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FUNCTIONS AND INTERPLAYS BETWEEN DIFFERENT SETTINGS IN PROBLEM SOLVING

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Our teaching experience and the observation of the difficulties of engineering students in exploring the properties of functions in the practice of problem solving motivated this research. It aims to investigate the contribution of a set of activities that make use of different representations for functions in solving optimization problems to deepen the understanding and/or consolidation of mathematical concepts related to functional relationships. Douady's interplays between different settings (jeux de cadres) as algebraic, geometric, functional frames, for example, in problem solving activities supported the project developed with the participation of eight engineering students, oriented by the Design Experiment methodology. Six problems were proposed considering aspects related to functions in order to mobilize settings changes in the resolution process. Next, we present two of the proposed problems and a brief analysis.

1)The church of São Francisco de Assis, a modernist architectural work by Oscar Niemeyer, located in Pampulha Lake, in Belo Horizonte - Brasil, has parabolic vaults.

The arrow in Figure 1 illustrates one of the vaults at the chapel's main entrance. Figure 2 provides a front view of this vault, with hypothetical measurements to simplify calculations. (Figure 4)

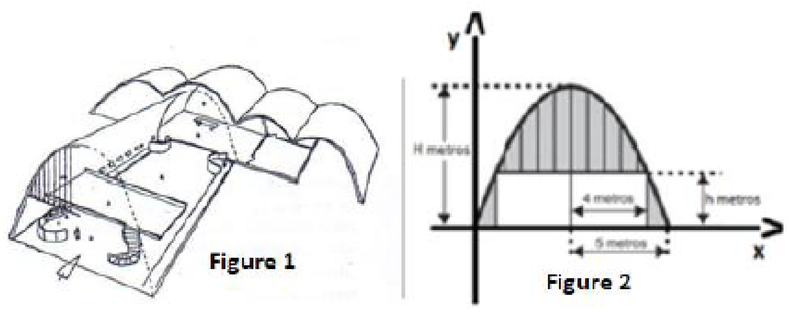


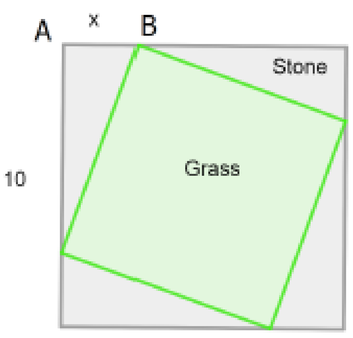
Figure 1 Figure 2

The church of São Francisco de Assis.
Source: ENEM – Question 167 (2017).

What is the measure, in meters, of the height H, and the height h, indicated in Figure 2, knowing that the function is described by f(x)=-x^2/3+10x/3 ?

This problem had as its main objective, to verify if the students know how to interpret the graph of a parabola of a function of the second degree, that means, we start on the graphic board, to work in the graphical and functional frames. By reading the graph, the student needs to identify where the necessary values are so that the required heights can be reached in the problem statement. The students' solutions showed only partial answers to the questions.

2) A Mayor wants to build a square as square whose sides measure 10m, which will have four triangular stone beds and a square grass patch as shown the figure. The Mayor has not yet decided on the area of the grass patch, which is why the length of segment AB is indicated by x in the figure.



A) Calculate the area of the grass patch for x = 2.

B) Write the expression for the area of the grass patch as a function of x.

It is known that the grass bed costs R$ 4.00 per square meter and the beds of stone cost R$ 3.00 per square meter. Use this information to answer to the following two items.

C) What is the smallest amount the mayor must have to build the five flowerbeds?

D) If the mayor has only R$ 358.00 to spend on the five flowerbeds, what is the area of the largest grass bed that the square might have?

The objective of this problem was to verify the students' level of understanding, regarding the understanding of Geometry, as well as the knowledge to build a function to describe the area. We also intended to analyze the knowledge to find the maximum area once the function is obtained.

The students changed from the geometric to the numerical frame, and that they are able to find an area from the data in the figure. The change from the geometric/numerical framework to the functional framework, in B), was easily carried out, as well as the determination of the function in C). In D), the change from the algebraic table to the graph did not present difficulties, which predominated in the algebraic work and in the determination of the maximum or minimum points.

The interpretative analysis indicated that the transition from the geometric to the algebraic frame was frequently done by the students in the process of problem solving. In the transition among the frames, the graphic one was the least used and in which difficulties for changing and interpreting the problem representation are identified. In this context, we sought to provide conditions for enriching the students experience with the resolution of problems that require functional representation and frame changes.

References

Coob, P., Confrey, J., Disessa, A., Lehrer, R., & Schauble, L. (2003.). Design experiments in education research. Educational Researcher, v.32(n.1), pp. 9-13.

Douady, R. (1984). Jeux de cadre et dialectique outil objet dans l'enseignement des mathématiques. Thèse de Doctorat. Université de Paris VII, Paris.

Douady, R. (1992). Des apports de la didactique des mathématiques à l'enseignement. Repères IREM.

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