

A Humanoid Robot as a Language Tutor

A Case Study from Helsinki Skills Center

Extended Abstract

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ABSTRACT

We are looking for a way to make use of Nao robot in learning Finnish as a second language. The pedagogical background of our experiment is based on Charles Arthur Curran's Community Language Learning method and its Finnish application called *'Toisto' ('Repeat')*. We approach the topic with the means of Conversation Analysis (CA). The target group are adult students studying at the Helsinki Skill Center aiming to work at the area of health care. Our questions are: 1) Can a humanoid robot reduce a fear of making mistakes and that way promote speaking? Is it easier to ask help from a robot? 2) Can robots support self-paced and self-guided learning? 3) How robots can deal with students' feelings and what kind of affective qualities does robot-assisted teaching have?

According to our material in human-tutored session students didn't take independent contact, but the teacher made the decision to ask help for the students. In robot-tutored session the students touched the hand of a robot independently. However, it is too early to draw general conclusions about if a robot is more approachable than a human. There was more laughter in the robot-assisted learning situations. The robot may have brought more joy and easiness to the learning situation and that way promote learning. Working with a robot in the teaching situation the studied language material was more limited and the robot repeated the words more than those with the human language tutor. We are using the double diamond (4D) service design model by the Design Council in developing a 'Repeat Robot' product which every teacher teaching adult language learners could use.

KEYWORDS

immigrants, language learning, robots, service design

1 INTRODUCTION

Helsinki Skill Center provides wide range of integration services for adult immigrants residing in Helsinki. Services combine Finnish language studies, vocational training, rehabilitation services, recognizing previous skills of our students and creating a personal and appropriate path towards the working life. The aim is to help the students to update their own learning paths until they get into vocational education or to work.

The use of robots in teaching is a new method. Therefore it needs to be explored and experimented more in real teaching contexts. At this point we are using Nao humanoid robot in various groups in order to collect information and experiences about using it with adult immigrants learning the Finnish language. Our aims in teaching with Nao is to develop a way all teachers would be able to use it. The most imminent reason to make it work, is the need to differentiate teaching because the study groups are heterogenous in nature. At first Nao is being used as a teacher's assistant or substitute. The next step is to test how the robot copes with coaches. At this point, Nao is also being used as a school's social worker's assistant. It is giving lectures about emotions and importance of sleep from student's point of view.

Other reason for using Nao is gamification and engaging the learners into the learning activity. The theory behind that comes from neurobiology. Most of our students have refugee background which in most of the cases also means high stress levels and low ability to take in new information. Nao is used to bring stress levels down and introduce fun and games in learning which makes learning more permanent and memorable. [1]

We have a special rehabilitation group for students who have either physical or mental traumas. The group is based on the feeling of trust and security which e.g. Goleman [2] believe to be the basis of a meaningful learning experience. Nao robot has been in experimental use also in this particular group. The testing of the robot has given us many interesting viewpoints for example from the role of a teacher in this kind of teaching context.

Helsinki Skills Center is an organisation with a strong demand to develop new ways of teaching adult immigrants. We are doing ongoing service design by experimenting new methods and then evaluating them and altering if needed. We use service design methods to understand the user view and then develop methods which are usable in everyday teaching in our context. The general evaluation of the quality and gathering of the client feedback is conducted by Bikva-method and depth interviews. Bikva is used mainly in social services sector, but it can be seen valid in this context also. [3]

By doing experimental work we came to the conclusion that we need to develop a service, which helps teachers to use the robot in teaching. In service design we are using ISO 9241-210 as a framework and the service design process will continue by following the double diamond (4D) model by the Design Council [4]. It gives four steps on the way to design a service. Steps are: Discover, Define, Develop and Deliver. **Fig. 1.**

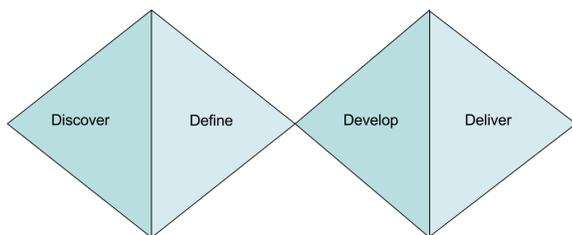


Figure 1: The Double Diamond (4D) model

We are now working with the Discover phase on most of our experiments. In this paper we will introduce our research on a model called 'Repeat Robot' that has been lifted from the Discover phase into Define phase. 'Repeat Robot' has already been noticed in practise to be a working method which we want to develop further to serve every language tutor's needs in adult education.

