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PRACTICES FOR GEOMETRY TEACHING USING GEOGEBRA

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Abstract

This work proposes the use of Didactic Engineering as a teaching methodology for Plane Geometry classes at the Federal University of Jequitinhonha and Mucuri Valleys using the dynamic geometry software GeoGebra. It aims to detect the main difficulties for teaching and learning Geometry and proposes methodologies to improve the concepts for the Mathematics undergraduation course. With this goal, a didactic sequence was applied to provide the necessary basic knowledge to work with interactive dynamic geometry, always interconnected with the formal empirical knowledge, and preparing them for the teaching practice of this specific content. After some analysis, was observed an improvement in the students understanding of the fundamental mathematical concepts.

1. Introduction

Plane Geometry has always been related to the way man sees the world, whether for necessity or even curiosity. It is essential for the student's formation and there are several reasons that lead educators and society to appreciate the knowledge derived from it. Pavanelo said that Plane Geometry does not receive its due value in the student's basic formation because is often not discussed in the classroom [3]. According to Lorenzato, the two main factors that act directly in the classroom are the lack of the geometric knowledge needed by the teacher and the geometric concepts omission, usually by the teacher and the textbooks [4].This devaluation of the Plane Geometry teaching in basic education has a great reflection on the undergraduation of the Exact Sciences courses where, according to [8], the high failure rates in the mathematics areas, especially in the initial periods, are causing a great students evasion rate. In particular, Seiffert [6] reports that the Mathematics undergraduation course at the Federal University of the Jequitinhonha and Mucuri Valleys has an average evasion rate of 38%. In addition, when analyzing only the students' retention in the discipline of Plane Geometry, it was concluded that between 2008 and 2014 this percentage was 53.48%.Based on these studies, were searched teaching methodologies that can provide the student a significant improvement in his learning process. On the other hand, the way mathematics was taught is no longer an essentially cognitive activity as before, since the use of new information and communication technologies enhances the human cognitive functions and is well known that technologies have a strong impact on the teaching and learning of mathematics. Thus, the university's role is not only to provide scientific knowledge, but also to supply the establishment of the bond between the teacher, the student and the technologies [8].The use of technological resources is important since it allows students to investigate geometric problems that would hardly be noticeable if they had only chalkboard and chalk. In this context, based on the concepts of Didactic Engineering (DE), this work presents a new research methodology for Plane Geometry using GeoGebra software, which detects the main difficulties in teaching and learning process.

2. Research Methodology

To choose a research methodology is the most complex stage of the research process, as observed by Chizzotti [5] that states that the research process is a set of continuous operations that do not depend on each other, managed by a researcher with the pretension of observing a phenomenon and explaining it or understanding it and its specificities. Thus, as research in teaching mathematics is usually experimental and the student is submitted to an experimentation and a didactic intervention, it was decided to base this work on the concepts of DE. According to Artigue, this research methodology is characterized similarly as the work of an engineering, which is initially based on scientific knowledge of its area, undergoes scientific procedures and finally is suitable to more complex objects than the initial ones [2]. In addition, according to Almouloud and Coutinho a project based on DE, should contain four stages: *a priori* construction and analysis, experimentation, *a posteriori* analysis and validation [1].

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2.1. The GeoGebra Session

Before the beginning of the didactic intervention, the students were submitted to a diagnostic questionnaire that sought to collect information about their use of the GeoGebra which was chosen because it connects Algebra, Geometry and Calculus. The results shows that more than 80% of the students did not have the necessary knowledge to participate in the activities involving the software. So they were submitted to an introductory session on GeoGebra with basic and intermediate level activities. They also learned other tools as to create sliders, animations and others functions. This introductory course was presented by the teacher in the class.

2.2. Didactic Intervention

In the *a priori* analysis phase of the DE, some hypotheses were created to be validated in the phase of the *a posteriori* analysis phase. Considering the student's manifestations, it is assumed that the GeoGebra contributes to the learning of geometric concepts and competences in the axiomatic treatment of Plane Geometry.The intervention was planned based on the difficulty presented in the classroom during the course of Plane Geometry and it can be observed that one of the subjects of greater difficulty to the students was the Axiomatic Treatment. This happened because previously they have never had a discipline that required a formal mathematical rigor. Thus, the challenge of this research stage was to plan an interactive activity that would provide the necessary subsidies to fill the knowledge gap presented.It was elaborated a theoretical and practical activity that would help them learn and practice the concepts using the software. Based on DE, questionnaires were prepared *a priori* and *a posteriori* with issues relevant to Treatment Axiomatic, besides a satisfaction questionnaire in which students evaluated the team and the organization. However, while the *a priori* questionnaire contained questions with an informal approach, allowing the students to answer freely and without worrying about mathematical formality, the *a posteriori* one contained questions that should be answered with the formal mathematical rigor.Was applied the *a priori* questionnaire that took place online and without identification, in order to minimize the risk of identifying the participants. The intervention was initiated and the students should access the planned activity. The first topics of the intervention were collinear points, non-collinear points, lines and their properties. These contents were theoretical and the definitions and explanations were reinforced with GeoGebra animations, allowing the students to interact with the software, as shows Figure 1.

