

## Pushing dynamics and outputs from laboratory courses

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### Abstract

Experimental courses contribute to the development of practical skills as well as a series of soft skills. Furthermore these courses are also useful to demonstrate the relevance of the fundamental courses taught previously and help the students to go through a self-evaluation process of the command they have of theory. When large numbers are involved, i.e. 2 or 3 classes with circa 15 students, continuous supervision can be challenging task, especially if the flow and dynamics of practical work are to be kept throughout the semester. In this work we present the set of activities that are being used in 4<sup>th</sup> year Chemical Engineering laboratory classes in order to push the dynamics and the outputs in these courses. Although it may seem a stunning amount of work, as it is well distributed along the semester it has proven efficient whilst keeping the rhythm of work and pushing outputs

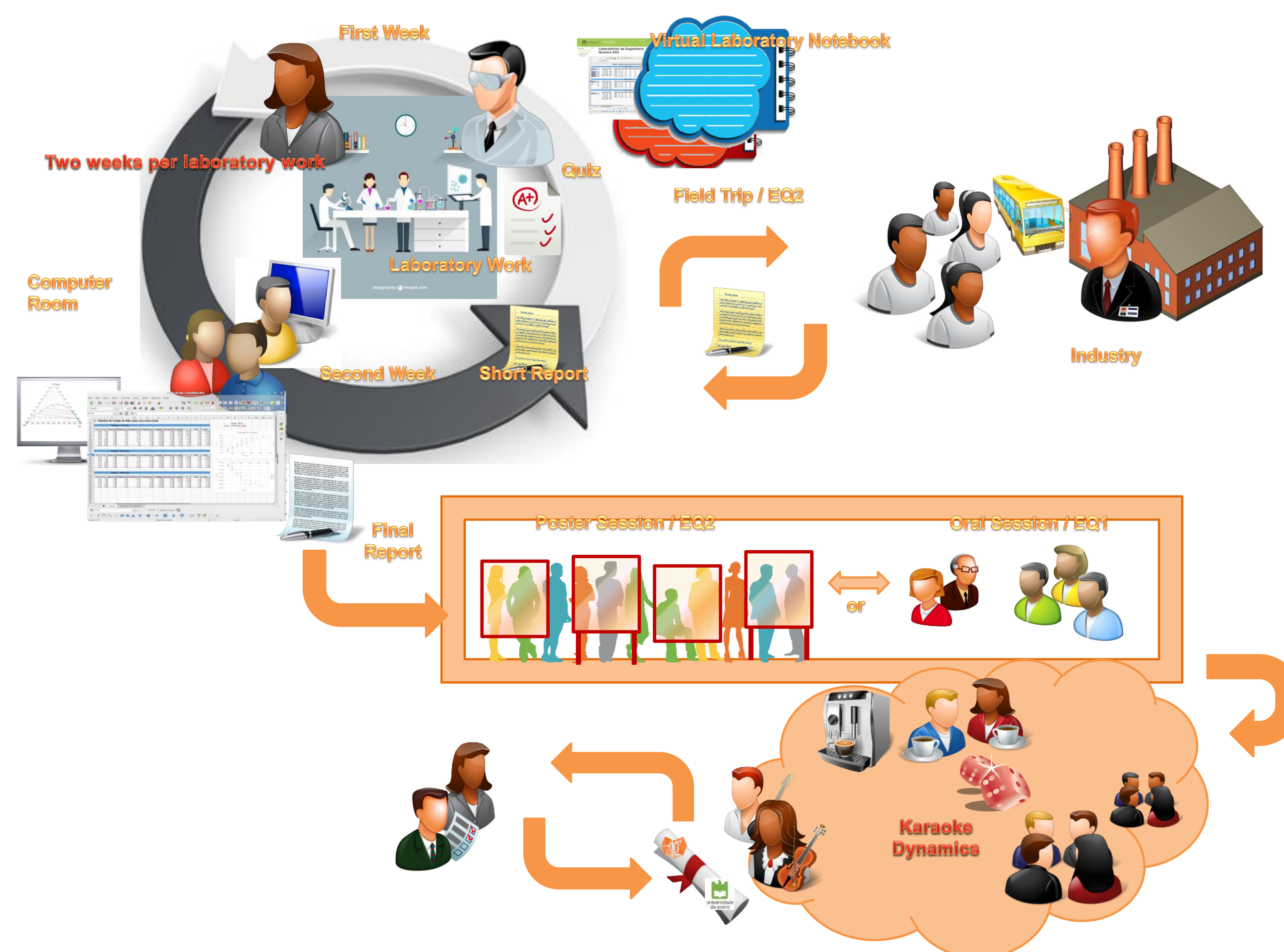


Fig.1 Semester teaching dynamics workflow.

