Adoption of social robots as pedagogical aids for efficient learning of second language vocabulary to children

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Abstract

In this digital age embracing robotics across various areas of life, especially intellectual ones, have reaped great benefits owing to this modern technology. Therefore, the learning field has not remained unchanged given current evolutions as the schooling conditions have been improved through these smart devices. However, teachers still face some difficulties when choosing pedagogical methods and means for effective language learning for children. Thus, this paper aims to measure the effectiveness of social robots in facilitating children's learning of a second language (L2). For this purpose, the term L2 learning and its subordinate concepts have been distinguished, and then the different methods of language learning were discussed. The latest research regarding social robots in the educational context was also discussed when reviewing the literature. An experimental study conducted on a sample of children illustrated that the use of the social robot significantly helped them in the L2 learning regarding the assimilation fast, retention, and correct pronunciation of its vocabulary. Finally, this study concludes that the social robot would be a good solution and recommends their widespread use in education given its role in improving the schooling conditions of children.

KEYWORDS: Social Robot, Children Learning, L2, Tangibility, Learning Outcomes.

1. Introduction

It is known that the progress of communities is measured by the amount of their scientific and technological output. But, what the communities are aware of this development is influenced by the readiness of the educational system, which must keep pace with the changes taking place in the world. Especially, in light of the evolution of the means of communication that made the world just a small city. To be in permanent contact with this world, which brings us more discovery every moment, it was not only necessary to master the mother tongue but to learn another language at least to prepare oneself to follow the evolutions and to adapt to them, in addition to opening up prospects for cultural interaction (Hansen-Thomas & Chennapragada, 2018), which helps to more understanding the others.

Many people have recently become aware of the importance of languages in human life. Therefore, they have tried to teach their children another language than their mother tongue at an early age to prepare them for the future without obstacles. Thus, attempting to educate L2 for children is considered a smart step due to their peculiarities regarding the flexibility of acquiring teaching content and memorizing them in the long run. In this context, we have noted many terms frequently used in the language sciences, such as learning, acquisition, native language, L2, and foreign language. Which led us to define the scope of each concept to eliminate any ambiguity that the reader may fall into.

Language acquisition is the process that takes place normally without the need for education, as is the case when a child has acquired his or her native language. In contrast, language learning is linked to the study of the

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language through the school system, which takes place in a formal setting. The L2 acquisition is concerned with how an individual becomes able to learn a language or more and not his mother tongue, whether in language classes or through natural learning through interaction with the native speaker (Oxford, 2017).

We can also introduce the term foreign languages into our broader concept of L2's because we see learning processes as essentially identical in languages with a local presence or languages that are the most distant target despite different learning objectives and circumstances. A foreign language is the language in which the student learns formally educated on one of the school curriculum topics, the age at which foreign language instruction is offered varies according to different societies, educational philosophies, and political circumstances (Becker, 2007).

The distinction between learning the mother tongue and foreign languages depends on the environment in which one is learned. The speaker acquires the mother tongue from the environment in which it is used for normal daily communication, while the foreign language learner relies entirely on a specified number of educational classes within the school. e.g., there is a fundamental difference between the adequacy of an Italian citizen and the adequacy of a foreigner who succeeds in mastering the Italian language. This is because the Italian has an implicit knowledge of the rules of his language, while the foreign Italian grammar is known directly (explicit). Thus, we should be placed on knowing that the foreigner's knowledge of the language is direct if he or she studies its grammar and learns the language in the language-oriented educational system. But, if it learns through indulging its people and using it in their diaries as they do, here the knowledge is implicit to the unconscious, not direct.

The comprehensive plan used by the teacher to achieve the required goals of learning the language which includes methods and procedures to help achieve the goals and also includes the teacher's use of educational material teaching. Whereas, research conducted in Larsen-Freeman & Anderson (2011) has identified five methods of language teaching, namely: grammar and translation, direct, audio-oral, audiovisual, and communication.

The grammar and translation method is one of the oldest methods used in language learning, where its use in the learning of classical languages such as Latin and Greek. It is used to help learners read and tasting etiquette in the L2. This method also focused on teaching the language through translation between mother tongue and L2. This method is interested in developing the skills of reading and writing of the L2. In contrast, the direct method is based on teaching the new language directly, without resorting to another language that is often the mother tongue without having to translate from into the native language. This method depends on the learner's

situation, where he creates within the department the conditions (Language bath) to acquire the language.

