



## ADAPTATION AND USE OF IA CHATBOTS (CHATGPT) AS A TOOL FOR MATHEMATICS TEACHER TRAINEES

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### Abstract

The main objective of this work was to propose implementation strategies for CHATGPT for the creation of pedagogical material for teachers in mathematics training. To achieve this, surveys were conducted among pre-service teachers who showed varying levels of familiarity with chatbots. Some had more experience, while others had limited knowledge, which could have affected their perception of these tools. However, the majority recognized its potential educational usefulness.

Lesson plans developed with and without instruction before the ChatGPT showed differences. Those created without guidance lacked clarity, whereas those created with guidance showed better structuring and resource selection. However, the tool cannot include specific curricular references without context.

The ChatGPT demonstrated the ability to autonomously generate assessments and workshops with precise instructions. However, the materials required revision because of the complexity of the tasks and thematic scope. This highlights the need for faculty to oversee any content created.

**Keywords:** ChatGPT, artificial intelligence, natural language, text generation, chatbots, math prompts, math education.

### 1. Introduction

Chatbots and artificial intelligence (AI) are transforming the manner in which people interact with technology. One such tool is ChatGPT, a generative language model developed by OpenAI that can effectively hold complex conversations and answer questions. Education is one of the fields that can benefit from virtual assistants, such as the ChatGPT.

However, responsible pedagogical use requires strategies that guide these interactions, both ethically and critically. Teachers face challenges in effectively delivering content with limited resources. Therefore, this thesis sought to explore how ChatGPT can be used as a tool to enhance pre-service teachers' mathematics instruction.

Chatbots and artificial intelligence (AI) are changing the way the world interacts with computers, automating tasks, and managing information. Since its launch in November 2022, the Generative Pretrained Transformer (ChatGPT) has had a huge global impact on generative artificial intelligence (AI). ChatGPT is an impressive generative language model developed by OpenAI that can hold complex conversations on large scales, answer questions, perform basic tasks, correct false statements, and explain complex concepts in a way that is understandable and easy for any user to manipulate. Despite some initial critical opinions about its ability to generate misleading or unethical

answers, ChatGPT represents a significant advance in automated conversations. Every day, it transforms the way we obtain information and, due to its constant updates, promises a better outlook that points to a technological and educational future, including add-ons that improve at an unimaginable speed.

Education is one of the fields that could greatly benefit from the incorporation of intelligent virtual assistants, such as ChatGPT. Teachers face constant challenges in meeting the individual needs of students, in tasks such as lesson planning and activities, and in providing high-quality inclusive education with limited resources and time.

The general objective was to propose strategies for implementing ChatGPT in the creation of mathematics teaching materials. The specific objectives included designing a usage guide, providing prompts as instructions, and raising the awareness of ethical use. The methodology was a qualitative case study of 6 undergraduate mathematics students.

## **2. Conceptual framework**

### **2.1 Definition of CHATGPT**

ChatGPT is a chat system based on the GPT-3.5 Artificial Intelligence language model developed by OpenAI. It is a model with more than 175 million parameters, and is trained using large amounts of text to perform tasks. In the case of ChatGPT, AI was trained to maintain conversations with anyone. Its algorithms should be able to understand what you are asking precisely, including the adjectives and variations you add to your sentences, and respond in a coherent way.

OpenAI chatbots have a wide range of possibilities. However, to obtain precise and coherent responses, it is necessary to use prompts, commands, or requests that are provided to the model to generate text automatically.

### **2.2 Definition of prompts**

A prompt refers to an initial instruction or text provided to a language model to guide the generation of responses or coherent text. It can be a sentence, question, or even an entire paragraph that sets the context or defines the task the AI system is expected to accomplish.

### **2.3 Ministry of National Education of Colombia - MEN**

The Ministry of National Education of Colombia (MEN) is the ministry of the Republic of Colombia in charge of formulating national education policy, promoting the development of competitive and quality education that generates opportunities for progress and prosperity and contributes to closing inequality gaps.

### **2.4 Educational planning**

Educational planning is responsible for specifying the purpose, objectives, and goals of an education. Owing to this type of planning, it is possible to define what resources and strategies do to do.

