Do Students Really Understand the Difference Between Simulation and Remote Labs?

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Francisco Garcia-Peñalvo

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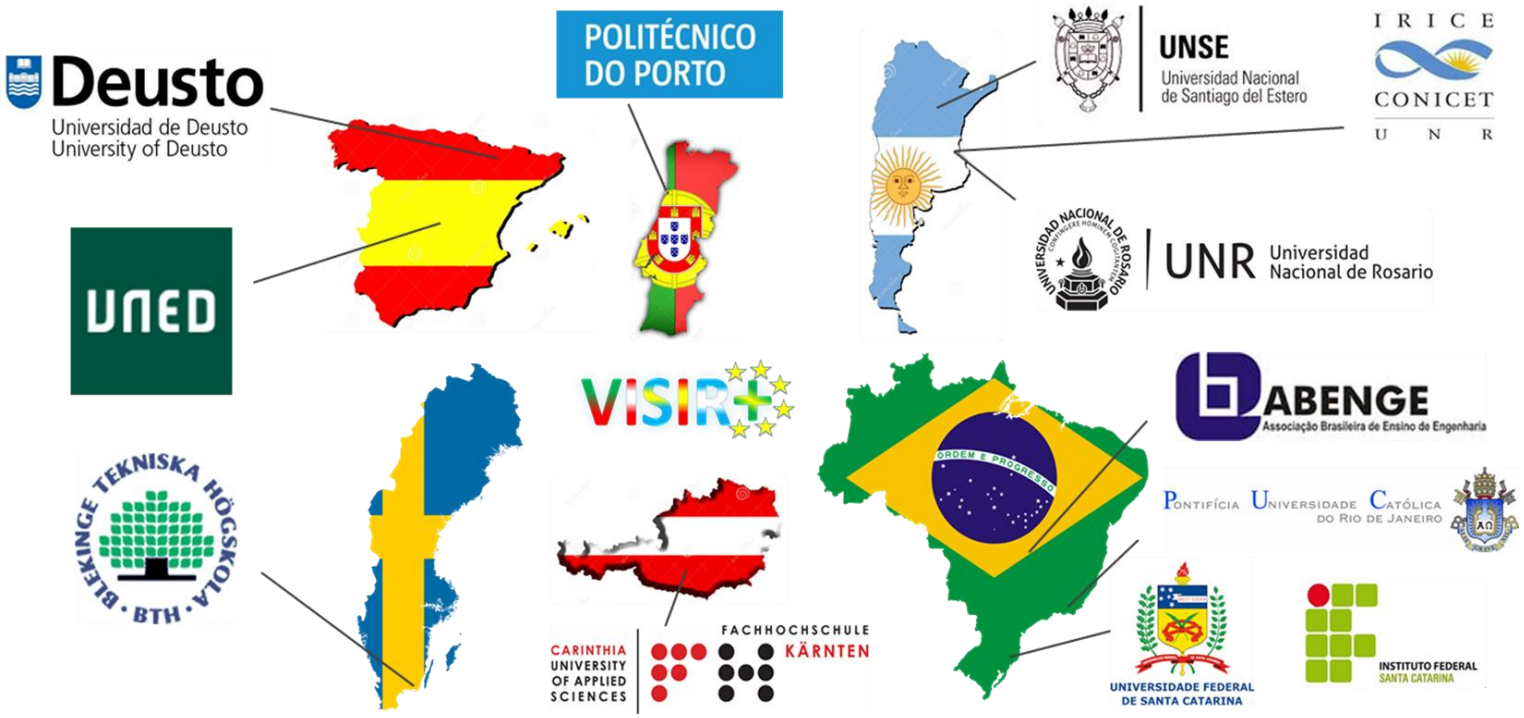
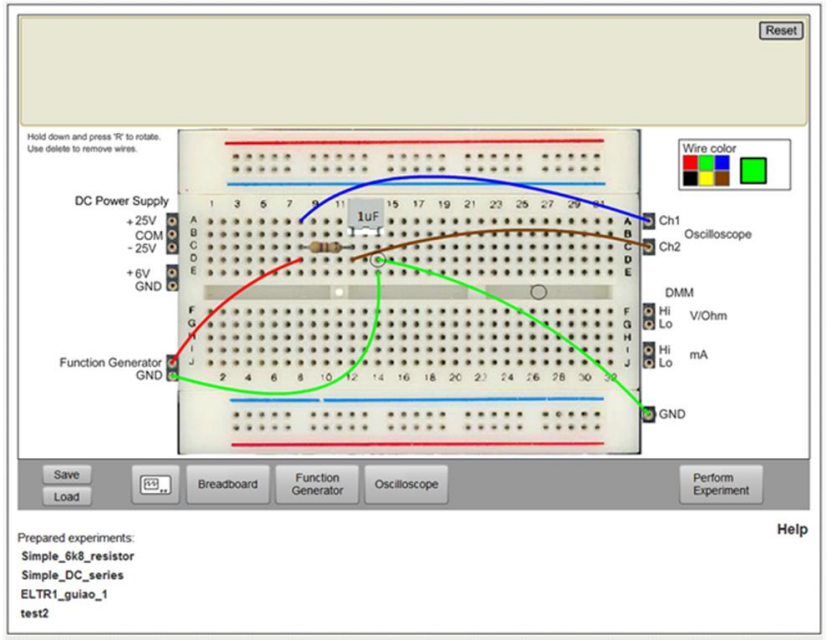
Under the scope of VISIR+ Project



