Advances in Differential Equations and Control Processes 2025, 32(1), 2259.
https://doi.org/10.59400/adecp2259

Article

Learning of a certain homogeneous reducible differential equation by means of ChatGpt in engineering students during the second semester of 2024 in Antofagasta-Chile

Jorge Olivares[1,*], **Byron Droguett**[2], **Pablo Martin**[2]

[1] Department of Mathematics, University of Antofagasta, Antofagasta 1240000, Chile

[2] Department of Physics, University of Antofagasta, Antofagasta 1240000, Chile

*** Corresponding author:** Jorge Olivares, jorge.olivares@uantof.cl

CITATION

Olivares J, Droguett B, Martin P. Learning of a certain homogeneous reducible differential equation by means of ChatGpt in engineering students during the second semester of 2024 in Antofagasta-Chile. Advances in Differential Equations and Control Processes. 2025; 32(1): 2259. https://doi.org/10.59400/adecp2259

ARTICLE INFO

Received: 10 December 2024
Accepted: 6 February 2025
Available online: 17 March 2025

Abstract: The main objective of this research work was to investigate the learning of a certain homogeneous reducible differential equation by means of ChatGpt in engineering students, during the second semester of 2024 in Antofagasta-Chile. This research followed a qualitative case study approach. Four students of the differential equations course were chosen. Personalized interviews of three questions, related to the general objective and two specific ones, were established after solving a certain exercise, through ChatGpt collaboration. It was found that the opinions expressed about the use of this artificial intelligence are very positive and valuable, evidencing what was stated by several authors. Finally, it can be concluded that the perception of ChatGpt enriches the mathematical confidence in the development of computers, which generates security in learning.

Keywords: case study; qualitative; artificial intelligence; learning strategies; differential equations

1. Introduction

Research on learning the homogeneous reducible differential equation $y' = 2 - y/x$ using ChatGPT among engineering students, particularly at the University of Antofagasta in Chile, stems from the need to explore innovative educational methodologies that integrate advanced technological tools into the teaching-learning process. In an era where digital technologies play an increasingly prominent role in education, it is essential to investigate how platforms like ChatGPT can enhance the understanding of complex mathematical concepts and improve the overall learning experience. This study focuses on identifying both the positive aspects that students perceive when using this tool and the difficulties and limitations they face, which will allow us to obtain a comprehensive view of its effectiveness in learning homogeneous reducible differential equations. The qualitative case study approach selected for this research is particularly appropriate as it allows a deep and contextualized exploration of the experiences perceived by the students. Through interviews and a problem to solve, this approach offers a rich understanding of the phenomenon studied, which can contribute to the improvement of educational practices along with the birth of new strategies, as stated by [1–8]. In [9], research on the teaching of differential equations highlights that this is an active field with a growing number of articles published over the last decade. However, much remains to be done to address the challenges associated with teaching and learning differential equations through the use of artificial intelligence in the various educational institutions where this subject is taught.

Lastly, the use of teaching strategies, along with information and communication technologies (ICT) such as ChatGPT, can strengthen teacher-student relationships and contribute to the creation of environments conducive to knowledge and learning [10].

2. Methodology and materials

The present research is a qualitative case study in which 4 students, out of a total of 12, were selected by the principal investigator from an engineering differential equations course during the second semester of 2024. The study investigates the role of ChatGPT in the learning process for solving a homogeneous reducible differential equation.

2.1. Objectives

2.1.1. General objective

To investigate the learning process of the homogeneous reducible differential equation

$$\frac{dy}{dx} = 2 - \frac{y}{x}$$

using ChatGPT among engineering students during the second semester of 2024 in Antofagasta, Chile.

2.1.2. Specific objectives

1) To identify the positive aspects perceived by engineering students when using ChatGPT to learn the homogeneous reducible differential equation.
2) To explore the difficulties and limitations experienced by engineering students in using ChatGPT to solve the homogeneous reducible differential equation.

2.2. Methodology

The study was divided into the following phases:

2.2.1. Phase 1: Initial resolution

The teacher and 12 students were in a classroom equipped with internet access and computers. The teacher divided the students into 3 groups of 4 and sent them the exercise

$$\frac{dy}{dx} = 2 - \frac{y}{x}$$

via email. Students were instructed to solve the problem without using AI or other technological tools, and without consulting the teacher. This phase lasted 30 min.