The main foundation of the audio-oral method is the presentation of the L2 on the educated at first sight, and the reading and writing are presented in a later period. In the first stage, the teacher's interest is limited to helping learners to master the phonetic and grammatical system of the L2 automatically and does not pay much attention at the beginning to teach the vocabulary, as it is enough to help the learner learn the system of sound and grammar of the L2 and there is no objection to resorting to translation if necessary. This method uses various instructions such as simulation, repetition, and memorization, and emphasis on the method of measurement, with less explanation and grammatical analysis. This may make the learner deal with the language studied mechanically, but it may prevent him from having the ability to free expression. On the other hand, the audiovisual method depends on the objective to be achieved or the used means. Sometimes is based on a linguistic basis or the basis of myself or be influenced by one of the ancient philosophies of education. The lesson in this method combines audio and visual and is considered integrated with the normal use of language.

The communication method makes its ultimate goal to acquire the learner's ability to use L2 as a means of communication to achieve its various purposes. This method does not consider language as a set of structures and stereotypes intended for itself but as a means of expression of different language functions, such as demand, improvisation, order, prohibition, description, and report. Through the communication between the speaker and the listener or the writer and the reader are clear meanings, the listener enriches the speaker language in a lot of meanings, trying to clarify its meanings as possible.

Despite the benefits of adopting one or more learning methods, the teacher still needs effective educational tools that can facilitate the delivery of teaching content to learners. It, therefore, requires interactive tools that allow learners to consolidate the content of the lesson. Because according to Bloom's taxonomy of knowledge levels, we need to use interactive teaching tools that allow us to see, hear and touch to increase the memorization rate of learners. We, therefore, suggest using the social robot in the learning of languages, as it is the result of artificial intelligence research on the simulation of humans' behavior in their interactions with their environment, it offers an amazing sensory experience that will undoubtedly achieve the pedagogical goals set in the best conditions.

In what follows, we will present a review of the most significant research conducted on social robots for teaching L2 to children. After that, we explain our materials and methods used. At the last, we give our results obtained with discuss them. We conclude by Conclusion section.

2. Related Work

Nowadays, the interference of modern technologies in learning has emerged as a fertile topic that has attracted its own share of interest. Therefore, several studies have explored the effect of existing digital products on children's learning, in which most of the thematic aspects of children's learning with social robots have been addressed. In what follows, the authors will review the most distinguished works in this field to accurately identify their research hypotheses.

The investigation performed in Negrini & Giang (2019) sought to understand how pupils perceive robots as a tool to enhance their skills, including foreign language learning. The results showed a notable difference, by gender, in the perception of the skills they can improve. Similarly, a European research project called L2TOR (http://www.l2tor.eu/), an acronym for second language teaching using social robots has been launched. This project focuses on preschoolers because their adequate knowledge of the academic language is crucial to their future schooling success. However, they recognize in its entirety the importance of these devices in developing skills and keeping in tune with the times. Moreover, the research conducted by (Kanero et al., 2021) led to experimental investigation of the effect of the physical embodiment of a robot on L2 learning. They also provided an example of why embodiment does not affect learning outcomes, which gave them hope for dealing with the challenging learning conditions caused by the COVID-19 pandemic, especially since all participants in their survey were successful in learning L2 vocabulary.

Some researchers have attempted to evaluate the effectiveness of L2 tutoring supported by social robots, where they have obtained promising results that have led them to recommend its adoption in language tutoring for children (Lee et al., 2011; Kennedy et al., 2016; Belpaeme et al., 2018a; Vogt et al., 2019). Similarly, the communicative aspect of social robots and how they interact with users has been the scoop of much research regarding ICT-assisted language tutoring. For example, a field experiment using an interactive robot was conducted (Kanda et al., 2004), where it was concluded that they can be considered a social companion capable of educating children. Also, some design characteristics were proposed in Vogt et al. (2017) to build a child-friendly robot that can give them good support in L2 learning. Other researchers have also studied the interaction among children and robots during storytelling (Leite et al., 2015; Westlund & Breazeal, 2015), they conclude that interactive storytelling with multiple robots is a valuable approach to promoting social skills for children. Likewise, the effect of multiple interactions with robots on children's engagement and L2 learning outcomes has been studied, where the results obtained revealed a significant positive change in performance through the interactions (Rintjema et al., 2018).