Global Online Laboratory Consortium

GOLC 2015 Online Lab Award

The GOLC Online Laboratory Award 2015 in the category



Remote Lab: VISIR (**V**irtual **I**nstrument **S**ystems in **R**eality)

This Laboratory was developed for remote experimentation on electricity and electronics. It is based on ***virtual Instrumentation***, i.e., real physical instrumentation accessible through virtual interfaces.

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Didactical approach:
Simultaneous usage of Hands-on Lab / Simulations / Remote Lab

TEEM '17

Hands-on Lab:	Remote Lab:	Simulation:
real experimental results		computational model results
physical contact with the experimental devices	use the internet (configuring, controlling and/or monitoring results)	

Advantage of the simultaneous use:

- Engineering students need to **perform experiments** as they allow them to **apply theory concepts** through the **handling of instruments** equipment and data, building up and consolidating knowledge and skills
- Different resources allow students to **practice some experimental skills in a different manner**, complementing their competences

VISIR+
Co-funded by the Erasmus+ Programme of the European Union
isep Instituto Superior de Engenharia do Porto
cieti centro de inovação em engenharia e tecnologia industrial

Research Question and Design

The problematic tackled in this study deals with students' perception about the **difference between simulation and remote labs**.

- *"Do students really understand the difference between simulation and remote labs and the different type of results obtained with each of them?"*

Multi-case study research

- 3 course implementations ⇒ 2 countries ⇒ 2 teachers ⇒ 93 students;

- Data analyzed:
  - students' grades;
  - number of accesses to VISIR (per student and course);
  - answers to a satisfaction questionnaire;
  - Students' interviews;

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Didactical Implementations

Institution (Country)	Degree	Course	Semester	Number of		
				teachers	students	Class hours per week
Federal University of Santa Catarina (BR)	Computer Engineering (CE)	Calculus IV	4th	1	16	4
	Energy Engineering (EE)				27	4
Polytechnic of Porto - School of Engineering (PT)	Systems Engineering (SE)	Applied Physics	2nd	1	50	6

All students : 1st time in the subjects and 1st time using lab.

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Implementation Description

	Description	Course Name		
		CE	**EE**	**SE**
General	**Resources**	VISIR, **simulation**, graphic tools, calculus	VISIR, **simulation**, graphic tools, calculus	VISIR, **hands-on lab**, calculus
General	**Goal**	Contextualize **mathematics** and develop **critical thinking**	Contextualize **mathematics** and develop **critical thinking**	Develop **experimental skills**
VISIR	**Introduction**	Tutorial Video	Tutorial Video	**Teacher brief explanation** followed by students practice trying to assemble a simple circuit
VISIR	**Task**	1 Task using VISIR, simulation and calculus	1 Task using VISIR, simulation and calculus	1 Task using VISIR and calculus
VISIR	**Period**	6 weeks	6 weeks	**1 week**

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Results: Students' Grades

- In general, students' achieved **a better grade in the task involving VISIR** than in the final grade

Course	Assessed students		VISIRs' task grade	Final course grade	Students Completing the Course
	VISIR	Final			
CE	12	16	80%	44.7%	43.8%
EE	26	27	83.5%	61%	74.1%
SE	49	46	70%	52.5%	64%

- Although being the same teacher and course, **results are clearly very different**;

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Results: VISIR Logs

- Average number of accesses per group: from 2.3 to 3.1;

  Higher VISIR usage: Computer Engineering - Calculus IV students.

- **Although different availability ⇒ no significant correlation** was found between the factors:

  "number of accesses to VISIR" ↔ "students' grade obtained in Task using VISIR".

