Part I

Chapter 1. Research Skills & PBL

This chapter was written with input from:
Patrick Bijsmans, Pietro Bonizzi, Thamar Bovend'Eerdt, William Bull, Rachel Cavill, Kurt Driessens, Roy Erkens, Catalina Goanta, Sylvia Heeneman, Irma Kokx, Lotte Lemmens, Wilco Letterie, Jan Nijhuis, Emilie Sitzia & Ragna Zeiss

1.1 Introduction

This chapter provides an overview of current best practices of teaching research skills at bachelor and master's level at UM and additionally serves as a general introduction to PBL and research skills. The following chapters are focused on essential elements to training research skills through PBL, such as merging skills and content, collaborating with external partners, alignment and repetition.

Research skills are perceived as essential competencies of academic students and include: problem definition, brainstorming, finding information, information literacy, retention, selection, critical reading, understanding of concepts, critical thinking, qualitative and quantitative analysis/analysis of empirical data, interpretation, logical reasoning, writing and argumentation, making use of existing knowledge, referencing, and data management. This chapter is guided by the following questions:

- What can be/are the strengths of research skills training at UM?
- What are current good practices of teaching and assessing research skills at UM faculties at both the bachelor's and master's level?
- What are the do's and don'ts of teaching and assessing research skills?

To answer these questions, each faculty created an overview of best practices of research skills training. This overview is non-exhaustive, but offers a satisfactory variety of cases. From this overview, we selected one best practice per faculty to present a range of cases that vary in terms of skills and embedment into the curriculum (see Annex 1 for a detailed presentation of best practices per faculty). We have used the following selection criteria:

- Innovative course design or practice;
- Application of PBL principles such as self-directedness, collaboration, constructiveness, and starting from real-world problems (contextualisation);
- Alignment (building on previously learned skills/embedment into learning trajectory);
- Sustainability (e.g. do students benefit from the research skills training when writing their thesis?);
- Encouraging/motivating students (e.g. seen in student evaluations);
- Transferability (the extent to which the course design could be applied to courses across UM faculties).

This chapter will first discuss the relationship between research skills training and PBL. This is followed by several recommendations (do's and don'ts) based on the lessons learned from the best practices (see Annex I for a detailed presentation of the selected cases). This chapter is of practical value to tutors, course coordinators, and programme directors.

1.2 PBL & research skills

Although the best practices are in diverse in their set up and application, the cases are all in accordance with UM's PBL philosophy, following the four core principles of collaboration, constructiveness, contextualisation, and self-directedness. Some cases follow the seven-step approach, whereas other practices demonstrate that there are other formats to incorporate the core principles of PBL to enhance active learning and student ownership.

Duch, Groh, and Allen (2001) describe the PBL model and the specific skills it nourishes. These include critical thinking, analysing and solving complex, real-world problems, finding, evaluating, and using appropriate learning resources, collaborating, demonstrating effective communication skills, and using content knowledge and intellectual skills to become continual learners. While this chapter did not take 'the skills that students learn through PBL' as a starting point, the analysis of the cases demonstrate that research skills can best be taught through engagement with the core principles of PBL. The best practices teach us that:

- Students often learn (or are taught) in smaller groups (e.g. FASoS, FHS-UCM);
- Students often do hands-on work (e.g. SBE, LAW);
- Students often work on real-world problems (e.g. FHML, FHS-UCM);
- Students must activate existing knowledge (e.g. FASoS, FHS-DKE, LAW);
- Students must construct problem definitions, be aware of assumptions, and understand that there may be more solutions (e.g. FASoS, FHS-DKE, FHS-UCM);
- Direct contact with, and guidance from, a tutor is essential (LAW, FASoS).

These lessons bear similarities to the core principles of PBL. Literature on PBL confirms these key elements. As Dolmans et al. (2016) outline, PBL activates students, enhances deep learning and facilitates the development of specific research skills: "The mechanisms through which PBL is assumed to enhance deep learning are active and self-directed learning. PBL is considered an active form of learning, since students need to analyse, compare, contrast, and explain information" (Dolmans et al., 2016, p. 1097). Furthermore, building on Gurpinar et al. (2013), Dolmans et al. (2016) emphasise the importance of finding the right sources in the PBL process: "They [students] are actively involved in their learning process because they themselves need to develop and explain hypotheses for the problem at hand and search for evidence for these explanations and hypotheses, using various literature and other learning resources" (Dolmans et al., 2016, p. 1097). To Dolmans et al. (2016), self-directedness is key to train research skills through a PBL format. As they highlight: "Self-directed learning comes into play in PBL since students take responsibility over their own learning. They have, to a certain degree and within the boundaries of the problem, the freedom to select their own resources to answer the learning issues, which gives them ownership over their learning" (Dolmans et al., 2016, p. 1097). The lessons mentioned above show a diversity of practices of research skills training. There is strength in the variety of formats presented, as it offers different approaches to research skills training.

1.3 Recommendations

Based on the faculties' best practices, a set of general recommendations on training research skills through the PBL format is presented below.

1.3.1 Do's

Multidisciplinary planning groups

A multidisciplinary course planning group can be very useful. This allows to 1) prepare the students for multidisciplinary research, 2) strengthen a competency-based course design, 3) agree as a team and discuss with other course planning groups what the key research skills for a given programme are and 4) work together with the Programme Coordinator on common criteria for alignment and evaluation of research skills training on the level of the curriculum. Such an approach supports the process of constructive alignment of skills education within the faculty. The importance of alignment (aligning learning objectives, assignments, courses and curriculum) is also a key element for successfully teaching research skills courses and is further elaborated on in chapter 4.

