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The Importance of Calculating Derivatives for Academics of Architecture and Urbanism Courses in Problem-Solving

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ABSTRACT

Background: The need to use different methodological strategies to approach the contents of Higher Education Calculation, aiming at teaching that allows the development of skills related to reading, interpretation, use of procedures and strategies and ways to express one's reasoning in Mathematics, led to the study on the teaching of Derivatives content, using the Problem-Solving methodology. As a theoretical subsidy on the topic of Problem-Solving, the studies of Polya (1995), Dante (1998) and Onuchic and Alevatto (2004) were used. **Objective:** To investigate the contributions of the use of the methodology of problem-solving in the discipline of Applied Mathematics of the Architecture and Urbanism course, aiming at the integral formation of the student relating the theory to practical situations. **Design:** The research had a qualitative methodological approach in which it was intended to understand and analyze how the academics participating in the research developed the proposed activities involving the content of Derivatives through Problem-Solving. **Setting and participants:** The research was carried out with twenty-two academics from the Architecture and Urbanism Course at Centro Universitário Luterano de Ji – Paraná, located in the state of Rondônia (Brazil). **Data collection and analysis:** An experiment was carried out with a group of academics from the Architecture and Urbanism Course at Centro Universitário Luterano de Ji – Paraná / RO. The data analysis was done through the written records of the students and the observations of the professor / researcher. **Results:** The results indicate that the didactic activities contributed to the understanding and development of the Derivatives content, as well as allowing the critical analysis of the academics regarding the resolution of problem situations. **Conclusions:** It is understood that the use of problem-solving methodology in Higher Education should be encouraged for the development of mathematical content, in order to enable academics to develop the theory, have autonomy, work in groups and develop strategies for solving problems. problems.

Keywords: Higher Education; Problem-Solving; Derivatives.

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A Importância do Cálculo de Derivadas para os acadêmicos dos cursos de Arquitetura e Urbanismo na Resolução de Problemas

RESUMO

Contexto: A necessidade de se utilizar diferentes estratégias metodológicas, para a abordagem dos conteúdos de Cálculo do Ensino Superior, visando um ensino que permita o desenvolvimento de habilidades relacionadas a leitura, interpretação, utilização de procedimentos e estratégias e formas de expressar o próprio raciocínio em Matemática, levou ao estudo sobre o ensino do conteúdo de Derivadas, utilizando como metodologia a Resolução de Problemas. Como subsídio teórico a respeito do tema Resolução de Problemas, foram utilizados os estudos de Polya (1995), Dante (1998) e Onuchic e Alevatto (2004). **Objetivo:** Investigar as contribuições da utilização da metodologia de resolução de problemas na disciplina de Matemática Aplicada do curso de Arquitetura e Urbanismo, visando à formação integral do estudante relacionando a teoria a situações práticas. **Design:** A pesquisa teve uma abordagem metodológica qualitativa na qual pretendeu-se compreender e analisar como os acadêmicos participantes da pesquisa desenvolviam as atividades propostas envolvendo o conteúdo de Derivadas por meio da Resolução de Problemas. **Ambiente e participantes**: A pesquisa foi desenvolvida com vinte e dois acadêmicos do Curso de Arquitetura e Urbanismo do Centro Universitário Luterano de Ji–Paraná, localizado no estado de Rondônia (Brasil). **Coleta e análise de dados:** Foi aplicado um experimento com um grupo de acadêmicos do Curso de Arquitetura e Urbanismo do Centro Universitário Luterano de Ji–Paraná/RO. As análises dos dados foram por meio dos registros escritos dos acadêmicos e das observações do professor/pesquisador. **Resultados:** Os resultados indicam que as atividades didáticas contribuíram para a compreensão e o desenvolvimento do conteúdo de Derivadas, bem como possibilitou a análise crítica dos acadêmicos frente a resolução de situações problemas. **Conclusões:** Entende-se que deve ser incentivado o uso da metodologia de resolução de problemas no Ensino Superior para o desenvolvimento dos conteúdos matemáticos, de forma a possibilitar que os acadêmicos desenvolvam a teoria, tenham autonomia, trabalhem em grupo e elaborem estratégias de resolução de problemas.

Palavras-chave: Ensino Superior; Resolução de Problemas; Derivadas.

INTRODUCTION

According to Palis (2009), there were already concerns, in Higher Education, regarding pedagogical and curricular changes, due to some factors, such as the rapid development of computational technologies, the calls for integration with other disciplines, for inclusion and diversity initiatives; for more efficiency in-service courses, for the use of multiple forms of assessment, for group work, among others.

Still, the Mathematics Departments of colleges and universities must be attentive to the needs of academics, in the process of teaching and learning mathematics, considering that for some difficulties of academics there are epistemological and pedagogical causes and that problems should not be reduced to expressions like: "the student is weak" or "the student is unmotivated" (Palis, 2009). For the author, what can contribute to these difficulties to be minimized is to believe that research in Mathematics Education, referring to teaching and learning, can bring positive results for Higher Education.

Cury (2004) also reports that the difficulties, particularly those related to learning calculus, have become more frequent and worrying, as it is increasingly evident the lack of previous knowledge or the misunderstanding of subjects addressed in previous levels of education.