2.2.2. Phase 2: Interaction with ChatGPT

The teacher provided a link to ChatGPT: https://chatgpt.com/share/6715a21e-4388-800f-976b-d507a06a8e37.

Students were asked to use ChatGPT individually, and as groups to solve the exercise, and to provide feedback on the answers generated by the AI. This phase lasted 30 min.

2.2.3. Phase 3: Sharing results

Each student shared their resolution of the exercise via email with their classmates and the teacher. This phase lasted 5 min.

2.2.4. Phase 4: Interviews

The teacher selected 4 students and conducted individual interviews, posing the following questions:

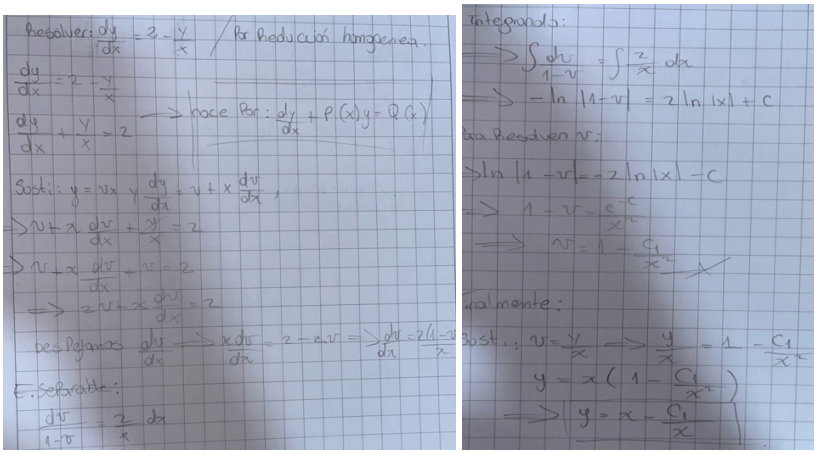
1) How would you describe your experience using ChatGPT to learn the differential equation $\frac{dy}{dx} = 2 - \frac{y}{x}$?
2) What specific aspects of ChatGPT did you find most beneficial in learning the differential equation $\frac{dy}{dx} = 2 - \frac{y}{x}$?
3) What were the main difficulties or limitations you faced in using ChatGPT to solve the differential equation $\frac{dy}{dx} = 2 - \frac{y}{x}$?

This phase lasted 25 min. At the end of the session, the teacher thanked all participants for their collaboration.

2.3. Answers given by students to the exercise

2.3.1. Answers given by first student

Figure 1 and the answers of the first student to the three interview questions were as follows:



(**a**) (**b**)

Figure 1. Responses provided by first student. (**b**) is the continuation of the response in (**a**).

Response 1: My experience with this AI, in general, is always satisfactory because I found a very good tool for study, and everything is very easy to understand.

Response 2: The most specific aspects are the fast delivery of information and the ability to focus on exactly what you want to study. No matter how difficult the subject may seem, with this Artificial Intelligence, everything becomes easier.

Response 3: The main limitation is that the Artificial Intelligence is not free, which restricts the study time. Additionally, you have to be very specific in the instructions; otherwise, it may not provide the correct resolution or result.

2.3.2. Answers given by second student

Figure 2 and the second Student answers to the three interview questions were as follows:

