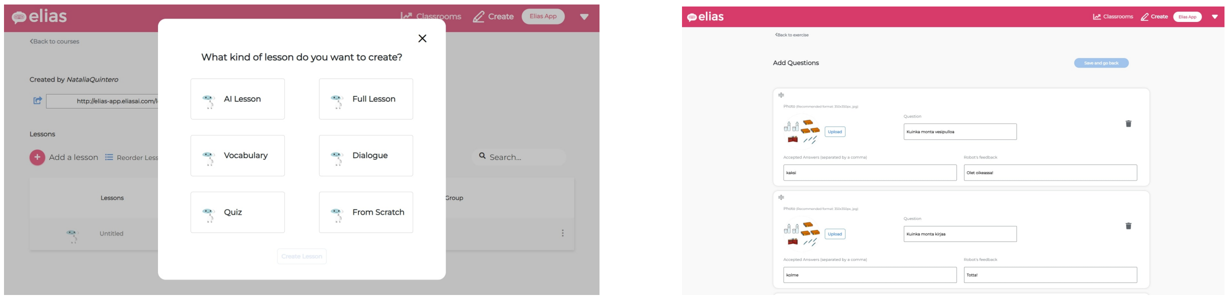


**Figure 1: Lesson editor from the Elias Robot app (left). An example of an activity created with the quiz type of activity (right).**

***Elias Robot App*** [15]***:*** is a language learning app designed to be used with social robots like NAO and Pepper accompanied by the support of a computer screen or tablet. The app enables students to practice multiple languages by listening and speaking, meanwhile the use of the screen aims to provide the visual support required for the presented activity. The app offers various activities related to different topics, and teachers can modify or create new activities using the lesson editor feature, see Figure 1. The type of activities available to create include watching videos, repeating words, remembering objects, having conversations, and quizzes. The process to create activities is straightforward, for example, for the quiz type of activity, teachers can upload a picture, write the question that the robot would need to ask and the answers that it would accept as correct, see Figure 1. Additionally, is it possible to specify the feedback that the robot would give to the student when the answer is correct. The teacher can also create a virtual classroom where they select which activities are available for the students. Then, students can try the activities by themselves, as the robot can guide the selected activity. Elias Robot app can also monitor students' progress and includes gamification elements such as collecting stars.

***Choregraphe*** [4]***:*** is a user-friendly programming platform with a graphical interface for NAO and Pepper robots. It uses visual-based programming, allowing non-programmers to create applications by dragging and dropping icons to build action sequences, though some basic programming understanding is needed.

The platforms presented provide essential tools for educational robotics. NAO Robot offers engaging experiences, while Choregraphe and the Elias Robot App simplify programming. The research process comprised three studies: RALL co-design workshop, RALL programming workshops, and RALL student evaluation, elaborated below.

## 3.1 RALL Co-Design Workshop

The co-design workshop was conducted in person, it involved one session of two hours in which we met with the language instructors to discuss and co-design the programming workshops. A PowerPoint presentation was created in order to guide the session. The session started with introductions and instructions for it. Participants were explained that they could leave the workshop if wanted and also that all the collected data was going to be reported anonymously. They were presented with a definition of social robots by Gallagher [22]. The session proceeded with the presentation of NAO robot, its functionalities, its context of use in recent research, and some concepts videos of NAO doing different activities such as playing games and practicing languages with kids.

Additionally, a physical NAO robot joined our meeting and did a short demo where it saluted, walked, and showed how some actions could be executed if its bumpers were pressed. Following, participants were presented with an Elias Robot app's video [16]. Proceeding a brainstorming part of the session started. Participants discussed about uses of NAO, possible activities, objectives of its use, and preferred learning modes for programming workshops. Each question was presented individually, written in a big paper. While discussing, they wrote their ideas in sticky notes and put them under the questions.

*3.1.1 RALL Co-Design Workshop Participants.* Two participants took part in the co-design workshop. Participants were university instructors who belong to the Language Centre from Tampere University, Finland, and teach initial courses of Finnish as a second language. One of the participants had previous experience with social robots and none of them had previous experience with programming, nevertheless, both were interested in learning to program.

