ARTIFICIAL INTELLIGENCE IN THE TEACHING OF PROGRAMMING: AN EDUCATIONAL EXPERIENCE IN THE SUBJECT OF PROGRAMMING II OF THE FI-UAEMÉX

Mireya Salgado Gallegos
Universidad Autónoma del Estado de México, Engineering course
Toluca - Estado de México
http://orcid.org/0000-0003-2675-9456

Juan Carlos Pérez Merlos
Universidad Autónoma del Estado de México, Engineering course
Toluca - Estado de México
https://orcid.org/0000-0001-6189-5125

Silvia Edith Albarrán Trujillo
Universidad Autónoma del Estado de México, Engineering course
Toluca - Estado de México
https://orcid.org/0000-0003-2620-5277

Guadalupe Rodríguez Camacho
Universidad Autónoma del Estado de México, Engineering course
Toluca - Estado de México

1

Abstract: Artificial Intelligence (AI) is currently entering different areas of the human being, the educational context has not been left out because it is revolutionizing both the way of learning and demanding more in the way of teaching. Based on this, the objective of this work is to present a proposal for the integration of AI tools in the programming teaching process, specifically the subject of Programming II of the ICO-FIUAEMéx. To this end, an investigation of AI tools aimed at teaching and particularly programming was carried out to combine with the university teaching methodology of Gouvêia et al (2023). The resulting proposal simplified and reduced the teacher's time to carry out activities, requiring a rethinking of teaching strategies and programming practices, hoping to serve as a guide for beginning teachers entering this area of AI.

Keywords: AI in education, AI tools for teaching, programming teaching, AI and programming.

INTRODUCTION

Artificial Intelligence (AI) today is revolutionizing numerous different sectors of society. Its ability to automate tasks, analyze data and improve decision making makes it a fundamental tool in today's world, transforming the way we live, work and relate to various aspects of society. Taking as reference the definition of (Schalkoff, 1990), AI is: *"A field of study that focuses on the explanation and emulation of intelligent behavior based on computational processes"*; field, which is currently interdisciplinary and which, specifically in education, helps in teaching practice, enhances the learning process and promotes the transformation of the educational system (Alonso Salinas, 2023).

ANTECEDENTS

In the educational field the number of research has grown exponentially in recent years. Acurio et al (2022) addresses the impacts of AI on teaching; Tandayamo et al (2023) stated that the application of AI in the school environment generates multiple advantages through adaptive tools; and Parra-Sánchez (2022) recommended that pedagogical and curricular models must be taken into account in the construction of learning personalization models.

Considering ChatGPT, Brasó (2023) conducted an interview with ChatGPT to respond to questions related to the teaching of physical education and whose results showed that although it provides coherent answers, it is still not able to specify and provide quality information; Alonso (2023) asked him for ideas on how to guide the development of practices. In response, he suggested making modifications and the result for the students was fabulous; Canfran (2023) conducted a study of teachers, verifying that they use it in a varied way and more frequently for tasks outside the classroom.

With reference to ChatBots, Ávalos and Monge (2020) implemented one (Bot0120) in the health emergency to speed up the work of teachers in responding to queries, turning out to be an innovation for the Chair; In the subject of Didactics of Geometry at the University of Málaga, Ruíz-Rey and Moral-Sánchez (2022), the students demonstrated a high degree of satisfaction with the usefulness and applicability of this tool; At the University of Valencia, Moreno-Picot et al (2010) with the AIBOs (*Artificial Intelligence roBOts*), demonstrated that the practices provide great attraction to students.

By integrating AI, Beltrán (2020) managed to improve reading fluency in people with visual disabilities and Ibarra (2020) achieved good communication with the

student, which was attractive and of great interest; Gouvêia et al (2023) proposed and implemented a methodological proposal for university teaching and the results obtained demonstrated its effectiveness in improving the teaching and learning process.

