Pedagogical evaluation of remote laboratories in eMerge project

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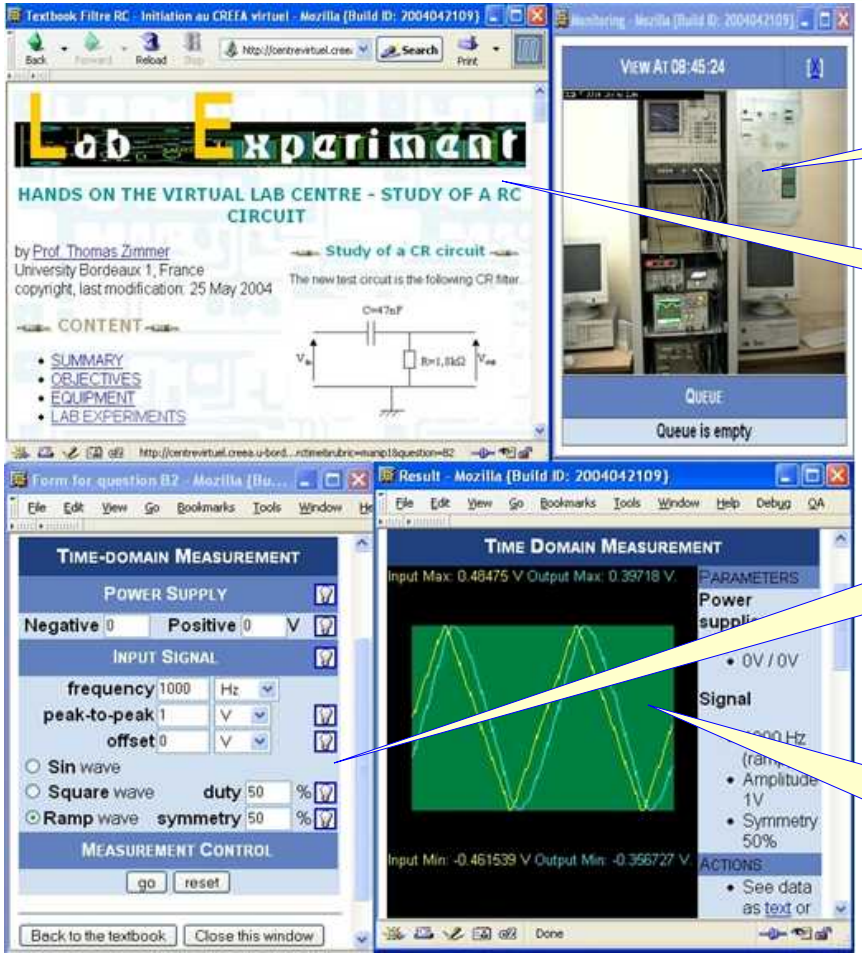
Structuring

1. Theory: evaluation of eLabs
2. Hypotheses and questions
3. Evaluation design
4. Results
5. Discussion of hypotheses and questions
6. Conclusion

What is an eLab?



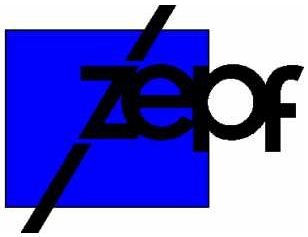
Picture of the experiment (webcam)

Textbook for students

Students set parameters

Results of experiment as diagram

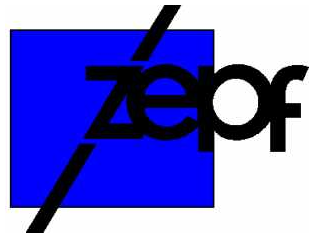
Framework for academic learning



- Experiments on the Internet potentially enhances the following learning activities:
  - Teacher can set task: the teacher can set the students various tasks which they carry out by means of experiments.
  - Teacher can set up environment to give intrinsic feedback on actions: teachers design the experiments so as to obtain the reaction to students' work in the form of measurements and diagrams.
  - Student can act to achieve goal: various parameters have to be entered to carry out an experiment.
  - Student can modify action in the light of intrinsic feedback on action: once the experiment has been carried out and the results are available, students can alter the parameters and repeat the experiment.

