

The Role of graphs in IBL study of optical diffraction by secondary students

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Abstract. Graph have a special role in physics and in physics education, but several research evidenced serious difficulties in reading, constructing, understanding graphs. On the base of a research educational path a study was conducted on the role of graph in learning optical diffraction of high school students.

1 Introduction

Graphs have a special role in physics and in physics education [1] not only for a synthetic data representation, but particularly because they give access to the “revelation of the complex” [2]. In spite of this, a wide literature related to many topics both in physics and other scientific disciplines evidenced the difficulties of students in reading, constructing, interpreting graphs [3-10]. On-line sensors offered new learning opportunities in that area of concern, aimed at constructing physics concept and developing graphing competencies [11-13]. New strategies have been studied to change graphing obstacles in learning tools [14-16].

2 Research

Optical diffraction is the focus of a series of activities in an inquiry based laboratory oriented to bridge from classical to modern physics for secondary school students [17,18]. A research based educational path suggests a preliminary qualitative exploration of a diffraction pattern with the task to sketch the graph of light intensity vs position. The second step of the activity offer to the students the opportunity to measure intensity vs position by means of USB computer on-line sensors system working as RTL. By means of tutorials, we studied the learning path in interpreting the diffraction phenomenon and the role of graphs of a sample of more than 200 Italian upper secondary students 17-18 years old. Students learning path were monitored using an open inquiry based tutorial, free notes of researchers during activities, students reports of their labwork. A) First, students explored qualitatively optical diffraction produced by single slits, just looking the diffraction pattern produced by red-laser light diffracted by single slit on a white screen. They were requested to draw the image on the screen, describe it, draw the corresponding intensity distribution vs transversal position they expect to observe performing a quantitative experiment, comment that graph. B) Then, students faced the role of parameters (D -distance slit-screen; a -slit width; λ -laser color used) in affecting the diffraction pattern observed on the screen. Presenting the opportunity to use Lucegrafo, an on-line system able to collect with a light sensor the intensity vs position [19], students were request to design a project of quantitative experiment and then of data analysis to characterize quantitatively the diffraction distribution. C) Students in groups of 3-4 performed some experiments in lab and analyzed and elaborated data (usually by tutoring of their school teacher).

3 Data Discussion and Conclusion

Analyzing first drawing (at the end of step A) emerged that the majority of students tend to represent only the envelope of the intensity, disregarding the periodic change in the intensity distribution and in particular the presence of minima. This seems connected from a side on the

absence of a coherent physical model capable to explain the presence of minima [20], from the other side to the lack in their mathematical background of a complex functions as the square sinc describing a diffraction pattern. Another group of students showed the tendency of emphasize the presence of minima with discontinuous curves. This seems connected with an idea of a discontinuous distribution of the light intensity coherent with the students' pattern drawings. When asked to design an experiments, students tend to mix parameters ($D-a-\lambda$) and physical quantities (light intensity, position) to be collected. Performing the experiment and the analysis of on-line graph the large majority of students gained a complete vision of the phenomenology, distinguishing the role of parameters and of the physical quantities measured. Few students continued to emphasize only the intensity of the central maximum in their distribution drawing, characterizing diffraction with an "enlargement of the pattern", because any new models was activated. In the analysis proposed by students emerged that they feel the importance to analyze position of minima/maxima and relative intensity. Usually they connected the minima position vs order number to the trivial minima condition. The intensity vs position relation constitute an immediate goal only for few students. Sharing the suggestion of all the students of a class was possible to reach a satisfactory students learning, without an instructional-guided path.

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