Report “Question-Driven Learning in STEM” Summer School

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Date Report: 7th July 2025

Dates summer school: 29th June – 1st July 2025

Location: Faculty of Chemistry at the Jagiellonian University, Krakow, Poland

Website: https://ectn.eu/work-groups/eurolecturer-academy/question-driven-learning-summer-school/

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In recent years, student-centered learning has become a shared priority for many universities and is frequently integrated into professional development programs for university teaching. While implementing active learning strategies and using digital technology can bring immense benefits, lecturers still face many challenges in adopting methods like questioning techniques or fostering collaborative learning among students. As a result, traditional lecturing often remains the default, particularly in large classes or conventional classroom settings.

To support academic teachers and program directors in navigating these challenges, the ECTN WG Eurolecturer Academy tend to organize short 2.5-day Summer Schools on “Teaching and Learning in Higher Education STEM” which aim to explore a specific educational theme within the STEM disciplines (Science, Technology, Engineering, and Mathematics), equipping participants with innovative approaches and practical tools for effective teaching. With this new series of short summer schools, of which the first is “Question-Driven Learning in STEM” Summer School, the ECTN builds up on the tradition of organizing summer schools on teaching and learning in university STEM, which began with the “Newly Appointed University Chemistry Teaching Staff – Summer School, Malta, Sliema” held from June 22–29, 2005, and June 12–16, 2007. Many who attended those events now hold high academic positions.

1. Organisation "Question-Driven Learning in STEM" Summer School

The "Question-Driven Learning in STEM" Summer School, the first in the new series of Teaching and learning in Higher Education STEM Summer Schools was organized by the ECTN Working Group Eurolecturer Academy in collaboration with the local organizing institution, the Faculty of Chemistry, Jagiellonian University in Krakow, Poland. The location of the summer school was Faculty of Science building (Image 1, Photo 1, 2).

Image 1: Photo 1, 2: Summer School venue Faculty of Chemistry (photo left), inside of the faculty: the hall with a glass roof (photo right).

Organizing Committee: Prof. Iwona Maciejowska (Jagiellonian University in Krakow, Poland, ECTN WG Eurolecturer Academy, contact person local organization), Dr. Natasa Brouwer (ECTN WG Eurolecturer Academy), Dr. Nineta Hrastelj (ECTN), Prof. Sanjiv Prashar (University Rey Juan Carlos, Madrid, Spain), Dr. Martino di Sario (ECTN treasurer)

Scientific Committee: Dr. Natasa Brouwer (retired), University of Amsterdam, The Netherlands**,** Bill Byers, Senior Lecturer (retired), Ulster University, UK, Prof. Iwona Maciejowska, Jagiellonian University in Krakow, Poland, Dr. Claire McDonnell, School of Chemical & Bio Pharmaceutical Sciences, Technological University Dublin, Ireland, Prof. Dr. Livia Simon Sarkadi, Hungarian University of Agriculture and Life Sciences, Budapest, Hungary

Developers and Educators Team: Mauro Mocerino (Curtin University, Perth, Australia), Brit Giesbertz (University of Amsterdam, The Netherlands), Iwona Maciejowska (Jagiellonian University in Krakow, Poland), Natasa Brouwer (retired, University of Amsterdam, The Netherlands)

Participants: Sixteen participants from eight different higher education institutions in five European countries took part in the intensive program of the "Question-Driven Learning in STEM" Summer School, which was designed and developed by four educators who also provided guidance throughout the summer school.

Recognition: The "Question-Driven Learning in STEM" Summer School by ECTN is recognized by EuChemS.

For teaching and learning materials, the "Question-Driven Learning in STEM" Summer School utilized an online course on the electronic learning platform Krakus (Moodle) from Jagiellonian University in Krakow. For socializing and quick information sharing, the summer school utilized a WhatsApp group.

The Summer School started on Sunday early evening, June 29, with an icebreaking and networking event (Image 2, Photos 3 and 4) and concluded on Tuesday late afternoon, July 1, with the participants' presentations of their teaching designs, reflections, and a certificates ceremony. There was a social dinner on Monday, June 30, at a restaurant serving traditional Polish food in the historical city center of Krakow. See the final programme of the summer school in the Appendix.