*3.1.2 Data Collection Methods from RALL Co-Design Workshop.* In order to gather qualitative data during the co-design workshop, multiple data collection methods were employed:

***Questionnaires:*** Participants were asked to complete two questionnaires, a background questionnaire for gathering essential information and a post-workshop questionnaire to capture their co-design workshop experiences. The latter questionnaire explored their opinions on workshop engagement, suggestions for improvement, emotions related to robot programming, views on integrating social robots into teaching, enthusiasm for acquiring programming skills, and willingness to participate in programming workshops.

***Audio-recording of the workshop:*** The entire co-design workshop was audio recorded to facilitate the creation of transcripts and enable thorough analysis of the data. Given that the workshop involved a two-hour discussion among three individuals, recording the session was deemed the most suitable approach to ensure comprehensive data capture.

***Paper canvas:*** During the brainstorming segment of the workshop, sticky notes were utilized to populate a paper canvas containing pertinent questions specific to the activity. Participants utilized these sticky notes to document their ideas and engage in discussions. Additionally, ideas and comments articulated by the language instructors during moments of verbal communication were also written by us to preserve their contributions and prevent any loss of valuable insights.

*3.1.3 Data Analysis Methods from RALL Co-Design Workshop.* Thematic analysis of qualitative data from the co-design workshop used the affinity diagram method [27]. Audio recordings were transcribed, and sticky notes' contents were integrated. Post-workshop questionnaire responses were also transcribed and included in the analysis. We constructed a diagram with three main categories, 15 sub-categories, and 72 affinity notes, using the Mural tool [45].

## 3.2 RALL Programming Workshops

The programming workshops were conducted in person, they involved eight hours of implementation where university language instructors did hands-on activities by designing and implementing the robotic applications. The programming workshops were divided into one session of two hours and two sessions of three hours where we and the language instructors met to go over the required learnings and implement the activities. In the first session, some initial instructions on how to connect NAO to the network and how to create activities in Elias' lesson editor were given, following the pictures presented on the mural-canvas created for the programming workshops. Mural-canvas is a tool employed in previous research by Ahtinen et al. [2] to design collaboratively social robots. Although some guidance was given, language instructors were able to start implementing the activities by themselves immediately. The second session also involved working with Elias editor to redefine the activities implemented in the previous session. During the third session, content related to Choregraphe was presented and some activities using the software were created.

*3.2.1 RALL Programming Workshops Participants.* The participants in this study were the same individuals presented in Section 3.1.1.

*3.2.2 Data Collection Methods from RALL Programming Workshops.* During the study, various methods were employed to collect qualitative data. These methods included learning journal, focus group interview, and observation and note-taking.

***Learning journal:*** University language instructors were provided with learning journals to document their reflections after each workshop session. The journals contained prompts related to their learnings, positive and challenging aspects of the session, and suggestions for improvement. Additionally, the instructors used Emocards [17] to indicate their emotional states during each session.

***Observation and note-taking:*** Throughout the programming workshops, we actively engaged in note-taking, documenting our own observations and learnings after each session.

***Focus group interview:*** A 60-minute session was conducted with the university language instructors, allowing them to discuss their experiences related to the programming workshops. Open-ended questions were posed on topics such as the programming workshops, co-design workshop, learning journal, and NAO in the classroom. The session was audio-recorded to enable a thorough analysis of the collected data.

*3.2.3 Data Analysis Methods from RALL Programming Workshops.* The method of content analysis [19], was utilized to analyze the qualitative data. The qualitative data included the information collected from language instructors' interview, language instructors' learning journal, and observation notes.

## 3.3 RALL Evaluation with Students

The evaluation took place over two weeks in five sessions with different Finnish language course student groups, totaling eight hours. Students interacted with NAO in a dedicated classroom setup to minimize distractions and background noise. We provided technical support and facilitated interactions, while the language instructor remained with the main student group. Students chose their activities from a virtual classroom interface created with the Elias Robot app. In three sessions, larger groups of 20-25 students had the option to participate, with about ten students per group interacting in pairs for around ten minutes and then completing a questionnaire. In smaller sessions, with 2-4 students, they had more extended interaction time of 20-30 minutes with NAO.

*3.3.1 RALL Evaluation Participants.* 38 university students who were currently taking the Finnish I or Finnish II language courses took part in this study. These students were asked to complete an anonymous questionnaire to gather their feedback and experiences regarding language learning with a robot. They provided written consent to be observed and to have their responses included in the research findings. It should be noted that three participants' answers were not included in the analysis as one participant failed to indicate their consent to participate in the questionnaire, and two participants did not fully complete the questionnaire. As a result, the analysis was based on the responses of 35 students.