Implementations of AI have occurred in different subjects, to mention a few: physical education (Brasó, 2023), physics and chemistry (Alonso Salinas, 2023), journalism (Codina and Garde, 2023). Specifically, in the area of programming, Hidalgo et al (2021) found that elements such as: automatic code evaluation, exercises with feedback, interactive tutorials, pair programming and group programming exercises helped improve students' training processes; Terán (2023), in his work, implemented the use of ChatGPT and the results showed that teaching programming can significantly improve student learning; Sande and López (2023) analyzed the impact of AI with ChatGPT, in the teaching and learning process of programming, carrying out experiments of practical exercises, the results affirm that the student was able to correctly solve most of the problems.

It can be seen that there are few works developed in the teaching of programming, which is why the objective of this work is to present a proposal for the incorporation of AI tools in the subject of Programming II of ICO-FIUAEMéx with the purpose of that serves as a basis and/or as an example for other case studies related to programming subjects.

DEVELOPMENT

To carry out this work, the following methodology was followed:

- Search, collection and analysis of information on Artificial Intelligence in the educational field

- Search, compilation and analysis of AI tools that can be integrated into the educational field and specifically in the

programming área

- Achievement of the proposal based on the integration of AI tools and the methodology for university teaching of (Gouvêia et aL., 2023) in the teaching practice of the subject of Programming II (ICO-FIUAEMéx)

- Writing conclusions

DESCRIPTION OF THE PROPOSED METHODOLOGY OF (GOUVÊIA ET AL., 2023)

The methodological proposal for university teaching implements key elements such as the personalization of learning, the resolution of complex problems, collaboration and adaptive feedback. However, they mention that "it is *important to recognize the limits of AI and maintain an appropriate balance, where human intervention and critical thinking continue to play a fundamental role in the educational process*". This methodology combines pedagogical strategies with the use of AI capabilities.

Figure 1 presents in general terms the methodological proposal to be implemented.
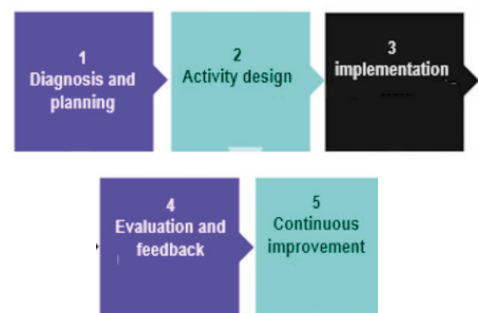

Figure 1: Methodological proposal for university teaching with AI

Source: (Gouvêia et al., 2023), Own elaboration

PROPOSAL

The proposal presents, in a general way, the implementation of the methodology of (Gouvêia et aL., 2023) for the teaching of the Programming II subject (ICO-FIUAEMéx). It is worth mentioning that this work only considers the intervention of the teacher, leaving the integration of the student for future work.

DESCRIPTION OF THE PROGRAMMING II SUBJECT (ICO-FIUAEMÉX)

It is taught in person in the second semester of the degree in Computer Engineering at the Faculty of Engineering of the UAEMéx, with a duration of 2 hours. theoretical and 2 hrs. practices per week, is made up of four units: Supplementary OOP concepts, Sorting and searching for elements, Linear and non-linear data structures, and File management. This is taught in an object-oriented paradigm and the implementation of the practice is carried out in Java. It is important to mention that it is a consistent subject of Programming I, where basic OOP concepts are addressed.

PROPOSAL DESCRIPTION

Based on what was stated above and on the stages of the methodology in Figure 1, the proposed proposal is presented below.

DIAGNOSIS AND PLANNING

- A diagnostic exam was carried out to identify the knowledge and skills acquired in the preceding subject:

  - A summarized text was generated that covered the topics of the Programming I subject (antecedent subject)

  - *Tool*: ChatGPT

  - *Comment: The time spent less than 1 minute. Prompt suggestions: "Describe what it is…", "Summary of the topic…", "Explain what it is …";* For each prompt example, more than one topic can be considered, that is, *"Describes what OOP is, classes, objects, methods,"*

  - With the previous text obtained, the diagnostic examination was carried out

  - *Tool:* Conker AI

  - *Comment:* The tool used requested the PDF document that included the information obtained in the previous activity, subsequently generated the questions and finally allowed the exam to be exported to Google Forms. Time spent was less than 2 minutes

The diagnostic exam generated can be shared with students through the link generated in Google Forms

  - *Tool:* Google Forms

  - *Comment:* After the diagnostic exam has been applied, educational analysis can be carried out with the results obtained and with this determine the knowledge and skills that the students have before the start of the course to detect the group and individual knowledge in which the students are below the required level

- To achieve the preliminary objectives of the course and based on the results obtained from the diagnostic exam, a review of the low-level topics and knowledge is chosen.

