A scheduled teaching intervention for Newton's Disc, programmable with Scratch, for teaching and learning Optics

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Abstract. This paper refers to a scheduled teaching intervention, based on Arduino and the Scratch programming environment, for programming the rotation of small Newton discs. The aim is for students in Primary or Secondary school classes, as well as for University students, to explore concepts of Optics and issues related to elements of Physics. In this context, concepts such as colours and persistence of vision are explored. The project has been published on electronic platforms in Greek. The application and the corresponding teaching intervention in school classrooms can contribute to the feedback from students and teachers regarding learning outcomes.

Introduction

As regards the concept of Physical Computing, it is a concept becoming more and more widely used and disseminated at all levels of education. In particular, Physical Computing is becoming an increasingly powerful tool for physics' and informatics' education [1]. Arduino, in particular, is already a popular device for teaching physics concepts [2], which has ease of use and relatively low cost. In education, projects with Arduino micro-controller have often been used, in order to teach the properties of light ([3]; [4]; [5]). However, a lack of educational proposals for using Newton's Disc, in combination with educational robotics and Arduino devices, is definitely apparent. An exception to this are some efforts made with rotating LEDs ([3]).

Theoretical framework and research questions

The aim of the scheduled research is the interaction of students with programming environments (Scratch) and with Educational Robotics devices, based on physical programming (Arduino). A sub-objective is the attempt to solve issues and problematic situations concerning light (with the main focus on Newton's Disc). Furthermore, the theoretical framework of the designed intervention as a whole, was Constructionism [6]. Some key questions that this educational research seeks to answer are: (i) the difference between the visual impression of Newton's classical disc (with indigo as the seventh colour, as found in many textbooks), and the theoretical scheme of the six-colour disc, and (ii) what kind of visual effects that we get when we rotate the two aforementioned disc types, at various rotation speeds.

Methodology - evidence from the proposed didactic intervention

In the intervention activities students should work collaboratively, planning, testing, and implementing their own ideas, with the teacher/researcher acting as a facilitator and assisting the groups, if they need help. In the first stage of the teaching intervention, the students in the classroom are to be familiarized - in groups - with various forms of small-scale Newtonian discs, controlled and driven by a motor (moter) attached to an Arduino Uno microcontroller.

Then, with the help of a digital revolution counter, students could measure the rotational speed of the disc, always watching out for possible technical difficulties and errors. The rotation speed can also be programmed from the Scratch code at one stage of the intervention. Also, with the aim of finding their correspondence, the recorded values would be compared with the programmed ones. In the next stage of the intervention, the students, assisted by both the teacher and the

researcher, should mount two Newton's discs on the Arduino, with the help of two motors. The one disk possesses the classic six (6) colors, while the other possesses also the seventh colour, indigo, as shown in Figure 1. At the same time, the students are answering the Worksheets distributed to them. The images and the descriptions/videos of the activities, have also been uploaded to the "Github" web platform [7] (https://github.com/artemisia69/-.-O-Arduino.git), all written in the Greek language, with the aim of creating a community of users/teachers who will use it in their own classrooms, thus providing feedback and improvements.

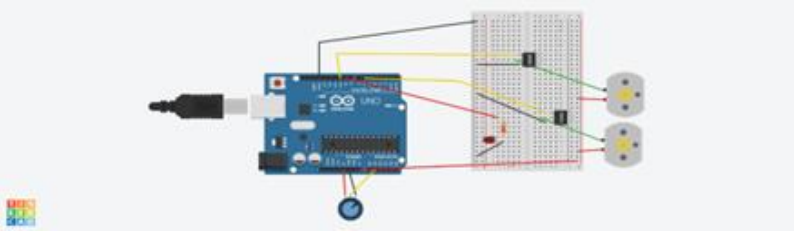

Fig. 1. The layout with the Arduino and the two motors turning the two Newton disks, one with six and one with seven colors.

Expected Results

Upon completion of the teaching sequence, the learners are expected, through their interaction with the Arduino-controlled Newton's disc/discs, to have a measurable improvement in both their knowledge of Optics and Light in Physics, as well as in their skills concerning operating Educational Robotics devices. Also, an expected outcome is experiencing in programming (especially Scratch) and algorithmic thinking.

Conclusion

This submission is a scheduled project in progress for teaching light, using physical computing and Educational Robotics. With its future implementation in the classrooms and with the feedback from the users' communities, more measurable results and educational effects of the intervention are expected to rise.

References

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