*3.3.2 Data Collection Methods from RALL Evaluation with Students.* During the study, students were asked to complete a questionnaire that assessed their experiences and perceptions of the language learning robot. The questionnaire included statements that students rated on a scale of 1 to 8, indicating their level of agreement or disagreement. Examples of these statements included: "Practicing my speaking skills with NAO was smooth," "NAO could understand what I said most of the time," and "The activities presented by NAO were suitable for my level of Finnish." The questionnaire also incorporated the Robot Attitudes Scale (RAS) [12]. Furthermore, the questionnaire contained an open-ended section where students could freely comment on their experience using NAO.

*3.3.3 Data Analysis Methods from RALL Evaluation with Students.* The method of content analysis [19], was utilized to analyze the qualitative data. The quantitative data from the students' questionnaire was analyzed statistically.

# 4 FINDINGS

## 4.1 Findings from RALL Co-Design Workshop

The co-design workshop yielded findings in three categories: Instructors' perceptions of RALL, Meaningful learning activities with NAO, and Design of the engaging programming workshops.

***Instructors' perceptions of RALL.*** The participating language instructors found it interesting to learn about the possibilities social robots offer for language learning and they were impressed by the advancements made in the field. Witnessing the robot in action and exploring the programming interfaces and videos showcasing its capabilities were highlights for them; P2: "It was very interesting to see the videos of the robot doing things. It is something I do not really see ever, and I had no idea how well they work.". They expressed interest in observing the practical application of the Elias Robot app. The instructors believed that incorporating a social robot into their teaching activities could enhance interactions, simulate real-life scenarios, facilitate vocabulary and pronunciation practice, and boost students' confidence. They were enthusiastic about working with the robot and participating in the programming workshops, feeling excited and intrigued about the prospect of learning to program a social robot and generate innovative ideas.

***Meaningful learning activities with NAO.*** Under this category of findings, the first subcategory focused on *the usage of NAO*. The language instructors described that NAO could be used individually or by a small group of two students taking turns interacting with the robot. The second approach, where students would assist each other while still having individual interaction with NAO, was considered optimal. The participants expressed that this approach allowed for collaborative learning and support, as they could help each other with tasks; P1: "because they can help each other, as we did. We both tried to make him stand up.", referring to their interaction with NAO when it did the short demo.

The second subcategory, *expectations,* revealed the desired outcomes associated with NAO. The language instructors expressed interest in using NAO as a support, companion, and alternative means of language practice. They believed that NAO could enhance students' speaking skills by enforcing stricter pronunciation standards compared to instructors. Students would need to be more precise in their pronunciation to ensure NAO's comprehension; P2: "Pronunciation, I know that there are some students who are already using this Siri phone to practice pronunciation, so it could be similar with NAO.". Concerns were raised about NAO's speech recognition capabilities and its ability to discern slight differences in answers. Meaningful activities that promote learning were emphasized over purely entertaining interactions.

***Design of the engaging programming workshops.*** This category included five subcategories. In terms of *expectations*, language instructors anticipated completing and programming activities during the workshops. They desired more advanced instructions, as they had a solid understanding of technology. The instructors preferred text and screenshots to illustrate the main steps of theoretical material and programming instructions.

*Engaging aspects* were considered important for programming workshops, and instructors wanted to actively program and explore their ideas. They saw small group work as an effective *learning approach*, allowing for collaboration and subsequent individual use of programmed activities in their classes. The *schedule* consisted of implementation and evaluation sessions across two campuses of Tampere University, and brainstormed *activities* included yes/no questions, verb conjugation, partitive cases, repetition of word sequences, and object recognition. Incorporating contextual pictures for certain activities to give context was expected.

## 4.2 Findings from RALL Programming Workshops

***Positive experiences by language instructors.*** The instructors expressed satisfaction with the progress made during implementation sessions. They viewed the hands-on workshops as a quicker and easier learning experience compared to other opportunities such as studying by themselves with videos or self-study courses. P2: "The workshop, especially when compared to any other way, if I would have wanted to learn how to program him [NAO] and do something, it was so much faster. I am sure that if I would have like, I do not know, got some little materials for example and videos... This was so much better and so much easier when you get to try it yourself and you actually are doing it immediately. It helps so much. It was so fast to learn it.". They also enjoyed thinking about what activities to do with NAO and testing them; P1: "The software was easy-to-use, and we could use our own ideas. So I think we really got what we want it.". They regarded the co-design workshop as an inspirational session and a foundation for designing their own activities aligned with their objectives and targeted concepts.