Carvalho and Savioli (2013) point out that the existing productions in this area deserve greater dissemination so that the difficulties pointed out are known to researchers who investigate such aspects and teachers. For the authors, in Higher Education, to the mathematical demonstrations, which, when using logical reasoning and arguments, need a mathematical maturation that the beginning students hardly have, and the professor of Mathematics, when making a demonstration, needs to worry about verifying if students are understanding, but students, accustomed to traditional teacher-focused education, often do not question and settle.

Malta (2004) points out the need for students to be led to the development of their reading skills in Mathematics and to express their reasoning, leading them to understand and use mathematical results. She says she is convinced that the deficiencies in the use of written language and the little development of the ability to understand Mathematics, are not only configured as simultaneous events, but these phenomena are related by a cause-effect relationship, as domain development is necessary of the language necessary for the understanding of abstract concepts and, without this, the development of mathematical thinking may not occur.

Frota (2013) points out that the mathematics teacher has a new role since he needs to reflect on his practice and develop efforts to change the focus of the tasks he proposes, creating learning environments that enable the exchange of experiences and the construction or reconstruction of mathematical ideas.

One way to modify the presented scenario can be proposing methods of mathematical reasoning that seek an understanding between the logic of calculation and the reasoning of it, thus stimulating the students' learning, aiming to assist them in understanding and interpreting the content taught in the classroom, through problem-solving, bringing an exploratory context, with introductory calculation phases, but with intermediation and clarification at each stage or step of the resolution.

Thus, it is understood that mathematical problems can be formulated according to the indications of Polya (1995), Dante (1998) and Onuchic and Alevatto (2004) that require the discovery of unknown mathematical information, that is, to propose situations in which students will have to face problems that will use different procedures, techniques, strategies and hypotheses to resolve.

PROBLEM-SOLVING IN TEACHING MATHEMATICS

According to Dante (1998) problem-solving presents several types of situations, which can be applied in the classroom, as well as different ways of explaining them.

For the author, a problem can be presented in the form of exercises or questions to be developed using knowledge and principles from other areas, as long as the theme or subject is related to something that arouses and stimulates the interest of the student who will solve it.

Still for the author, it is up to the teacher to keep in mind that theory and practice need to be in tune, in the sense that the mathematical objectives applied must be very clear when he proposes the resolution of a problem situation to the student. Thus placing the student, who will be able to make their own decisions and make use of the didactic devices provided by the teacher. Since all problem-solving situations originate from a construction process between students and the teacher, thus bringing the formulation and writing of the problem into the classroom (verbalized language versus mathematical language of the situation), as well as a discussion of the group to obtain the resolution and finally the discovery of new mathematical knowledge, such subjects being interpreted and analyzed, in the context of teaching and learning.

This leads us to the teacher's role in this problem-solving process, which is to make the appropriate interventions, in the sense that he and his students seek together to solve a situation that, at first, is not in the problem statement. Since the student must contribute with his previous knowledge and the teacher must help him with his knowledge, always observing the objectives that he aims to achieve with the proposed situation. Under such considerations, states Nuñez and Ramalho (2004, p. 148): "[...] as characteristics of the problem situation, we consider the need to represent something new in the student's intellectual activity and the possibility of motivating his activity in the task of searching and building knowledge".

In this sense, problem-solving seeks to develop the following skills: to make the student learn concepts, techniques, the mathematical language and to communicate ideas abstractly. Thus, trying to highlight the thought processes and mathematical content used by the student. In this way, the student explains his thought processes, becoming aware of how to use them in solving problem-solving.

For Dante (2003), a problem need not necessarily present an extensive statement or include superfluous data for it to be a great problem situation to be solved. Since a problem-solving situation must require the student to calculate more than one mathematical operation and these are not evident in the statement. Such a situation needs to have an accessible language, be per the students' experiences, and require the ability to reason from the acquired knowledge.

As Onuchic and Alevatto (2004) solving problems is a practice that accompanies human beings throughout their existence. For the authors, if the problem is easy, for those who are solving it, then the problem does not exist, since the process that involves the resolution of problem situations is the essential means for the development of the process of teaching and learning mathematical knowledge.

Onuchic and Alevatto (2011, p. 82) highlight six principles that must be taken into account when addressing problem-solving:

> Problem-Solving puts the focus of students' attention on mathematical ideas and making sense. Problem-Solving develops mathematical power in students, that is, the ability to think mathematically, use different and convenient strategies in different problems, allowing to increase the understanding of mathematical content and concepts. Problem-Solving develops the belief that students are capable of doing Mathematics and that Mathematics makes sense; students' confidence and self-esteem increase. Problem-Solving provides continuous assessment data, which can be used to make instructional decisions and to help students succeed with mathematics. Teachers who teach in this way are excited and do not want to go back to teaching in the so-called traditional way. They are gratified by the fact that students develop understanding through their reasoning. The formalization of mathematical concepts and theories, carried out by the teacher, starts to give more meaning to students.

Still, according to Polya (1986), solving a problem is a challenge and a little bit of discovery, since there is no rigid method that the student can always follow to find the solution of a problem situation. The author states that there are stages of thought, more specifically those of resolution, that can help the student in this process, which is the following: understanding the problem, establishing a plan, executing the plan and looking back.

The first step to solving a problem "understanding the situation", refers to interpreting what the problem situation suggests, that is, the survey of relevant data is carried out, it is verified what is being asked and what it needs to be solved in terms of mathematical knowledge.

