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Project-Based Learning (PBL): A Methodological Approach to Teaching Physics and Astronomy

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Abstract. The teaching of Physics in high school and early University has presented many challenges for educators and educational institutions. The problems encountered by teachers and educational institutions in attracting and maintaining student attention by reducing lack of interest and motivation have impacted performance and dropout rates. Traditional teaching and learning methods have not been successful. Given this, it is proposed to use Active Learning Methodologies (ALM), in particular Project-Based Learning (PBL). Six wave activities were created, emphasizing Astronomy. The projects were concluded with a scientific exposition with posters sessions and on oral presentations to the school community, making the PBL a feasible and promising proposal in the Integrated Technical Education to the High School (ITEHS) of the Paula Souza Center, where the methodology was applied.

Resumo. O ensino de Física no ensino médio e início da Universidade tem apresentado muitos desafios para os educadores e instituições de ensino. Os problemas verificados por professores e instituições de ensino em atrair e manter a atenção dos alunos reduzindo a falta de interesse e motivação, têm impactado sobre o desempenho e taxas de evasão. Métodos tradicionais de ensino e aprendizagem não têm surtido bons resultados. Diante disto, propõe-se a utilização das Metodologias Ativas de Aprendizagem (MAA), em particular a Aprendizagem Baseada em Projetos (ABP). Foram criadas seis atividades, sobre ondas, enfatizando a Astronomia. Os projetos foram concluídos com uma exposição científica com sessões de pôsteres e apresentações orais à comunidade escolar, fazendo da ABP uma proposta exequível e promissora no Ensino Técnico Integrado ao Ensino Médio (ETIM) do Centro Paula Souza, onde a metodologia foi aplicada.

Keywords. Teaching of Astronomy

1. Introduction

The work made use of Active Learning Methodologies (ALM), in particular Project Based Learning (PBL), applied at ETEC São Mateus, São Paulo, in 3rd year students of Integrated Technical Education to the High School (ITEHS). Difficulties over the years in the Physics learning of high school and high school students motivated the researcher professor Pinto, guided by Voelzke, to search for new teaching methodologies capable of reducing the problem. Wave content was used as theme, but with applications in Astronomy. The use of PBL proved satisfactory both to create a study routine, as well as to develop student participation, autonomy and increase self-esteem (Barbosa & Moura 2013). Two activities per class were suggested and elaborated, involving 160 students from third grade classes.

2. Development

A previous questionnaire was applied [Chart 1] containing 15 objective questions, with five alternatives each, on themes related to waves, applied in Astronomy. After applying the previous questionnaire, it was suggested to students to choose topics of interest to continue the work under the guidance of the researcher teacher.

The proposed questions are pertinent with the content addressed in the generating theme, in order to understand a little about the level of knowledge that students have before applying the methodology (MOREIRA, 2002). At the end of the intervention process the post test will be applied, that is, a series of questions, which may be the same as the previous ones, with the same structure made in the pre test (Bardin 2006).

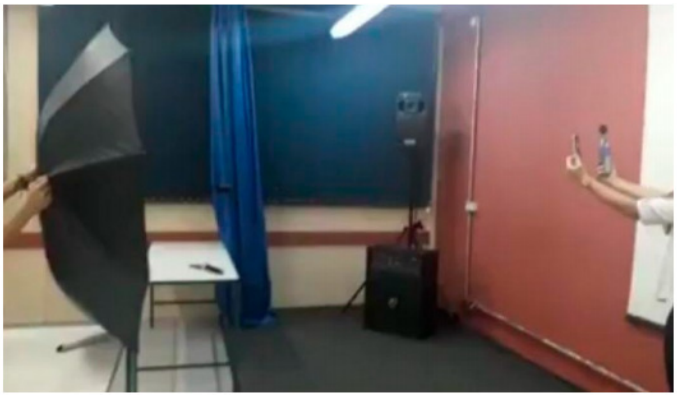

Figure 1. Demonstration of the operation of Radio Astronomy using the capture of electromagnetic waves with an umbrella. Source: Pinto, Nivaldo Robson, personal files.

The ABP aims to build knowledge using a continuous process of study in order to answer a question, a challenge or a problem. It is a teaching methodology that engages students with learning content and is therefore recommended by many educational leaders as one of today's best educational practices.

From this point, the students began with their hypothesis research and the search for resources to perform the activity. With the application of the ABP students developed a product or a satisfactory solution to the initial question. The topics addressed were: Radio Astronomy, wave differentiation, gravitational waves, sismology, space robotics [Figures 1, 2, 3, 4, 5 and 6].

Figure 2. Demonstration of wave behavior and differentiation with an oscillatory model. Source: Pinto, Nivaldo Robson, personal files.

Figure 3. Experimental model for demonstration of the Michelson- Morley experiment, illustrating gravitational wave detection. Source: Pinto, Nivaldo Robson, personal files.