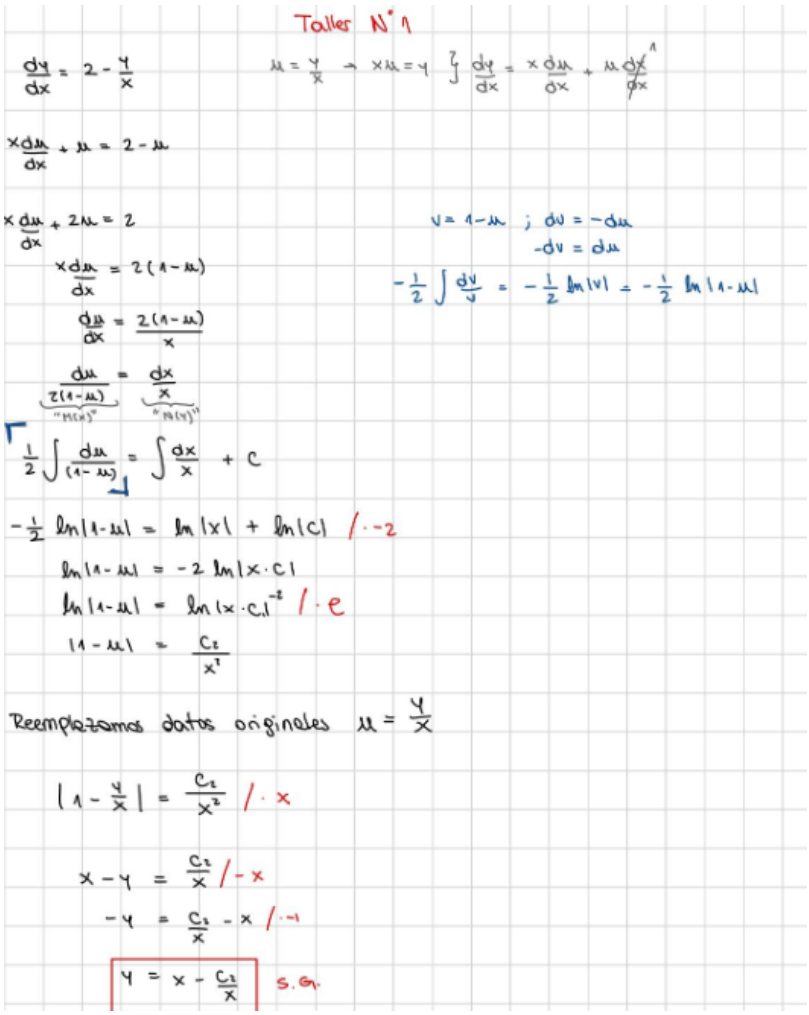


Figure 2. Responses provided by second student.

Response 1: This process was faster for me, because the steps were easier to visualize, and more aligned with my own approach.

Response 2: The most useful aspect was that the ChatGPT could explain concepts directly and clearly without skipping difficult steps, making them easy to understand on the first attempt.

Response 3: I did not find any difficulty in understanding each step, as it was very similar to my approach. However, ChatGPT skipped some steps that I had already understood.

2.3.3. Answers given by third student

Figure 3 and the third Student answers to the three interview questions were as follows:

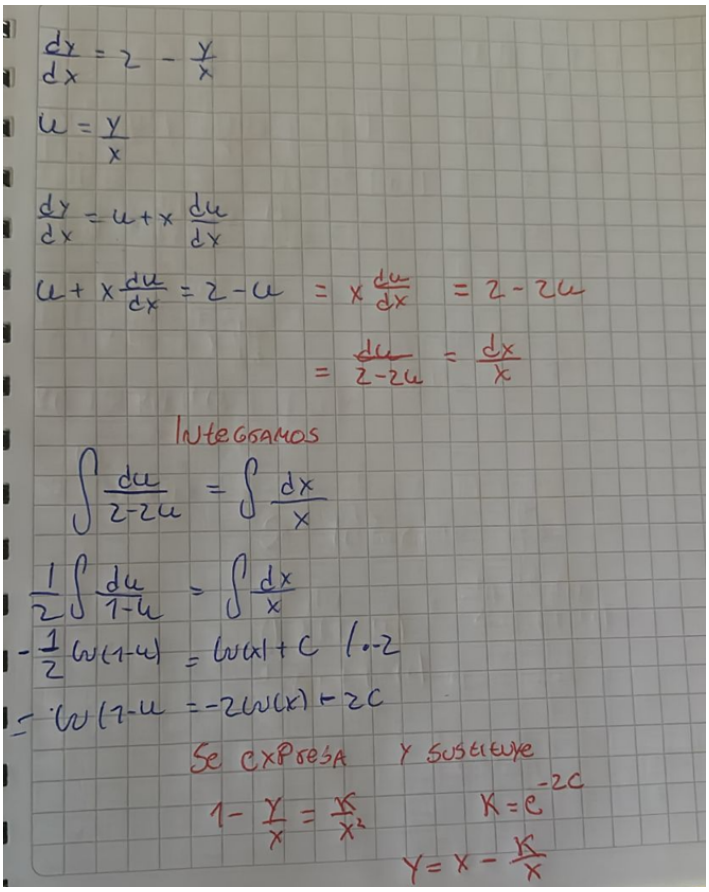


Figure 3. Responses provided by third student.

