Stimulating university chemistry students' interest in nuclear and radiochemistry by problem-based laboratory

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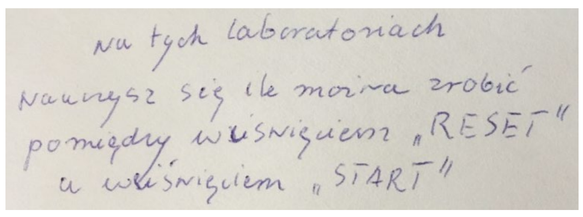
BACKGROUND

The problem-based learning (PBL) method has been widely accepted in education, and it also has been successfully applied in HE chemistry courses. However, most of the laboratory courses at our Faculty are still taught traditionally, even during graduate (Level 8) studies.
Nuclear chemistry is a part of a Physical and nuclear chemistry course for 1st-year students of MSc Chemistry, and it consists of 10 hrs lecture and 24 hrs of laboratory). Typically, experiments are carried out in pairs or individually (4 or 5 close-end experiments) according to the detailed recipe-style instructions. Assessment of the course includes evaluation of individual reports and a final test. Although nuclear chemistry is interesting for the students in general, they do not find lab classes valuable and engaging. Quite monotonous and repetitive measurements contribute to this.



„In these labs you will learn how much can be done between pressing „RESET" and pressing „START"

an anonymous student's note inside a lab bench drawer

This project aimed to:

- ❑ enhance the students' engagement and interest in practical nuclear chemistry by shifting responsibility for developing experimental procedures onto students,
- ❑ increase communication and teamwork skills and improve problem-solving skills by team mini-projects

METHODOLOGY

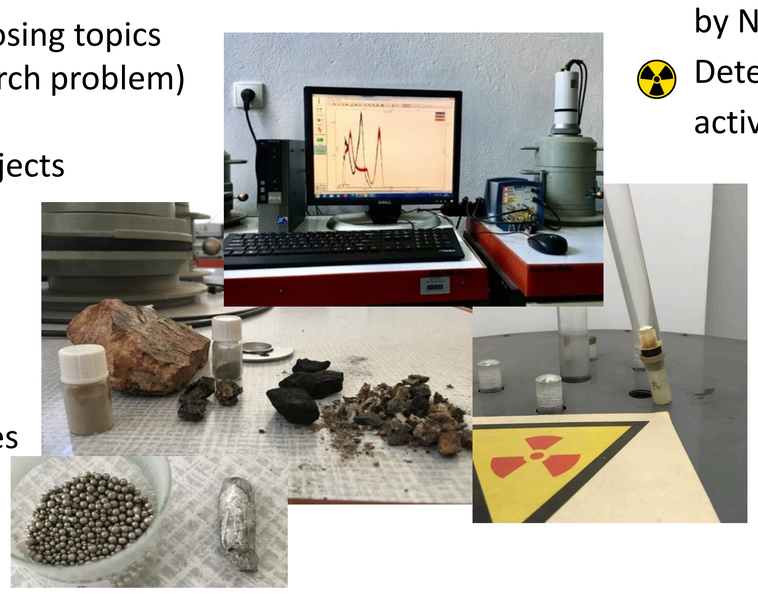
Participants: N = 12 1st-year students of MSc Chemistry course

Conditions:

- ❑ Problem-based laboratory (students were choosing topics from a proposed list or design their own research problem)
- ❑ Experiments conducted in teams of three
- ❑ Each team prepared two open-ended mini-projects
- ❑ Project reports were prepared in teams

A questionaire was designed for students to

- identify strong and weak sides of open-ended laboratory
- estimate how this way of conducting lab classes effected their interest for the subject, skills and competences
- identify parts of the project that caused difficulties and identify the causes of these difficulties



FINDINGS (TEACHER'S PERSPECTIVE)

- ❑ A much better pre-lab literature review;
- ❑ Students were more interested in their results;
- ❑ Noticeably better reports, although in some cases the analysis of the results could be more elaborated;
- ❑ The discussion of the results more often included references to other studies, standards, and other documents;
- ❑ Students have problems with interpreting results that differ from the expected ones

Conclusions: Changing the method of conducting laboratory classes by introducing student-driven lab projects increased students' involvement. Future work should focus on practising the ability to analyse and interpret experimental results and write research reports.

REALISATION

Students	Teacher
Introductory lab: choosing project topics	Introduces to the laboratory, assigns students to teams, facilitates discussion
Designing experiments in teams	Verifies students' ideas in terms of their feasibility
Performing experiments (two lab weeks per mini-project)	Monitors students' work, ensures safety, facilitates results verification
Writing report (cooperative writing)	Provides feedback

STUDENT PROJECTS

Example student project topics:

- Radioactivity of rocks, slag, ash and coal samples
- Natural radioactivity of food poducts (e.g. brazil nuts, banana)
- Determination of potassium in water and juices using radioactive tracer
- Quantitative analysis of metals in jewelry (silver) and alloys (indium) by NAA combined with γ-spectrometry
- Determination of selected elements in food products by neutron activation analysis (NAA)

STUDENTS' PERSPECTIVE

„The way the classes were run made them far less stressful and they made a change from other classes."

The student survey response rate was 42% (due to the COVID-19 pandemic, half of the students involved has not yet finished the laboratory at the moment of preparing the poster).

All the students who responded to the questionnaire declared that the classes had a positive or very positive effect on **their interest in the subject**, **cooperation**, **problem-solving**, **experiment planning**, **motivation** and **control of their own learning**.
Students defined a slightly negative or neutral effect of a problem-based laboratory on their **ability to analyse results and writing reports**.
All the questioned students agreed that this way of conducting classes made sense in the case of this laboratory.

The positives: freedom to choose experiments topic, understanding the limitations of methods
The negatives: not very specific topic; the experiment did not always go as expected

When asked what the most difficult for them was, the students unanimously stated **writing reports, analysing and interpreting the results**. They indicated the lack of experience in planning experiments on their own as the cause of the difficulties.

References:
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