The individual learner differences and their effect on the added value of learning an L2 using social robots have taken recently their share of researchers' concerns. Therefore, the authors (van den Berghe et al., 2021) highlighted differences in robotic effects and behaviors among children that need to be considered when designing and assessing robot-based L2 learning. Moreover, the investigations done by (Kanero et al., 2018) found that all research on social robots confirms their effective ability to fill the gaps in early language learning that human teachers cannot. They emphasized that no studies are indicating that social robots are more effective than humans, and that they can in no way replace them.

The adaptive feature of social robots of L2 tutoring for children has also been addressed in numerous recent researches. In this respect, a new approach based on Bayesian knowledge tracking and predictive decision-making has been developed to design an adaptive robot for language tutoring (Schodde et al., 2017). Other authors have gone further when they wanted to investigate the effect of robot gestures and adaptive teaching on children's L2 acquisition (Wit et al., 2018). Hence, the assessment study demonstrated good results in the adaptive tutoring condition of L2 vocabulary. Another research evaluated the effect of three scaffolding strategies (adapt, explain, and engage) on helping young children learn L2 through social robots. To reach this aim, an experimental study was conducted with very successful results across the board regarding children's engagement, learning gains and persistence, perceived learning, and re-engagement after dis-engagement (Schodde et al., 2019).

Indeed, to better understand robots supporting language learning, we suggest to readers consulting the review papers of (Belpaeme et al., 2018b; van den Berghe et al., 2019) as they include many recent studies related to social robots in an educational context and outline the features of their future use.

Despite everything said above on the advantages of using social robots in learning, it must be emphasized that the current interactive skills of these smart devices do not allow them to lead an educational process without the steering of a human teacher. Nevertheless, they can bring a qualitative addition aiming to transfer educational content to learners in optimal conditions when they play the role of pedagogical aids.

Although numerous studies have recently been conducted on social robots, they have not, in their totality, illustrating the quality of support that can be given to a child when learned L2. In other words, to what extent can robots influence learners practically when they use them as a pedagogical aid? For this purpose, we are developed research hypotheses to determine the tangible effect of the social robot on the children participating in our survey in terms of pronunciation, memorization, and assimilation skills.

The following section will exhibit the materials and methods used in the field study of the social robot by

outlining the research hypotheses, the characteristics of the target sample, and the adopted design for this survey.

3. Materials and Methods

This section aims to outline the characteristics of the field study related to determining the extent of the impact of using the social robot on children's ability to acquire a L2. Therefore, the authors have declared their research hypotheses at the outset and then identified the quantitative and qualitative characteristics of the target population, while clarifying the method by which this study will be conducted.

3.1 Research hypotheses

To discover the effects of using social robots on children's L2 vocabulary learning, a range of research hypotheses were developed, including the homogeneity hypothesis (H0).

Homogeneity in this study means that both groups consisted of a homogeneous mix of participants' personalities (see personality types in Table 1) and received the same educational material, except that the members of the EG were exclusively given an additional tool, which is a social robot.

Three research hypotheses were adopted regarding children's schooling conditions in terms of phonics, dictation, and capacity, namely:

1. Phonetics hypothesis (H1): there is no significant effect of the social robot on the proper pronunciation of the L2 vocabulary;
2. Dictation hypothesis (H2): there is no significant effect of the social robot on the memorization of the L2 vocabulary;
3. Capacity hypothesis (H3): there is no significant effect of the social robot on reducing the time to acquire a L2.

3.2 Participants

The target category by this study is children in their early years of schooling because there are two main reasons for this choice: (1) the distinctive feature of this age group is the long memorization time of the studied contents, as there is a pedagogical rule that says learning in childhood is like engraving on stone, and (2) trying to prepare the children's minds entering the battlefield of life and overcome the language difficulties they will inevitably encounter in the future. Indeed, the chosen sample in our field study is consistent with the findings of research conducted on (Ghenghesh, 2010; Nejadansari & Nasrollahzadeh, 2011) regarding younger individuals' preference in language learning.

A field study was conducted on a sample of 54 children to measure the effect of the use of social robots on the language learning process. Indeed, the studied sample was not large, but it was representative enough which

allowed us to evaluate the positive impact of these smart devices. The authors considered the participant's gender as a non-influential factor in the process of L2 learning. The parameters of this study are listed in Table 1.