  - In the theoretical part, the student is asked to make his flashcards (study cards) of the topics in which he received a low grade in the results obtained in the diagnostic exam.

  - *Tool:* Wisdolia

  - *Comment:* It allows students to review the topics, in addition to being

able to create their study flashcards and count on them for a future occasion. Flashcards can be requested as evidence of the activity.

- In practice, a series of programs are carried out with the support of the AI tool

■ *Tool:* ChatGPT

■ *Comment:* It made it possible to quickly generate basic and very specific programs on the topics in question. Time to perform the activity no more than 1 minute. The prompt used: *"5 proposals for basic exercises on the topics of… that can be implemented with the OOP paradigm and the MVC architecture"*

· For course planning

- The planning of the complete course was generated (16 weeks, 4 hrs. per week with the topics of the Programming II program)

■ *Tool:* ChatGPT

■ *Comment:* The general planning for weeks and the agenda to be addressed was obtained. Estimated time less 1 minute

- With the previous planning, planning by themes was generated

■ *Tool*: EducatorLab

■ *Comment:* The learning objectives, methodology, required resources/ materials, participation activities, evaluation activities and the expected final conclusions or objectives were obtained. Estimated time to perform this activity no more than 1 minute.

It is important to mention that in this section, although two tools were used, ChatGPT with a very specific and complete prompt can also generate a complete planning

(Complete ChatGPT Prompt: "Planning of the programming course II with the learning objectives, the Methodology, Resources/ Materials required, participation activities, evaluation activities and the expected final conclusions or objectives and *duration to be taught in 16 weeks, 4 hours per week, inheritance topics, polymorphism, abstraction, Iterators, recursion, sorting algorithms, search algorithms, lists, stacks, queues, binary trees, traversals of a binary tree, binary trees search, balanced trees, multipath trees, text files, random files and object persistence"*)

ACTIVITY DESIGN

Based on the participation activities and evaluation activities proposed in the previous planning stage, specific activities were generated for each topic, in addition to including the presentation of the course contents.

· For the presentation of the topics contained in the course

- Collect, in a simple way, the required information in texts, videos, links

■ *Tool*: ChatGPT

■ *Comment*: Prompts used: "Recommended videos to teach the topic of …" and "*Recommended* videos *to teach the topic of… in Java", "recommended web pages or links to teach the topic of…",* This prompt can be applied to any other source of information. Time less than 1 minute per prompt.

- Create presentations from a topic

■ *Tools:* Gamma AI, Presentations.AI and Tome

■ *Comment:* Presentations on different topics were made only specifying the theme to generate the information, this way the presentations were created in

approximately 3 minutes, in Tome you can add images also generated with AI.

· For participation activities

- Creation of theoretical textual content

■ *Tools:* ChatGPT and You.com

■ *Comment:* These tools allowed the generation of textual theoretical content of the topics to be addressed. Time of this activity per topic, approximately 1 minute, this depended on how specific the topic was obtained, this way, theoretical information was available regarding a particular topic in conjunction with the references of the sources (case of You. com). The prompts used in both tools: *"Describe what it is... "Summary of the topic…", "Explain what it is…"* It is worth mentioning that You.com, after generating the requested text, also proposes to extend the information with topics it suggests through links that, by simply clicking, show more related information.

- Creation of Educational ChatBots for each topic that is theoretically addressed

■ *Tool:* BotPress

■ *Comment:* Online tool, which allowed chatbots to be generated on the topics in question from the text generated in the previous activity. Time spent in this activity no more than 1.5 minutes. This tool allows you to generate a QR or a link, which can be shared with students so that they can study, in a different way, the theory addressed at any time.

