Exploring the Efficacy of NAO Robot as a Language Instructor: A Comparative Study

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Project

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1 Introduction

In an increasingly interconnected world, learning foreign languages is an essential skill and Human-Robot Interaction (HRI) has garnered significant attention as a means to enhance learning experiences. This proposal outlines a research project aimed at exploring the effectiveness of using the NAO robot as a language instructor in comparison to traditional human instructors and language learning mobile application. By conducting a comprehensive study, we seek to understand the potential of Human-Robot Interaction (HRI) in language education and assess its impact on learning outcomes.

2 Motivation

Language instructors and researchers have utilized different procedures and methods to engage learners and expose them to authentic learning material [1]. In recent years, educational robots have been used for different purposes, including supporting the learning of second languages [2]. Humanoid robots offer the advantage of engaging students through interactive and personalized experiences, potentially enhancing the language learning process. Understanding the effectiveness of NAO as a language instructor can inform future educational strategies, providing insights into how HRI can be applied in various educational settings. However, few studies have directly compared NAO to traditional human instruction and language learning mobile apps. Furthermore, the unexplored territory of utilizing a NAO robot as a Japanese language instructor within the context of Human-Robot Interaction serves as a compelling driving force for our research.

3 Literature Review

One of the goals of Human–Robot Interaction (HRI) is to research and develop autonomous social robots as tutors that are able to support children as well as adults in learning new skills effectively through repeated interactions. To achieve this, the interactions between humans and robots should be pleasant, challenging, and pedagogically sound. Interactions need to be pleasant for them to enjoy, challenging so that they remain motivated to learn new skills, and pedagogically sound to ensure that they receive input that optimizes their learning gain. [3] investigated how the way university students learn English vocabulary and their attitudes toward it is affected by a humanoid social robot as a teaching assistant, NAO, which can work autonomously or be teleoperated, illustrated in Figure 1.

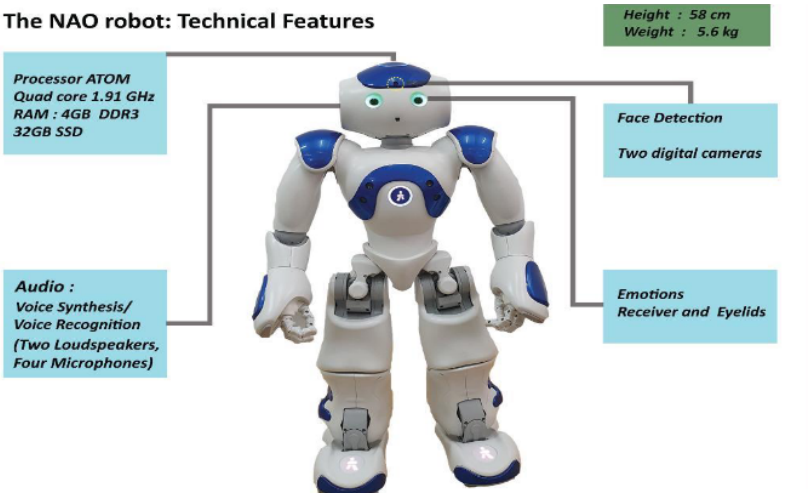

Figure 1: Technical Features of the humanoid robot NAO [3]

They have followed a mixed-method approach to gather both quantitative and qualitative data. A similar work by Belpaeme et al. [4] highlights how social robots can be used to tutor a second language to young children using an NAO robot.

This paper surveys the developmental psychology of second language learning and suggests an agenda to study how core concepts of second language learning can be taught by a social robot. It suggests guidelines for designing robot tutors based on observations of second language learning in human–human scenarios, various technical aspects, and early studies regarding the effectiveness of social robots as second language tutors.

3.1 Observations from Related Works

None of the works discussed above drew any comparisons of a robot's teaching performance with that of both an app and a human instructor. the effectiveness of using a robot as a Japanese language instructor in the Human-Robot Interaction context is also left unexplored, which acts as a solid motivation for our study.

4 Problem Statement

Examining prior studies on interactions between humans and robots has guided us in framing these questions:

1. How does the language acquisition and retention of participants learning a language through the NAO robot vary compared to those using a language learning app or receiving instruction from a human teacher?

2. What are the differences in the overall learning experiences, engagement levels, and perceived effectiveness among participants in the three learning groups?

3. Can we identify any significant variations in learning curves over time for participants taught by the NAO robot, learning app, or a human instructor?

