Animations and interactive creations in linear differential equations of first order: the case of Geogebra

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Animations and interactive creations in linear differential equations of first order: the case of Geogebra

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Abstract. GeoGebra is one of the software that is used in the teaching of mathematics and differential equations. By using GeoGebra, which is a dynamic and educational software, one can acquire the expected learning, especially in linear differential equations of the first order, which is a lesson in which intense learning difficulties are experienced. In this document, interactive animated applications have been made for engineering students of the University of Antofagasta, Chile, so that they can learn through technological resources.

1. Introduction

Within the basic training of an engineering student at the University of Antofagasta of Chile, knowledge of differential equations plays a very crucial role and teachers must pay close attention to the way they teach. In addition, linear differential equations of the first order, which deal with various engineering problems, is a very dynamic subject. Teaching and learning in how are the solutions of linear differential equations especially those of first order is still very difficult when only static or fixed images are used, no matter matter how good they are.

Mathematical visualization is the process of image formation (either mentally, or with pencil and paper, or with the help of technology) and the effective use of such images for mathematical discovery and understanding and in our special case we will concentrate in the visualization of several examples of a first order linear differential equation and its solutions.

To achieve a deep understanding, visualization can not be isolated from the rest of mathematics. Students must learn how ideas can be represented symbolically, numerically and graphically, and move forward and backward between these modes (1), (3). For example, students generally need to transform the solutions of differential equations into Cartesian graphs. This type of transformation is called conversion. To allow students to approach the concepts of a linear differential equation studied in a first course of differential equations, using various GeoGebra applets. We resort to the use of geogebra software mainly for the freedom to execute it and that through several experiences of the integration of GeoGebra it is demonstrated

that it offers possibilities to students the development of intuition through the visualization of mathematical processes, allowing.

Students explore a variety of types of functions through connections between symbolic and visual representations (2), (4). The objective of this paper is to show some animations with examples of linear differential equations of the first order, emphasizing their solutions. These tools were designed for the course of Differential Equations of the Department of Mathematics of the Faculty of Basic Sciences of the University of Antofagasta. It is possible to use or download these Applets and others on the website https://edocongeogebra.blogspot.cl.

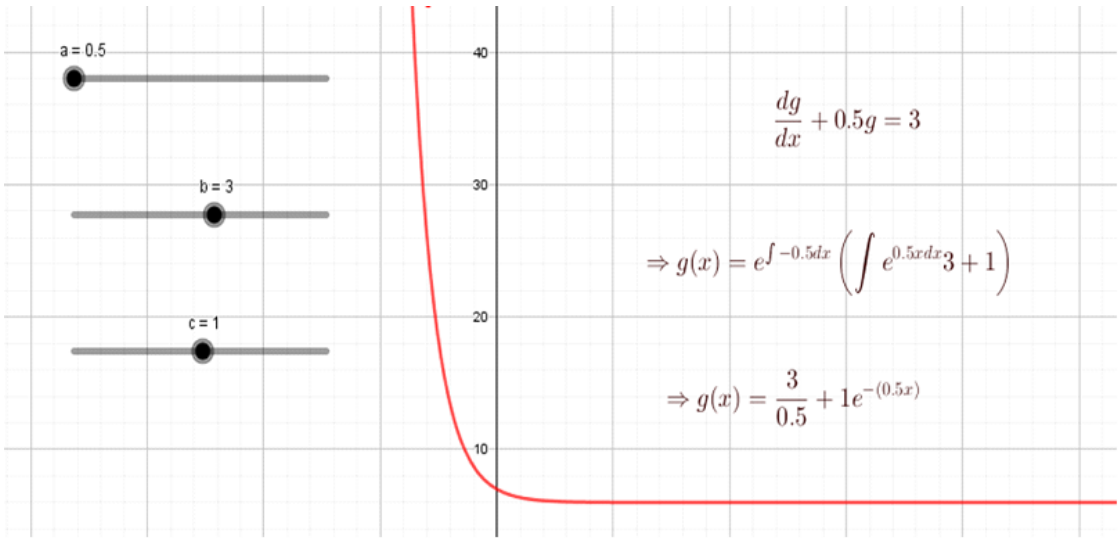
2. The Applets Geogebra

GeoGebra application is an interactive and free software that combines algebra and calculus allowing diverse representations of mathematical objects. It is also possible to determine derivatives and integrals of functions and identify their singular points. GeoGebra is a practical and easy to use tool that allows you to create interactive learning objects that can vary from simple graphics to dynamic web pages. To facilitate the visualization of a first order linear differential equation taught in the course of differential equations, the following applets and examples were prepared.