The second stage to solve a problem "establishment of the plan" requires the student to make the theory-practice-problem connection mentally or in writing: the theory is the mathematical knowledge learned previously and taught by the teacher, the practice is the knowledge obtained from their daily experiences and the problem are the data obtained from the proposed problem situation. At this, stage the student can make various plans or strategies and exchange ideas with other colleagues.

The third stage to solve a problem "execution of the plan" the student must execute the plan elaborated in the previous stage, to try obtain the solution of the problem situation. For Polya (1986) it is at this stage that the use of concrete material and the ability to calculate mentally becomes important.

The fourth and last step, to solve a "retrospect" problem, the student must verify if the solution he found is the one requested by the statement and the question of the problem situation. At this stage, the teacher should be a mediator, to consistently make the necessary interferences when examining the solution that each student found, whether or not he got it right: if he got it right, questions should be asked, such as if there are other ways to reach the same solution; and if you made a mistake, check where the error is and help you in this constructive process in the search for the correct solution.

In this way, it is possible to perceive that the problem-solving process is somewhat complex, being necessary that the student can understand and interpret the problem, make the appropriate representations and apply their strategies (Dante, 2003).

The resolution of problem situations should be a frequent practice in Mathematics classes in Higher Education, as its use contributes to the teaching of mathematical concepts making the student's learning interesting and, at the same time, placing it based on awareness of their processes of thought and in the relationship that it can establish between the formalization of Mathematics and the solving of everyday professional problems. Also, the interpretation and resolution of problem situations enable students to mobilize their knowledge in an organized manner, being able to exercise their logical reasoning when applying their resolution strategies in various types of problem situations.

Thus, it is understood that the teaching of Mathematics in Higher Education can develop mathematical knowledge linked to the students' professional reality, using problem-solving as a methodological strategy. However, it is important that before using problem-solving in the classroom, the teacher makes a prior diagnosis of the group involved to obtain information regarding the mathematical knowledge they already have. Furthermore, the more the teacher understands the dimension of dialogue as a necessary posture in his classes, the greater progress he will be making concerning to the students because, in this way, they will feel more comfortable talking to the teacher at work with problem-solving.

According to Vygotsky (1989), the relationship between teacher and students should not be a relationship of imposition, but a relationship of cooperation, respect and growth, in which the student must be considered as an interactive and active subject in his / her process of education. construction of knowledge, assuming the teacher a fundamental role in this process, as an individual with more experience. For this reason, it is up to the teacher to also consider what students already know, that is, to consider their cultural and intellectual background, for the construction of learning.

In this sense, the teacher's performance is important, since he is the mediator of the students' learning and this progress process will depend on their advances and achievements concerning learning in the classroom environment.

RESEARCH METHODOLOGY

The methodology used in this research was of a qualitative basis, in which it was sought to know the object under study in its natural setting, trying to understand the phenomena in terms of the meanings people give them (Denzin & Lincoln, 2006). In this sense, qualitative research attributes fundamental importance to the testimonies of the social actors involved, to the speeches and meanings transmitted by them, valuing the detailed description of the phenomena and the elements that involve it (Vieira & Zouain, 2005).

When discussing the characteristics of qualitative research, Creswel (2007, p. 186) draws attention to the fact that, from a qualitative perspective, the natural environment is the direct source of data and the researcher, the main instrument, with data collected are predominantly descriptive, in which data analysis tends to follow an inductive process. In the course of the research, five actions were proposed: first, a literature review on Derivative education was carried out on the research platform of the Coordination for the Improvement of Higher Education Personnel (CAPES). The second was the Problem-Solving survey. The third was the selection and organization of teaching activities. The fourth action was the development of an experiment with the students of the Architecture and Urbanism course. The last action was the description and analysis of the experimentation phase.

EXAMPLE OF *A PRIORI* ANALYSIS OF SOLVING A PROBLEM SITUATION FOR THE TEACHING OF DERIVATIVES

An example of a problem situation involving the derivative calculation is "A farmer has 1,200 m of fence and wants to surround a rectangular field on the bank of a straight river. He doesn't need a fence along the river. Which dimensions of the field have the largest area?" (Stweart, 2013, p.294). To resolve this situation, the steps proposed by Polya (1995) will be used.

In the first stage "Understanding the problem", it is proposed to identify the data presented in the problem, being:

- The perimeter of the fence is 1,200 m, and the dimensions refer to three parts, as seen, which describes the statement, that the fence does not need to be along the river, where it can be seen that sketches can be made. fields shallow and extensive or deep and narrow, proposing a diversity of areas.
- The unknown question of the problem is "What are the dimensions of the field that has the largest area?".