### Context

The Integrated Master in Chemical Engineering at University of Aveiro (MIEQ) has a set of laboratory disciplines which covers wide areas from Chemistry, Physics to Chemical Engineering Science and Technology. The technological labs include two main courses[1]: EQ1 and EQ2 which are offered in the fourth year 1<sup>st</sup> and 2<sup>nd</sup> semesters, respectively. The EQ 1 focuses on equilibrium based and steady state processes, while the EQ2 is more directed towards non-equilibrium and non steady state processes. Both cover concepts from transport phenomena, applied thermodynamics, reactor engineering and separation processing and control, which have been previously taught.

### Laboratory activities

9 different experiments are set up and operate on rota shift basis.

Each group (≈3 students) carries out 5 out of 9 experiments.

Each experiment takes 2 sessions: 1 in the lab + 1 in the computer room

The topic of the full report and final oral presentation are known from day one of the course,

### Semester Dynamics

At the beginning of the semester students are grouped and a detailed work program spanning weakly through the complete semester is presented and explained. The practical laboratory classes begin with a 5-10 min quiz, to verify if students are prepared to carry out the experimental activity. The relevance of this quiz is twofold: 1) it forces students to prepare and plan carefully the laboratory work and 2) provides information whether students understand the fundamental aspects as well as safety issues. Once the experimental activities are all set up and running, the teacher evaluates the quizzes. This allows detecting faulty concepts, misconceptions and potential difficulties. Moreover, it is useful to use computer generated exams to ensure students are not preparing specific/standard types of questions. Whilst internet platforms can be useful to automatically mark the answers, our experience has proven that from the point of view of learning it is more effective to use one page paper sheets which upon evaluation allow good discussions (sometimes rather lively one) with students whilst they are carrying out their experimental activity just in time! At the end of each experimental work, students upload their experimental observations and data in our E-Learning system, simulating the laboratory notebook.

This is important for freezing the experimental observations and data whilst preventing plagiarism. In the following week students work in the computer laboratory where they prepare the written reports. During this activity they discuss in group and treat the data using different computer resources (Office software, special engineering tools) interacting with the teacher whenever necessary and prepare a structured written report. Reports can be short or full length. The full report is evaluated at three different moments: 1) At the beginning of semester a first version is submitted following a fully detailed template which is corrected and commented by the teacher; 2) At the end of semester, students submit a revised version of this document and 3) make an oral or a poster presentation [2]. Additionally, a field trip to visit a nearby industry, targeting a specific process, available at smaller scale in the laboratory.

### Evaluation

5 quizzes & overall assessment (15%)

4 short reports (40 %)

1 or 2 full reports (20 %)

1 Field trip report ( 10 %)

1 Final assessment – Oral presentation or Poster Karaoke (15 %)

### Conclusion

A general diversified continuous evaluation strategy has been proposed aiming at practical laboratory courses. It consists in a multi-tactic approach: from classical reports to advanced software programs and poster-karaoke techniques, combined with field visits provide a procedure which can be adaptable to any practical laboratory courses.

### References

- [1] Páginas das Disciplinas Laboratórios de Engenharia Química 1, <http://www.ua.pt/ensino/PageDisc.aspx?id=11176>, e Engenharia Química 2, <http://www.ua.pt/ensino/PageDisc.aspx?id=9294> Departamento de Química/CICECO, Universidade de Aveiro 2016.
- [2] Barros-Timmons, Ana and Da Silva F. Francisco A. *Shaking up final oral evaluations: Poster-Karaoke in Chemical Engineering Laboratories*. ChemPor 2014, 12th International Chemical and Biological Engineering Conference, 10 – 12 September 2014, Porto, Portugal

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