AI-Driven Approaches to L2 Learning: Technology Applications and Perspectives

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Abstract

This paper investigates the impact of AI-powered interactive scenarios on Italian language acquisition. By simulating real-life conversations and providing instant feedback, AI-driven tools create an immersive and adaptive learning environment. Current research suggests that these technologies can effectively enhance learners' proficiency and foster engagement and motivation, offering a personalized learning path tailored to individual needs and learning styles. Essential elements include Natural Language Processing (NLP) for facilitating diverse and contextually relevant interactions, and machine learning algorithms for continuously adapting the learning experience based on learner performance and progress. Additionally, AI-driven analytics can provide valuable insights into learner behaviors and outcomes, enabling more targeted instructional strategies. The contribution explores recent advancements in AI applications for online language learning and presents case studies showcasing their successful implementation in educational settings, highlighting the transformative potential of AI in language education.

Keywords: *ICALL, NLP, AI-supported language learning*

1. Introduction

The integration of artificial intelligence (AI) into language learning has revolutionised the way learners acquire new languages, offering unprecedented opportunities for personalised and adaptive learning experiences. A key aspect of this potential is the use of AI-powered chatbots that simulate real-life scenarios. This is made possible by AI technologies such as Natural Language Processing (NLP) and Machine Learning (ML), which play an important role in creating an intelligent environment in which chatbots and students can communicate [1]. An example of this personalised approach is the use of specific AI-powered tools that support language learners at different stages of their learning process. Other platforms and software are already transforming the way students interact with language, providing translation and writing support that adapts to user input and context [2]. These technologies are embedded in chatbots that promote active engagement by encouraging interactive language practice and improving skills such as vocabulary and grammar through instant feedback and 24/7 availability. Research shows that these AI-powered chatbots are effective in supporting independent learning by providing students with extensive resources, including translation systems, that facilitate the self-learning process. These tools not only help learners acquire new terms, but also increase their productivity and encourage authentic interactions in language practice [3]. As a theoretical exploration, this paper aims to provide a review that contextualized the rapid advancements and potential of AI in creating responsive, intelligent environments for language learners. Through this theoretical lens, it hopes to offer educators and researchers insights into the implications of AI integration and inspire further empirical investigations into the evolving relationship between AI and language education.

2. Designing Immersive and Adaptive Learning Environments

In recent decades, numerous studies and research have demonstrated the potential of virtual and immersive environments for language learning [4] [5]. The term immersive teaching refers to teaching/learning modalities within virtual worlds, which are simulated 3D online environments created and managed by computers. Users, often mediated by an avatar, can explore settings, contribute to their construction, communicate with other users, and participate in and design activities. Immersive teaching can promote meaningful and profound learning experiences in which students are holistically and emotionally engaged. Activities characterizing this approach include, for example, the simulation

of real-life situations, collaboration with industry experts, and the application of gamification techniques [6]. Immersive environments for language learning fit well within the socio-constructivist framework [7], considering language learning as closely related to the communicative approach in which students build new knowledge based on their experiences and interactions, moving towards a co-construction of meanings. Therefore, communicative exchange in simulated contexts is of utmost importance, both in terms of developing linguistic competence and cultural and intercultural competence.

Numerous European documents encourage the research and use of innovative, inclusive, and multilingual pedagogical methods, including digital tools and Content and Language Integrated Learning (CLIL). Among these is the Proposal for a Council Recommendation for a comprehensive approach to language teaching/learning. In the Annex to the Proposal for a Council Recommendation, the document states that: "The potential of digital tools could be fully embraced to enhance language learning, teaching and assessment. Technology can massively support broadening the language offer, provide opportunities for language exposure, and be very useful for supporting those languages which are not taught in schools. Developing critical thinking and media literacy and an appropriate use of technology can be an essential learning element in this context" [8]. Therefore, it is desirable that the potential of digital tools be maximized to improve language teaching/learning and assessment, increasing exposure to the target language. The development of critical thinking, media literacy, and appropriate use of technologies is crucial, as it also supports languages that are not taught in school settings and minority languages.

Playful teaching in immersive environments, appropriately tailored to the age group and linguistic level of learners, can thus contribute to increased motivation and curiosity, activating highly complex cognitive mechanisms, with excellent outcomes in terms of learning results [9] [10] [11] [12]. The integration of artificial intelligence (AI) in language learning represents a transformative shift in educational methodologies and immersive scenarios. Key technologies such as Natural Language Processing (NLP) and Machine Learning (ML) serve as the foundation of AI-driven language learning platforms, enabling a sophisticated understanding of linguistic nuances and learner needs. Natural language processing (NLP) refers to "a theoretically motivated range of computational techniques for analyzing and representing naturally occurring texts at one or more levels of linguistic analysis for the purpose of achieving human-like language processing for a range of tasks or applications" [13].