Training of and communication between tutors and course coordinators

The case studies demonstrate that training tutors and course coordinators and communication between them are important. Tutors and coordinators should for example be trained in guiding a brainstorming session, i.e. knowing when to go off the beaten track, how to construct intentionally ill-defined problems and how to provide the rationale for intended learning outcomes. One of the roles of the tutor is to guide processes and to make learning steps explicit, to tackle the assumption that students learn by simply 'doing'. Tutors need to be well prepared to be able to do this.

Link content and skills by infusing the coordinator's/tutor's expertise

The case studies put forward the importance of an explicit relationship between content and research skills. The course should simulate/follow the research process in terms of designing research questions and showing a diversity of research designs. Step-by-step student guidance is important. However, this guidance should be moderated by the student's self-directed attitude (e.g. through choice of topics). Expectation management is important: a small course cannot give all students the key to all research methods. The tutor should take on the role of both the instructor and model researcher. Furthermore, the tutor should provide a point of entry for the student to his/her research community. Cases should be tailor-made for each curriculum/discipline/field and allow for course coordinators and tutors to link their expertise to the course. The integration of content and method is further explored in chapter 2.

Enhance the link to real-world problems

Our cases present a wide variety of formats to approach research skills training from a real-world perspective, such as interview training for clinical practice and research, creating ill-defined problems with real-world applications (e.g. in mathematics) and papers that serve as an exercise to provide expert advice to a government. With such real-world problems as the course's foundation, students understand the relevance of the course's content and are motivated by this. Chapter 3 further explores research skills training through real-life problems.

Increase group-work

Collaboration in small classes or study groups increases interactivity and engagement, and maximises learning. In order to encourage self-activation, motivation and the sense of responsibility, it is advisable to reduce the class size and to diverge from the traditional lecture format. Student self-directedness, while the concept implies a loss of control, greatly improves the learning experience.

Use students' existing knowledge
Using the students' existing knowledge facilitates the integration of research skills within the curriculum. Some cases present students with real-world problems which they will need to solve by using existing knowledge, critical thinking and argumentation skills. Abstracting these problems and linking the content to existing knowledge is key to linking real-world problems to academic theories/solutions. A risk to this approach is that students may have 'wrong' knowledge/assumptions.

Promote self-directedness
Give students freedom and ownership of their learning experience, e.g. provide them with a challenge and the right set of tools to think out of the box. Relinquishing control will not necessarily impact the learning process negatively. Tutors should not be too afraid to let students go off track and give them the freedom to be guided by their curiosity. The element of curiosity needs to be embedded into assignments. For instance, the students are not supplied with predefined answers and the problems students are presented with should have more than one answer or multiple ways to reach a solution. However, tutors should not assume that learning will take place automatically.

Combine formative and summative assessment
A combination of formative and summative assessment is often successful as the students gradually learn about the process of research. Alternative forms of assessment, e.g. assessing engagement rather than result or knowledge-driven assessment, are also effective especially if the course aims to enhance self-directed learning.

Use a variety of PBL approaches
A variety of PBL approaches can serve as an alternative to the seven-step PBL method. For instance, tutorial groups may be explicitly focused on determining the quality and/or credibility of the reading assignment's material (see Annex I, FHML case, for an example of journal clubs).

1.3.2 Don'ts

Do not assume students will learn automatically by doing
Do not assume that the students will learn and recognise research skills automatically just by 'doing' and repeating them in several courses.

The process of research needs to be unfolded for students to understand and be able to conduct research. The rationale behind research skills training needs to be clarified. Step-by-step instruction, explanation and guidance are crucial.

One size does not fit all
There is no *one-size-fits-all* approach that can be transferred to all research courses. The variety of tasks and the right groups size are key to successfully organising research skills training. Our case studies demonstrate the importance of training research skills in various professional and academic contexts.

Too much content, large groups, and lack of time
Do not try to fit too much content and exercises in the course. Large groups and limited time may result in superficial learning. Choice and integration in the curriculum are key.

1.4 Overview of the cases

See Annex 1 for a detailed presentation of best practices per faculty.

Table 1.1 Overview of the cases

Faculty	Programme	Skills	Key elements
FASoS	Bachelor European Studies	• Brainstorming • Critical reading and thinking • Making use of existing knowledge • Problem definition	• Training brainstorming skills • Form to prepare pre-discussion • Own learning self-assessment form
FHML	Bachelor Biomedical Sciences	• Finding information • Critical reading • Information literacy • Interpretation • Writing and argumentation	• Journal club sessions • Specific questionnaires used to evaluate academic articles with different research designs
FHS-DKE	Bachelor Data Science and Knowledge Engineering	• Critical thinking • Information literacy, retention, selection • Interpretation • Argumentation	• Use the students' existing knowledge to reach a solution to a problem, before explaining the state of the arts solution. • Provide solutions with 'missing steps'.
FHS-UCM	Bachelor University College Maastricht	• Critical thinking • Argumentation and interpretation • Qualitative/quantitative analysis	• Tailor-made case work • Encourage students to put together knowledge from different parts of the course • Multiple solutions to problems or multiple pathways to a single solution
FPN	Research master's programme in Cognitive and Clinical Neuroscience	• Critical thinking • Qualitative analysis • Interpretation • Writing and argumentation • Logical reasoning	• No final exam • Practice of interview • Expectation management
LAW	Bachelor European Law School	• Information literacy • Critical reading • Interpretation • Writing and argumentation • Referencing	• Peer panel to discuss student's own work
SBE	Master International Business	• Academic writing • Analysis of empirical data • Critical thinking	• Flexible course that allows for combining teaching and research which motivates both staff and students • Exercise in translating theory to practice

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