In 'Repeat Robot' project we are looking for a way to make use of Nao humanoid robot in learning Finnish as L2. The pedagogical background of our experiment is based on Charles Arthur Curran's Community Language Learning method and its Finnish application called '*Toisto*' ('Repeat'). We approach the topic with the means of Conversation Analysis (CA). In this case study the material consists of authentic learning situations. The participants were students of Helsinki Skills Center aiming to work at the area of health care. The research questions were the following ones:

1. Can a humanoid robot reduce the fear of making mistakes and that way promote speaking? Is it easier to ask help from a robot in a learning situation? Are the ways of asking for help different if the language guide is a robot instead of a human being?

2. Can robots support self-paced and self-guided learning?
3. How robots can deal with students' feelings? What kind of affective qualities does robot-assisted teaching have?

2 APPROACH

2.1 Repeat Method

Student groups in Helsinki Skills Center are very heterogenous, ranging from analphabets to the ones with academic background. Because students have a wide range of language skills and many of them have a background as an asylum seeker, there is a need for a quick and practical language learning method that is suitable also for people with traumatizing experiences. We have applied a method called 'Repeat' ('Toisto') which is designed for voluntary language guides teaching in reception centers. The idea of the method is that anyone can assist language learning at the early stage. The idea is simple: A teacher presents new words and phrases with the help of pictures or tools. New words and phrases are as authentic as possible. No written language is used and therefore the method is suitable also for analphabets. The students listen and repeat words and phrases until they can call them to memory when seeing a tool or a picture presented to them earlier.

At first Repeat method was used without robots. We have applied it on learning of everyday language as well as on professional language (e.g. vocabulary and phrases needed in working life). Now we are developing the method into a new direction with humanoid robots that can act as language tutors. The goal is to learn work life language in a practical way. The original method is developed by Maria Ahlholm, title of Docent in the University of Helsinki and her students of Finnish as a second language in the Department of Teacher Education. It is free to use, share and apply to different needs. Although 'Repeat' method was designed for voluntary language teachers teaching in reception centers, it can be easily modified for different purposes and places.

2.2 Community Language Learning

The Repeat Method is based on Community Language Learning (CLL), method developed by Charles Arthur Curran. According to Curran, adult students often feel threatened by a new learning situation. Curran found out that the way to get on by shame and fear is that the teacher becomes a language counselor. [5]

The learner doesn't have to be afraid of losing face because he/she knows help is available. We take a step further and use a robot as a language tutor. We want to find out whether the learner relates to a robot even more casually than to a human and if a humanoid robot is more approachable than a human. In other

words, can a robot reduce a fear of making mistakes and that way promote speaking. When help is at hand, the learner might dare to experiment on more complicated structures, words and phrases and overcome his/her uncertainty. And daring to use them his/her language skills keep developing.

A key principle of the method is ‘a speaking dictionary’. A student can ask help from a teacher or a language tutor who acts as a speaking dictionary, if the student can’t remember the right expression. The purpose is to reduce the fear of making mistakes and that way make the learning environment safe and encouraging. In this project we use a Nao robot as a speaking dictionary. A robot recognizes tools and pictures and can tell the right word or expression. The idea of the speaking dictionary is that students can ask help only when needed and independently define their goals and search information. [5] We want to find out, how robots can support self-paced and self-guided learning and that way help to differentiate teaching in heterogenic groups. Asking for help only when needed increases the feeling of autonomy. The theoretical background of this notion relies on the constructivist conception of learning and the idea of a learner-based teaching in which the learner’s needs lead the way. The teacher’s role is more that of a facilitator or a helper and a guide [6].

The responding to the students’ feelings is considered important in Community Language Learning. The teacher has to be sensitive and listen and respond carefully. [5] This is the biggest challenge when the language tutor is a robot. Affective qualities have a significant role in learning.