Extended availability

Course	Number of Accesses		Semester Length (in weeks)	Period of Time (in weeks)	
	Total	Per Group		Availability	Task
CE	25	3.1	18 w	4 - 18 w	6 w
EE	36	2.8	18 w	4 - 18 w	6w
SE	53	2.3	11 w	10 – 11 w	1 w

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Results: Students' Satisfaction Questionnaire

- 3 dimensions were considered:
  - **D1 - Learning environments (traditional, remote, simulation)** (Q3, Q13, Q18)
  - **D2 - Development of higher order competences** (Q2, Q16, Q20)
  - **D3 - Period of Time and Technical Restrictions** (Q15, Q19)

Students enjoyed it and think having develop competences

Lower response level

Category	Course	Number of answers			D1			D2			D3		
		CE 56,3%	EE 88,9%	SE 38%	CE	EE	SE	CE	EE	SE	CE	EE	SE
	Good	1	4	6	10.00	10.00	10.83	10.00	10.60	10.25	2.75	2.30	2.29
	Fair	8	13	13	7.88	7.62	8.15	8.43	8.08	8.56	4.00	4.20	4.50
	Weak	-	7	-	-	5.43	-	-	5.57	5.50	-	**6.00**	-

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Results: Students' Satisfaction Questionnaire: Open Questions

Most important features about VISIR:

- *"practicality"*
- *"simplicity"*
- *"availability"*
- *"ease of use"*
- *"being able to practice without the fear of damaging"*

Some issues:

- *"when I make a mistake, the system doesn´t give me information about the type of mistake"*
- *"some bugs, that implied to restart the experiment"*
- *"some difficulties at the beginning"*

On the other hand, some statements called our attention:

- *"the lack of precision on the measures – they vary"*,
- *"difficulties in understanding what is happening in the simulation"*,
- *"I downloaded another software"*,
- *"not being able to save the assembled circuit for a future use"*

...for they suggest some students didn´t truly assimilate the difference between simulation and remote lab.

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Results: Students' Interviews

Interviewed Students (A-I) Characterization

	A	B	C	D	E	F	G	H	I
Country	**BR**				**PT**				
Degree	**EE**		**CE**		**SE**				
Course	**Calculus IV**				**Applied Physics**				
Teacher	**X**				**Y**				
Semester	**4th**				**2nd**				
1st course enrollment?	yes	yes	yes	yes	yes	yes	no	yes	yes
N accesses personally?	11 no	1 no	2 yes	9 yes	1 no	2 yes	2 no	3 yes	2 no
VISIR task grade (%)	90	80	75	90	70	83	65	65	80
Final grade (%)	85	75	65	80	50	75	Fail	Fail	85
High order skills?	yes	no	no	yes	no	no	no	no	yes

All students were invited to a final interview

Diversified sample

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Results: Students' Interviews

Student D

"*The **S** is a non-faithful representation of reality; It is only a model that allows to work with situations similar to those of the real life*"

Student C

"*tested it only once and checked with the other instruments that the professor suggested*"

Student B

"*I have heard that **RL** it's a development of a graphical interface, however it doesn't use physical connections like wire"; "In the **RL** we can truly make a real circuit*"; "***RL** does not require the use of physical means, such as wires*"

Student H

"*A **S**, in this case with VISIR (**RL**), we are basically using a digital platform, we are simulating, that's it …*"

Student D

"Sometimes it would change the decimal places, you know? …everything was due to the control of our variables, so if we put the same variables we would have equal results. But it is very difficult for us to faithfully represent several times the same thing on a device that required rotation of the buttons and everything else… I did not notice something discrepant in the results …and if it was discrepant it is because some parameter (that we had not adjusted) was missing".

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Discussion and conclusions

- Even with **teachers' extreme care on the emphasis of the difference** between SIM and RLs and even showing students the real (physical) RL they were accessing, some students still do not truly assimilate it.
- When students were asked **to repeat their measures**, most of them did not had perfectly clear that **it would be natural to get similar but not equal** results with the RL.
- There is a **gap between students' understanding and teachers learning objectives**, which may be undermining students' critical thinking while discussing their lab results.

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Discussion and conclusions

- This conclusion seems to be **independent of the context, content, students' level of maturity, assessment or teacher**, having only in common the fact of being the students' first contact with remote labs (and electric circuits).

- Especially for these students working with these topics and resources for the first time, it **seems important teachers engage students in a simple activity, exploring the different types of results and their meanings**.

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Thank you!

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