Variables	Description
Educational stage	Third primary grade.
Sample size	54 children.
Targeted language	English.
Length of study	8 weeks.
Curriculum	100 words.
Participants' Personalities	Sensitive, Kinetic, Stubborn, Quiet and Bold.
Gender	Male = 19 pupils; Female = 35 pupils.
Experimental Group (EG)	This group benefited from the social robot as a pedagogical aid throughout their second language learning process (N=28).
Control Group (CG)	This group studied the second language without relying on the social robot (N=26).
Test rating scale	Percent.
Survey goals	Perceived usefulness; Perceived interaction; Perceived impact on children assimilation; Attitude towards robotics; Satisfaction; Intent to continue using social robots.

Table 1 - Parameters of study.

3.3 Design

This study aims to know how to help children enrich their L2 vocabulary in terms of writing and correct pronunciation, and did not address its grammatical and morphological aspects. To do this, participants were first divided, as they wished, into two groups: experimental group (EG) and control group (CG). Then, every child was given a uniform curriculum of 100 cards containing a spoken word in English and its meaning in the participants' native language and was asked to study it carefully within an eight-week period. Participants were then asked, as a pre-test, to read the English words on their cards to see how well they were pronounced.

Moreover, the authors provided the EG exclusively with a social robot called EMYS to determine how it affects the L2 learning process (Emys, 2018). It's a friendly robot head designed in 2018 to teach foreign languages to children in a fun and engaging way. It can move, speak and interact with users by displaying various emotions and using its expressive face. Figure 1 shows a social robot teaches a child a new language.

Eventually, a reading test was repeated as a post-test to assess the extent to which participants' language practice had improved. Also, another test was performed by asking participants to write the English words with

corresponding meaning to their mother tongue to check the extent to which they had acquired the L2 and preserved its terminology. Besides, the time invested in L2 learning by each child was calculated.

Figure 1 - EMYS robot teaches children new languages.

4. Results

The results obtained from the field study were encouraging for adopting social robots in children's L2 learning. In fact, the gathered data were processed using a statistical method called one-way analysis of variance (ANOVA) as they are based on the following assumptions: normality, independence of the sample, and equality of variance. It allows measuring whether there are statistically significant differences between the means of several unrelated groups. Concerning this study, F-test was calculated with a significance level of 0,05.

The results of the reading and writing tests, as well as the recorded learning times and the pronunciation progress for every child participating in the study, will be presented in what follows, where:

- N: Cardinality of the sample;
- M: Mean;
- SD: Standard deviation;
- P-value: Probability value;
- F-test: Fisher test.

4.1 Reading pre-test

Initially, each child was given a set of words and asked to read them to measure their ability to read L2 vocabulary. The reading pre-test results showed a high degree of convergence which supports the credibility of this study, where the EG members were delayed by a slight percentage of their counterparts on the CG by 1,69% (see Table 2).

Groups	N	M	SD	P-value/ F-test
Experimental	28	39,93	8,35	0,492 / 1,005
Control	26	40,62	8,37	

Table 2 - Basic statistics for both groups in reading pre-test.

4.2 Reading post-test

It is another test similar to the reading pre-test that took place after the end of the study period. Table 3 shows that both groups had high scores, where a significant advancement was recorded for the EG members over their counterparts, with a rate of 11,89%.

Groups	N	M	SD	P-value/ F-test
Experimental	28	67,61	9,82	0,421 / 0,923
Control	26	60,42	9,43	

Table 3 - Basic statistics for both groups in reading pre-test.

4.3 Writing test

It is a retention test in which participants had to write a set of words of the L2 they had studied. It turned out that the whole children scored closely, and the EG members had slightly outperformed their counterparts in conservation ability, which amounted to 4,83% (see Table 4).

Groups	N	M	SD	P-value/ F-test
Experimental	28	54,11	7,28	0,188 / 0,702
Control	26	51,62	6,10	

Table 4 - Basic statistics for both groups in writing test.

4.4 Pronunciation progress

This factor is the result of dividing the reading post-test by its pre-test, it allows to measuring the extent to which children improved their pronunciation of L2 vocabulary. Table 5 illustrates that EG members who received social robot services significantly improved their speech skills compared to others, with a rate of 40,74%.

Groups	N	M	SD	P-value/ F-test
Experimental	28	224,28	117,59	0,206 / 0,72
Control	26	159,35	89,56	

Table 5 - Pronunciation progress for both groups.

4.5 Learning time

It is the sum of time invested by the child to learn the L2. Table 6 shows a significant decrease in learning time recorded by EG members compared to their counterparts, with an estimated rate of -7,92 %.