(McKavanagh et al., 2002, based on model of Laurilliard, 1997)

Usability as criterion of evaluation



Usability

- **Learnability:** The system should be easy to learn.
- **Efficiency:** The system should allow a high level of productivity.
- **Errors:** Users make few errors, and if they do make errors they can easily recover from them.
- **Memorability:** The casual user is able to return to the system after some period of not having used it.
- **Satisfaction:** The system should be pleasant to use.

(Nielsen, 1993)

Questions and hypotheses

1. Students know more after the courses than before the courses.
2. Students carrying out experiments via the Internet learn at least as much as in a laboratory.
3. Can students assess their learning effect sufficiently realistic?
4. Do students find experiments carried out on the Internet useful?
5. Are the experiments considered positive and helpful to the learning process?
6. Are eLabs easy to use?

Evaluation design

	t_1: before the course	Treatment	t_2: after the course
Experimental group	Test of prior knowledge	Course with experiments carried out via the Internet	Questionnaire, knowledge test
Control group	Test of prior knowledge	Course with experiments carried out in the laboratory	Knowledge test

Questionnaire

- Answers from 1="I totally refuse" to 6="I completely agree"
- Acceptance: whether carrying out experiments via the Internet is a good or bad way of learning.
  - Example: "I enjoyed using the eLab."
- Usability: how easy students found it to handle the experiments.
  - Example: "The instruction to make use of the eLab is sufficient."
- Usefulness: how useful the Internet experiments were thought to be in terms of study, personal goals and future career.
  - Example: "The eLab is a good preparation for my exams. "
- Self-assessed learning effect: three items, looking at memory, comprehension and application of the material.
  - Example: "I am able to memorize ____ % of the topics."

Test of knowledge

- knowledge test in French
- devised by Bordeaux University academic staff
- 80 items to answer "correct", "incorrect" or "don't know“
  - Feedback (40 items)
  - Differential amplifier (40 items)
- Scoring:
  - 0 points = wrong answer
  - 1 point = “don’t know”
  - 2 points = right answer

This ensures that students who simply guessed at all the items would have the same score as students who replied "don't know" to all the items

Results: Sample

84 male participants
Average age: 21.8 years

42 participants carrying out experiments via the Internet

42 male participants carrying out experiments in the laboratory

Results: Questionnaire

scale	items	N	alpha	M [a]	SD
Acceptance	9	38	.84	3.58	.79
Usability	6	40	.83	4.10	.84
Usefulness	5	38	.76	3.38	.83
Self-assessed learning effect	3	39	.86	[b] 64.34	16.21

[a] Response scale from 1= "I totally refuse" to 6= "I completely agree"
[b] Response scale from 0% to 100%

- All scales reached satisfactory reliability levels (alpha>.70)
- The *acceptance* of eLab was assessed as average.
- The *usability* of eLab was assessed really good.
- The *usefulness* of eLab was assessed as average.

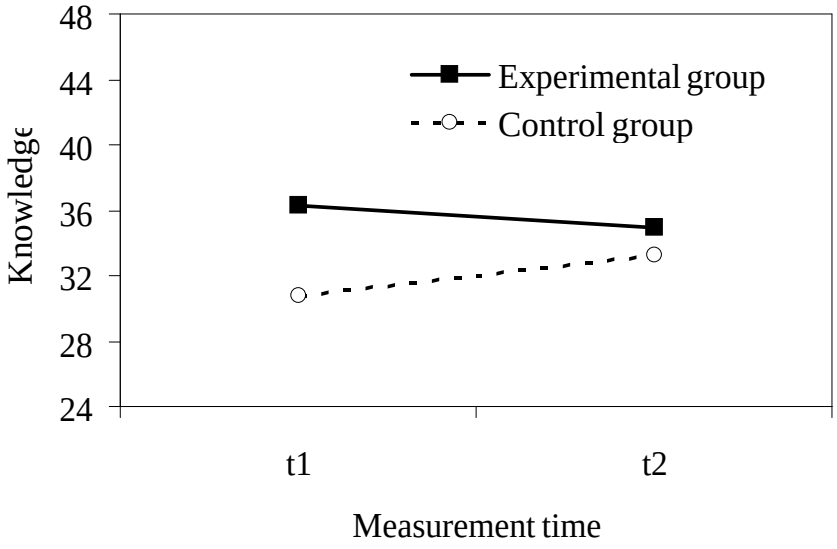
Results: test of knowledge

scale	items	N	alpha	M	SD
Feedback before course	24	71	.80	39.00	8.93
Differential amplifier before course	17	68	.76	24.13	5.90
Feedback after course	24	66	.78	33.73	8.12
Differential amplifier after course	17	74	.73	25.08	5.70

