

# Enhancing Metacognitive Skills in Language Learning through a Conversational Pedagogical Agent

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**Abstract.** Intelligent tutoring systems can adapt to learners to the extent of preventing them from making poor decisions related to underestimating or overestimating their abilities, however, they must be exposed to making poor decisions to develop their autonomy. This paper proposes the use of a conversational pedagogical agent to support language learners while solving grammar exercises, so that they can be aware of their performance level and strengthen their metacognitive skills. Students will interact with the agent through an instant messaging application and answer the Metacognitive Awareness Inventory (MAI) to identify whether there are significant differences in using or not using the agent. A qualitative evaluation of the learners' experience using the agent will also be conducted.

**Keywords:** Intelligent tutoring systems, conversational pedagogical agents, autonomous learning, adaptive learning, metacognition.

## 1 Motivation

Intelligent tutoring systems (ITSs) are learning environments that rely on the ability of intelligent algorithms to adapt to learners at a fine-grade level [1]. This can be done according to two adaptation techniques: adaptability and adaptivity. The first one allows the learners to take control, while the second empowers the system [2].

Some ITSs have a shared student/system control to prevent students from making suboptimal decisions and elicit high motivation [3]. However, when one of the goals is to promote learner autonomy, it is necessary to expose them to make suboptimal decisions so that they can correct them with the help of the system.

Another important fact is that previous research reports a lack of mobile-based ITSs. This is observed in two systematic reviews, one of which reported 54.71% of web-based systems and 15.09% mobile-based systems [4], while the other study found no systems capable of providing mobile-based content, even though mobile devices are considered emerging technologies and their use is part of daily routine [5].

According to the described above, this paper proposes an ITS based on a conversational agent that supports language learners to enhance their metacognitive

skills, i.e., skills related to planning, monitoring and evaluation, while solving grammar exercises. Different paths will be proposed including exercises corresponding to different mastery levels, and the learners will be able to decide which one to take, if they consider it necessary, they will be able to change levels. The system will be linked to the instant messaging app Telegram.

## **2 Previous Works in the Area**

In [6], the teaching of Spanish punctuation through a chatbot was compared to the traditional method through written exercises on paper. A quasi-experimental design and a quantitative methodology were used during pre-test and post-test in a control and experimental group. Subsequently, the perception of the experimental group was analyzed through text mining in a forum. Their results showed that the students who used the conversational agent substantially improved their performance compared to the students who used the traditional method. In addition, the perception of the students who used the agent showed that they positively value it in three aspects: support and companionship in their learning process, greater feedback, and the possibility of interacting and learning anywhere and anytime.

A study comparing the use of two self-regulation strategies through an ITS is described in [7]. Participants speak English as their second language and performed exercises to improve their speaking ability according to three groups: one that used a help-seeking strategy, a second one using a self-monitoring strategy, and a control group that used the traditional teaching method that does not focus on a self-regulation strategy. A mixed method, quasi-experimental, pre-test, post-test design was used. The pre-test, and post-test are aligned with the International English Language Testing System (IELTS) speaking test. They comprise the quantitative section of the study. The qualitative section is constituted by a questionnaire about learning through an ITS. Their results revealed that self-monitoring strategy had a more significant effect on the students' performance than help-seeking. Students who used the ITS were satisfied with its capability to support them.

The systems described above are web-based, so it is important to mention that [8] used Rain Classroom, a mobile-supported tool based on the instant messaging app WeChat. In that study, the Critical Thinking Skills Survey (CTSS) was adopted to measure the critical thinking skills (CTS) of learners of English as a second language. A pre-test-post-test non-equivalent quasi-experimental design was applied to compare the CTS of learners instructed under a Rain-Classroom-based ITS with those taught by the traditional lecture approach. Their results indicated that the ITS had a positive effect on students' overall CTS, with significant improvement in the interpretation subscale, but had almost no influence on the evaluation and self-regulation subscales.

## **3 Research Objectives**

The objective of this study is to verify if a conversational pedagogical agent helps English language learners enhance their metacognitive skills while practicing grammar exercises, compared to solving exercises without additional guidance.

