Educational Data Mining in an Open-Ended Remote Laboratory on Electric Circuits. Goals and Preliminary Results

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ABSTRACT

WebLab-Deusto is a learning environment used at the University of Deusto as the landing platform to several remote laboratories currently used in high school and university level courses. One of these remote labs is VISIR, a remote electricity kit that can be used in teaching DC and AC circuits. As happens in any open-ended educational environment, it is difficult to assess the learning effects of this tool. Fortunately the communication between the users and the VISIR remote lab in the Weblab-Deusto leaves behind a set of log information that can be analyzed. This contribution presents our current work-in-progress in analyzing these logs for better understanding the learning processes that take place when using this remote lab.

Keywords

Remote lab, logging, learning, physics, electric circuit

1. INTRODUCTION

WebLab-Deusto [1] is an open-source management system for remote laboratories in development at DeustoTech, Universidad de Deusto since 2001. Its features web and mobile access to several remote laboratories in different topics, e.g. programming or physics.

One of the remote labs that is used through this platform is VISIR [2], a remote laboratory which supports experimentation with electric circuits (see Figure 1).

As is common in using open-ended educational environments, it is difficult for students, teachers and researchers alike to understand and to assess how to use them to improve learning.

Fortunately, the use of VISIR through the WebLab allows collected each of the circuits made by the students and sent to the remote lab for its construction.
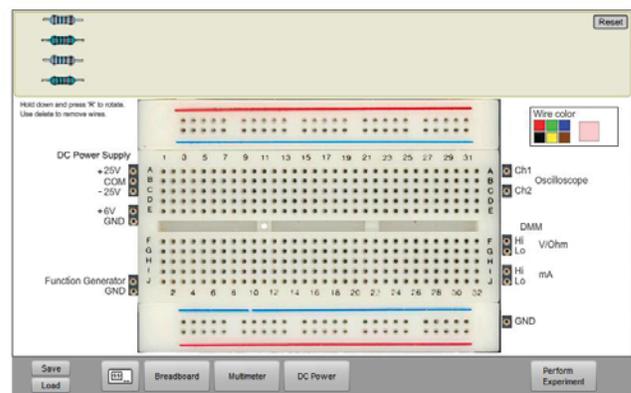

Figure 1. Web interface to VISIR in WebLab-Deusto

This work describes the data collected in WebLab-Deusto for the VISIR remote lab and it presents our efforts to provide (a) a tool for teachers to check students' work, and (b) a toolbox for a quick understanding of the students' activity when the lab is used in medium-to-large class settings.

2. WEBLAB-DEUSTO VISIR DATA COLLECTION

As indicated above, any call to the VISIR remote lab in the WebLab-Deusto system is collected to a database.

Each register in the collected data includes the following fields:

- **studentId**, a key corresponding to each student,
- **sessionId**, a WebLab-Deusto session key,
- **requestTime**, a date/time indicating when the request was made,
- **responseTime**, a date/time indicating when the response was sent back to the web client,

- **queryXML**, the information sent from the client to the remote lab and,
- **answerXML**, the digitized information of the measures collected in the remote lab and sent back to the client.

In this data, the electric circuit made by the user is encoded in character string in the queryXML field. For example, the text "W_X DMM_VHI A11 W_X DMM_VLO A7 R_X A7 A11 10k" indicates that a 10 kΩ resistance is connected to the voltage plugs of the digital multimeter.

3. ASSESSMENT TOOL FOR TEACHERS

The assessment tool for teachers allows selecting a specific call to the remote lab and retrieving in friendly interface the most significant information about the circuit that was constructed and, if it's the case, measured.

This tool, detailed in an earlier publication [3], allows to compare a specific circuit built by a student with a teacher's proposed solution. It automatically evaluates the main characteristics of both circuits and tries to estimate whether both circuits are equivalent.

4. DATA MINING FOR ACTIVITY EVALUATION

The data mining part of the effort implies querying the database for all the actions done by a group of students in solving a predesigned educational hands-on activity.

The results shown here correspond to an educational activity carried in the second semester of the 2013-14 academic year in an introductory physics course in a first-year undergraduate program. It belongs to the teaching of DC circuits, i.e. to the measure of voltage and current in simple DC circuits and Ohm's law. The activity included two 1.5-hour sessions of using the VISIR remote lab.
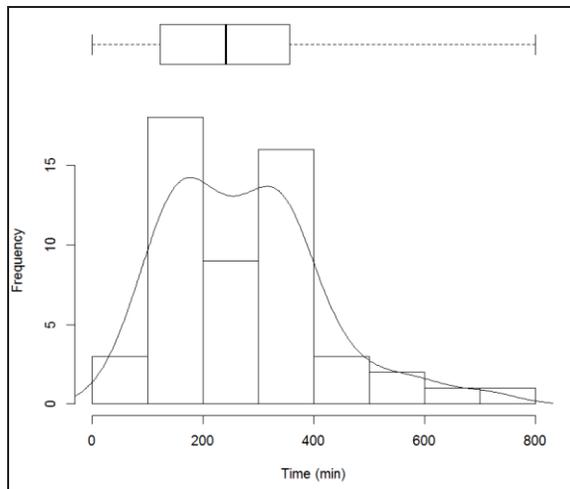

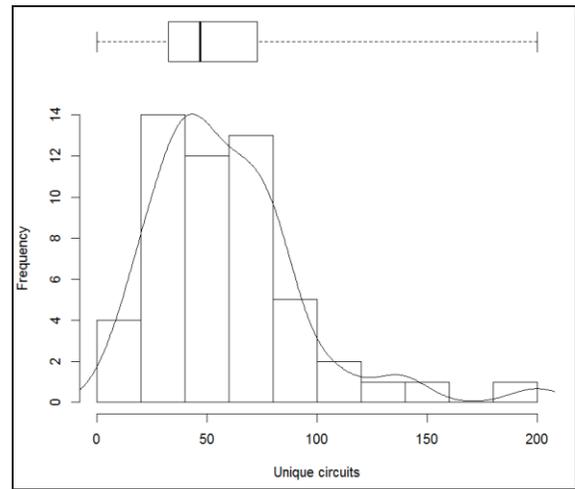**Figure 2. Time spent per student**

Figure 3. Unique circuits per student

From the pooled data (53 students, 18064 registers, 12114 circuits), a data-based evaluation of the activity has been carried on. For example, the teacher can know the distribution of time-on-task per user (Figure 2), the number of different circuits built per user (Figure 3) or, if required, identify the students who did not take enough profit from the lab session.

Other information that we are currently able to analyze include which circuits are more often built, what measure is attempted in each of them and the correctness of this measure.

5. CONCLUSIONS AND FURTHER WORK

Current logged data in remote laboratories delivers enough information to provide better feedback to students and teachers to support learning in these open environments.

Work is in progress to offer the users of these resources, analytic tools that allow for detecting learning difficulties and affordances for educational improvement.

6. ACKNOWLEDGMENTS

7. REFERENCES

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