Example 1 *Here the differential equation*

$$\frac{dg}{dx} + a \cdot g = b$$

Where; a and b are real constants and with the slider that moves between 0.5 and 5. In Figure 1 the solution is given by $g(x) = \frac{b}{a} + Ce^{-ax}$ *, where* C *is a real constant and moves for comfort purposes in the calculation between -50 and 50.*



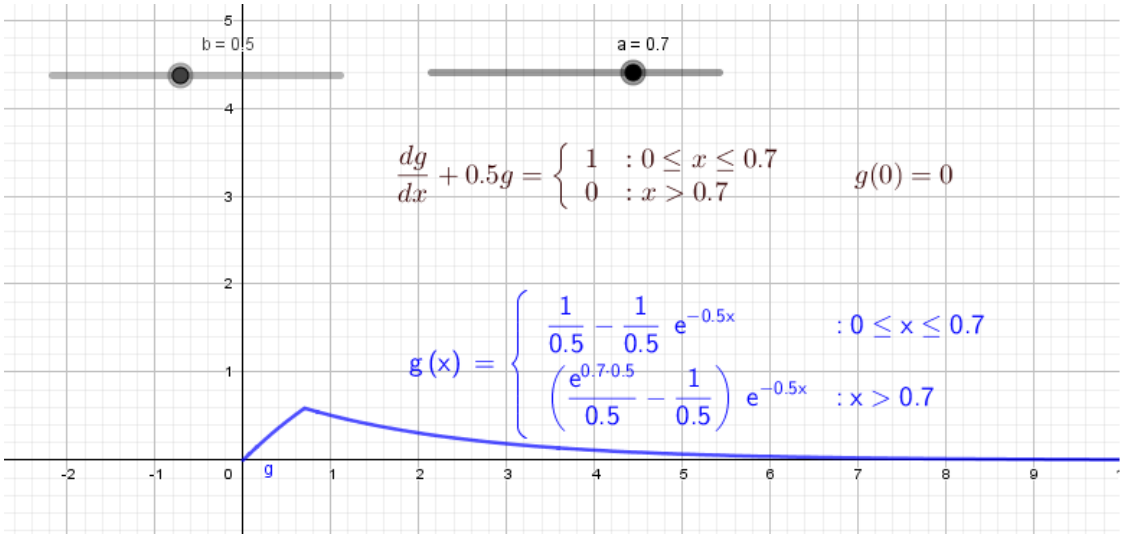
Example 2 *Here the differential equation*

$$\frac{dg}{dx} + b \cdot g = \begin{cases} 1 & 0 \leq x \leq a \\ 0 & a < x \end{cases}$$

Where b, is a real constant with the slider moving betwen 0.1 and 1 the value a, with the slider moves between 0 and 1.

In figure 2 the solution is given by

$$g(x) = \begin{cases} \frac{1}{b} - \frac{e^{-bx}}{b} & 0 \leq x \leq a \\ \left(\frac{e^{ab}}{b} - \frac{1}{b}\right) & a < x \end{cases}$$