5 Methodology

In our proposed study, we plan on working with three groups: Group A(NAO), Group B(Mobile App), and Group C(Human Instructor). Participants will be randomly assigned to one of the three groups: one group will undertake learning sessions with the NAO robot, one group will be provided with the mobile application, and the other group will learn from human instructors.

Each learning group will undergo a structured Japanese language learning program. The duration and frequency of training sessions will be consistent across all groups. The training materials will be designed to cover fundamental language skills, including vocabulary, listening, and speaking. As a part of the experimental design, a pre-test and a post-test will be conducted to examine the impact of the study. Participants will receive equal instructional hours to ensure fairness in the comparison. Figure 2 shows the outline for the proposed experimental setup.

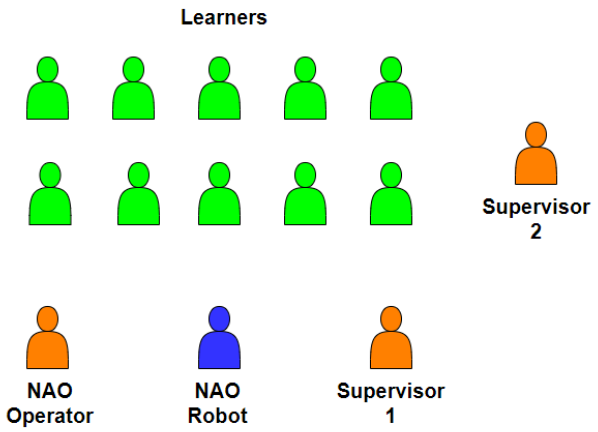

Figure 2: Outline for the experimental setup where the NAO Robot is teaching a language to a group of participants

Following the training period, participants will take a standardized Japanese language proficiency exam. This exam will serve as the primary quantitative measure of language acquisition and retention. The assessment will be conducted in a controlled environment to maintain fairness and validity. Additionally, continuous assessment throughout the training period will provide data on participants' progress and allow the analysis of learning curves.

Data collection will be multifaceted. It will encompass quantitative and qualitative data to gain a comprehensive understanding of the participants' experiences and learning outcomes. Quantitative data will include exam scores, which will be statistically analyzed to determine differences in proficiency among the three groups. Qualitative data will be collected through surveys and interviews to capture participants' perspectives, attitudes, and overall experiences. Observations during training sessions will also be recorded to assess participant engagement and interaction with the respective teaching modality.

Statistical analysis will be conducted to compare the learning outcomes of the three groups based on exam scores. This analysis will include descriptive statistics, such as means and standard deviations, as well as inferential statistics, including t-tests or ANOVA, depending on the data distribution. Correlations will be made between various parameters and the overall learning experience and effectiveness of all three learning methods. Learning curves will be plotted and analyzed over time to gain insights into how language proficiency develops in each group. Qualitative data from surveys and inter-

views will be thematically analyzed to identify common themes, preferences, and challenges reported by participants.

The findings from the data analysis will be synthesized to conclude the effectiveness of the NAO robot as a Japanese language instructor in comparison to the app and human instruction. The study will provide insights into which process yields better language acquisition, retention, and overall learning experiences. Additionally, the role of the NAO robot in language education will be assessed in-depth.

5.1 Preliminary Precautions

The preliminary precautions in this study encompass several vital aspects. Ethical considerations include obtaining informed consent, safeguarding participant privacy, and adhering to ethical research guidelines. Technical testing will be conducted to identify and address any equipment issues. Standardization ensures consistency in training materials and methods, while randomization minimizes bias. Data management will prioritize security, and human instructors will follow specific guidelines to maintain teaching consistency. These precautions aim to maintain research integrity and ethical standards throughout the study.

5.2 Work Done So Far

To configure the NAO Robot, we employed Choregraphe, a versatile desktop application designed for creating advanced robot behaviors with a drag-and-drop approach, eliminating the need for manual programming.

After going through the library of in-built gestures and functions for the NAO Robot, we settled on the following modules:

1. **Greeting:** This module involves the NAO Robot giving a simple greeting to the user in front. We designed this to make the students easy with NAO by using the in-built "Say" block in Choregraphe.
2. **Introduction:** This module involves the NAO Robot giving a simple introduction of itself to the user. This behavior is programmed using the built-in "Say text" block in Choregraphe.
3. **Japanese Vocabulary:** This module involves the NAO robot to teach the students some words in Japanese. This behavior is programmed

by sequencing a series of pre-programmed "Set Language" and "Say" blocks in a sequence. For each Japanese word entered into the "Say" block, we positioned a "Set Language" block before and after it to switch between English and Japanese. urrently, we have selected two groups of words: 'Fruits' and 'Body Parts'. To streamline the process, we have created two separate projects for 'Fruits' and four individual projects for 'Body Parts'.