### **2.5 Teaching materials**

Materials are different elements that can be grouped into a set and gathered according to their use for a specific purpose. The elements of the set can be real (physical), virtual or abstract.

Teaching material brings together means and resources that facilitate teaching and learning. They are usually used within an educational environment to facilitate the acquisition of concepts, skills, attitudes, and skills.

### **2.6 Institutional educational project - PEI**

PEI is the navigation chart of schools and colleges that specifies, among other aspects, the principles and purposes of the establishment, the teaching and didactic resources available and necessary, the pedagogical strategy, the regulations for teachers and students, and the management system.

## **3. Materials and methods**

This research is presented as a qualitative case study with a confirmatory approach, seeking to test the hypothesis that the use of CHATGPT can be a useful tool for mathematics teachers in training to develop quality pedagogical and didactic materials. A case study research design was used to explore the implications of generative technology such as ChatGPT for teacher education and to suggest ways in which mathematics pre-service teachers can use generative AI-style tools such as ChatGPT to improve lesson planning and pedagogical materials.

In the process of this study, a schedule of activities was carried out that included the following: first, convenience sampling was carried out, choosing six students from the Bachelor of Mathematics program who were studying from the sixth to eighth semester, who provided training on the optimal use of this tool for pedagogical purposes, following the guidelines and protocols previously designed as part of the specific objectives of the research (see Annex). A previous questionnaire was applied to determine the level of knowledge and manipulation of this tool, followed by a subsequent form after having received instruction.

Six students were asked to prepare five complete lesson plans for each participant, which included certain criteria given by the PEI using CHATGPT, in which a specific topic corresponding to the five mathematical thoughts that are currently being worked on at the level was addressed, school, and defined by the MEN. Based on these plans, analysis of the results was carried out qualitatively, observing the content of the materials prepared to identify patterns and obtain conclusions. The document analysis procedure was conducted in terms of the objective of this study, and a general evaluation of the lesson plans made by ChatGPT (3.5 turbo) was conducted, followed by its ability to suggest supporting material based on the lesson plans.

The main limitation is the small convenience sample size, which does not allow for absolute generalization. However, an initial exploratory study could provide important insights and comments on the potential of CHATGPT in this specific field.

In summary, this methodological design seeks, in the time available, to test the hypothesis about the benefits of CHATGPT for mathematics teachers in training.

## **4. Results**

### **4.1 Project development**

In the first instance, the population is made up of students from Bachelor's program in Mathematics at the University of Sucre. Subsequently, six students from the program, who were studying between the sixth and eighth semesters, were chosen to be part of the sample. The first questionnaire, carried out through Google Form, was designed to determine the level of prior knowledge that graduates in mathematics in training have about the use of CHATGPT (currently the most popular AI chatbot). In the second instance, the six students designed lesson plans that addressed the five mathematical thoughts defined by the MEN, with free themes and without training in the use of CHATGPT.

Subsequently, we proceeded to observe the lesson plans without instruction and free themes to evaluate how knowledge and instruction of this tool is necessary to take full advantage of the capacity of this powerful instrument. Instructions are then given based on prompts from the list or protocol guide designed for this project, and it is suggested to repeat the activity again, but with the corresponding instruction and support. In total, 30 lesson plans were designed with instructions that were reviewed individually.

At the end of this activity, the prepared lesson plans were evaluated again with the six participants, using an evaluation matrix based on some of the aspects that the PEI requires of a lesson plan, again using Google Form. A comparison is made between the first lesson plans prepared and the last ones to reflect, analyze, and detect patterns of this tool in the creation of lesson plans in the area of mathematics.

Finally, from the lesson plans designed with instruction by the sample participants, we proceeded to choose some lesson plans at random and design workshops, guides, or activities (without participation of the sample students), with the help of the list of prompts or protocol guide mentioned above, to demonstrate the coherence that CHATGPT has to link and continue conversations and design pedagogical material based on the class plans already prepared.