Figure 2 shows graphically the effect of adopting social robot in L2 learning for children.

Groups	N	M	SD	P-value/ F-test
Experimental	28	55,72	1,33	0,01 / 2,52
Control	26	60,52	2,11	

Table 6 - Learning time for both groups.

5. Discussion

Very encouraging results have been obtained, motivating the educational community to adopt robotics in language learning for children. In what follows, the authors will be discussing the study results and determine the extent to which the null hypotheses previously identified are disproved.

5.1 Phonetics level

The hypothesis concerning the no-effect on the pronunciation of L2 vocabulary was disproved, as the calculated factor of pronunciation, progress showed a significant improvement for the children who used the social robot. According to the authors, this advance is due to the role played by this machine to stimulate the children's mimesis aspect and helped them to reach an advanced level in the pronunciation of L2 vocabulary.

The phonetics level is consistent with the results of (Gordon & Breazeal, 2015), who proposed a Bayesian teaching robot based on actively learning children's

word reading skills. This level also conforms to the work in Eun-jahyun et al. (2008), which compared the effects of a language learning program using an intelligent multimedia robot on children's language skills.

5.2 Retention level

The hypothesis of no effect on the ability to memorize the L2 vocabulary was also refuted because the writing test performed in this study illustrated a noticeable improvement in memorization resulted from the adoption of robotics in the learning process. This positive effect is due to the role played by these machines in attracting children's attention and urging them to focus while they are taught the L2 vocabulary. This is congruent with research conducted by (Leyzberg et al., 2012; Schodde & Kopp, 2018) wherein authors proved that the physical presence of a robot teacher increases cognitive learning gains, including memorization ability.

5.3 Engagement level

The hypothesis of no effect on the time invested in L2 learning was refuted, as this study recorded a significant reduction in schooling time following the adoption of a social robot. Such reduction in learning time is explained by the fact that the use of these smart devices in the learning process as a pedagogical aid improved the level of assimilation of the teaching contents by the children. This result does support the research studies carried out in Bourguet et al. (2020).

6. Conclusion

The present paper provided reliable results indicating that the use of social robots in children's L2 learning enhances the effectiveness of the educational process and significantly improves learning gains. As well as,
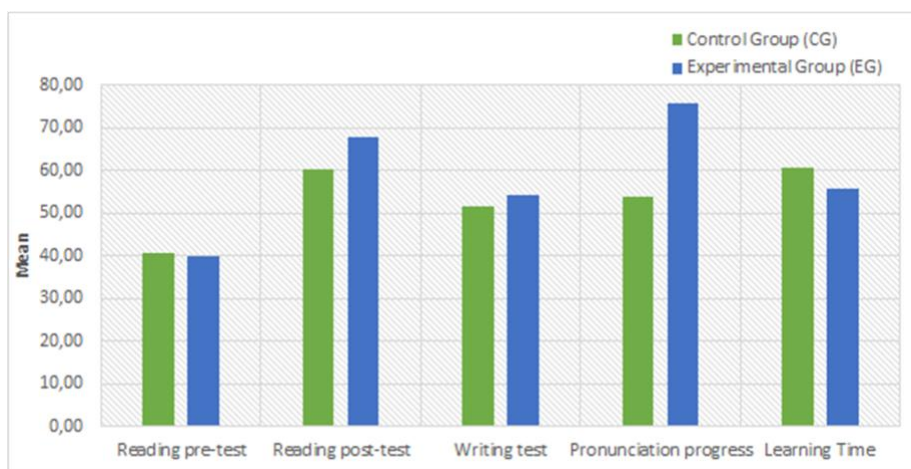

Figure 2 - Graph of the impact of social robot on L2 learning for children

given the facilities offered by the social robot through its support for L2 learning to children, the authors are compelled to recommend it to widespread use of what it can provide in terms of quality in the learning outcomes and comfort in the schooling conditions.

The somewhat price of these smart devices can be a hurdle to their adoption in learning, especially in poorer regions of the world. To overcome this dilemma, the authors suggest urging governments to allocate budgets to provide such equipment to their public educational institutions or to solicit the help of international charitable organizations interested in the learning domain.

Finally, we can consider the social robot as a good investment, regardless of its cost, because it offers a unique educational experience that has a good impact at all levels.

As future work, we are working to apply the system of intelligent tutoring (Belazoui et al., 2021) as a foundation of social robots that provide access to information on the web automatically and offer them to children's L2 learning as additional information sources.

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