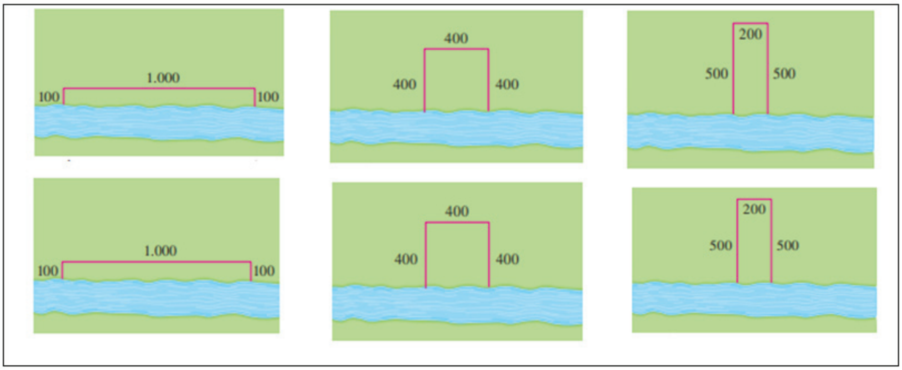
In the second stage "Establishing a plan", academics are expected to develop a strategy for resolving the proposed situation, which may be:

First make the layout with the possible measures for a perimeter of 1200 meters, where such layouts define them as shallow, extensive, deep and narrow fields, thus obtaining different areas, being necessary, to the layout analysis to determine the largest area. For this reason, academics need to make schematics, as they need to understand the possibilities of defining various types of areas with the data of the problem in question.

Some examples of schematic diagram/sketch are shown in Figure 1.

Figure 1

Examples of schematics of the problem situation (Adapted from Stewart, 2013)



From the schematics, there are three different possibilities for the perimeter, such as those described below: 100 + 1000 + 100 = 1200; 500 + 200 + 500 = 1200 or 400 + 400 + 400 = 1200.

Then, the area for each layout is calculated, being a rectangle and its area is obtained by base multiplied by the height:

- First the layout of the area of 1000 x 100 = 100,000 m²
- According to the layout of the area of 400 x 400 = 160,000 m²
- Third the layout of the area of 200 x 500 = 100,000 m²

Such schematics are necessary for the student so that he realizes that the biggest area is the one shown in schematics 2.

In the third stage "Execution of the plan" it is expected that academics will put into practice the plan established in the previous stage. One possibility will be presented below.

Variables are assigned to the dimensions of the rectangle, being x and y and a symbology for area is adopted, being A.

Thus, the area will be given by the function A (x) = x.y, in which y needs to be expressed in terms of x. To express y in terms of x, you need to use the perimeter.

The perimeter can be expressed as, P = x + x + y. Substituting the problem information in the perimeter, we get: 1200 = 2x + y. In the perimeter, isolating the y has the following equation: y = 1,200 - 2x.

Returning to the area calculation, we have: A (x) = x.y, replacing y with "1,200 - 2x", the area will be: A = x (1,200 - 2x). Soon the area will be $A = 1200x - 2x^2$.

To determine the dimension x, so that the area is as large as possible, it is necessary to equal the function to zero and apply the drift. That is, first equaling zero gives $0 = 1200x - 2x^2$ and performing the derivative calculation we get $1200 - 4x = 0$. Thus, solving the equation "$1200 - 4x = 0$", we find the value of x, $x = 300$. Substituting in the perimeter formula, you can find the value of y, where $y = 600$.

In the last step "Retrospect of the problem", it is hoped that academics will verify if the result found is adequate.

Therefore, it is necessary to verify that the values found $x = 300$ and $y = 600$ are correct, replacing them in the formulas of area $A = x.y$ and perimeter $P = 2x + y$ (Figure 2).

Figure 2
Calculation of the verification

Área	Perímetro
$A = x, y$ $A = 300 . 600$ $A = 180\ 000$	$P = 2x + y$ $P = 2.300 + 600$ $P = 1200$

Therefore, the maximum area is 180 000 m².

PRESENTATION AND DATA ANALYSIS

The activities were developed with a group composed of 22 academics from the Architecture and Urbanism Course of the Centro Universitário Luterano de Ji-Paraná / RO, being proposed to work with didactic activities of applications of Derivada, to enable the use of the methodology of solving problems of problems, through collective work among academics. For data analysis, students were identified by A1, A2, A3, ..., A22. In this article, analyzes of three problem situations developed with this group of academics will be presented.

Initially, the professor/researcher presented the proposal for the work to be developed and asked students to fill out and sign the ethics committee term and the authorization to use the image[1].

Then, it worked on the concept of Derivatives and its applications and after clarifying doubts, activities started with a list of problems that covered the content of Derivatives. Students were asked to develop group activities so that they could talk and share resolution strategies (Figure 3), however, the delivery of the records of the activities was done individually.

[1] Pesquisa aprovada pelo comitê de ética e pesquisa com seres humanos sob o número - 83252318.4.0000.5297.

Figure 3

Images of students during the experimentation phase (Students of the Architecture and Urbanism Course at the Lutheran University Center of Ji-Paraná-CEUJI)

The first problem situation proposed involved the derivative calculation, as shown in Figure 4.

Figure 4

Problem situation (taken from Stweart 2013, p.294).

