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Use of Physical Education Classes as a Didactic Laboratory for Teaching Affine Function

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***Abstract*— The objective of this article was to present an alternative way to teach mathematics, more specifically the affine function. In this research, Physical Education classes were used as a Didactic Laboratory for Mathematics classes, where from athletics tests, 100 and 400 meters races, basic concepts such as graph construction and calculation of coefficients are carried out. Also, an analysis is made if the interdisciplinarity presented reaches some of the objectives required for the use of a Didactic Laboratory. During the research, the students were divided into groups to solve the proposed problem based on data obtained through measurements of the athletics events carried out by the students themselves, with this, they had the opportunity to produce arguments and answers in a significant way. for the questions emanating from the study of affine function. The results showed that there was a good absorption of the content and performing an average comparison between the students of the class participating in the experiment with students of classes that did not participate, a higher average of the participants was observed, a difference of 19.3%.*

I. INTRODUCTION

The difficulties in the act of teaching Mathematics provokes a search for alternative methods as new didactic resources to stimulate the student to show the concepts in a way that they have less difficulties in the teaching and learning process. Thus, the need for innovation and the use of alternative methods has become a trend in recent years [1].

Some alternative methods offer an environment in which students can problematize and investigate, through mathematical exercises, more real and concrete situations, thus enabling the analysis of the discursive dimension of the teaching and learning processes of Science in real situations in the classroom. class [2].

The traditional Didactic Laboratory seeks to identify within routine activities, such as athletics events and other recreational activities, the mathematical concepts involved in them. The use of the traditional Didactic Laboratory is a subject that has been widely studied by researchers in Science teaching in Brazil, even without a specific space for it [3]. For a country where a considerable fraction of students have never had the opportunity to enter a science laboratory, it may seem counter-intuitive to question the validity of practical classes, especially since in most schools they simply do not exist [1]. With this thought in mind, one should try to provide students with an alternative to the traditional laboratory through everyday activities, such as Physical Education classes. Thus, this proposal aims to identify within athletics activities and other recreational activities the concepts of related function ([4],[5]) involved in them and analyze not only quantitatively, but also conceptually. Physical Education exercises through Mathematical concepts.

II. METHODOLOGY

The research was carried out in a Public School in the city of Belém-PA. Initially, we sought to determine the objectives of the didactic laboratory, as described in [3] are: 1) Illustrate content taught in theoretical classes; 2) use experimental data to solve specific problems; 3) stimulate and maintain students' interest in the study of Mathematics and 4) help to bridge the gap between theory and practice. This search consisted of a research based on materials developed by other researchers in area of the use of the Didactic Laboratory and the use of recreational activities ([6],[7],[8]), seeking to establish modeling processes in Mathematics classes. In this research, the importance of the Didactic Laboratory in the formation of high school students was evidenced [3].

In a second moment, the formation of competition groups, dividing the group of 38 students into four groups, two groups with 9 students and others two group with 10 students. These groups would be involved in two forms of competition.

The first competition was related to the athletics events themselves and the second related to the greater precision of the measurements of the times and distances involved in it. Each team would then have to choose its athletes who would participate in each activity, the 100 m and 400 m races were chosen.

In the 100 m race, each team chooses one component to participate in the race itself, while the rest are responsible for measuring the time, using hand stopwatches. Each team would have to measure the times not only of its competitors, but also the times of the competitors of the other teams.

In addition, the teacher makes his own measurements using more accurate instruments with a camera and a computer. Table 1 shows the values obtained. After measuring the teams' times, they are compared with those obtained by the teacher, and the mistakes made are verified. The students were impressed by how their averages were larger than the computer's measurements

At that moment, the concept of reaction time was explained and one of the objectives of the Didactic Laboratories was highlighted, which is to overcome the barrier between theory and practice.

Table 1: Time measurements obtained in the 100 meters race.

Runners	Average time as measured by teams (s)				
	Team 1	Team 2	Team 3	Team 4	Time by computer (s)
Team 3	14,57	14,83	14,68	14,53	
Team 2	15,12	15,20	15,18	15,12	14,83
Team 1	15,38	15,22	15,26	15,29	15,13
Team 4	16,02	15,85	15,90	15,71	15,38

The teams then began to prepare for the 400 m race, which was held in a different way. Each team competitor would race separately. Only one member of each team would be the runner. The other components of the teams were distributed in 4(four) points of the track to measure the times for each 100 m of race. Table 2 presents the measurements of the runner of team 3 that was the winner.

Table 2: Time measurements obtained in the 400m event.

Team 3 Runner.	Time as measured by teams (s)				Time by computer (s)
	Team 1	Team 2	Team 3	Team 4	
100	14,56	14,45	14,61	14,58	13,07
200	31,85	31,81	31,89	31,82	31,32
300	49,25	49,13	49,28	49,35	48,76
400	67,57	67,46	67,56	67,94	67,02

For the 100m sprint, the activities were: Determine the average speeds, in m/s, of each runner with the values obtained by their team; transform these speed values into km/h and Build graphs relating to the movements.