## 4.2 Analysis of project development

The first activity, designed with CHATGPT, consisted of designing five lesson plans for a particular grade for each student designed to strengthen the five mathematical thoughts for high school:

- Numerical Thinking and Number Systems
- Spatial Thinking and Geometric Systems
- Metric Thinking and Measurement Systems
- Random Thinking and Data Systems
- Variational Thinking and Algebraic and Analytical Systems

For practicality, a single lesson plan was selected for each grade, from sixth to eleventh.

**Figure 1.** Sixth grade lesson plan chosen randomly without guidance with numerical thinking

ChatGPT 3.5

**Anonymous**  
Hazme un plan de clases para el grado sexto con el pensamiento numérico, el tema que sea sobre los números negativos y que la duración de la clase sea para dos horas. Necesito que esté bien estructurado con actividad motivacional, ejemplos y actividades para los estudiantes

**ChatGPT**  
Clase: Números Negativos (Duración: 2 horas)

**Objetivo General:**

- \* Comprender y manejar conceptos relacionados con números negativos, incluyendo su representación, operaciones básicas y aplicaciones en la vida cotidiana.

**Objetivos Específicos:**

1. Identificar y representar números negativos en una recta numérica.
2. Realizar operaciones de suma, resta, multiplicación y división con números negativos.
3. Aplicar el concepto de números negativos en situaciones de la vida cotidiana.
4. Resolver problemas que involucren números negativos.

**Estructura de la Clase:**

**I. Actividad Motivacional (15 minutos):**

- \* Iniciar la clase con una pregunta motivadora: "¿Alguna vez te has preguntado qué significa un número negativo?"
- \* Pedir a los estudiantes que compartan ejemplos de situaciones en las que han encontrado números negativos en la vida cotidiana.
- \* Mostrar un video corto o una imagen que ilustre una situación con números negativos (por ejemplo, una temperatura bajo cero) para captar la atención de los estudiantes.

**II. Introducción a los Números Negativos (20 minutos):**

- \* Explicar qué son los números negativos y cómo se representan en una recta numérica.
- \* Dibujar una recta numérica en la pizarra y colocar ejemplos de números negativos en ella.
- \* Invitar a los estudiantes a participar en la representación de números negativos en la recta numérica.

**III. Operaciones Básicas con Números Negativos (30 minutos):**

- \* Explicar cómo se realizan las operaciones de suma, resta, multiplicación y división con números negativos.
- \* Proporcionar ejemplos de cada operación y resolverlos en la pizarra.
- \* Dividir a los estudiantes en parejas y proporcionarles hojas de ejercicios para practicar las operaciones básicas con números negativos.

**IV. Aplicaciones en la Vida Cotidiana (20 minutos):**

- \* Discutir ejemplos de situaciones de la vida cotidiana en las que se utilizan números negativos, como temperaturas, finanzas personales y coordenadas geográficas.
- \* Pedir a los estudiantes que compartan ejemplos adicionales que conozcan.

**V. Resolución de Problemas (30 minutos):**

- \* Plantear problemas que involucren números negativos y trabajar en su resolución como clase.
- \* Proporcionar ejercicios adicionales a los estudiantes para que los resuelvan en grupos.
- \* Invitar a algunos estudiantes a compartir sus soluciones en la pizarra y discutirlos como grupo.

**VI. Resumen y Evaluación (15 minutos):**

- \* Resumir los conceptos clave sobre números negativos y su aplicación en la vida cotidiana.
- \* Realizar una breve evaluación escrita o una discusión en grupo para verificar la comprensión de los estudiantes.
- \* Aclarar cualquier pregunta o duda final que puedan tener los estudiantes.

**VII. Tarea (5 minutos):**

- \* Asignar tareas relacionadas con números negativos, como resolver problemas adicionales o buscar ejemplos en la vida cotidiana.

**VIII. Cierre de la Clase (5 minutos):**

- \* Agradecer a los estudiantes por su participación y esfuerzo durante la clase.
- \* Motivarlos a seguir explorando el tema de los números negativos fuera del aula.

**Materiales:**

- \* Pizarra o papelógrafo.
- \* Marcadores o tiza.
- \* Hojas de papel y lápices para los estudiantes.
- \* Recta numérica.

**Figure 2.** Seventh-grade lesson plans were chosen randomly without guidance from metric thinking and measurement systems.