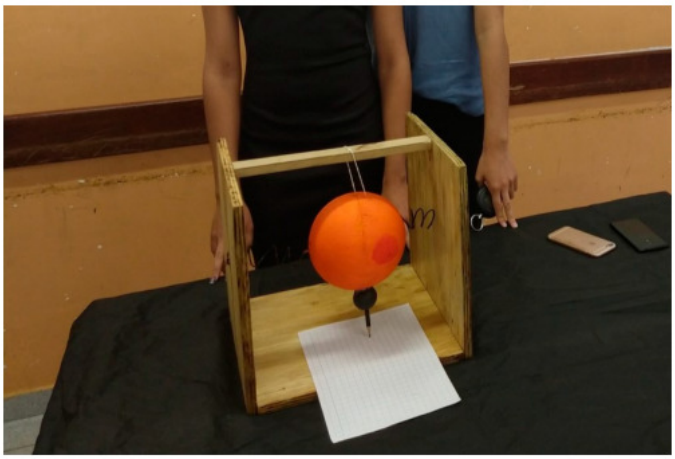

Figure 4. Model for demonstration of the seismic wave detection experiment. Source: Pinto, Nivaldo Robson, personal files.

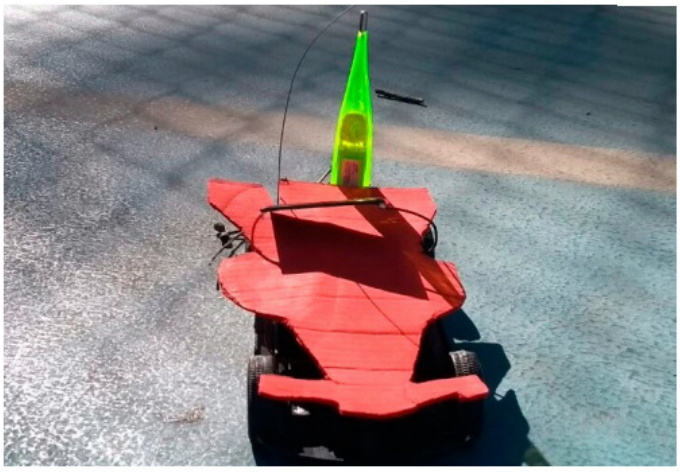

Figure 5. Solar-powered and radio-frequency controlled vehicle. Source: Pinto, Nivaldo Robson, personal files

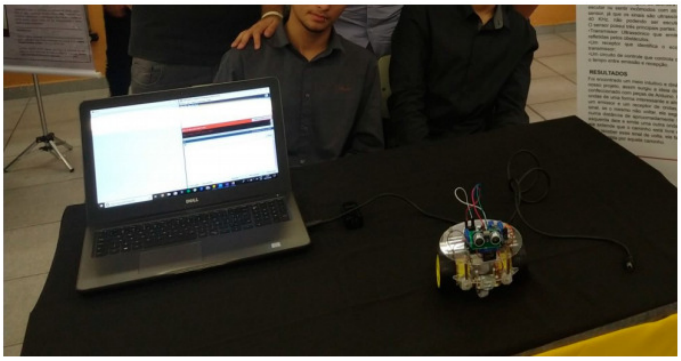

Figure 6. Figure 6: Robot “Walter”. Radiofrequency “smart” automaton programmed with ®Arduino software. Source: Pinto, Nivaldo Robson, personal files.

PRE-TEST

1. How would you describe a wave?
2. What types of waves?
3. Do all waves have the same speed on earth?
4. Is it possible to hear the noise of a conversation or an explosion in space?
5. What is the great scientific evidence in the field of undulatory this year?
6. Light is said to have constant velocity, so why in physics is it said to change its velocity when it "penetrates" into liquids?
7. What evidence in NATURE proves the difference between the speed of sound and light on Earth?
8. Is a boat on the high seas "carried" by the wave?
9. Is it possible to distinguish with the naked eye the planets from the other stars seen in the clear night sky as we observe?
10. Earthquakes (earthquakes and tidal waves) that occur on Earth are disturbances of a wave nature. What kind?
11. Regarding the previous question, it is possible to detect them with:
12. The different colors we see are manifestations of waves. What kind?
13. The orientation of robots in other celestial bodies off Earth occurs by:
14. When communicating by satellites, radios and cell phones, are waves present? If so, what nature?
15. Another great achievement of science was the “photographic” detection of a black hole. For this feat one was used:

Chart 1: Model of previous questionnaire (pre-test) applied to students before starting the work. Source: Pinto, Nivaldo Robson, April 2, 2019.

3. Conclusion

The use of ALM in particular by ABP, has brought positive results in the teaching and learning process of students, encouraging a collaborative, interdisciplinary and motivating work, breaking with the passive teacher focused learning model. The results obtained in the execution of the work encouraged the researcher professor to carry out future projects. In the final phase of the Professional Master in Science and Mathematics Teaching, the work will continue as research for further development.

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