Image 2: Photo 3, 4: Icebreaking and networking event

Dr. Iwona Maciejowska opened the "Question-Driven Learning in STEM" Summer School and introduced the Dean of the Faculty of Chemistry at Jagiellonian University in Krakow, Prof. Piotr Pietrzyk, who welcomed the participants during a short opening ceremony on Monday morning, July 30 (Image 3, Photos 5 and 6).

Image 3: Photos 5, 6: Opening by Dr. Iwona Maciejowska and welcoming words of the Faculty of Chemistry Dean Prof. Piotr Pietrzyk

2. Programme and working approach

<u>Intended learning outcomes:</u> after the "Question-Driven Learning in STEM" Summer School the participants are able to:

- design questions with different goals to implement in their teaching practice
- design a short guided inquiry session for their students
- take a role of a "guide on the side" in a session with students in an inclusive way
- discuss how this type of teaching could be adapted to available teaching facilities
- share experience about the guided inquiry teaching method with colleagues

The summer school had eight sessions that focused on topics associated with teaching through questioning, from basic principles and elements of questioning to complex teaching methods such as Process-Oriented Guided Inquiry Learning (POGIL). The Summer School's teaching/learning approach itself was also question-driven, meaning that participants experienced this type of collaborative learning and co-creation "as students." The presence of Mauro Mocerino on the developers' and educators' team, who has been using the POGIL method in his own teaching practice with students for many years, ensured an authentic and rich learning experience. During the Summer School sessions, participants mostly worked in small international groups of three, with one group rotating to include four people at different times, on various assignments related to teaching through questioning (Image 4, Photos 7 and 8).

The 8 sessions were (find the final programme of the Summer School in the Appendix):

<u>Session 1</u>: First steps into developing processing skills

Session 2: Active learning through questioning. Why and What?

Session 3: Designing questions with different goals

Session 4: POGIL session: Designing guided inquiry session

Session 5: Diversity and inclusion in question-driven teaching

Session 6: Hands-on working discussion and preparing of presentations

Session 7: Presentations participants and discussion

Session 8: Wrap-up Summer school and future plans. Closing Ceremony Summer School Question-Driven Teaching

Image 4: Photo 7: participants lined up to create mixed collaborative learning groups. Photo 8: start Session 1, Photos 9, 10: learning in collaborative groups

In Session 4, participants practiced their questioning skills (Image 5).

Image 5: Session 4, photos 11, 12, 13, 14, 15, 16: practicing questioning technique in pairs

In Session 5 Brit Giesbertz discussed aspects of diversity and inclusion in guided inquiry teaching and learning methods (Image 6). Each of the five groups then prepared a poster in collaboration with a neighboring group.





Where is the cat?

Image 6: Start Session 5, photo 17, preparing posters and reflection, photos 18, 19, 20, 21

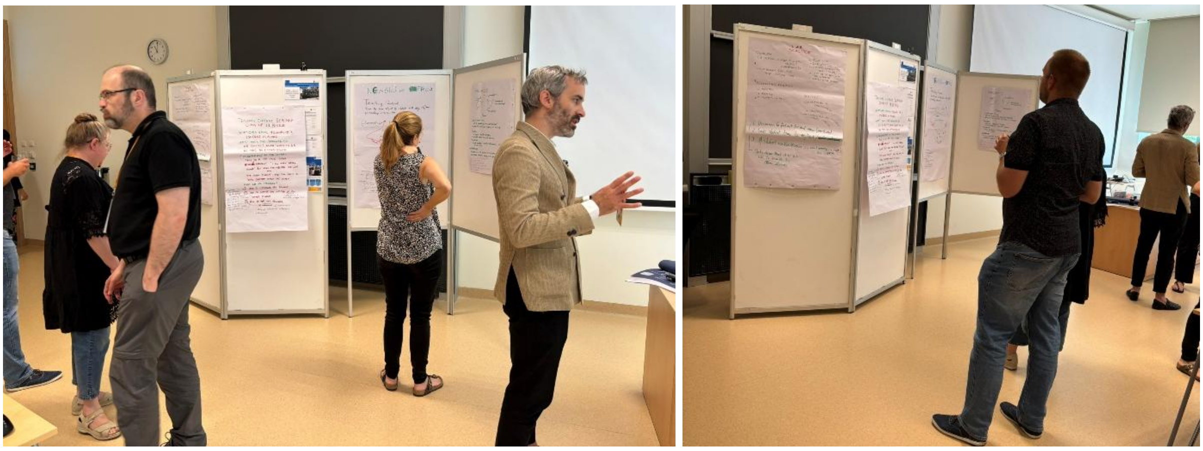

Image 7: Photo 22 and 23; During the coffee break, the posters created in Session 5 were exposed in the room.