**Anonymous**  
Actúa como un profesor de matemáticas y Realizame un plan de clase de grado 7 de 2 horas de duración, del tema de sistema de medida, basándote en los estándares de competencia y derechos básicos de Colombia, el plan de clase debe contener objetivo, junto con unas actividades de afianzamiento con situaciones problemas que involucren las competencias matemáticas

**ChatGPT**  
Claro, puedo ayudarte a diseñar un plan de clase de matemáticas para séptimo grado sobre sistemas de medida, basado en los estándares de competencia y derechos básicos de Colombia. Aquí tienes un plan de clase de 2 horas de duración:

**Tema de la Clase:** Sistemas de Medida

**Estándares de Competencia:**

- \* Comprender y utilizar sistemas de medida para longitud, masa y capacidad.
- \* Realizar conversiones entre unidades de medida.
- \* Resolver problemas prácticos que involucren mediciones.

**Objetivo de la Clase:** Los estudiantes serán capaces de entender y utilizar los sistemas de medida para longitud, masa y capacidad, realizar conversiones entre unidades de medida y resolver problemas que involucren mediciones en contextos cotidianos.

**Materiales:**

- \* Pizarrón o pizarra digital.
- \* Marcadores o herramienta digital para escribir.
- \* Hojas de trabajo con ejercicios de conversión y problemas de medición.
- \* Reglas, balanzas y recipientes de capacidad para demostraciones.

**Duración:** 2 horas

**Desarrollo de la Clase:**

**Hora 1: Introducción a los Sistemas de Medida (60 minutos)**

1. **Inicio (10 minutos):**
  - \* Saludo a los estudiantes.
  - \* Pregunta de reflexión: "¿En qué situaciones cotidianas utilizamos sistemas de medida?"
2. **Conceptualización (20 minutos):**
  - \* Explicación teórica sobre los sistemas de medida para longitud, masa y capacidad.
  - \* Ejemplos de unidades de medida en Colombia.
3. **Actividad Individual (15 minutos):**
  - \* Los estudiantes resolverán ejercicios de conversión de unidades de medida en sus hojas de trabajo.
4. **Puesta en Común (15 minutos):**
  - \* Discusión de las respuestas y aclaración de dudas.

**Hora 2: Conversiones y Problemas de Medición (60 minutos)**

1. **Recapitulación (10 minutos):**
  - \* Breve revisión de lo aprendido en la primera hora de clase.
2. **Demostración Práctica (15 minutos):**
  - \* El profesor realizará una demostración con reglas, balanzas y recipientes para medir longitud, masa y capacidad.
  - \* Los estudiantes tomarán medidas y registrarán resultados.
3. **Actividad de Grupo (15 minutos):**
  - \* Los estudiantes trabajarán en grupos pequeños para resolver problemas de medición relacionados con situaciones cotidianas, como medir el área de una habitación o la cantidad de agua en un recipiente.
4. **Puesta en Común y Cierre (15 minutos):**
  - \* Cada grupo presentará un problema resuelto.
  - \* Discusión sobre la importancia de utilizar sistemas de medida con precisión en la vida diaria.

**Tarea para Casa:** Los estudiantes recibirán una hoja de trabajo adicional con problemas de medición y conversiones de unidades de medida. Deberán traer sus respuestas en la próxima clase.

Este plan de clase aborda los estándares de competencia en matemáticas y derechos básicos de Colombia al centrarse en los sistemas de medida, conversiones y su aplicación en situaciones cotidianas. También promueve la participación activa de los estudiantes y la resolución de problemas en grupo.

Below are the lesson plans made with the list of prompts provided in the guide or the protocol to follow.

**Figure 3.** Instruction for Sixth-grade lesson plans with numerical thinking and number systems

**Anonymous**  
A partir del estándar: " Utilizo números racionales, en sus distintas expresiones (fracciones, razones, decimales o porcentajes) para resolver problemas en contextos de medida." Y del derecho básico de aprendizaje: "Utiliza las propiedades de los números enteros y racionales y las propiedades de sus operaciones para proponer estrategias y procedimientos de cálculo en la solución de problemas."- Diseña un plan de clases para grado sexto, de dos horas de duración con el contenido central: Conjunto de los números racionales que fortalezca las competencias: Modelar procesos y fenómenos de la realidad. Incluye en el diseño del plan de clases la metodología, etapas de la clase : Inicio, desarrollo y finalización, tareas para la casa y la evaluación formativa. En formato de tablas e Incluye el estándar (abreviado como E02) y el derecho básico de aprendizaje( abreviado cómo DBA 2).

