Research-based teaching of large groups: it can be done!

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Two hundred years ago, the world of education was shaken up by the revolutionary ideas of the Enlightenment, personified by great thinkers like Prussian philosopher Wilhelm von Humboldt. The Humboldtian ideal of education centred on academic freedom and the integration of education and research (Klencke et al., 1854). Instead of passively transmitting knowledge and irrefutable dogmas, the emphasis came to lie on questioning and discussing them.

With the Bologna Declaration in 1999, European education became firmly rooted in this Humboldtian model, promoting critical thinking and research-based teaching (Bologna Working Group, 2005). Most universities, including the University of Antwerp, therefore explicitly refer to the strong nexus between research and education in their mission statements. The question is now whether it is possible to pursue the Humboldtian ideal when faced with large student groups.

Different forms of research-based teaching

Humboldt's ideal of education led him to oppose the traditional ways of teaching in secondary and higher education. Originally, students were mainly 'read to' (hence the term 'lecture') and were given little opportunity to develop their critical thinking over the course of their education. Humboldt was convinced that the introduction of research-based teaching would change this.

The theme remains relevant to this day. Based on qualitative research conducted at the Faculty of Social Sciences of Leiden University, Visser-Wijnveen et al. (2010) identified five profiles or prototypes of research-based teaching, based on different approaches: (1) teach research results, (2) make research known, (3) show what it means to be a researcher, (4) involve students in your own research, and (5) provide research experience.

These five specific approaches can also be found implicitly in a study by Healy (2005) within the field of geography, and in recent research by Blonder and Mamlok-Naaman (2019) within the field of chemistry.

In what follows, we offer five possible scenarios for research-based teaching, based on the five profiles. However, our teaching scenarios do not fully match the five profiles put forward by Visser-Wijnveen et al. The 4th and 5th profiles have been lumped together, and an additional scenario has been added, i.e. teaching scenario 3. Each scenario also features a testimonial by a chemistry professor.

Scenario 1 | Incorporate (your own) research results into your lectures

An approach that works well, even with large student groups, consists of incorporating your own research results into your lectures and/or learning materials. Unfortunately, this is not always possible, as the content of your programme component is unlikely to always connect seamlessly with the research you are conducting. In that case, you can integrate research results from fellow researchers into your teaching.

In other words, you should refer to relevant research results in your teaching, even if students do not immediately actively engage with them. It is important that explicit reference is made to the research conducted

(who, what, when?), so that students can interpret the information correctly.

Pros

- This is an 'organic' way of working, provided that the programme component you teach is in line with the focus of your research.

Cons

- If the results from your own research are not useful in this regard, you will need to look for relevant results from other people's research. If this is not your own research focus, it will require more of your time.
- It is a rather passive approach: students do not actively engage with the research results.

> ***Testimonial from a chemistry professor***
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> *'In our Chemistry Department, most lecturers teach content related to their respective fields of research. For example: "To illustrate the use of infrared spectroscopy in pharmaceutical research, here's an infrared spectrum that I recorded during my own research".'*

Scenario 2 | Include academic literature in your learning materials

In this scenario, you extensively introduce students to academic research, without actively involving them in the research. You familiarise them with research results, specific research terminology and jargon by integrating academic literature into your learning materials.

For example, you can ask students to subject peer-reviewed articles from academic journals or research papers to a critical review. You can also have them present the articles to each other in smaller groups and start a discussion, either in the small group or with the entire class.

Pros

- Students get to engage with research results in an active and critical manner.

Cons

- This approach is difficult to apply in very large student groups.
- This scenario requires some content knowledge within a certain field of research, so it is more difficult to use with students at entry level.

> ***Testimonial from a chemistry professor***
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> *'Within the Chemistry programme, it's sometimes difficult to find a textbook containing advanced, specialised knowledge that is suitable for students. A useful alternative is then to base the learning content on a review of recently published scientific literature in that field. Every week, before the lecture, you can have students read an article you've selected – on the different steps in organic synthesis, for example – and then have them discuss which main conclusions can be drawn from it in small groups. This way, students are truly immersed in recently conducted or ongoing research.'*

Scenario 3 | Introduce students to research methods in an accessible way

In this teaching scenario, the research experience is fully incorporated into the lecturer's teaching, independent of the classic research or project setting. For example, you can have students fill in an online survey about a certain topic and then analyse and show the results in your lecture. You can then position your own analyses more broadly within a/the research approach specific to the discipline.

Pros

- This way of working can also be used in the early years of the study programme.
- By discussing the results of a survey the students themselves provided input for, you increase their involvement.

Cons

- Students should not feel that the results of their analyses or interpretations are used inappropriately. In other words, sufficient attention must be paid to scientific integrity.

Testimonial from a chemistry professor

'Surveys related to 'green chemistry' policies always yield interesting results. In general, it's always interesting to find out what students think about chemistry and chemicals in society, in the environment, and so on. The link between their studies and the 'real world' makes it all the more exciting for them.'

Scenario 4 | Put students in the shoes of a researcher through case studies

In this teaching scenario, you familiarise students with scientific attitudes by involving them in the theoretical preparation of research through a realistic case study. For example, you can have them draw up a research plan and various possible research scenarios for mapping pollution near industrial production sites, or have them think about research techniques that can be used for this purpose. Students can work independently in preparation of a lecture during which the results are discussed, either with the entire class or in small groups.

Pros

- You stimulate critical thinking in students.
- The activating approach has a motivating effect.
- You introduce students to research design.
- If several research approaches are possible, this can lead to exciting discussions.

Cons

- Preparing the case study can be time-consuming.
- When various research approaches are possible, it can be difficult to come up with a feasible case study, for both the lecturer and the students. It is then advisable to delineate the case study clearly in advance and to apply a certain focus.

Testimonial from a chemistry professor

'In physical or computational chemistry, it's relatively easily to present students with large amounts of data from a real-life case and have them think about how these data can be processed in the form of measuring points or trajectories from molecular dynamics calculations. This gives them an insight into the practical methodology within this field.'

Scenario 5 | Involve students in your own research

This teaching scenario is very hands-on: you involve your students in your own research. The approach seems especially suitable in the later stages of a study programme, for instance in the context of a bachelor or master dissertation or an internship. However, it may be interesting to set such intensive research assignments in other programme components as well. In practicals, for example, you can have students collect or process small sections of data. It is crucial for students to feel that they can add value to a larger research project, and that they can generate new results or data themselves, allowing them to experience that research is not static but dynamic.

Pros

- This approach can stimulate students to pursue a career in research.
- The activating approach has a motivating effect.

Cons

- This requires intensive supervision, especially when the students have little research experience. In the case of a large student group, quite a few supervisors will need to be involved.
- Not all research is suited to student involvement. Often there are protocols on reporting, or there may be data processing restrictions due to privacy regulations.

Testimonial from a chemistry professor

'It's common practice in our study programme to entrust students in their bachelor years with a small part of a real research project. They're often supervised by junior researchers. In certain practicals for specific courses, students are given samples that haven't been studied before using that particular method. An example of a task could be: "Measure the NMR spectrum of this compound and determine the spectrum so that we can add the data to our database". This assignment allows students to produce new results instead of reproducing existing results.'

It should be clear from these five teaching scenarios, based on Visser-Wijnveen et al., that the

Humboldt ideal can most certainly be upheld in the 21st century, even with large student groups.

For more inspiration on this theme, please check out the resources below.

Want to know more?

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