## **4 Methodology**

A mixed method, quasi-experimental, pre-test, post-test design will be used. Learners will take the Spanish version of the Metacognitive Awareness Inventory (MAI) [9] as the pre-test, and they will be divided in the experimental and control group. The experimental group will use a conversational agent as a support tool for solving English grammar exercises, while the control group will solve them using a Google form. Participants in both groups will have to select their level between basic, intermediate, and advanced, while the experimental group will have access to feedback and hints from the agent. After answering the exercises, the two groups will answer the MAI again. Finally, students in the experimental group will write a short text about their experience with the chatbot.

The conversational agent will be implemented on the Dialogflow platform and will be linked to the Telegram app through the BotFather framework. In this way, each participant in the experimental group will access a Telegram group in which the agent will appear as a member.

The quantitative phase covers independent sample t-tests to compare the mean scores and change scores of MAI results in both groups, and for the measurement of the effect size, Cohen's  $d$  will be used [8]. In the qualitative phase, a discourse analysis will be conducted with the texts on the students' experience.

## **5 State of the Research**

The stage of defining the state-of-the-art on intelligent tutoring systems to improve metacognition has been completed. The selection of grammar exercises for the conversational agent is currently underway.

## **6 Contribution**

This work contributes to the field of artificial intelligence in education by going against the mainstream trend of empowering algorithms to provide fully tailored solutions to learners, instead returning autonomy to learners and encouraging shared adaptation between learners and intelligent tutoring systems. This could lessen the gap between artificial intelligence and the humanities.

## **References**

1. Graesser, A.C., Hu, X., Sottolare, R.: Intelligent Tutoring Systems. In: Fischer, F., Hmelo-Silver, C.E., Goldman, S.R., Reimann, P. (eds.) *International Handbook of the Learning Sciences*. Routledge (2018)
2. Dascalu, M.-I., Nitu, M., Alecu, G., Bodea, C.-N., Moldoveanu, A.D.B.: Formative Assessment Application with Social Media Integration Using Computer Adaptive Testing Techniques. In: Campbell, L.O. and Hartshorne, R. (eds.) *Proceedings of the 12th International Conference on E-Learning*, pp. 56–65 (2017)

3. Long, Y., Alevan, V.: Mastery-Oriented Shared Student/System Control Over Problem Selection in a Linear Equation Tutor. In: Micarelli, A., Stamper, J., and Panourgia, K. (eds.) *Intelligent Tutoring Systems, ITS 2016, Lecture Notes in Computer Science*, pp. 90–100 (2016)
4. Mousavinasab, E., Zarifsanaiey, N., Niakan Kalhori, R., Rakhshan, S., Keikha, M., Ghazi Saeedi, L.: Intelligent tutoring systems: A systematic review of characteristics, applications, and evaluation methods. *Interactive Learning Environments*, pp. 11–22 (2018)
5. Soofi, A.A., Uddin, M.: A Systematic Review of Domains, Techniques, Delivery Modes and Validation Methods for Intelligent Tutoring Systems. *IJACSA*, 10 (2019)
6. Vázquez-Cano, E., Mengual-Andrés, S., López-Meneses, E.: Chatbot to improve learning punctuation in Spanish and to enhance open and flexible learning environments. *Int J Educ Technol High Educ.*, 18, 33 (2021)
7. Mohammadzadeh, A., Sarkhosh, M.: The Effects of Self-Regulatory Learning through Computer-Assisted Intelligent Tutoring System on the Improvement of EFL Learners' Speaking Ability. *International Journal of Instruction*, 11, pp. 167–184 (2018)
8. Chen, J., Hu, J.: Enhancing L2 Learners' Critical Thinking Skills Through a Connectivism-Based Intelligent Learning System. *International Journal of English Linguistics*, 8, pp. 12–21 (2018)
9. Huertas Bustos, A.P., Vesga Bravo, G.J., Galindo León, M.: Validación del instrumento 'inventario de habilidades metacognitivas (Mai)' con estudiantes colombianos. *Prax. Saber*, 5, pp. 55 (2014)