Questão Problema 01 – Um fazendeiro tem 1.200 m de cerca e quer cercar um campo retangular na margem de um rio reto. Ele não precisa de cerca ao longo do rio. Quais as dimensões do campo que tem a maior área. Exemplo 01 (James Stewart , Ed. 7º) pág.294

In this activity, after reading the proposed situation and dialogue between academics, some questions emerged, such as:

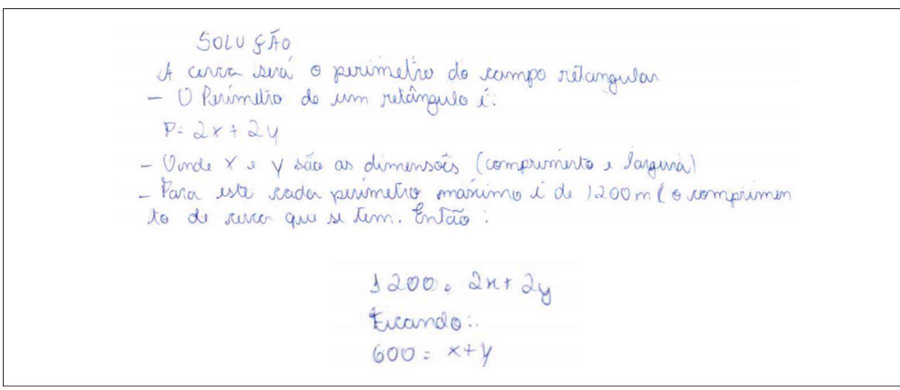
> *Student 01: Teacher, how would I interpret these two sides. Could you use several ways to interpret these sides in the figure?*
> *Answer: You should make some illustrations, with respect to the sides of the fence.*
> *Student 02: Could you use both sides as an unknown factor, relating them to the length of the fence?*

Answer: Yes, you can, by placing these variables in letters and matching them to the length of the fence.
Student 03: Could you vary these sides as an unknown factor, relating them to the length of the fence?
Answer: Yes, remembering that the sides only refer to the perimeter, it is not necessary to make the river bank.

In the first question, about the demarcation of the fence, we tried to take the student to understand some concepts of the derivative calculation, and the student needed to identify essential points to start solving the problem in question.

Student A1 reads his proposed situation and tries to understand what is being requested. Then, it searches for information that becomes evident with the determination of one side of the fence, proposed in the problem, thus making the survey and data collection of the relevant information (Figure 5). This moment in carrying out the activity refers to the stage of "understanding the situation" proposed by Polya (1995).

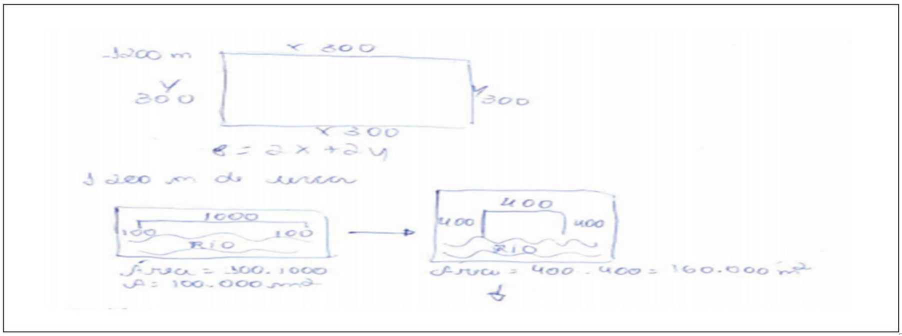
Figure 5
Resolution of academic A1


SOLUÇÃO
A cerca será o perímetro do campo retangular
– O Perímetro de um retângulo é:
P= 2x + 2y
– Onde x e y são as dimensões (comprimento e largura)
– Para este caso perímetro máximo é de 1200 m (o comprimen
to de cerca que se tem. Então:
1200 = 2x + 2y
Ficando:
600 = x + y

It is noticed that the student A1, observed that it was necessary to calculate the perimeter and assigned symbols for the variables, being x and y. He uses some illustrations or diagrams to represent possibilities for the perimeter of the fence, thus associating it to three different situations, as shown in Figure 6.

Figure 6

Development of academic resolution A1

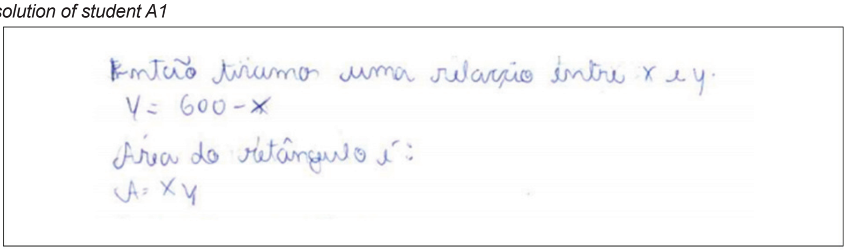


It is also noticed that the student A1, when associating the unknowns x and y, uses them to represent the dimensions of the figure given in the problem and through the schematisation the phase of the "establishment of the plan" begins (Polya, 1995). As it is a rectangular terrain, the student soon knows that the sides of a rectangle are proportional, arriving at the perimeter formula, as "P = 2x + 2y", knowing that the maximum perimeter is 1200 meters.

Student A1 defines (A) as being a function of only one variable, where y is expressed in terms of x, the total length of the fence being 1,200 m. Then, he determines that the area (A) of the rectangle, where x and y, define the depth and width of the rectangle (in meters), can be expressed by A = x.y, as shown in Figure 7.