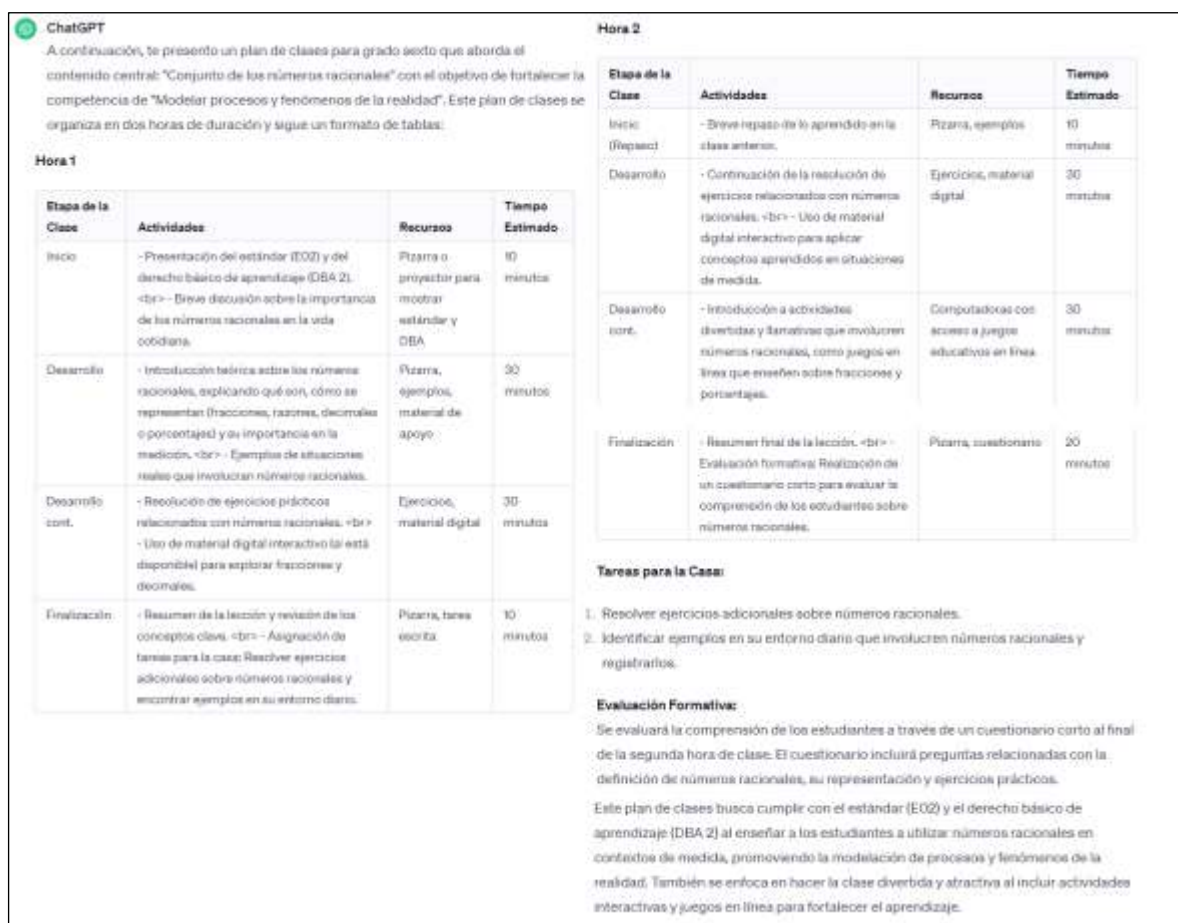


Figure 4. Instruction for Seventh Grade lesson plan with Numerical Thinking and Number Systems