- Reinforcement activities

■ *Tools:* AI Quiz Creator and ChatPDF

■ *Comment:* Time to generate the evaluation approximately 2 minutes, this depends on the number of questions. Writing the topic to be reinforced, the questions proposed by Quiz Creator are chosen, which were exported to Google Forms, Kahoot and Quizizz, to proceed with their application and subsequently do educational analysis once having the students' answers. A search for articles and PDF documents on a topic was carried out to have a base of articles that will be given to students so that they can "chat" with those documents through ChatPDF and reinforce the knowledge acquired.

- Preparation of practices for the implementation in Pseudocode and Java of a particular topic

■ Tools: ChatGPT and You.com

■ *Comment:* Basic examples were generated on the topic in question (ChatGPT and You.com). The prompt used in both: *"X proposals for basic exercises on the topic of… that can be implemented with the OOP paradigm and the MVC architecture."*

- Carrying out internships with a different approach

■ *Tools:* ChatGPT y You.com

■ *Comment:* Basic programs were generated in Pseudocode and Java referring to a topic considering OOP and MVC. Time spent no more than 1 minute per program. The solutions obtained can be presented in class by requesting the participation of students to explain what a piece of code does or how it would be solved in a different way or what would happen if an instruction were changed or asking where in the code a certain action is performed. or how to improve a program. In the event that ChatGPT is not used for the solution of a program, the student can be asked to document

her decisions, explaining why she chose that particular solution; carry out team programs allowing discussion of different proposals, collaborative learning, review of programs among peers, problem solving and programs out loud

· For evaluation activities

- Preparation of exams to evaluate the knowledge acquired on the topic in question with educational chats

■ *Tools:* ChatGPT and You.com

■ *Comment:* The prompts used for ChatGPT and You.com: "Proposal of 5 multiple choice questions on the topic of simple inheritance and their correct answers", "Prepare a multiple choice exam with 2 questions on simple inheritance, 2 on polymorphism and 1 on abstraction with their *correct answers" or "Develop an exam with 2 multiple choice questions on simple inheritance, 2 true and false questions on polymorphism and 1 short answer question on abstraction, all questions with their correct answers.".* The results generated by these tools must be used to structure them in other exam generation tools.

- Preparation of exams to evaluate the knowledge acquired on the topic in question with automated evaluation platforms

■ *Tool:* AI Quiz Creator

■ *Comment:* Time to generate the evaluation approximately 5 minutes, this depends on the number of questions and the different topics to be considered. The topic to be included in the evaluation is written and the questions proposed by Quiz Creator are chosen. This is done until the exam is finished, which can be exported to Google Forms, Kahoot and/or Quizizz, and proceed to its application later. do educational analysis once you have the students' responses.

- Preparation of rubrics for program evaluation

■ *Tools:* Corrector.app, Rubrik, ChatGPT and RubiStar

■ *Comment:* Once the students deliver the programs, with Corrector.app it will be possible to check whether the program code was written with AI tools, this in order to prevent students from resorting to AI to solve the practices and subsequently evaluate the programs. with the previously established rubrics. Rubrik generated the program evaluation rubric on a specific topic or topics automatically only by specifying the topic in question, estimated time 5 minutes. ChatGPT also generated the rubric with the following prompt: *"Rubric for basic OOP programs considering the topics of inheritance, polymorphism, sorting and search algorithms in Java and with MVC with assigned scores or percentages and with score levels in each criterion",* In this case, with the rubric generated, the information was entered into RubiStar to format it, estimated time 8 minutes.

IMPLEMENTATION

As already mentioned, the work only focuses on the teacher, which implies that the student's implementation is left for future work.

· To introduce students to the use of selected AI tools

- Teaching will proceed as the activities of the topic in question are addressed.

· To facilitate access to digital resources and AI platforms

- The activities designed in stage 2 contemplated that the tools allow access to students through QR or shared links, so it is only necessary for the student to have technology at the time of the activity, whether cell phone or computer

· To continually monitor and evaluate student progress and feedback from teachers to adapt and improve activities

- In stage 2, evaluation and feedback activities were designed in the same tools

EVALUATION AND FEEDBACK

· To use AI tools to collect and analyze data on student performance, identifying strengths and area for improvement

- The tools, to be implemented in stage 2, with respect to evaluation, offer monitoring and educational analytics options that will allow an analysis of student performance.

