

An Open Electronic Prototyping Platform as Resource for Teaching

Rafael Rosa Egea, Renata Lopes Rosa, Demóstenes Zegarra Rodríguez

Departamento de Ciência da Computação – Universidade Federal de Lavras (UFLA)

CEP 37200-000 – Lavras - MG – Brazil

rafegea@computacao.ufla.br, {renata.rosa, demostenes.zegarra}@
dcc.ufla.br

Abstract. *The use of the Prototyping Platform Arduino has been very used in automation projects. In this study, the Arduino was used in classes of electronic laboratory. The purpose of the project is facilitating the students' learning with the use of a simple and didactic prototype and at the end of the course, to evaluate the knowledge of undergraduate students. Prior to the use of Arduino, other traditional electronic components were used in the laboratory to verify if the use of Arduino facilitated the learning in laboratory classes. The results showed that the use of Arduino facilitated the achievement of theoretical concepts by 30% compared to the use of traditional teaching modules for electronic.*

1. Introduction

Theoretical and practical concepts of disciplines such as electrical circuits, language and programming techniques and computer architecture in computer science courses should have a focus on the construction and operation of computers in general. Often the demonstration of computer architecture is limited due to the scarcity of economic resources to set up a computer and there is the difficulty in finding ergonomic prototypes of a logical programming architecture and hardware. The use of the Open Electronic Prototyping Platform Arduino as a learning tool in the discipline of electronics and computer architecture allows the application of knowledge and has become, according to the results obtained in this work, a good learning tool. Concepts that were previously exposed only in a theoretical way were materialized in a solid way. Arduino is a low-cost prototype with use of an Open Source hardware and can also be used in the development of independent interactive objects. The purpose of the project is facilitating the students' learning with the use of a simple and didactic prototype and at the end of the course, to evaluate the performance of the students in terms of electronic knowledge. Initially, the student applied all theoretical concepts in the laboratory classes with the practical classes using the Arduino, at the end of experiment, theoretical tests were applied to analyze the performance of the practical classes presented to the students. Prior to the use of Arduino, other electronic learning modules based on analog electronic components and protoboards, were used in the laboratory to verify if the use of Arduino facilitated the learning in laboratory classes. The results showed that the use of Arduino increase the number of approved students by 30% compared to the traditional teaching methodology. Therefore, it was verified that the Arduino is an useful tool for teaching electronic and programming courses.

2. Related Works

The use of Arduino as a facilitator in the teaching of electronics and robotics has been approached in several studies, such as in [Pinto et al. 2012],[Chang et al. 2009],[Hertzog and Swart 2016] which presents the training of teachers in the field of electronics, to disseminate and insert the use of Arduino, as a low-cost platform in the daily life of public schools. These studies do not measure the relation between the classes performance using and not using the Arduino. In [Costella et al. 2016] is built a prototype, the EduPi, based on the Raspberry Pi platform, applied in two young men of 12 and 13 respectively and the prototype presented good results of learning.

Arduino is used as a tool in the work of [Zanetti et al. 2015], with the aim of developing computational thinking. The students were in the secondary school and the Arduino was used as introduction to the programming language course; at the end of the practices, through a questionnaire applied to the students, it was found that there were improvements in learning, especially in relation to debugging of errors, and the learning process with the prototype was considered by the students a more interesting method of learning.

The related studies using Arduino as learning platform, in the majority, are applied in young students, teenagers, and our study applies a learning methodology in undergraduate students and pretend stimulate the use of Arduino and the learning methodology not only in high school or secondary school, but also in Universities, in the teaching of electronic and robotics.

3. Teaching Methodology with the use of a Low Cost Prototype

This section presents the methodology used in classes of electronic using a low cost prototype.

The Arduino UNO was used in the electronics classes and its use facilitated the understanding of concepts such as, diode, transistor, different types of sensors, digital and analog signals, capacitors and inductors, AD/DA conversion, memories, processors, among others.

The purpose of the project is to facilitate the students' learning of electronic area in a University, with the use of a simple and didactic prototype; and at the end of the course the electronic knowledge of the students was evaluated. The study was organized and applied by one professor.

The following methodology was used to compare the results of using or not the Arduino, all the experiments were organized in a laboratory, always with the same conditions:

- In two semesters only traditional teaching modules of electronic based on analog components were used in laboratory classes, without the use of Arduino; at the final of the course a test was applied to measure the knowledge of the students. Each semester had a number of 20 students. The students worked with the sensors, measuring diverse variations of temperature, pressure, light, among others.

- In another two semesters the Arduino was taught the same theoretical concepts of the two previous semesters, but using the Arduino; at the final of the course a similar test was applied in the students.

In the learning methodology with Arduino, the electronic devices were used together with the use of sensors, such as, temperature, luminosity, pressure, relative humidity, among others. Therefore, the students had practical examples of the functionality of each component and how work a global electronic circuit.

4. Results

The experimental results showed that the use of Arduino facilitated the learning of theoretical electronic concepts increasing 30% the number of approved students, in relation to the use of traditional electronic modules and analog electronic components. Therefore, it was verified that the Arduino is an ergonomic tool of easy assimilation and use.

Table 1. Average Performance in the Tests without and with Arduino

Final middle grades	Assessment without Arduino	Assessment with Arduino
50 – 100 (Approved)	54%	84%
0 – 49 (Disapproved)	46%	16%

5. Final considerations

The results demonstrated that students learned more electronic concepts, increasing the number of approved students, with the use of Arduino and the methodology that uses different kind of sensors together with the electronic devices. The use of Arduino or another Prototype of low cost is useful in laboratory classes not only in students of the secondary school, technical courses, but also in undergraduate students. As future works, the study will be applied in undergraduate students in the discipline of sensors & instrumentation of other courses, such as food engineering.

Reference

- Chang, M., Kuo, R., Kinshuk, Chen, G-D., Hirose, M. (2009). "Learning by Playing. Game-based Education System Design and Development". International Conference on E-Learning and Games, Edutainment Banff, Canada, August 2009.
- Costella, L., Licks, G. P., Teixeira, A. C. (2016). "Uma solução livre e de baixo custo para prática e aprendizagem de programação e robótica". SBIE 2016, pp. 846-855.
- Hertzog, P. E., Swart, A. J. (2016). "Arduino — Enabling engineering students to obtain academic success in a design-based module," *IEEE Global Engineering Education Conference*, Abu Dhabi, pp. 66-73.
- Pinto, M. d. C., da Fonseca Elia, M., and Sampaio, F. F. (2012). "Formação de professores em robótica educacional com hardware livre arduino no contexto um computador por aluno". Anais do Workshop de Informática na Escola, pp. 25-45.
- Zanetti, H. A. P.; Oliveira, C. L. V.; (2015). "Prática de ensino de Programação de Computadores com Robótica Pedagógica e aplicação de Pensamento Computacional". Congresso Brasileiro de Informática na Educação, pp. 34-51.