**Anonymous**

A partir del estándar: " Predigo y comparo los resultados de aplicar transformaciones rígidas (traslaciones, rotaciones, reflexiones) y homotecias (ampliaciones y reducciones) sobre figuras bidimensionales en situaciones matemáticas y en el arte. " Y del derecho básico de aprendizaje: "Observa objetos tridimensionales desde diferentes puntos de vista, los representa según su ubicación y los reconoce cuando se transforman mediante rotaciones, traslaciones y reflexiones. "- Diseña un plan de clases para grado séptimo , de 2 horas de duración con el contenido temático: Poliedros y cuerpos redondos que fortalezca las competencias: Interpretación y representación.  
Incluye en el diseño del plan de clases la metodología, etapas de la clase : Inicio, desarrollo y finalización, tareas para la casa y la evaluación formativa.  
En formato de tablas e Incluye el estándar (abreviado como E17) y el derecho básico de aprendizaje( abreviado como DBA 5 )

**ChatGPT**  
 A continuación, se presenta un plan de clases para séptimo grado, centrado en el estudio de poliedros y cuerpos redondos, con el objetivo de fortalecer las competencias de interpretación y representación, en línea con el estándar E77 y el derecho básico de aprendizaje DBA 5.

**Plan de Clases - Poliedros y Cuerpos Redondos**

Etapos de la Clase	Objetivos	Actividades
<b>Inicio</b>	- Introducir el estándar E77 y el DBA 5.	- Presentar una breve definición de poliedros y cuerpos redondos.
	- Comprender la importancia de la representación de objetos tridimensionales.	- Preguntar a los estudiantes si han sido familiarizados con poliedros y cuerpos redondos y qué saben al respecto.
	- Despertar el interés de los estudiantes con una pregunta inicial.	- Plantear una pregunta intrigante relacionada con poliedros o cuerpos redondos.
	- Establecer los objetivos de la lección.	
<b>Desarrollo</b>	- Introducir conceptos clave de poliedros y cuerpos redondos.	- Explicar qué son poliedros y cuerpos redondos, y presentar ejemplos de ambos.
	- Fomentar la participación activa de los estudiantes.	- Realizar una actividad en la que los estudiantes describan objetos tridimensionales en su entorno.
	- Enseñar a los estudiantes a identificar y clasificar poliedros y cuerpos redondos.	- Proporcionar imágenes de diferentes poliedros y cuerpos redondos y pedir a los estudiantes que los clasifiquen.
	- Presentar transformaciones rígidas y homotecias en contextos tridimensionales.	- Explicar conceptos como traslaciones, rotaciones, reflexiones, ampliaciones y reducciones en el contexto tridimensional.

	- Realizar ejercicios prácticos de identificación y transformación de objetos tridimensionales.	- Proporcionar ejercicios en los que los estudiantes deban predecir y comparar los resultados de las transformaciones en poliedros y cuerpos redondos.
	- Fomentar la colaboración entre los estudiantes en la resolución de problemas.	
<b>Finalización</b>	- Realizar una recapitulación de los conceptos aprendidos.	- Pedir a los estudiantes que compartan sus experiencias al identificar y transformar objetos tridimensionales.
	- Asignar tareas para la casa que refuercen el aprendizaje.	- Proporcionar ejercicios para que los estudiantes practiquen la identificación y transformación de objetos en casa.
	- Preparar a los estudiantes para la evaluación formativa.	- Explicar el formato de la evaluación formativa y aclarar cualquier duda.
<b>Tareas para Casa</b>	- Identificar y representar objetos tridimensionales en su entorno.	- Pedir a los estudiantes que busquen objetos tridimensionales en su casa o entorno y los representen gráficamente.
	- Realizar ejercicios de transformaciones rígidas y homotecias en objetos tridimensionales.	- Proporcionar ejercicios que requieran que los estudiantes predigan y comparen resultados de transformaciones en objetos tridimensionales.
<b>Evaluación Formativa</b>	- Evaluar la capacidad de los estudiantes para identificar, representar y predecir transformaciones en objetos tridimensionales.	- Realizar una evaluación en clase que incluya preguntas y problemas relacionados con la identificación y transformación de poliedros y cuerpos redondos.
	- Proporcionar retroalimentación a los estudiantes.	- Corregir las evaluaciones en clase y discutir las respuestas con los estudiantes.
	- Identificar áreas en las que los estudiantes necesitan más apoyo.	