Response 1: It was really effective for studying because I could use ChatGPT's explanations as references when solving exercises.

Response 2: It simplified the process by breaking down the steps, allowing me to integrate them more easily without overcomplicating the process.

Response 3: ChatGPT can make mistakes, so it is not a good idea to rely 100%.

2.3.4. Answers given by student 4

Figure 4 and the fourth Student answers to the three interview questions were as follows:

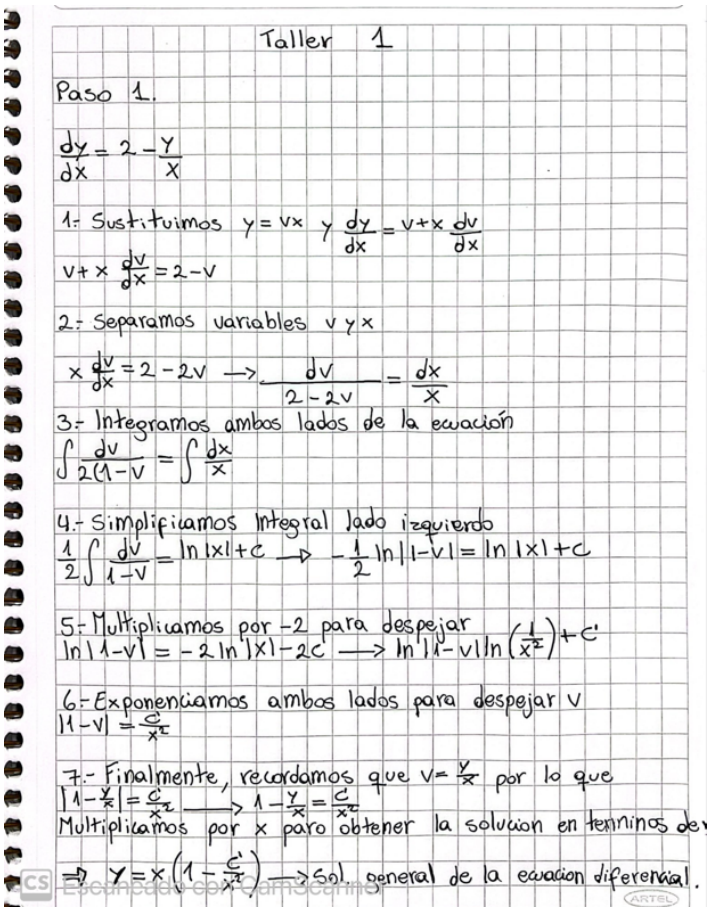


Figure 4. Responses provided by fourth student.

Response 1: My experience was good because it helped me significantly in solving the exercise.

Response 2: The most beneficial aspect was the clear, step-by-step explanations.

Response 3: I did not encounter any difficulties or limitations.

3. Discussion

The three interview questions were derived from the study of objectives. Based on the responses to question 1 and references [1,2], there is consensus on the importance of adapting educational strategies, such as to one employed in this research, to create positive educational experiences, and foster a blended, guided learning process involving both the teacher and ChatGPT.

Similarly, considering the answers to questions 2 and 3, along with reference [3], it becomes evident that conducting qualitative studies of this nature is essential. Such studies help establish clear expectations and to provide guidance on the integration of artificial intelligence tools like ChatGPT in mathematics learning processes [4], particularly in the context of differential equations.

4. Conclusions

4.1. Conclusion to question 1

The responses of the four students reflect a positive perception of using ChatGPT in learning differential equations. They found that the AI facilitated their understanding by providing clear and straightforward explanations of the steps. Additionally, they

noted that the tool made the learning process faster and more visually accessible, allowing them to derive useful references for their exercises.

4.2. Conclusion to question 2

In general, students appreciated the speed and accessibility of the information provided, as well as the clarity and simplicity of the explanations. They valued that ChatGPT did not omit challenging steps and affirmed the usefulness of the step-by-step, organized approach in the explanations.