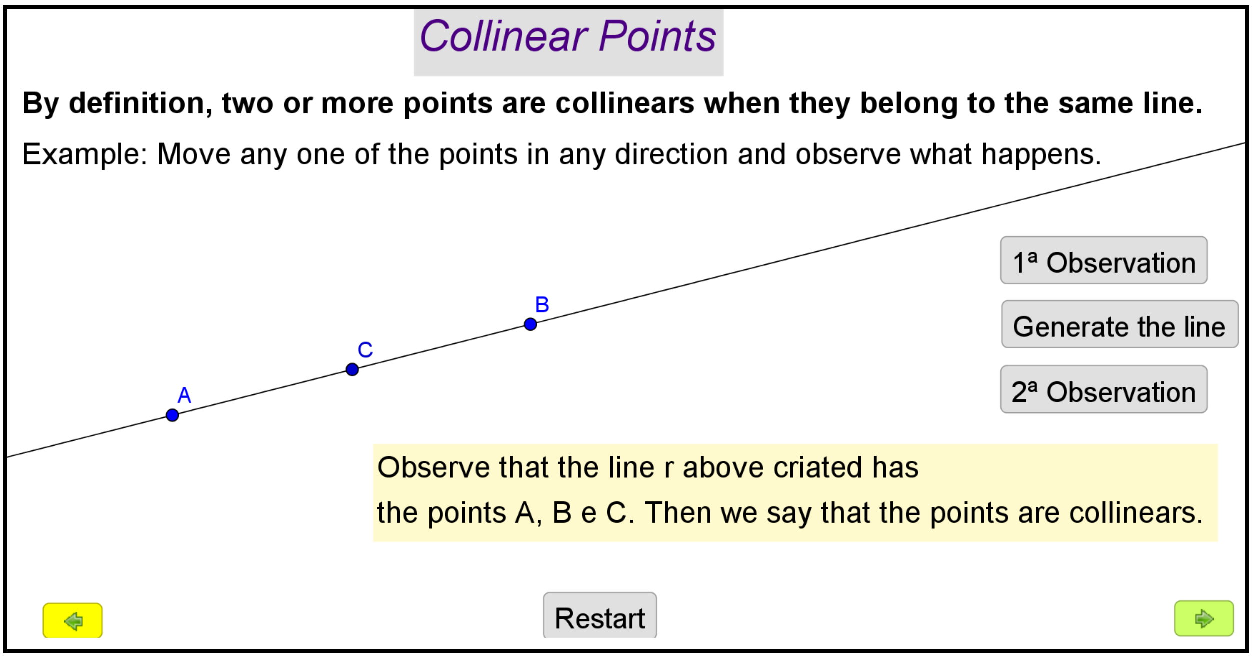

Figure 1. Collinear Points

After this stage, the students should solve, on their own, a challenge proposed and the solution produced entirely using GeoGebra. The reason for the solution to be made only in GeoGebra that the challenge has a relatively difficult analytical solution, so they could reflect on the importance of using the software.

Considering any triangle ABC:

a) Proof that barycenter, orthocenter and circumcenter are collinear.

b) Which of these three points is located between the other two?

c) Proof that the distance between barycenter and orthocenter is twice the value of the distance between barycenter and circumcenter.

With the beginning of the challenge, there were some difficulties regarding the geometric competences, since it includes concepts of Notables Points of the Triangle. However, as it was told that the students could help each other, doubts were quickly remedied and all students successfully completed the first activity, which the result is presented in Figure 2.