Session 6 (Image 8) was a hands-on session in which participants worked on developing their guided inquiry teaching units / POGIL units. They discussed the reasoning behind their units in small groups with colleagues who had chosen similar content. Each group collaboratively prepared a presentation for Session 7 (Image 9).

Image 8: Photo 24, Mauro Mocerino explains Session 6

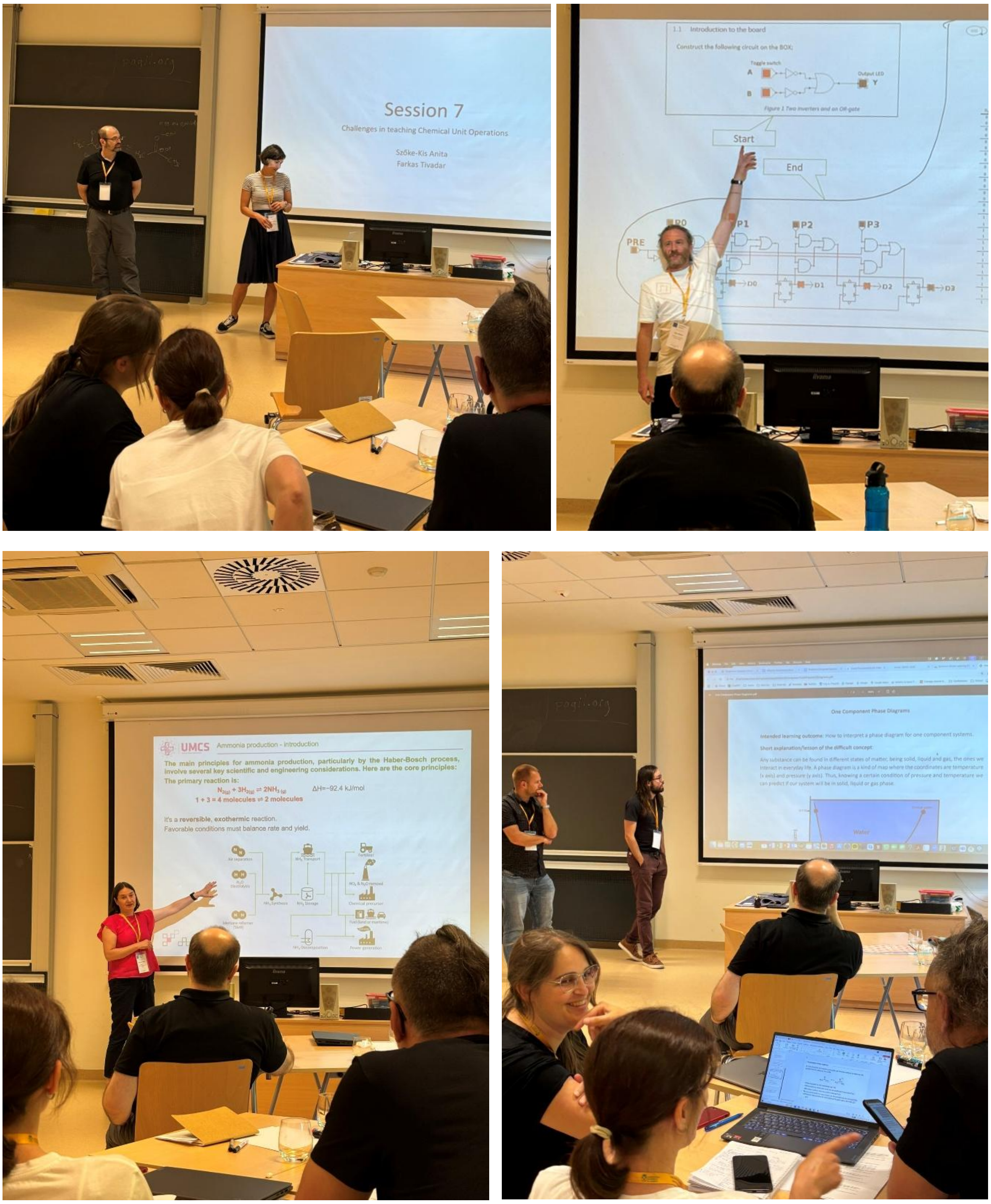

Image 9: Photo 25 and 26, 27, 28, Session 7, Presentations of guided inquiry teaching units

3. Facilities and social part of the “Question-Driven Learning in STEM Summer School

Between the sessions, coffee breaks were served in the working room (Image 10).