An example of such a project is illustrated in Figure 3.

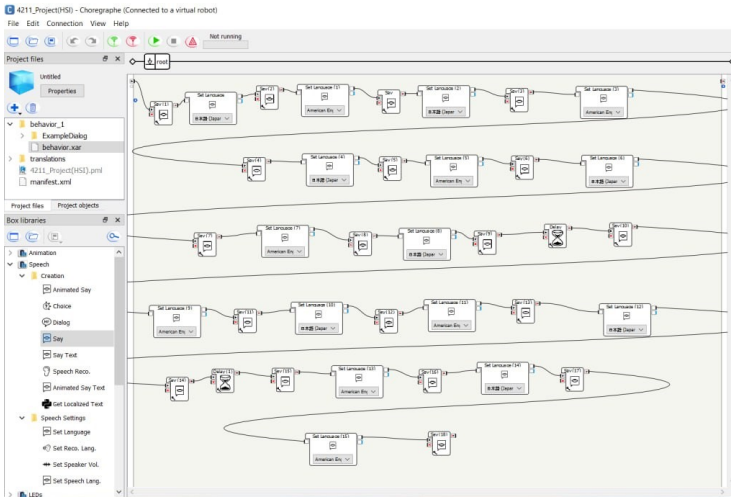

Figure 3: Sequence of blocks in Choregraphe software.

We have identified a suitable Android App, "Learn Japanese Phrases", to facilitate our app session. This app is highly effective and widely popular for learning the Japanese alphabet, vocabulary, and sentence structure. It offers various word categories, and during our sessions, we will ensure that students exclusively use the word categories corresponding to our NAO sessions.

Additionally, we have created a presentation slide to help students visualize the words that NAO will pronounce concurrently. This presentation includes the same items featured in the app, alongside their English translations, ensuring consistency across platforms.

Furthermore, we have developed three types of questionnaires to gather feedback from participants after each session. These questionnaires include Likert scale questions, close-ended questions, and open-ended questions.

Questionnaire for those who would taught Japanese words by NAO:

1. Their age.
2. Their gender.
3. Their class.
4. Their interest in Robots?
5. Whether they ever learned Robotics, like from the internet or a workshop?
6. How much they liked the NAO Robot.
7. How friendly it looks like.
8. How well the NAO taught the language.
9. What they liked best about the NAO.

Questionnaire for those who would taught Japanese words by Android app:

1. Their age.
2. Their gender.
3. Their class.
4. Whether they use smartphones at home.
5. The amount of time they use their phone per day.
6. How much they like using different Apps.
7. How well they think the app taught the language.
8. What they think about the app.

Questionnaire for those who would taught Japanese words by a human tutor:

1. Their age.
2. Their gender.
3. Their class.
4. How much they like their teachers at school.

5. How much they liked their tutor from the session.
6. How friendly the tutor was.
7. How well the tutor taught the language.
8. What they liked best about the session.

5.3 Expected Work To Be Done

We need to validate our setup and the NAO robot's functionality by conducting preliminary tests with volunteers to ensure it can perform its tasks effectively. The primary experiments will involve students at the school level, and they will be randomly and equally distributed into three groups. Initially, we will administer an exam to assess their familiarity with Japanese words. During the evaluation of the experiment, we will exclude words they are already proficient in. Subsequently, we will conduct sessions with each group, ensuring fairness in the process. Following the sessions, we will distribute questionnaires to gather feedback from the participants. We will then assess the effectiveness of each of the three learning methods by analyzing the data. Ultimately, we will be able to provide a comparative analysis and draw valuable insights in the field of Human-Robot Interaction (HRI).

6 Conclussion

In summary, this research project aims to evaluate the effectiveness of the NAO robot as a Japanese language instructor compared to traditional human instruction and the an mobile application. The comprehensive methodology we've outlined will provide insights into language acquisition, retention, and overall learning experiences. The study has the potential to inform future language education strategies and enhance our understanding of human-robot interaction in education.

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