***Challenges encountered by language instructors.*** Some challenges identified included NAO not responding as expected and initial apprehensions about programming, especially for those without knowledge of the existence of visual-based programming languages. Participants noted that the primary challenges in session 1 included figuring out how to connect NAO, Elias, and the computer to the same network, understanding the need for close positioning when speaking to NAO, and desiring a preview option in the Elias app instead of using the robot for activity testing. They also encountered difficulties with the robot's pronunciation differentiation. They wanted to incorporate pictures into the type of activity dialogue and customize incorrect feedback but found these options unavailable in the Elias app. Overcoming picture size issues, they discovered square shapes worked best. A personal lesson learned was the importance of appropriately scheduling breaks during the session, rather than leaving it to participants to decide when they want to take breaks.

In session 2, P2 mentioned that they were becoming familiar with the Elias app, resulting in a smooth session. However, they observed a picture disappearance issue in the Elias editor, despite the picture being visible when using the Elias app with the robot. Additionally, it was noted that when the robot's feedback was not provided, NAO displayed the correct answer in a written form as feedback.

Furthermore, during session 3, language instructors expressed feeling overwhelmed by the multitude of functions presented in Choregraphe and doubted their ability to grasp all the content. Despite requiring more logical thinking than the Elias Robot app, they found understanding how loops functioned to be a simpler process than initially expected. Although they set the language to Finnish, they encountered challenges with the way the robot pronounced words.

***Aspects that helped with motivation.*** The instructors shared aspects that helped them stay motivated during the programming sessions, such as clear and specific goals, visible progress, learning new skills, and having a well-defined schedule. P2: "That we knew that we are actually going to use it for something. We are going to

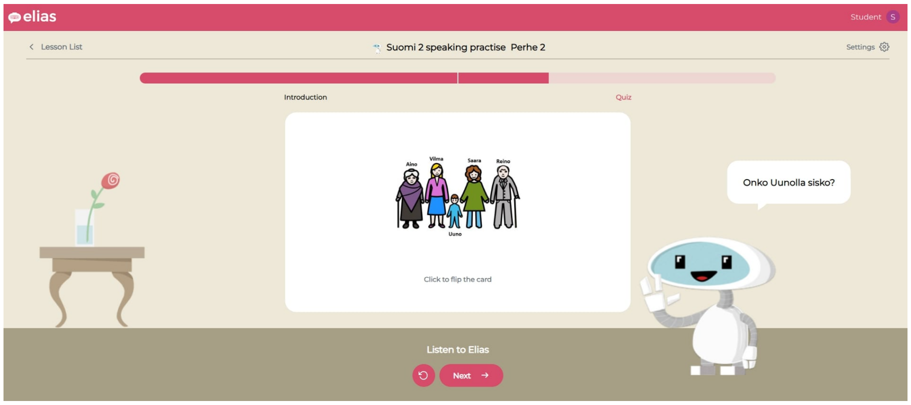


**Figure 2: An activity created in Elias Robot app with the Quiz type of activity.**

use it with students, because if we would have just been learning this and then we would not have those sessions with the students, it would not be as motivating because now we have like a very clear goal.".

***Activities with NAO.*** In terms of planning activities, the language instructors found it relatively easy due to shared goals and a desire to use NAO for simulating interactions and conversations resembling real-life scenarios. It was observed that when designing activities with Elias Robot app, they mostly used the Quiz feature to create activities that involved some comprehension of the vocabulary used, i.e., picture of a family with names, refer to Figure 2, asking if Uuno has sisters, what is the name of his grandmother and grandfather, what is the name of Reino's wife, etc. For instructors, it was important to provide students some context, given in this situation by the pictures, because they consider that language always happen in a contextual situation. The activities were designed with the aim of proving students of Finnish II a way to practice, with the help of NAO, activities and questions like the ones the instructors were going to ask in the final speaking test of the course.