Figure 7

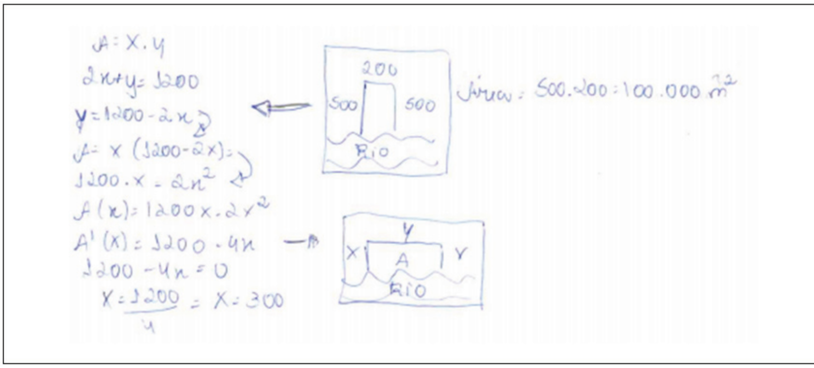
Resolution of student A1



Having established a formula for calculating the perimeter and area, student A1 uses this information and schemes to determine the maximum area (Figure 8).

Figure 8

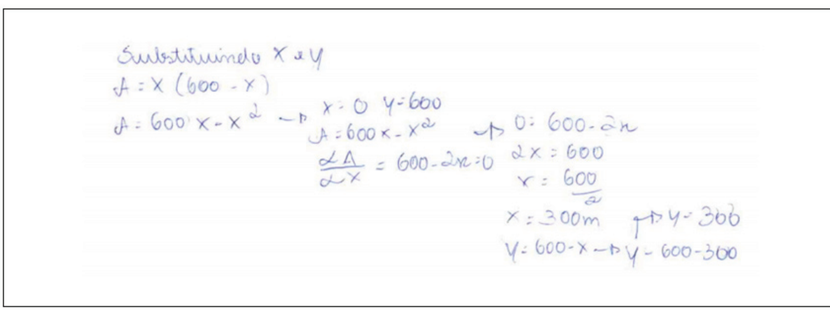
Resolution of student A1



To verify the strategy used, student A1 presents, in Figure 9, the validation of his strategy, solving the proposed situation.

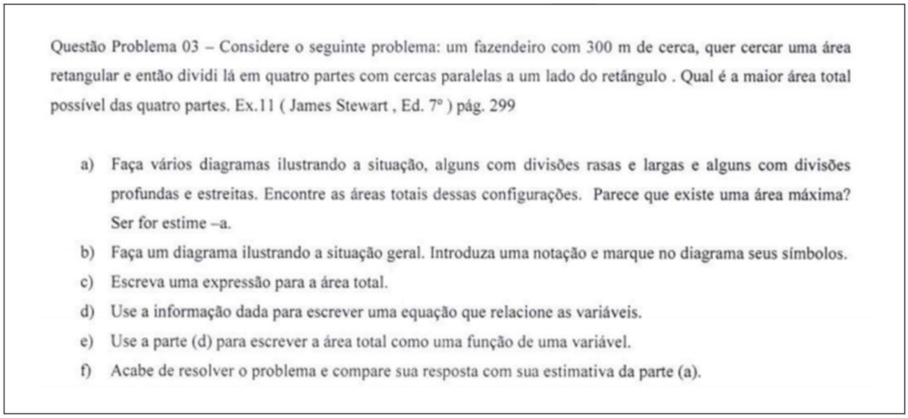
Figure 9

Resolution of student A1



The second problem situation proposed is presented in Figure 10. In this activity, in the classroom, from the perspective of this research work, we sought to lead the student to understand both concepts, regarding the calculation of the derivative and the proposition how to solve the problem, thus inserting the design of strategies as the basis for the solution.

Figure 10
Problem situation (taken from Stweart, 2013, p. 299).



Questão Problema 03 – Considere o seguinte problema: um fazendeiro com 300 m de cerca, quer cercar uma área retangular e então dividi lá em quatro partes com cercas paralelas a um lado do retângulo . Qual é a maior área total possível das quatro partes. Ex.11 (James Stewart , Ed. 7°) pág. 299

a) Faça vários diagramas ilustrando a situação, alguns com divisões rasas e largas e alguns com divisões profundas e estreitas. Encontre as áreas totais dessas configurações. Parece que existe uma área máxima? Ser for estime –a.
b) Faça um diagrama ilustrando a situação geral. Introduza uma notação e marque no diagrama seus símbolos.
c) Escreva uma expressão para a área total.
d) Use a informação dada para escrever uma equação que relacione as variáveis.
e) Use a parte (d) para escrever a área total como uma função de uma variável.
f) Acabe de resolver o problema e compare sua resposta com sua estimativa da parte (a).

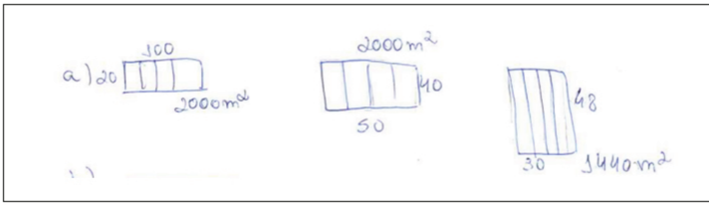
Students start solving the activity, understanding the proposed situation that involves the problem and establishing a plan, using schematics built by them, and begin to illustrate the situations that are relevant to the problem in question, thus using their assumptions divisions of shallow and wide areas, thus evidencing their initial interpretations, on which they discussed the strategies of resolutions in a shared way, allowing the interaction between them regarding the problem, as indicated by Polya (1995), Dante (1998) and Onuchic and Alevatto (2011).