Our approach to language is based on Construction Grammar. The language is seen as a web, a construction built by the learner combining diverse fragments of language (words and phrases) [7]. A student can learn the structure of language just as well as in a garage or in a kitchen. The purpose of our robot-assisted language lessons is that students learn to use Finnish language in meaningful situations from early on. New words are introduced in ready-to-use language structures. That prepares students for linguistic situations outside the classroom. Students learn something that they can put to use immediately.

3 TECHNICAL IMPLEMENTATION

In our project we use Nao V5 Evolution humanoid robot developed by Aldebaran Robotics. The Repeat application is programmed with Choregraphe 2.1.4.13 software. Its technical implementation is very simple. Acting as a language guide requires the robot of being able to repeat a limited amount of language items defined in advance, of being able to recognize picture cards or things and to react on a physical touch and verbal questions. Nao also expresses feelings during the session, e.g. happiness about the learner’s success. Recognizing the learner’s emotions hasn’t been taken into consideration yet, but it will be the next step. Our goal is that Nao offers help when noticing the

hesitation of its counterpart in conversation, if answering seems to take a lot of time, or encourages when noticing non-verbal messages implying the counterpart’s despair.

We have encountered one technical problem related to Finnish double consonants. The difference between single and double consonants can cause a difference in meaning in the Finnish language, so in QiChat script this has had to be taken into account by cutting the word in two between the consonants. In addition we have solved certain problems in pronunciation by coding them to the script the way they are pronounced instead of their writing (assimilation <np> that is pronounced /mp/ or doubling at the end of the word in some cases). Otherwise the robot is pronouncing quite understandable Finnish.

Recognizing speech can cause trouble when the speaker is not a native speaker. For this reason it is important that he/she can ask for help by touching the robot. In teaching occasions Nao is a bit vulnerable to disturbances and noise. On the other hand Repeat sessions have a clear manuscript and they contain less simultaneous speaking than ordinary lessons. The robot is placed so that both the teacher and the students have an eye-contact with it: Fig. 2.



Figure 2: The robot in the classroom.

4 MATERIALS AND METHODS

4.1 Data collection

In this paper we present our observations on two learning situations both involving students studying at the Helsinki Skills Center aiming to work at the area of health care. The groups consisted of three female students with as similar level of language skills as possible. Their level corresponded to the level A2.1. according to the CEFR.

In one of the groups the teacher was assisted by a human language tutor and in the other group by a Nao robot. The same teacher was present in both sessions. (Table 1.) The students were instructed to ask for help from the language tutor by touching his/her/its hand.

Table 1: Participants.

Group 1	Group 2
Student 1 (*STU1)	Student 4 (*STU4)
Student 2 (*STU2)	Student 5 (*STU5)
Student 3 (*STU3)	Student 6 (*STU6)
A teacher (*TEA)	A teacher (*TEA)
A tutor (human) (*TUT)	A tutor (Nao robot) (*NAO)

The teacher presented seven cards picturing medical / health care tools and a simple dialogue containing asking for one of them, handing it and thanking for help. The sessions were videotaped with the consent of the participants. Afterwards the recordings were roughly transcribed. The parts that contained asking for help were transcribed using Clan program according to the convention of Conversation Analysis (CA). In the transcription non-verbal qualities such as tones, intonations, physical expressions and directions of the eyes were also taken into account, since they may point at intentions to ask for help.

The next day both groups were asked to write down as many words as they can remember from the session. After the teaching sessions the participants had the opportunity to chat freely with the robot.

4.2 Conversation Analysis

Conversation analysis is a method based on lectures of Harvey Sacks in the 60s that studies structures and practices of social interaction. For the most part it concentrates on studying conversation but has an eye on non-verbal aspects as well. The basis of the CA is the notion that human interaction is organized. A conversation can be observed with the help of three organizations. [8]

Turn taking organization is a code that helps the participants to negotiate who will speak next, for how long and how the turn will be passed on. The CA can be used to examine

formal and informal situations. The classroom situation is formal. The turn taking organization is that of a classroom in which the teacher chooses the speaker. Typical to formal situations of interaction are asymmetry and institutionality. In Repeat sessions turns are regulated because the lesson has a certain conventional structure. That's why it is less asymmetrical than ordinary class situations – students speak even more than the teacher. The fact that the teacher is native whereas the students are non-native speakers of Finnish increases asymmetry. [9]

Another basic organization of the CA is the sequence organization. It means the way how the turns of the conversation are connected to each other. Sequences of conversation are formed by adjacency pairs that are the turns of two different speakers, entities connected with each others. [8]

The third organization of a conversation, repair organization, refers to practices that help participants to deal with the trouble in speaking and comprehending. According to Kalin [10] non-native speakers use repetition as a mean to cope with trouble in comprehension. As to repair organization the teaching situations observed by us are problematic because repetition is a method of teaching in them. So we pay less attention to it.