Therefore, NLP is concerned with the automated processing of human language. It addresses the analysis and generation of written and spoken language, though speech processing is often regarded as a separate subfield. NLP can be seen as the applied side of computational linguistics, the interdisciplinary field related to formal analysis and computational modeling of language at the intersection of linguistics, computer science, and psychology. It is dedicated to the conversion of written and spoken natural human languages into structured mineable data. Through the combination of linguistic, statistical and AI methods NLP can be used either to determine the meaning of a text or even to produce a human-like response.

NLP analizes mainly the lexical, morphological, and syntactic aspects of language and recently the focus has shifted towards also aspects of meaning, discourse, and the relation to the extralinguistic context. In this context, NLP for second language learning distinguishes two broad uses. First to analyze learner language, as words, sentences, or texts produced by language learners. This includes the development of NLP techniques for the analysis of learner language by tutoring systems in intelligent computer-assisted language learning (ICALL), automated assessment in language testing, as well as the analysis and annotation of learner corpora. Secondly, NLP applied to native language analysis is also crucial in the context of language learning. In this domain, it facilitates the retrieval and improved presentation of reading materials for learners and enables the creation of exercises and tests derived from authentic content [14].

On the other hand, machine learning is an evolving branch of computational algorithms that are designed to emulate human intelligence by learning from the surrounding environment. The term Machine Learning (ML) is related to "programming computers to optimize a performance criterion using example data or past experience". The model can serve a predictive purpose, providing forecasts about future events, or a descriptive purpose, extracting insights from existing data, or both. Machine learning relies heavily on statistical theory for constructing mathematical models, as the primary objective is to draw inferences from data samples. These machine learning techniques have been successfully implemented across a wide range of disciplines, including the field of language acquisition [15].

These innovative technologies enable the development of AI-powered interactive scenarios, conversational simulations, and real-time feedback mechanisms. In this perspective, AI-driven tools are crucial for enhancing learner engagement and effectiveness in language acquisition. Moreover, the use of AI analytics to understand learner behaviors and develop targeted instructional strategies based on data insights marks a significant advancement in personalized education.

As previously mentioned, NLP and ML are central to AI-driven language learning. NLP supports the understanding and generation of human language, allowing systems to accurately interpret, analyze, and respond to learner inputs. This technology is instrumental in designing interactive language exercises, delivering immediate corrections, and producing contextually relevant responses in conversational simulations. Additionally, machine learning algorithms analyze extensive datasets to discern patterns and enhance system performance over time. By continually learning and adapting to individual learners' progress, these systems foster and facilitate effective learning experiences.

AI-powered interactive scenarios and conversation simulations play a critical role in language acquisition by providing immersive and practical language practice. These simulations mimic real-life conversations, allowing learners to practice speaking and listening skills in a controlled yet dynamic environment. The interactive nature of these tools engages learners more effectively than traditional methods, promoting active participation and sustained interest. Additionally, the immediate feedback provided by AI systems helps learners correct mistakes in real-time, reinforcing correct language use and accelerating the learning process.

In summary, the integration of AI technologies in language learning represents a significant advancement in the field of education. The capabilities of NLP and ML, combined with interactive scenarios and real-time feedback, provide a highly personalized and engaging learning experience. Moreover, AI analytics offer a deeper understanding of learner behaviors, which allows for the development of targeted instructional strategies that enhance learning outcomes and achieve educational objectives.

3. A Review of Practical Implementations

One notable example of AI implementation in language education is the use of chatbots, also known as conversational agents, which have been integrated into language learning to provide real-time interaction and personalized feedback. These AI-driven tools simulate human conversation, offering learners a unique opportunity to practice language skills in a dynamic and interactive way.

A substantial body of research has demonstrated the beneficial impact of conversational agents on language learning: Fryer and Carpenter [16] investigated the interaction between two chatbots and 211 students. The findings from the study indicate that chatbots can serve as effective tools for language practice, offering learners the flexibility to engage in language learning anytime and virtually anywhere. This accessibility is particularly beneficial for students who may have limited opportunities for real-time language practice outside the classroom. Most students reported enjoying their interactions with the chatbots, highlighting the engaging nature of these tools. This research underscores several key benefits of using chatbots in language learning. Firstly, chatbots provide real-time interaction, allowing students to practice conversational skills in a dynamic and responsive environment. Secondly, chatbots offer personalized feedback tailored to the individual learner's needs. This customization enhances the learning experience by addressing specific areas where the student may need improvement. Moreover, chatbots provide opportunities for unlimited practice, enabling students to repeat exercises and conversations as many times as necessary to achieve confidence.

The study also notes that chatbots can help reduce language anxiety, a common barrier to effective language learning. By interacting with a non-judgmental AI, students may feel more comfortable and confident in practicing their language skills. This increased confidence can lead to greater participation and engagement in language learning activities.

Ayedoun *et al.* [17] employed a semantic approach to demonstrate the positive impact of conversational agents on willingness to communicate in English as foreign language (EFL) contexts. Their study revealed that these agents create immersive environments that simulate everyday conversations, thereby reducing anxiety and increasing self-esteem. This immersive experience is crucial for language learners, as it helps them build confidence and fluency in a supportive setting.