The construction of the graphs by the students was done both using traditional materials such as a ruler and protractor, and with a more modern tool, in this case GeoGebra (dynamic mathematics software).

During the dissemination of the results obtained from the average speeds of each runner, the film of the recording of the 100m tests made by the Physical Education teacher was replayed, and the test time was shown on the screen with the aid of the computer. The values obtained by the students had a much greater dimension now in this stage, with the situations experienced by the students, that the first time during the practical activities stage of the work, the same problems seen with a new approach, were much more significant and understood in a different way. more pleasant and lasting way.

The concepts of distance traveled and elapsed time were worked in a contextualized way, using the data collected to solve different problems. It was observed here how the objectives of a Didactic Laboratory can be achieved.

For the analysis of data from the 400m events, the proposed activities were: 1) Determine the time spent by the runners in each 100m section of the event; 2) Determine the average speed in each section of the race; 3) Determine an approximate value for the runner's acceleration; 4) Graphically sketch the variation in speed as a function of time for each runner; 5) Interpret the concept of angular coefficient of the graph referring to the movement.

With these exercises, the concepts of angular coefficient were worked in order to show how the decrease in the runner's speed during the race can be determined by measuring their split times. And also the analysis of the graph v × t (velocity as a function of time).

III. PROPOSED ISSUES BASED ON THE COLLECTED DATA

Next, we will have a collection of some of the problems proposed to students in the classroom regarding the data collected during physical education classes. The tables obtained were organized and distributed to students before each series of exercises.

3.1. 100 Meters Race Problem

The following problems will use the data from Table 1.

1. What is the percentage error in the times measured by each team for the winning athlete in relation to the time measured by computer?

Resosolution:

Team 1: (14,57-13,67)/13,67=0,066=6,6%;

Team 2: (14,83-13,67)/13,67=0,085=8,5%;

Team 3: (14,68-13,67)/13,67=0,074=7,4%

Team 4: (14,53-13,67)/13,67=0,063=6,3

2. Considering the data of the team with the smallest margin of error in the measures of the winner, what is the average speed of the runners of each team in m/s? Convert the values obtained to km/h.

Resolution: The team that achieved the highest accuracy was Team 4. Using the data measured by this team we will have the following average speeds per team.

Team 1:

$$V_m = \frac{100}{15{,}29} = \frac{6{,}54m}{s} = 23{,}54\frac{km}{h};$$

Team 2:

$$V_m = \frac{100}{15{,}12} = \frac{6{,}61m}{s} = 23{,}80\frac{km}{h};$$

Team 3:

$$V_m = \frac{100}{14{,}53} = 6{,}88m/s = 24{,}77\ km/h$$

Team 4:

$$V_m = \frac{100}{15{,}71} = 6{,}36m/s = 22{,}89\ km/h$$

3. Considering as constant the speeds of the winning runner and the last one placed in this competition, construct the space graphs (in meters) as a function of time (in seconds) in the same Cartesian Plane.

Resolution: The winning runner was team 3 and the time function of their movement is given by $X = 6.88t$ and the last placed team which is team 4 and the time function of their movement is given by $X = 6.36t$, the requested graph is shown in Figure 1.

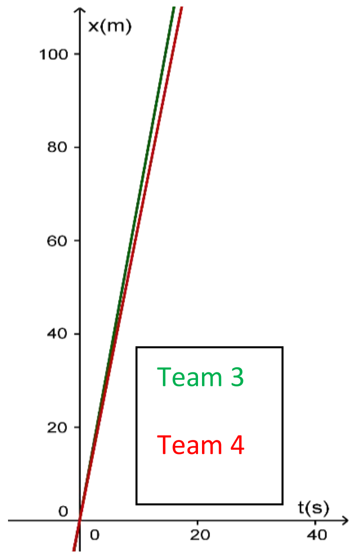

Fig.1: Function graph of runners' movements

3.2. 400 Meters Race Problem

The following problems will use the data from Table 2.2.

1. What is the average speed of the race winner in each 100m stretch, in m/s and in km/h, use the times determined by your team?

Resolution: The student athlete of team 3 was the winner of this race, we will solve this problem with the data collected by team 3 itself.

stretch 1: $V_m = \frac{100}{14{,}61} = \frac{6{,}84m}{s} = 24{,}62\frac{km}{h}$;

stretch 2:

$V_m = \frac{100}{31{,}89-14{,}61} = \frac{100}{17{,}28} = \frac{5{,}79m}{s} = 20{,}84\frac{km}{h}$;

stretch 3:

$V_m = \frac{100}{49{,}28-31{,}89} = \frac{100}{17{,}39} = \frac{5{,}75m}{s} = 20{,}70\frac{km}{h}$;

stretch 4:

$V_m = \frac{100}{67{,}56-49{,}28} = \frac{100}{18{,}28} = 5{,}47m/s = 19{,}69\ km/h$

2. Based on the data obtained in the previous question, determine the average acceleration in section 1 and then calculate the average acceleration in the rest of the test.