· To provide individualized and timely feedback to students, using both AI and human assessment

- This feedback will be provided through the evaluation tools and in person.

· To promote self-reflection and metacognition

- Some activities designed in stage 2 alone promote self-reflection and metacognition, such as evaluation results, reflection activities on program code, continuous feedback, teamwork, collaborative learning, review of peer-to-peer programs, problem solving and aloud programs, and promoting self-assessment

CONTINUOUS IMPROVEMENT

· To collect and analyze data on the effectiveness of the AI teaching methodology

- The results of the evaluations, as well as the continuous work, will allow monitoring the effectiveness of this new integration, which must be compared with previous experiences on the part of both the teacher and the student.

· To make adjustments and modifications to the methodology

- During the march, the necessary adaptations to the teaching process will be made without leaving aside the teaching and pedagogical experience that one already has.

· To encourage collaboration and the exchange of good practices between teachers

- It is important to share experiences with other teachers in the area, and even teachers in general, since although it is focused on the subject of programming II, the proposal could be generalized in terms of the design of activities and use of AI tools, and that among peers the results obtained can be communicated to generate continuous improvement of the methodology

CONCLUSIONS

It was possible to make a proposal for the implementation of AI tools to support the teaching work in teaching the subject of Programming II.

The use of AI tools managed to minimize the time, in a very considerable way, in the preparation of tasks that had already been carried out. To carry out a didactic planning, the preparation time was a minimum of 4 hours, with the tools it was no more than

8

5 minutes, already in document format; The presentation took up to 25 hours. of completion (5 hrs. per day), with IA was approximately 30-45 minutes including image modifications; The time for generating exams was more or less 5 minutes, which previously involved about 120 minutes, so the time invested in these activities decreased by 90% compared to what was done previously, thus allowing time to be spent thinking about the design of the exams. new tasks and teaching strategies.

The methodology of (Gouvêia et aL., 2023) served as the basis for making the proposal since it explains how AI can be used as an ally in university teaching.

The importance of developing skills in the use of AI tools in the educational field was highlighted. Likewise, the area of Artificial Intelligence was made known with the purpose of integrating it into the teaching process, later in the learning process.

The integration of AI in teaching work was proposed, requiring the development of skills in the use of AI tools that can suggest new teaching and therefore learning strategies.

AI is a tool that improves the efficiency and effectiveness of teaching without replacing the experience of teachers who must use these tools ethically, maintaining a central role in the teaching and learning process.

The inclusion of Artificial Intelligence requires rethinking teaching and learning strategies. The design of new tasks must no longer focus on only giving one result, since this can be generated by AI tools, the strategy must be changed to know what and how to request that task, even if it is carried out with AI but that leaves learning behind. in the students.

Currently there are countless AI tools that support the teaching and learning process, only a few were proposed here, which may change as their implementation is experienced, new ones emerge or, in other cases, new activities are integrated.

RECOMMENDATIONS

Although the tools that were used are easy and quick to understand, it is recommended to consider training mainly on the use of prompts.

To use "chat" tools, the Prompt (text input that the user provides to obtain a response) must be as specific as possible to obtain the required information (response), the more specific it is, the more specific the result will be. close to the information requested and expected.

Do not lose the sense of the importance of the teacher in front of the group, to always keep in mind that AI can never replace the experience or pedagogy of the teacher.

The teacher must raise awareness among students so that they use these tools ethically and understand their limitations in terms of the active and critical learning process.

As future work and a continuation of this, "*AI-Driven Learning*" will be considered, which refers to the application of AI in the field of education to improve and personalize the learning process. implementing the activities designed and proposed in this work.

REFERENCES

Acurio, W. P. P., Cuchipe, W. C. C., Castro, D. J. N., y Zamora, L. E. M. (2022). **Implementación de la Inteligencia Artificial (IA) como Recurso Educativo.** RECIMUNDO, 6(2), 402-413.

Alonso Salinas, R. (2023). **Aplicación de la inteligencia artificial a la enseñanza en física y química.** (Máster Universitario en Formación del Profesorado), Universidad Católica de Murcia, Murcia,.