Similarly, Shawar [18] explores the integration of Computer Assisted Language Learning (CALL) systems with chatbots to enhance language learning. The findings underscore several benefits of using chatbots in language education, including increased learner enjoyment, reduced language anxiety, opportunities for unlimited repetition, and the provision of multimodal learning experiences. These benefits highlight the versatility and effectiveness of chatbots in catering to diverse learning needs and preferences.

Haristiani [19] focuses on how chatbots can be utilized as tools for practicing language skills and as independent learning mediums. The author analyzed several types of chatbots, noting advantages such as reduced language anxiety, wide availability, multimodal practice, novelty effect, rich contextual vocabulary, and effective feedback. Key findings indicate that chatbots have a high potential for use in language learning due to their accessibility and the confidence they instill in learners. Indeed, students reported finding chatbots useful because of the 24/7 availability of the tool and feeling more comfortable practicing languages with chatbots compared to human tutors. This accessibility ensures that learners can practice at their own pace and convenience, making language learning more flexible and personalized.

Bibauw *et al.* [20], conducted a systematic review of 343 publications on dialogue-based systems, describing interactional, instructional, and technological aspects. They highlighted learning gains in vocabulary and grammar, as well as positive effects on self-esteem and motivation. This comprehensive review underscores the broad applicability and effectiveness of chatbots in various educational contexts, reinforcing their role as valuable tools in language education.

Additionally, Belda-Medina and Calvo-Ferrer [21] examined the knowledge, satisfaction, and perceptions of future educators regarding the use of conversational AI in language learning. A mixed-method approach was used, involving 176 undergraduates who interacted with three chatbots over four weeks. The findings revealed positive perceptions, particularly in terms of ease of use and attitudes towards chatbots. This study highlights the potential of chatbots to be integrated into formal education settings, providing educators with innovative tools to enhance language instruction.

Intelligent Tutoring Systems (ITS) represent another significant application of AI in language education. These computer programs are designed to provide individualized instruction and feedback to learners, utilizing AI techniques to create a personalized educational experience that adapts to the specific needs of each student.

A systematic literature review by Wang *et al.* [22] analyzed 40 studies on the effectiveness of ITS in educational contexts. The review found that ITS can effectively transform teaching and learning by providing personalized learning paths, selecting and recommending content, and engaging students in dialogue.

One of the most well-known ITS is the Cognitive Tutor, developed by Carnegie Learning and implemented in various educational settings to enhance students' learning [23]. Cognitive tutors assist learners in developing complex problem-solving skills through several methods. They provide a rich problem-solving environment that makes the learner's thought processes visible and offer step-by-step feedback on performance. When errors occur, they deliver specific feedback messages and provide context-specific hints at the learner's request. Additionally, they select problems tailored to the individual learner's needs [24]. Various studies have demonstrated that cognitive tutors can enhance language learning through predictive analysis and immediate and personalized feedback, which can help students to correct errors and improve their language skills effectively [25], [26].

AutoTutor is another ITS that has been successfully implemented in language education. Developed by researchers at the University of Memphis, AutoTutor engages learners in natural language dialogues, helping them develop their language skills through interactive conversations [27]. A study by Graesser *et al.* [28] found that AutoTutor significantly improved students' comprehension and retention of language concepts. This case study highlights the potential of ITS to enhance language learning by providing interactive and engaging learning experiences.

An additional interesting case of implementation of ITS in language education is E-Tutor, designed at Simon Fraser University to support English language learners [29]. It provides personalized instruction and feedback based on the learner's proficiency level. A study by [30] examined the effectiveness of

E-Tutor in improving learners' writing skills. The results showed that students who used E-Tutor demonstrated significant improvements in their writing proficiency compared to those who did not use the system. This case study underscores the potential of ITS to enhance language learning by providing tailored instruction and feedback.

Numerous case studies have exemplified the successful integration of AI-driven tools in language education. Although this paper cannot encompass all relevant research due to space limitations, it has highlighted a selection of representative studies that illustrate the efficacy of these technologies. These examples underscore the substantial impact of AI-driven tools on language learning, demonstrating their effectiveness in improving educational outcomes, personalizing instruction, and enhancing student engagement.

4. Conclusion and Future Directions

The new possibilities offered by AI in second language acquisition demonstrate positive impacts on students. Chatbot and ITS promote a new, stimulating, and accessible environment whenever needed provides learners with a new way of accessing knowledge, encourage independent study that also helps and supports the emotional aspects of speaking and writing in a new language, reducing anxiety. The encouraging results leave the door open for further studies and technological applications, in a landscape that is continuously evolving, such as the development of specific features for speech recognition, which will effectively enhance oral practice as well. From chatbots and their positive outcomes to ITS, which have proven to be effective tools for education, in the future, we can expect not only new tools but also increasingly efficient data analysis and student performance tracking to promote adaptive teaching that considers their needs, fostering a new approach linked to technology. The challenges that the education sector may face include training tutors and teachers on these tools and integrating them into existing curricula. It is essential to understand the data and adapt teaching strategies to meet the needs of students. In addition, it is important for chatbots to be linguistically accurate, ensuring they do not make errors that could confuse learners.

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