Following the resolution of the proposed problem, students asked some questions, as to the proposition of what you want to know and what is asked to solve the problem, according to the following dialogue:

> *Student 04: Teacher how I would interpret these sides could interpret a rectangle, a square, or just present the layout.*
>
> *Answer: Yes, you must present some schematics, and they must coincide with the 300 meters of the fence.*
>
> *Student 02: These sides must be the same or not.*
>
> *Answer: It depends on the analysis that you are interpreting the problem, but you have to analyze what the question asks you first.*
>
> *Student 01: I could make the variation of these sides with a variable, relating them to the length of the fence, already using the plan I have in mind.*
>
> *Answer: Yes, no problem.*

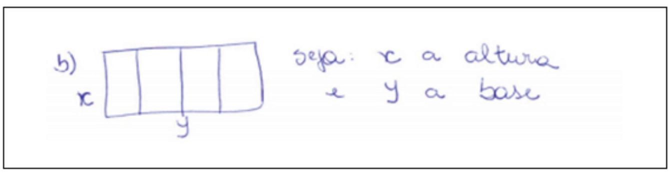
In the resolution of letter (a), the academic makes the appropriate illustrative layout of the shallow and deep areas, placing them with different measures, as shown in Figure 11.

Figure 11
Student A2 resolution



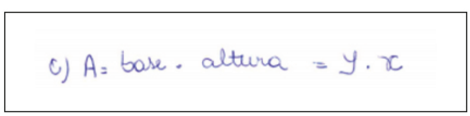
In Figure 12, it is possible to observe the illustrative form of the resolution in which the student A2, begins to solve the question (b), using a sketch to represent the fence, with its due divisions and dimensions called x and y.

Figure 12
Resolution of student A2



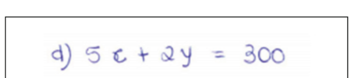
In Figure 13, it was identified that student A2, answered question (c) presenting the expression that is related to a total area of the problem situation, using the variables x and y.

Figure 13
Resolution of student A2



In question (d), student A2 uses the information given in the problem to describe an equation for the proposed situation, using the variables x and y (Figure 14).

Figure 14
Resolution of student A2



Continuing the resolution of the activity, student A2 starts using the information from the previous question, to obtain the total area, through the function of a variable (Figure 15).

Figure 15
Resolution of student A2

e) $5x = 300 - 2y$

$$x = \frac{300 - 2y}{5}$$

$$A = y \cdot \left(\frac{300 - 2y}{5} \right)$$

$$A = \frac{300y - 2y^2}{5}$$

In question (f), student A2, solves the problem, comparing his estimate with question (a), reaching the final result (Figure 16).

Figure 16
Resolution of student A2

$$A = \frac{300 - 4y}{5}$$

$$300 - 4y = 0$$

$$4y = 300$$

$$y = 75\,m$$

calculando x

$$x = \frac{300 - 150}{5} = 30\,m$$

$$A = 75 \cdot 30 = 2.250\,m^2$$

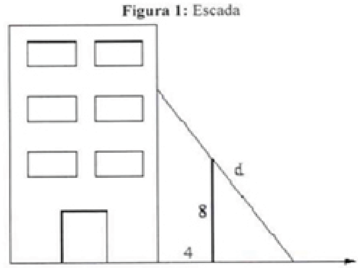
The third problem situation (Figure 17) started with the students, reading and interpreting the problem information, as well as discussing it with the other classmates in the classroom.

Figure 17

Problem situation (taken from Stweart, 2013. p.300).

Questão Problema 04 – Uma cerca de 2,00 m de altura corre paralela a um edifício alto, a uma distancia de 1,00 m do Edifício. Qual o comprimento da menor escada que se apoie no chão e na parede do prédio , por cima da cerca ?
Ex. 38 (James Stewart , Ed. 7°) pág. 300

Figura 1: Escada



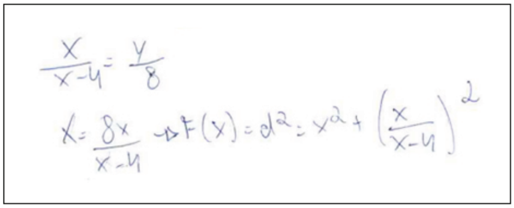
After the reading and understanding of the problem, the students talked to the teacher.

> *Student 04: Teacher, how do I get the main data, first check the height in relation to the length?*
>
> *Answer: Yes, first you should check the understanding of what you want to know about the problem in question, collect data such as height and length.*
>
> *Student 05: Does my height affect my length for me to start the equation?*
>
> *Answer: Yes, it affects, but the length becomes variable.*
>
> *Student 03: Could you make the correlation between length and height?*
>
> *Answer: Yes, but it should be noted that the two focus on an equation of variables.*

Then academics return to the resolution. In the first moment, student A3, inserts the data that comprises the height and the length, initiating an understanding and the interpretation to solve the problem, thus highlighting their due variables proposed, starting the elaboration of an equation (Figure 18).