Image 10: Photos 29, 30, 31 and 32, Coffee break treats

Lunch was served in the Faculty of chemistry staff and students restaurant (Image 11)

Image 11: Photo 33, Lunch break in the faculty staff and students restaurant

Social dinner in the restaurant in the old city centre of Krakow (Image 12).

Image 12: Photo 34, Social dinner

During one of the lunch breaks, the group visited the garden on the roof of the Faculty of Chemistry (Image 13).

Image 13: Photos 35, 36, 37, 38, 39, 40, Roof garden Faculty of Chemistry

4. Reflection and Certificates ceremony

During the Summer School, there was ample space for reflection. The last session of the Summer School was devoted to evaluation and the awarding of certificates.

Image 14: Photo 41, Group photo on the stairs in the hall of the Faculty of Chemistry

All participants achieved the intended learning outcomes and received certificates.

Image 15: Photo 42, Example Certificate participants

5. Evaluation

At the start of the last session of the Summer School, participants were asked to complete an anonymous evaluation. All sixteen attendees responded to the survey, expressing very positive feedback about the "Question-Driven Learning in STEM" Summer School. On a Likert scale of 5, they evaluated the structure, the program, the organization, how useful they found the Summer School, and how much they appreciated experiencing POGIL from the learner's (student's) perspective. The average score on all these questions was **4.90**, with no ratings lower than 4 on any of these questions. For organization, all sixteen participants gave a 5.

On the **question**: ***"I will use elements (questions I prepared, structure, etc) of my (almost finished) question-driven teaching unit in my teaching"*** 15 participants answered *"Yes, definitely"*, and one answered *"Maybe"*.

On the **question**: ***"I will try out my (almost finished) question-driven teaching unit in my teaching as a POGIL activity"*** 10 participants answered *"Yes, definitively"* and 6 *"Maybe"*.

Three participants found the duration of 2.5 days for this Summer School too short, while thirteen found the length just fine.

Fourteen participants recommended definitely organizing a Summer School on the topic of "Question-Driven Learning in STEM" again. All sixteen participants recommended definitely organizing a new ECTN Teaching and Learning Summer School on a different topic while maintaining the same structure. The topics they recommended for a new ECTN Teaching and Learning Summer School were:

- Other active learning methods.
- Other inclusive methods, methods to involve new generations
- Teaching on case studies
- New teaching method
- New teaching methodologies / managing motivation of students
- Problem based learning and other methods of guided inquiry methods (and every other ways and possibilities how to reach out to students and make them understand things)
- How to use modern digital tools to improve the involvement and engagement of students in the learning process and improve the effectiveness of teaching.
- Any educational topic could be interesting. The CPD summer school had a different goal. What I liked about the question-driven learning summer school is that it is for your own lectures.
- It could be interesting other summer schools that approach other question-driven methods that we could use . Or other specific active learning methodologies.
- new teaching methods applied to big groups of students
- AI in STEM Education, Programmatic Assessment in STEM, From Multidisciplinary to Transdisciplinary STEM Education
- Basics of Pedagogy, Theory of Knowledge, Philosophy of Teaching
- Solving conflicts in teamwork, any other active learning methods
- Project-based education, evaluation, addressing equality

On the **Question**: ***"What did you in particular like in this summer school and we may tell this to our future participants to join our next summer schools? Please put your name if we may cite it, otherwise we will use it anonymously."*** the following reactions were given:

- A lot of activities that allowed me to feel not only as a teacher but also as a student. Very friendly atmosphere.
- Discussions with other motivated colleagues to deal with problems that arise in higher education teaching.
- Experiencing new tools and discussing about issues we all struggle

