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Rodrigues

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The construction and study of the ellipse through Huzita-Hatori axioms: An investigative activity in analytic geometry classes

Fabiana Chagas de Andrade¹, Thais de Sales Ribeiro² and Bruna Mayara Batista Rodrigues³

¹ Centro Federal de Educação Tecnológica Celso Suckow da Fonseca, Brasil
bia.profmat@gmail.com

² University of Lisbon, Institute of Education, Portugal; thaissales.rib@gmail.com

³ University of Lisbon, Institute of Education, Portugal; brunamayarabatistarodrigues@gmail.com

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This work presents part of the thesis developed in the Professional Master's Degree in Mathematics, at the Pontifical Catholic University of Rio de Janeiro, entitled "The study of Conics through Origami." In the present work, we will focus on the construction and study of the Ellipse, highlighting the definition of its geometric place through the axiomatic geometry of the Origami.

Teaching geometric concepts may present many challenges, because its process requires the study of concepts and relations that are not learned by students in activities which use memorizing and exercise techniques. Therefore, it's necessary to have creativity and reasoning. In this context, it is important that the student is encouraged to see the Geometry study as a practice of investigative and exploratory nature.

According to Ponte, et al. (2006), "The geometric investigations contribute to realize the essential aspects of the mathematic activity, such as the formulation and conjecture tests, the search and demonstration of generalizations." Moreover, to investigate, explore and establish conjectures in activities of geometric nature are not easy tasks. Among various teaching methods that can be explored in order to foster the meaningful learning, we can be highlighted the use of manipulable materials. In this regard, we spotlighted the possibilities of geometric investigation offered by a simple and powerful teaching tool: the paper.

Ancient and modern at the same time, "the art of the paper folding", better known as "Origami", transcends the boundaries of a simple art with its ability of conducting to the mathematic learning, either by its harmonic visual or by the Axiomatic Geometry inherent in the folds. Its description is given by the Huzita-Haroti Axioms, which consists in the seven basic operations capable of align straight lines and pre-existing points in a paper sheet through a single fold.

Some researches have already chosen origami as a resource which improves the learning of maths, such as Monteiro (2008), who used the technique to solve some equations and to demonstrate theorems, as well as Asrlan & Isiksal (2014) who described an experience about preservice teachers training using this japanese tool.

Despite the different themes that can be broached through the axiomatic geometry of folds, allied to an investigative and exploratory practice, we will highlight an activity which the objective is to explore the definition of the geometric place of the Ellipse. In its teaching, it is verified an undue priority for the memorizing of equations, and in many cases, the students only dedicated themselves to the repetition of exercises which solely involved algebraic methods. In order to rescue the

geometric approach of the topic in question, we unite these two elements in the present work, conic curves and Origami, with the aim of developing concepts of the first one from the constructions of the second, emphasizing the investigative practice through the process.

In order to spread the geometry of folding as a resource for activities of geometric investigation, to rescue the approach of the geometric place of the Ellipse and to validate the presented research, a workshop was developed, applied, evaluated and enhanced in a group of 17 Mathematics Licenciante Degree students.

As a basis for the development of the activity, which consisted of the construction of the curve, we used four moments related to the investigation process in mathematics classes mentioned by Ponte, et al (2006): recognition of the situation, its preliminary exploration and the formulation of questions; conjecture formulation process; testing and eventual refinement of the conjectures; argumentation, demonstration and evaluation of the work done.

Thus, we will present in this poster the Huzita-Hatori axioms description, the method of the Ellipse construction, the mathematics concepts related to the folds and finally the results of the activity application with the future mathematics teachers.

Through the application of the construction activity and the study of the Ellipse, we realize that the geometric place concept is underexplored in Mathematics Licenciante Degree courses, which culminates in disfavouring this content in Basic Education. Thus, this work is expected to be a source of motivation to the teachers and professors to valorise the approach of the geometric concepts in an investigative way. Also, we look to find in the folds a possibility to mix various mathematical themes in a meaningful manner.

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