## Conclusions

This chapter concludes the study by summarizing the key research findings in relation to the research objectives and questions and discussing their value and contribution. It also reviews the limitations of the study and provides an overview of opportunities for further research.

The findings related to the project reflect different points to consider that are related to the problem statement. How can CHATGPT be adapted and used as a tool for pre-service mathematics teachers to improve the quality of teaching and learning in this discipline and support their future work in an ethical manner?

Lesson plans developed with and without prior instruction showed significant differences. In the plans created without instruction, little clarity or coherence was evident in the objectives, sequences, and proposed teaching strategies. This shows the need to train students in the use of tools such as ChatGPT and teach them to give precise instructions about the educational context (theme, level, curricular standards, student needs, or level of knowledge).

On the other hand, the plans prepared with detailed instructions showed positive quality in terms of structuring the contents, measurable objectives, varieties of ideas, and adequate selection of resources. However, in the absence of prior information, the ChatGPT was unable to include specific references to Colombian DBAs or curricular standards.

These results show that, although the tool has massive text generation capabilities, it depends largely on the precision and quality of the instructions given by the user. Therefore, it is crucial for teachers in training to master the theoretical and practical foundations of educational planning to get the most out of the virtual assistant.

With detailed instruction, ChatGPT can support teacher creativity by providing guidance and examples of lesson plans in a short time, thus providing a quick overview and/or outline for planning more lessons in a systematic and orderly manner. However, it requires validation by the teacher from a critical point of view and assumes that it is a tool and not a human being since CHATGPT provides information that is too generalized regarding certain topics.

In the development of the schedule of activities to design evaluations and workshops based on the prepared class plans, it was evident that ChatGPT had the ability to autonomously generate this type of supportive teaching material. By providing precise instructions on the topic and objectives, the system was able to devise different types of practical activities, such as individual, guided, or group workshops, as well as rubrics and performance criteria for competency-oriented formative assessments.

However, when reviewing these materials in detail, it was found that sometimes the complexity or level of difficulty of the exercises, questions, or tasks posed was not directly related to the degree of depth expected for the topic and the level of the students involved. This discrepancy could be due to limitations in the assistants' ability to fully understand the educational context to which these instruments were directed.

One of the main limitations of this study is the small sample size, which consisted of only six undergraduate mathematics students. This small number of participants makes it difficult to generalize the results to the entire population of future mathematics teachers.

Another limitation was associated with the qualitative approach chosen through a case study. Although this allowed for an in-depth analysis of the individual experiences of each participant, measurements or statistical comparisons with quantitative rigor could not be established.

Although these limitations prevented us from conclusively generalizing the results, the study managed to provide significant initial guidelines that justify further, broader, and more rigorous research.

## 5. Recommendations

The findings obtained in this research provide the opportunity to continue deepening and investigating the potential of generative AI tools such as ChatGPT to support educational processes, among which the following ideas are raised:

- Expand the sample of participants: Conduct new studies with a larger and more diverse sample of teachers in training and service. This would allow us to better generalize the results and detect possible variations associated with factors such as educational level, area of specialization, and teaching experience, among other aspects that could not be generalized in this research.
- Compare updated versions and/or other models: Conduct comparative analyses between ChatGPT and its future versions, such as ChatGPT-4, to evaluate improvements in capability, accuracy, and educational usefulness. You could also explore the use of custom GPTs or other models such as Claude, Google Bard, and Microsoft Bing, among others.
- Validate the quality of materials: Implement studies that evaluate the quality of the materials generated with ChatGPT through specific pedagogical criteria and expert opinion. (With a sample of veteran teachers in teaching) This allows us to evaluate their real suitability for educational purposes.

This type of work would allow us to expand knowledge about the real capabilities, benefits, and limitations of these assistants to optimize their complementary role in the educational field in a responsible, ethical, and pedagogically significant manner.

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