- All scales reached satisfactory reliability levels before and after course (alpha>.70)
- Therefore the learning effect can be analyzed with inferential statistic methods

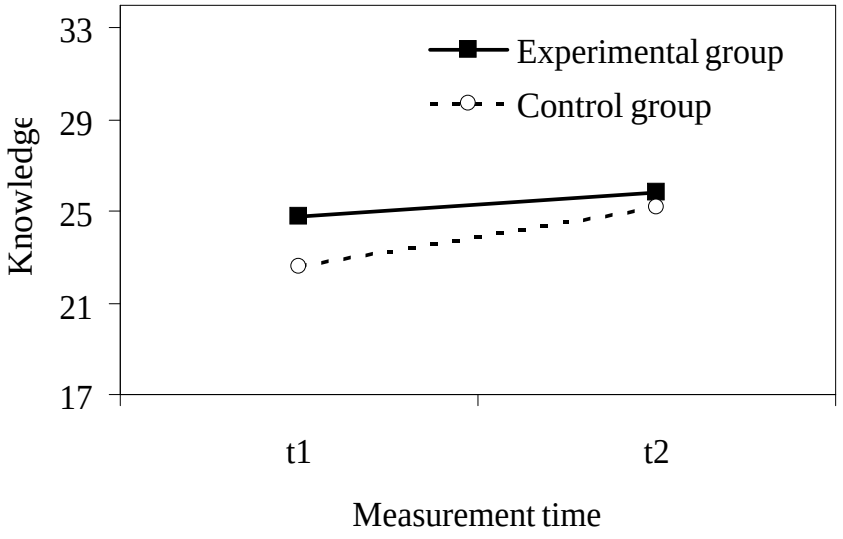
Results: learning effect

Analysis of Variance: feedback



- No significant main effect, no positive learning effect
- No significant interaction effect, that is no differences between groups

Analysis of Variance: differential amplifier



- Significant main effect, $F(1,60)=5.57$, $p<.05$, $\eta^2=.09$, that means positive learning effect
- No significant interaction effect, that means no differences between groups

Results: self-assessed learning effect

		Knowledge test at t_2	
		Feedback	Differential amplifier
Self-assessed learning effect	r	.08	.21
	p	.656	.214
	N	33	38

- No significant correlation between Self-assessed learning effect and Feedback
- No significant correlation between Self-assessed learning effect and Differential amplifier

Discussion: First, and second hypothesis

- Hypothesis (1): Students know more after the courses than before the courses.
  - There was a positive learning effect in one scale of the test of knowledge. We maintain the hypothesis at least partly.
- Hypothesis (2): Students carrying out experiments via the Internet learn at least as much as in a laboratory.
  - For both scales in the test of knowledge there is no difference between groups according to the learning effect. We maintain the hypothesis.

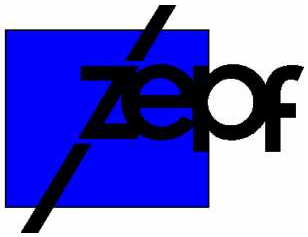
Discussion: question three

- (3) Can students assess their learning effect sufficiently realistic?
  - There is no significant correlation between self-assessed learning effect and test of knowledge. So students can not assess their learning effect sufficiently realistic to use self-assessments to evaluate their learning effects.
  - This is in accordance with results found in a meta-analysis (Mabe & West, 1982) finding a rather low correlation of r=.29.

Discussion: question four

- (4) Do students think experiments carried out on the Internet are useful?
  - Average score on scale usefulness , but students do not consider eLabs as a waste of time
  - Recommendation: course should be more closely matched to the curriculum. Connection to examinations should be made more clear to the students

Discussion: question five



- (5) Are the experiments considered positive and helpful to the learning process?
  - Average score on scale acceptance: Students enjoyed working with eLab but would prefer to see the experiments in reality.
  - Recommendation: Add more photos/pictures of the real circuits using a webcam.

Discussion: question six

- (6) Is the eLab easy to use?
  - The scale usability shows an high value.
  - Students did not have any difficulty carrying out the experiments.

Conclusion

- Internet-based experimentation does not damage the positive learning effect of the students.
- Students have no difficulties in using experiments via Internet.
- Future potential lies in
  - incorporating other multimedia teaching techniques
  - cooperation with students from other countries