5 RESULTS AND DISCUSSION

The adjacency pair of asking for help and giving advice was chosen to be studied more carefully of the material. The amount of sequences containing asking for help was almost the same in both learning situations. Fig. 3.

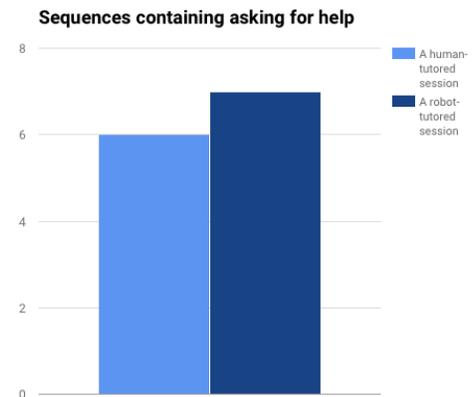


Figure 3: Sequences containing asking for help.

In both groups the student avoided to ask for help until the teacher guided to use a dictionary. Avoiding to ask for help turned out to be common in both the teaching situations. According to our material there was a clear distinction in how the student approached the dictionary when advised to do so: Fig. 4.

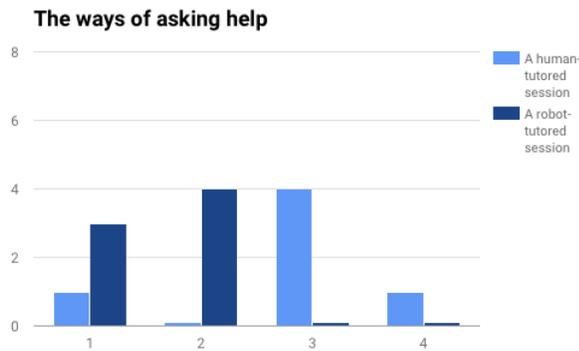


Figure 4: The ways of asking help

1. The student asks help independently
2. The teacher guides student to ask help and the student contacts the tutor directly
3. The teacher makes a decision to ask help for a student
4. The tutor gives advice without being asked

The students were instructed to ask for help independently by touching language tutor's hand regardless of whether it was a robot or a human being. Touching the hand can be seen as an independent initiative to ask for help. The students touched the hand of a robot more often than human hand when asked to do so by the teacher. Both the teachers and the students were female so difference of sex didn't have any affect in the case. According to our material it seems that in the robot-assisted session the students applied to the language tutor somewhat more independently.

*TEA: ((showing a picture))
 *STU5: ((smiling))
 *STU4: \$i- (.) in-\$
 *STU6: *tämä on vaikea*. 'this is difficult'
 *STU5: \$tämä on vaikea he he\$. (0.9) ((touching Nao's hand)) 'this is difficult'
 *NAO: näytä kuva. 'show me a picture'
 *STU4: \$(--)(.) no-\$
 *NAO: inhalaattori. 'an inhalator'
 *STU4: [\$inhalaattori\$]. 'an inhalator'
 *STU5: [\$inha-\$].
 *STU6: [\$inhalaattori\$].
 *STU4: *inhalaattori*.
 *TEA: inhalaattori
 [11]

However, avoiding to ask for help turned out to be common in both groups. The participants showed they didn't remember the word by delaying the answer or expressing frustration. Then the teacher made a decision to ask help for a student.