Instructors learned to use Elias app quickly and they took advantage of some offered possibilities as duplicating a lesson or using the pictures from the picture bank, which then were replaced with their own ones. Language instructors worked collaboratively, they continuously tested their ideas, and after each implementation, they checked with the robot how everything was working and looking. They really liked that the robot was able to generalize answers and recognize them using keywords, for example, if the answer was "John", the robot was able to recognize: "Minä olen John", "Mä olen John", "Mä oon John", "Minum nimi on John", etc. (all different forms of saying: "I am John / My name is John"). The activities implemented during the first two programming sessions with the Elias Robot app were related to the topics: family members (three sets of seven questions), hobbies (one set of three questions), and how much (money vocabulary) (two sets of four questions).

During session 3, they created two new activities aimed for students of Finnish I, using Choregraphe software. Language instructors took turns to program the activities, P1 mentioned that she needed hands-on experience in order to be able to understand properly how everything in the software functioned. They were able to create two activities that allowed students to have a simple conversation with NAO. In the designed activities, the conversation between robot-student was achieved by a sequence of question/answer interactions. An example representation of the programmed sequence can be seen in Figure 3, the workflow has been inspired by previous work from Glas et al. [23].

Language instructors liked the fact that for Elias app, there is no need to be present controlling the activities, allowing students to practice the activities by themselves. Comparing this liking to Choregraphe, in the latter one, a person is needed to be present during student-robot interaction to run the program every time needed.

Although language instructors were able to design practical activities that could benefit beginner language students to practice their speaking skills, they struggled to envision how NAO could be effectively utilized with more advanced learners. They were concerned that with more advanced students, language possibilities are extensive, and the activities should not limit their ways of expression in any manner. They also expressed concerns about NAO's influence on students' speaking skills, noting that the robot's speech recognition still requires further development. It currently cannot recognize accents, word stress, or different intonations, posing challenges for accurate back-and-forth communication.

## 4.3 Findings from RALL Evaluation with Students

**Students' positive experiences.** Students defined the experience of using NAO as fun, good, interesting, and considered NAO as a useful technology. S2: "It is a very good experience practicing with NAO. Fantastic job!.", S6: "It worked pretty well with simple input speech, and I think it is very useful technology. Fun to use :)". Additionally, they said that NAO worked well when simple language was used, and some students were willing to speak with NAO in the future, S10: "It was a neat experience. I would like to do it again.".

***Students' challenging experiences.*** Students also highlighted the difficulties of NAO to understand what they said, other accents, and its difficulties in general regarding speech recognition. S1: "NAO seems to have difficulties understanding other accents.",

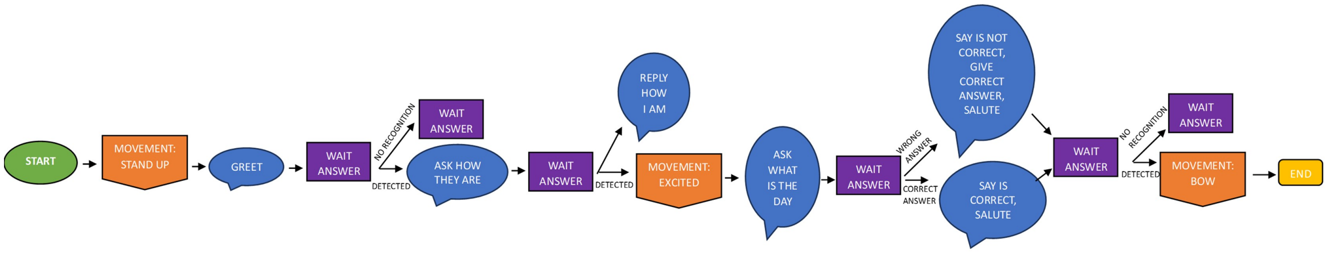


**Figure 3: Sequence of questions and answers for robot-student interaction.**

S15: "NAO could not understand some words that I pronounce.". Additionally, they mentioned that sometimes NAO is misleading as it nods even though it is not able to understand what it heard.

***Students' level of agreement with given statements.*** Students rated the experience of practicing their speaking skills with NAO with an average score of 6.80 out of 8. They found checking their vocabulary knowledge with NAO interesting, with an average score of 6.71. The highest rating was given to the statement indicating that the activities presented by NAO were suitable for their level of Finnish, with an average score of 7.26. On the other hand, the lowest ratings were given to the statements "Practicing my skills with NAO was smooth" (4.77) and "NAO could understand what I said most of the time" (4.49).

***Students' ratings to RAS.*** In terms of the Robot Attitudes Scale (RAS), students rated NAO as friendly (6.94), interesting (6.74), and simple (6.77). However, lower scores were given to the categories of basic/advanced (5.49), unreliable/reliable (5.77), and fragile/strong (5.89).