Ávalos Dávila, C., y Monge Mata, L. (2020). B**OT0210, una herramienta de apoyo a la docencia. Experiencia de la Cátedra Tecnologías de la Información de la UNED, Costa Rica I**nnovaciones Educativas, 22, 188-199.

Beltrán Díaz, M. J. (2020). **Desarrollo de estrategias pedagógicas con la inteligencia artificial para mejorar la fluidez en la lectura en las personas con discapacidad visual de la Escuela Luz del Mundo ubicada en el cantón Ventanas Provincia Los Ríos**. (Licenciado en ciencias de la educación), Universidad Técnica De Babahoyo, Babahoyo.

Brasó, J. (2023). **¿ Puede la inteligencia artificial ayudar en la docencia en el nuevo marco curricular? Uso de Chat GPT para la didáctica de la educación física (EF)**. Paper presented at the VII Congreso Internacional en investigación y didáctica de la educación física.

Canfran Duque, C. (2023). **CHATGPT: Una herramienta de inteligencia artificial en el aula de secundaria.** (Máster Universitario de Psicopedagogía), Universitat Oberta de Catalunya, Catalunya, España.

Codina, L., y Garde, C. (2023). **Uso de ChatGPT en la docencia universitaria: fundamentos y propuestas**. Paper presented at the Seminario sobre experiencias docentes, Barcelona, España.

Gouvêia, M. A. D. S., Melo, M. L. O. F., Augusti, R., Silva, V. D. M., Lobo, Y. J. G., Figueiredo, Y. G., . . . Souza, K. M. O. d. (2023). **Propuesta metodológica en la enseñanza universitaria con la inteligencia artificial.** Abordagens Sobre Ensino-Aprendizagem E Formação De Professores, 1(1), 127-140.

Hidalgo Suárez, C. G., Llanos Mosquera, J. M., y Bucheli Guerrero, V. A. (2021). **Una revisión sistemática sobre aula invertida y aprendizaje colaborativo apoyados en inteligencia artificial para el aprendizaje de programación.** Tecnura, 25(69), 196-214.

Ibarra Cruz, E. (2020). **Implementación de un asistente basado en inteligencia artificial para ambientes de aprendizaje de niños con discapacidad visual**. (Doctor en investigación e innovación educativa), Benemérita Universidad Autónoma de Puebla, Puebla, México. Retrieved from https://repositorioinstitucional.buap.mx/items/867383f6-5f9e-4e0c-9a30-eeac384f6966

Moreno-Picot, S., Arevalillo-Herráez, M., y Cavero-Millán, V. (2010). **Utilización de Robots AIBO en la enseñanza de la asignatura Inteligencia Artificial**. Paper presented at the XVI Jornadas de Enseñanza Universitaria de La Informática.

Parra-Sánchez, J. S. (2022). **Potencialidades de la Inteligencia Artificial en Educación Superior: Un enfoque desde la personalización.** Revista Tecnológica-Educativa Docentes 2.0, 14(1), 19-27.

Ruíz-Rey, F. J., y Moral-Sanchez, S. N. (2022). **Implementación de chatbots para el aprendizaje en geometría.** Paper presented at the XIV Congreso Internacional Latina de Comunicación Social.

Sande, F. d., y López Ramos, P. (2023). **El impacto de asistentes basados en IA en la enseñanza-aprendizaje de la programación.** Actas de las Jeniu, 8, 163-170.

Schalkoff, R. J. (1990). Artificial Intelligence: An Engineering Approach. Michigan: McGraw-Hill, Inc.

Tandayamo, R. C. G., Haro, R. E. M., Lozada, R. F. L., Cobos, D. I. J., y Gaibor, W. A. C. (2023). **La Inteligencia Artificial Utilizada como un Recurso para el Aprendizaje.** Ciencia Latina Revista Científica Multidisciplinar, 7(4), 8263-8277.

Terán, H. (2023). **La implementación de la Inteligencia Artificial en la enseñanza de la programación. Un estudio sobre el uso ético de ChatGPT en el aula.** Paper presented at the Encuentro Internacional de Educación en Ingeniería, Cartagena de Indias, Colombia.

10