*TEA: joo (.) ja sinä kysyt? 'yes' 'and you ask'
 *STU2: anna (.) teppi. (0.7) 'give me a tape'

*STU3: anna teippi. 'give me a tape'
 *STU1: [ei]. 'no'
 *STU2: [ei ei (--)] 'no no' (0.7)
 *STU1: [(--)]
 *TEA: sanakirja?
 *TUT: *sanakirja?* 'a dictionary'
 *STU2: LASTARI. 'a band aid'
 *TEA: laastari ↑hyvä. joo. 'a band aid' 'good' 'yes'
 *STU1: mm.
 [11]

In both sessions teacher avoided to give a direct advice and instructed a hesitating student to ask help from a tutor. In robot-assisted situations the students asked help from the tutor somewhat more often, after the teacher had advised to do so. In sequence organization the first member of the adjacency pair defines what the next member is supposed to be like. In this case the expected and preferred next member after asking for advice would be giving the advice. The non-preferred and the non-expected, would be not to help. The speaking dictionary in the teaching situation is meant to prevent the teacher from giving the direct answer. It can be seen as the preferred but polite way to avoid the unwanted delay in giving advice. Avoiding to give a direct advice is certainly due to the learner-based nature of the method. This manifested so that the teacher guided the student to consult a dictionary.

According to our material, the robot tutor was slightly more approachable than the human tutor. In human-tutored session students didn't take any independent contact. Instead the teacher made the decision to ask help for the students. In robot-tutored session the students touched the hand of a robot independently. When teacher guided to ask help from the tutor, students contacted the robot tutor directly.

The next day the participants had to do a little vocabulary exercise in which they had to write on a piece of paper as many as they can remember from the teaching moment. The robot-assisted teaching sessions yielded somewhat better learning results. It is too early to draw general conclusions because we are in preliminary phase and the data is very small. However, the results may be due to the fact that those studying with the robot repeated the words more than those with the human language tutor. Repetition may be frustrating to a teacher whereas to a robot it doesn't make any difference:

*NAO: näytä kuva. 'show me a picture'
 *STU5: ((showing a picture))
 *NAO: sideharsorulla. (.) sideharsorulla.(.)
 [sideharsorulla]. 'a gauze roll'
 *STU5: [sideharsorulla]. 'a gauze roll'
 *STU6: [sideharsorul-]
 *STU4: [sideharsorulla].
 *STU5: sideharsorulla.
 [11]

Another reason may be that working with a robot in the teaching situation the studied language material is more limited. Limiting

the amount of the language material is one of the principals of the Repeat method. The goal is to narrow down the usage to the studied material in the session and to avoid excessive language material. In sessions led by the teacher and the human language tutor there was some excessive talking between the teacher and the tutor. In robot-tutored session there was none.

We also reflected on the effect of affective factors in robot-assisted learning. The study material shows that there was more laughter in the robot-assisted learning situations: **Fig 5**.



Figure 5: Sequences containing laughter

The robot may have brought more joy and easiness to the learning situation and that way promote learning. Nao is an emotional robot that can both express feelings and recognize them. At this point we didn't take recognition of feelings into account, but the next step is to help Nao to recognize when the learner needs help. However, NAO robot reacts to the students successes, e.g., with encouraging exclamations such as "good" or "hooray".

*NAO: hyvä. ((cheering)) 'good'
 *TEA: \$oho he he\$ ((laughing)) 'ooh'
 *STU4: [he he] ((laughing))
 *STU5: [he he] ((laughing))
 *STU6: [he he] ((laughing))
[11]

Other obstacles we encountered dealt mostly with the technique of the NAO-robot. Speech recognition is challenging when the speaker is not native. In teaching situations it has to be close enough to the students so it can hear. At the next phase we are going to experiment on teaching method with two humanoid robots without any human teacher.

Learning by listening and repeating with a robot is best suited for early phases of the language learning process. Our robot-assisted method is not meant to replace systematic teaching of Finnish as a second language, but it can be used as an

additional method in situations where professional human teachers are not available.

Our observations so far are promising. However, it is too early to draw general conclusions about if it is easier to ask help from a robot. The next phase is to test the application with students of different language proficiency levels and develop it further. Later we will try a session with two robots and no human teacher. We use the service design tools in developing our project. At the end we hope to be able to develop a product which every teacher teaching adult language learners could use.

A.1 Introduction

A.2 Approach

A.2.1 Repeat Method

A.2.2 Community Language Learning

A.3 Technical implementation

A.4 Materials and methods

A.4.1 Data collection

A.4.2 Conversation Analysis

A.5 Results and discussion

A.5 References

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