4.3. Conclusion to question 3

Some students highlighted the need to provide very specific instructions and pointed out the limitation of access due to the tool not being free. Others mentioned that ChatGPT can occasionally make errors, which required them to confirm its output with additional sources. However, some students reported no significant difficulties, noting that the tool was straightforward and comprehensible.

5. Summary

In summary, the use of ChatGPT was enthusiastically received by students for their learning process. This indicates the need to continue exploring and rethinking traditional learning methods in light of advancements like ChatGPT, as suggested by references [5,6].

Furthermore, this research raises important questions for readers about conducting new studies that combine artificial intelligence with other software tools. It invites exploration of the educational and research activities that can be undertaken, as proposed in references [7,8].

Author contributions: Conceptualization, JO, BD and PM; methodology, JO, BD and PM; software, JO, BD and PM.; validation, JO, BD and PM; formal analysis, JO, BD and PM; resources, JO, BD and PM; data curation, JO, BD and PM; writing—original draft preparation, JO, BD and PM; writing—review and editing, JO, BD and PM; visualization, JO, BD and PM ; supervision, JO, BD and PM; project administration, JO, BD and PM; funding acquisition, JO, BD and PM. All authors have read and agreed to the published version of the manuscript.

Acknowledgments: This work was funded by Research Management Directorate at the University of Antofagasta-Chile. We thank the University of Antofagasta, especially the Teaching Innovation Management Area via the University Teaching Investigation Support Program (PAIDU) to which the University Teaching Investigation Core belongs (NIDU 2-001-22) called “Geogebra Applets for teaching Mathematics”, whose members are responsible for the investigation which led to the present publication. Thank you for your support, accompaniment and formative program intended to promote investigation in Teaching and elevating the academic indicators of this institution.

Conflict of interest: The authors declare no conflict of interest.

References

1. Sánchez-Ruiz LM, Moll-López S, Nuñez-Pérez A, et al. ChatGPT Challenges Blended Learning Methodologies in Engineering Education: A Case Study in Mathematics. Applied Sciences. 2023; 13(10): 6039.
2. Farahani MS, Ghasmi G. Artificial Intelligence in Education: A Comprehensive Study. Forum for Education Studies. 2024; 2(3): 1379.
3. Wardat Y, Tashtoush MA, AlAli R, Jarrah AM. ChatGPT: A Revolutionary Tool for Teaching and Learning Mathematics. Eurasia Journal of Mathematics, Science and Technology Education. 2023; 19(7): em2286.
4. Ávila MU, Crespo LF, Moya M, et al. Using GPT chat as a literacy strategy in digital teacher competence in mathematics education (Spanish). In: Proceedings of the 19th National Congress on Technology in Education and Education in Technology-TE&ET; 13–14 June 2024; Morón, Venezuela.
5. Galli MG, Kanobel MC. ChatGPT in Higher Education: exploring its potential and limitations (Spanish). Educación Superior y Sociedad (ESS). 2023; 35(2): 174–195.
6. Berrones Yaulema LP, Buenaño Barreno PN. ChatGPT in the Educational Environment (Spanish). Esprint Research. 2023; 2(2): 45–54.
7. Funes JO, Parada BD, de Julian PM, Villegas AB. Incorporation of GeoGebra Applets and ChatGPT to Strengthen the Learning of Exact Equations in Engineering Students. In: Mathematics and Computer Science: Contemporary Developments. Narosa Publishing House; 2024. pp. 133–143.
8. Funes JO, Valero Kari ER, Martin P. Description of Parameter Variation Learning with Artificial Intelligence and GeoGebra in Students of a Differential Equations Course. Journal of Physics: Conference Series. 2024; 2701: 012049.
9. Lozada E, Guerrero-Ortiz C, Coronel A, Medina R. Classroom methodologies for teaching and learning ordinary differential equations: A systemic literature review and bibliometric analysis. Mathematics. 2021; 9(7): 745.
10. Ojeda AD, Solano-Barliza AD, Alvarez D, Cárcamo EB. Analysis of the impact of ChatGPT artificial intelligence on teaching and learning processes in higher education (Spanish). Formación Universitaria. 2023; 16(6): 61–70.