Example 3 *Here the differential equation*

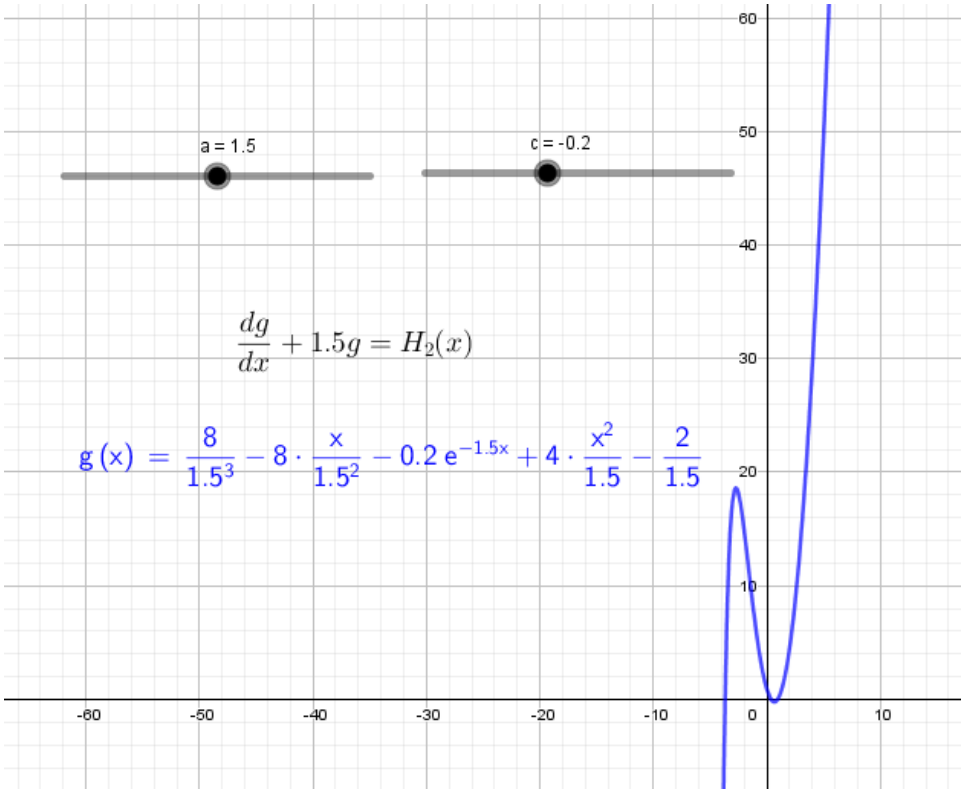
$$\frac{dg}{dx} + a \cdot g = H_2(x),$$

where a is constant real and with slider that moves between 1 and 2. $H_2(x)$ is the hermite polynomial of degree 2.

In the figure 3 the solution is given by

$$g(x) = \frac{8}{a^3} - \frac{8x}{a^2} + ce^{-ax} + \frac{4x^2}{a} - \frac{2}{a},$$

with c constant real and with the slider that moves between -1 and 1.



3. Conclusion

The linear differential equations of first order and especially their graphic solutions in the various texts and books, as well as on the blackboard, are static and sometimes very uncomfortable and difficult to visualize and require a very good imagination on the part of the students. When reflecting on the teaching and learning strategies of differential equations, we must take into account the existence of geogebra as free software with versatile capabilities and interactive representation, as it helps to improve the presentation of the taught content.

4. Reference

1 Zimmerman, W. & Cunningham, S. (1991). Editors introduction: What is mathematical visualisation? Visulasation in Teaching and Learning Mathematics. In W. Zimmennan & S. Cunningham (Eds.). Notes and Reports Series, 19. Washington DC: The Mathematics Association of America

2 Dikovic, L. (2009). Application geogebra into teaching some of mathematics at the college level. Computer Science and Information Systems, 6(2), 191-203.

3 Marta Graciela Caligaris, María Elena Schivo and María Rosa Romiti (2015. Calculus & GeoGebra an Interesting Partnership. Procedia - Social and Behavioral Sciences, Volume 174, 12 February 2015, Pages 1183-1188.

4 Fredy Barahona Avecillaa , Olga Barrera Cárdenasa , Byron Vaca (2015). GeoGebra para la enseñanza de la matemática y su incidencia en el rendimiento académico estudiantil. Revista Tecnológica ESPOL RTE, Vol. 28, N. 5, 121-132.