- Very hands-on program with a clear objective. Practical information and resources to apply directly in our courses.
- I liked how i could be a student again and experience difference aspects of that. I enjoyed group work and got a lot of experience regarding that work. I feel that with the active learning possibilities I got a deeper understanding and I will be able to remember better.
- Experiencing the POGIL process as a student meanwhile we are understanding the method is a very effective way of learning. (Tivadar Farkas)
- I liked the hands-on approach on POGIL and got confident in applying this in my own teaching through the example I developed.
- The School offered a good balance between introductory training activities and own work of the Participants. I will definitely use the POGIL approach in my teaching. The School gave the Participants from many different countries a great opportunity to share their various teaching experiences in a very pleasant atmosphere.
- This summer school was very helpful, since it focus on a specific methodology. In this way it is much more easy to translate this to my class topics, and understand how to implement it in my reality. (Goreti Pereira)
- It was a very rewarding to understand that the process of changing the way I teach my courses, which can be quite overwhelming, can and should be done in small steps. The summer school gave me confidence enough to start and not to be afraid of partially failing in the first time I try something completely new for me. (Vânia Calisto)
- It was inspiring to learn about and experience first hand a new learning approach, Inquiry-Based Learning, and to think about combining it with the philosophy of Problem-Based Learning which my university practices. (Jurica)
- Experiencing the methodology as a "student" during the course development
- "The formula of the school was great, with similarly motivated people working together and solving problems. It could be great to work on common tasks and compare results. (Alicja Kluczyk)

We also received some comments on how to improve the Summer School. We have listed them all below:

- Keeping the time to have more time to relax between sessions
- Experience less examples to have a bit more time to reflect and discuss
- It is helpful to experience the different roles in a POGIL exercise. Maybe some simpler exercises that encourage participants to take on the roles and evaluate/reflect on the experience?
- I am still not sure how/if having the roles changes or influences the design of the POGIL exercise I am developing.
- I do not have
- The topic and organization was very good, but it was very intense. Maybe to expand for a 3 day course could be interesting.
- Organize a day trip with the summer school participants
- "If the course was longer we could work on more examples
- I suggest to extend the diversity section"
- On-line presentations after certain period of time, with effects in teaching

In the “Any other comments” section, one participant mentioned that it was very handy to organize the Summer School adjacent to the Eurovariety 2025 conference but noted that we did not advertise this clearly enough. Another participant suggested using a forum on a website instead of a WhatsApp group to facilitate the continuation of the group, sharing, and keeping in contact.

In conclusion, the participants did a fantastic job! Their engagement was very strong, and the POGIL teaching units they produced are of high quality.
We are grateful for their input and suggestions and we will use the evaluation results when preparing new summer schools and for the continuation of the activities in this community.

Appendix: Final programme "Question-Driven Learning in STEM" Summer School

Programme "Question-Driven Learning in STEM" Summer School

Sunday, 29th June				
17^{30}–18^{00}	**Registration**			
18^{00}–20^{00}		*Ice-breaking and networking event. Introduction to the school (snacks and drinks included)*		
Monday, 30th June				
8^{45}–9^{00}	**Walk in**			
9^{00}–9^{15}		*Greeting by Local Organizing University*		
9^{15}–10^{30}		*Session 1*	*First steps into developing processing skills*	Mauro Mocerino & Iwona Maciejowska
10^{30}–11^{00}	**Coffee break**			
11^{00}–12^{30}		*Session 2*	*Active learning through questioning. Why and What?*	Mauro Mocerino & Natasa Brouwer
12^{30}–13^{30}	**Lunch break**			
13^{30}–15^{00}		*Session 3*	*Designing questions with different goals*	Iwona Maciejowska & Mauro Mocerino
15^{00}–15^{30}	**Coffee break**			
15^{30}–17^{00}		*Session 4*	POGIL session: *Designing guided inquiry session*	Mauro Mocerino Iwona Maciejowska Brit Giesbertz Natasa Brouwer
17^{00}–17^{30}		*Day Wrap-up*		Iwona Maciejowska
19^{00}–22^{00}	**Social Dinner**			
Tuesday, 1st July				
9^{00}–10^{30}		*Session 5*	*Diversity and inclusion in question-driven teaching*	Brit Giesbertz
10^{30}–11^{00}	**Coffee break**			
11^{00}–12^{30}		*Session 6*	*Hands-on working discussion and preparing of presentations*	Mauro Mocerino Iwona Maciejowska Brit Giesbertz Natasa Brouwer
12^{30}–13^{30}	**Lunch break**			
13^{30}–15^{30}		*Session 7*	*Presentations participants and discussion*	Mauro Mocerino Iwona Maciejowska Brit Giesbertz Natasa Brouwer
15^{30}–16^{00}	**Coffee break**			
16^{00}–17^{00}		*Session 8*	*Wrap-up Summer school and future plans* *Closing Ceremony Summer School Question-Driven Teaching*	