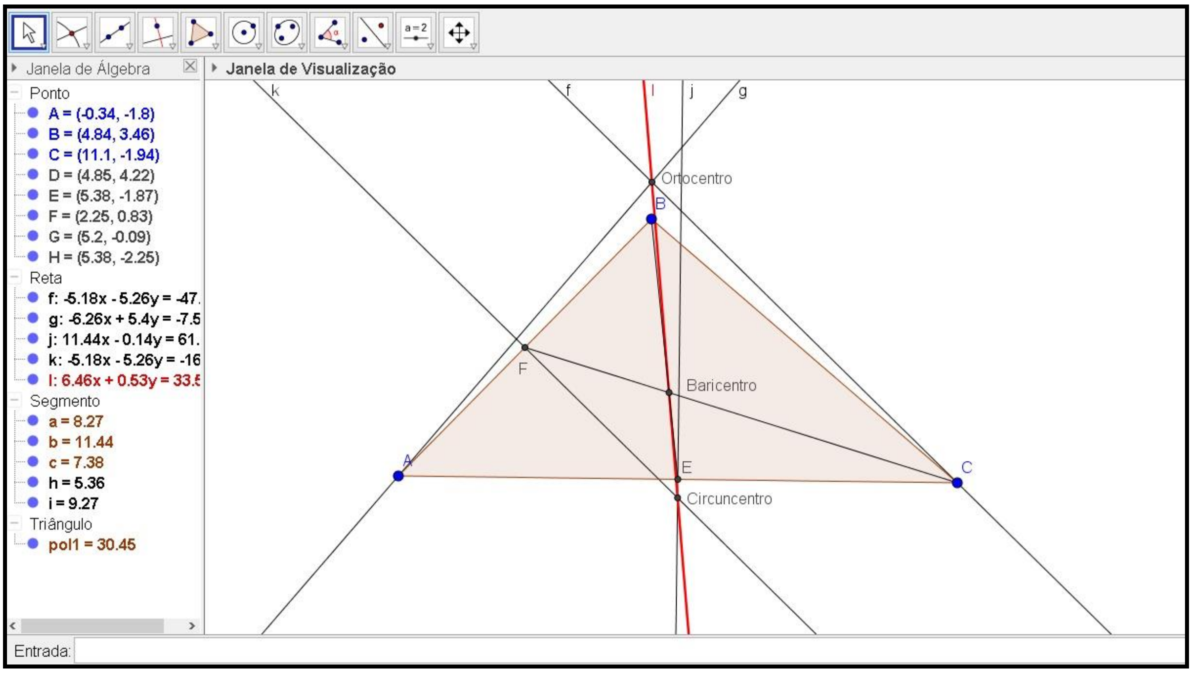

Figure 2. Resolution of the challenge produced by the students

With the theoretical topics involving angles between the lines, the students could use the possibility of dragging objects from GeoGebra and verifying some definitions and propositions. Several other tools have been used, such as Slider Control, Object Animation and Text and Numbers Tools, always with the objective of creating an environment where the student could experiment in practice everything that was teached. Finally, after completing the activities, the students answered the questions of the *a posteriori* and the satisfaction questionnaire.

2.3. Results

DE methods were adopted for detailed studies of the data collected, which were deduced in general with statistical contribution. The improvement of the majority of the participating students was clear, with respect to demonstrative and objective questions. A conceptual progress related to geometric tasks and a remarkable pedagogical organization by the students was observed. The biggest advance was the evolution in formal mathematical writing. Most of the students were able to express correctly in the formal questions of the *a posteriori* questionnaire. In particular, they were able to distinguish the different types of angles between parallel lines intersected by a transversal, which was one of the questions with greater error in the *a priori* questionnaire. It was concluded based on the results obtained in this research, that GeoGebra is an effective auxiliary tool in the understanding of the mathematical specificities related to the topic of Axiomatic Treatment of Plane Geometry.

3. Discussions

The main objective of this study was to provide a collaborative environment to use the GeoGebra as a tool to study the Axiomatic Treatment of Plane Geometry, so the students could have an active participation during all stages of the activity.In all the planning and execution process, it was noticed that the insertion of the educational technologies in the classes of Plane Geometry depends on a good planning by the teacher. As we can see in Borba and Penteado, the use of technologies implies changes in operational aspects, and even in the epistemological ones [7].At the previous analysis stage, it was possible to notice that one of the greatest difficulties of the students was to be able to visualize what was explained in theory, and to be able to apply this knowledge. However the students presented a significant improvement in this area, helping them to better describe in detail their own resolution strategies. When questioned about the advantages of using GeoGebra to understand the Axiomatic Treatment of Plane Geometry, they reported that the tool contributed positively:

1) *"With GeoGebra, Plane Geometry concepts are more visible and helps understanding the concepts studied in the classroom, besides motivating and making the class more interesting, and also helps with the sketching of figures."*
2) *"GeoGebra is excellent for fixing the content learned, encouraging the student's necessities to make the knowledge in the classrooms visible in a certain way. This is good because these concepts are hardly visible due to their abstract feature."*
3) *"The workshop increases the interest in the discipline, because it gives us the opportunity to learn in a different way."*

In addition to what was presented, it should be emphasized that the experiences in this research, allows to the professional training of the new teachers and new mathematical educational researchers, contributing to future discussions about Plane Geometry teaching practice.

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