Figure 18

Academic A3 resolution



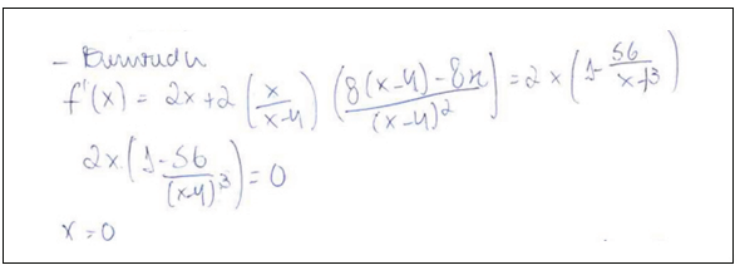
$\frac{x}{x-4}=\frac{y}{8}$

$x=\frac{8x}{x-4} \to F(x)=d^2=x^2+\left(\frac{x}{x-4}\right)^2$

In the second moment, student A3, continuing his resolution strategy, calculate the derivative of the previously established function, as shown in Figure 19.

Figure 19

Academic A3 resolution



– Derivada

$f'(x)=2x+2\left(\frac{x}{x-4}\right)\left(\frac{8(x-4)-8x}{(x-4)^2}\right)=2x\left(1-\frac{56}{x+3}\right)$

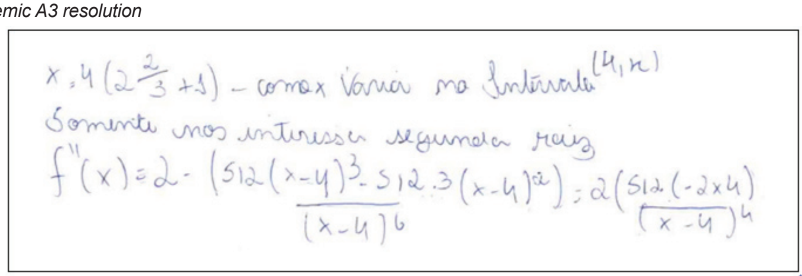
$2x\left(1-\frac{56}{(x-4)^3}\right)=0$

$x=0$

In the third moment, student A3, already with the information obtained in the previous steps, begins to correlate the x that varies in the interval $[4,\infty)[4,\infty)$, thus developing the second root (Figure 20).

Figure 20

Academic A3 resolution



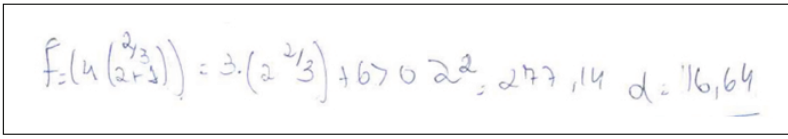
$x=4(2^{\frac{2}{3}}+1)$ – como x varia no intervalo $(4,\infty)$

Somente nos interessa segunda raiz

$f''(x)=2-\left(\frac{512(x-4)^3-512\cdot 3(x-4)^2}{(x-4)^6}\right)=2\left(\frac{512(-2x4)}{(x-4)^4}\right)$

In the fourth moment of the resolution, student A3, determines the result of the problem, as shown in Figure 21.

Figure 21
Academic A3 resolution



When questioning the students about what difficulties they felt when solving the problems proposed in the classroom, they described that they had difficulty in interpreting the statement and identifying the path that should be followed to solve the problem. They also reported that they had difficulties in collecting the data that were in the problem to insert them in situations where it was necessary to use the content of Derivatives.

According to the academics, when difficulties were overcome, through the mediation of the teacher or with the help of colleagues, they were able to properly use the contents of the derivative calculation necessary to solve the problem situations. They considered teaching with the methodology of problem-solving to be important, as it enabled the application of their plans and strategies in their projections, since it can contribute to the perception of the academic in the face of the errors and the successes found during the realization of the situations. They also mentioned that they were surprised by the capacity of logical reasoning to determine the solution of the activities, as they could perceive that they were able to solve them, following the steps and that they would be able to solve other problems, as they already had a base of reasoning outlined, as indicated by Polya (1995), Dante (1998) and Onuchic and Alevatto (2004).

Therefore, it is understood that using problem-solving in calculations of application of the derivative can help students of the Architecture and Urbanism Course to solve practical situations, involving important concepts for their professional life, such as calculating an area, of geometric space, or a projected environment.

FINAL CONSIDERATIONS

When it comes to bringing mathematical content closer to the reality of Higher Education, it is understood that problem-solving is a methodological possibility, as academics need to face different problem situations, in which they need to have initiative, an exploratory spirit, creativity and independence, as well as they must understand and think productively, inventing, searching and using different strategies. Also, it encourages academics to question the professor and colleagues, to clarify key points for solving the problem, in which they need to highlight important information and understand what the problem requires and what data and conditions they have to solve it (Polya, 1995).

It is understood that it is necessary to encourage the use of the problem-solving methodology in Higher Education, in which teachers need to look for situations involving the different mathematical contents covered in the Architecture and Urbanism Course, so that academics have the opportunity to place in practice their strategies for the construction of the different mathematical concepts developed throughout their professional training, giving them conditions for later use in the world of work.

AUTHORSHIP CONTRIBUTION STATEMENT

N. A. R. and C. A. O. discussed the research methodology and theoretical framework. The author N. A. R. collected the data. Also, N. A. R. and C. A. O. contributed to the production of this article.

DATA AVAILABILITY STATEMENT

The data that support the results of this study will be made available by the corresponding author, N. A. R., upon reasonable request.

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