Resolução:

stretch 1: a_m=6,84/14,61=0,47m/s²

Resr of the race: a_m = (5,47-6,84)/(67,56-14,61)= -0,026m/s².

3. Construct the graph of the variation of velocity as a function of time considering the accelerations obtained in the previous question.

Resolution: Let's build the graph considering constant accelerations both in the first section and in the rest of the route.

We mark the point P1 = (14.61; 6.84) and trace a segment from the origin to it, then we mark the point P2 = (67.56; 5.47) and trace a segment from P1 to P2. The graph obtained is shown in Figure 2.

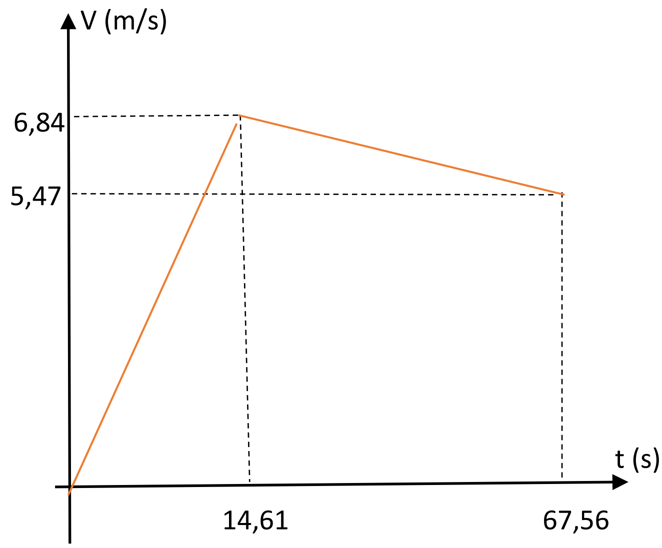

Fig.2: Graph of speed variation as a function of time

One way to assess the understanding of the subject through the application of the Didactic Laboratory is to apply the same assessment on the subject to the class that participated in the teaching process with another class without participation. From the results, it appears that the average grade of students in the other 1st year classes of the college was 5.7 and the average grade of students in the class where the research was carried out was 6.8, that is, an average grade of 19.3% of the other classes as shown in Figure 3.

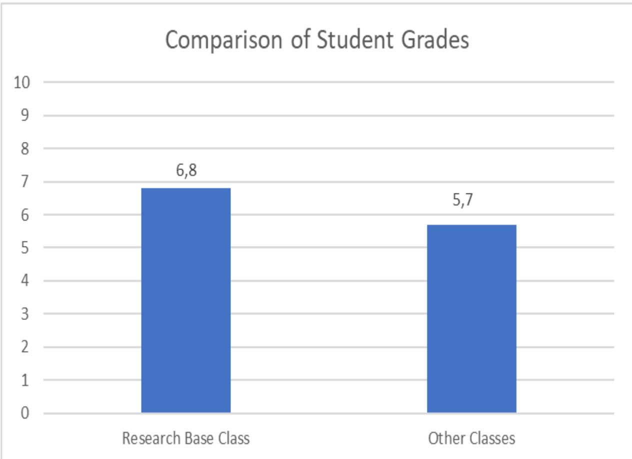

Fig.3: Comparison graph between the averages of the research base class and the other classes in the school.

IV. CONCLUSION

During the research, few publications were found that related the Didactic Laboratory and Physical Education classes [9]. This influenced the analysis of the results, causing them to present some limitations, as there was no deep specific theoretical foundation on this subject.

Despite this, it was possible to observe with this research that Physical Education classes work as a great tool, including achieving the objectives of a Didactic Laboratory and also serving to arouse students' interest in learning.

The activities proposed to the students in the classroom, after the practical classes, served to illustrate in a more interesting way the concepts of related functions worked in the first year of high school. It is also noteworthy that the practical classes directly influenced the students' arguments, which allowed them to make a more concrete analogy of the contents taught with phenomena observed and performed by themselves.

The objectives of the Didactic laboratory were satisfactorily achieved when using Physical Education classes, being important to provide experimental data for problem solving and mainly to stimulate students in the study of Mathematics.

Finally, one can observe the need for prior planning of the classes taught, to provide attractive tools in order to provide students with more instruments that they can use to form a solid argument from athletics activ ities and other recreational activities.

Another important point to highlight is the verification of the results obtained by the students of the class that participated in the process. While the average grade of students in the other 1st year classes of the school was 5.7, the average grade of students in the class where the research was carried out was 6.8, an average of grades 19.3% above the average of the other classes.

The taboos related to Mathematics when their learning difficulties can be rebutted with activities that encourage students to think for themselves, developing more solid forms of argumentation through lived experiences.

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