## 5 DISCUSSION

The co-design workshop focused on addressing the research question ***RQ1:*** *What are the expectations and needs of university language instructors regarding programming a social robot for teaching languages?* The findings indicate that language instructors had expectations of programming a social robot that could simulate real-life conversations with native speakers, aligning with the communicative language teaching method [50]. They also desired to create simple activities that allowed pairs of students to interact with the robot, fostering positive learning experiences. This group setup was found beneficial in previous studies [20]. Furthermore, language instructors preferred small group settings for the programming workshops, as they taught the same Finnish course and believed that collaboration would be productive and reasonable. The co-design workshop was crucial in enabling collaboration and designing programming workshops tailored to educators' needs and expectations. This approach allowed educators to influence and decide what, how, and when they wanted to learn, introducing novelty into the research process as compared to prior studies [51] where educators were not participants and co-designers of their own learning experiences.

The evaluation of the programming workshops aimed to address ***RQ2:*** *What are the university language instructors' perceptions of the benefits and challenges of programming a social robot themselves?* Language instructors identified several benefits, including gaining firsthand knowledge of the possibilities and limitations of the robot, experiencing a fast and easy learning process, and being able to immediately test their implementations with the robot to observe what worked well and what needed modification. These benefits align with best practices such as practice, feedback, and support presented by Schina et al. [51]. However, challenges arose when the robot did not function as expected, echoing findings from Ahtinen et al. [1]. Language instructors also faced initial fears about programming based on their first impressions of the software or prior knowledge of text-based languages. They felt overwhelmed by the Choregraphe platform's numerous possibilities but soon realized that it was not as difficult to use as expected. These findings correspond to the challenges of text-based programming and the benefits of visual-based programming languages for novice users highlighted by Bravo et al. [11].

Regarding ***RQ3:*** *What are the university language instructors' experiences of the programming workshops?* The experiences can be divided into implementation sessions with the instructors and evaluation sessions with the language learning students. During implementation, language instructors had positive experiences, finding the workshops well-organized with clear objectives. They appreciated the ease of use, particularly the Elias Robot app. Being able to use their own ideas to design activities for the Finnish language students was a significant difference compared to previous studies [14, 38], where predefined tasks were given. Language instructors were satisfied with NAO's performance and progress, even though they did not expect perfection.

Regarding the evaluation sessions, language instructors had both positive and challenging experiences. They observed students' motivation and curiosity in interacting with the robot, similar to findings from previous studies [10]. However, there were challenges related to NAO's speech recognition. NAO struggled to understand accents, stress, intonation, volume, and speech speed, leading to some frustration among students. While no negative effects on students' speaking skills were observed, language instructors expressed concerns about the robot's impact on students' speaking skills due to these limitations. They also pondered the usefulness of a social robot for language learning, particularly with more advanced students, as the students' possibilities for interaction are diverse and a robot may restrict development rather than facilitate it.

Nevertheless, the research had some limitations related to NAO's speech recognition and challenges with NAO's object recognition function. The limitations of speech recognition affected NAO's understanding of diverse accents and complex sentences, whereas the object recognition function did not work properly in our NAO. Additionally, there were limitations with the number of participants involved in the research. Having a larger number of participants in future research would allow for observing how more educators working together in programming activities could influence their learning experiences. Furthermore, a limitation was time constraints that did not allow to iterate the process in order to improve the design of the co-design workshop, programming workshops, and testing with students.

## 6 CONCLUSION

The research underscores the value of collaborative, hands-on robotic programming workshops for educators to learn programming social robots easily. Involving educators in workshop design addresses their specific needs and ensures theoretical coverage for teaching. To keep motivation high, workshops offer early hands-on practice and encourage educators to design their robot applications with clear objectives. Workshop time also includes creating teaching materials while receiving relevant theoretical content.

Educators designing and programming their robotic applications allows for efficient production, quick adjustments, and improved student benefits. Concerns exist about the robot's impact on speaking skills and determining its optimal use. Designing meaningful activities for language learning is vital. While language students enjoy interacting with social robots, it is observed that robots face challenges in speech recognition, including accents, word stress, intonation, complex sentences, and speech speed. Future enhancements should focus on improving the robot's speech recognition to facilitate more complex conversations and thorough learning.

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