Objectives of undergraduate research programs - Creating a program theory for research-based learning

Abstract

Even though research-based learning is an approach often used to promote students' scientific education, there is a lack of evidence on the aims that Higher Education institutions want to achieve with the students' exposure to research, especially in early stages of the study career. In this paper, we use program theories as a tool to identify aims on different levels (target systems, key objectives, intermediary objectives and detailed objectives). We conducted an empirical analysis with interview data from 21 research-based learning programs. Our analysis resulted in four target systems that are further divided into different objectives on the other levels: *student graduation/final degree*, *curricular coherence, scientific education and selection*. Within these target systems, we find many interconnections but also contradictions between particular aims. Our analysis provides hints on further research on the impact of undergraduate research and on the question how to evaluate these types of programs.

Paper

In Higher Education research-based learning is regarded in a two-folded way: On the one hand it is considered as a concept to foster holistic education in the sense of "Bildung" (idealistic approach). On the other hand, it is considered as an instrument for promoting research-related competencies that promise additional professional relevance (functional approach; Simons & Elen 2007). Nevertheless, the distinction does not explain at what time in their study career students should start performing their own research. Many have argued for an early exposure to research even on undergraduate level (e.g. Brew 2006; Linn et al. 2015; Walkington et al. 2011). But what are the reasons behind the early contact with research? Which aims do Higher Education institutions pursue with undergraduate research? These questions have rarely been addressed in studies on undergraduate research. The paper provides results from an empirical investigation of in-depth interviews with program coordinators and lecturers from 21 projects on undergraduate research in German universities.

As a methodological frame to analyze the objectives of research-based learning we refer to program theories. Program theories are used as one of the central approaches in evaluation research (e.g. Chen 1990, Rogers et al. 2000). A program theory is based on "assumptions of

impact" by the people involved in a program. By analyzing these assumptions, "individual" program theories are elaborated for complex programs (Giel 2016). For our analysis we made use of a central aspect of program theories: Different levels of aims are identified within the "assumptions of impact". They include target systems, key objectives, intermediary objectives and detailed objectives (Bartsch et al. 2016). In our interview data, we identified four target systems for undergraduate research using this heuristic *across* the different programs instead of program-specifically. The result are four target systems that consist of aggregated aims:

Student Graduation/Final Degree

The first target system we identified is "student graduation" or "final degree". This target is connected to reducing student drop-out rates. To reach this aim it seems to be particularly important for the interviewees to maintain the motivation to study by implementing a research-based learning approach. This is done by enabling students to work on their own interests and (research) questions or by arousing the students' curiosity on research.

1. Curricular Coherence

In our interviews we found that the rationale for research experiences in the first study year is based on the requirements of the bachelor thesis. The aim is to improve the quality of the bachelor thesis. The core argument here is that early experiences in the field of research allow a realistic assessment of the effort of research projects and promote the perseverance needed for research. Experiences of failure in the first year can improve the bachelor thesis: The decent application of research methods is hardly possible for first-year students but these negative experiences can initiate a learning process and help students to achieve better research results in later research phases.

Interdisciplinary projects are offered in the first year with an orientation towards the jobs market. Undergraduate research aims to prepare students for the work on complex interdisciplinary and transdisciplinary problems.

The third goal has a stronger focus on the individual student: They are supposed to understand the coherence of a program in itself through research-based learning. The idea is to use the practical research experience made at the beginning as "frame of reference" in order to understand the theoretical content of the course in terms of its practical value and relevance.

2. Scientific Education

This target system is the one most discussed in the literature (see Simons & Elen 2007, mentioned above). It comprises two key objectives based on different perspectives. Students are to undergo an "edifying" process through their engagement with research. This guiding principle is expressed most succinctly in a quote by an interviewee: *„Learning to think, learning to work, learning to persevere, and learning to fail."* This quote makes clear that failure is not so much related to classical learning processes as it is a more general education and personality building process, which encompasses basic principles of action (thinking, working). The development of a research-oriented attitude is a frequently used term describing such a transformational educational process. The strength of such a guiding principle can be seen in the fact that it works across faculties and disciplines, precisely because concrete competences and methods do not have to be used as learning objectives.

In the functional approach, research is the means to acquiring competencies. Getting to know the research process is divided into a multitude of detailed goals. Here you will find the methodological knowledge that was so important in the key objective of coherence. In addition, writing skills, reading skills and the ability to evaluate scientific literature are supposed to be trained as well.

3. Selection

Due to the complexity and high workload of research processes, it is assumed that on the one hand only certain students are interested in student research projects. On the other hand, it is assumed that only the more capable (talented) students are able to carry out their own research projects. The selection refers not only to the question who participates in research-based learning projects, but also to the fact that research-based learning is an opportunity to attract students interested in research as a profession.

Target system	Key objectives	Intermediary objectives
Student graduation/final degree	Reducing drop-out rates	Increasing student motivation
Coherence	Institutional coherence	Improving the bachelor thesis' quality
		Offering an orientation towards the job market
	Individual coherence	Connecting theory and practice
Scientific Education	Research-oriented attitude	Learning to think
		Learning to work

		Learning to persevere
		Learning to fail
	Competencies acquisition	Methodological skills
		Writing and reading skills
		Literature evaluation skills
Selection	Promotion of certain students	Promotion of motivated students
		Promotion of "talented" students
	Excellence	Recruitment of junior scientists

Tab. 1: Overview over target systems, key objectives and intermediary objectives

Conclusion

With our aggregated analysis we are able to broaden the discussion on research-based learning. We showed that there are multiple aims connected to research-based learning. To a certain extent, the projects we are investigating contribute to the broad lines of general program theories of research-based learning. A closer look at the target systems reveals interconnections, but also contradictions between particular aims. Our analysis provides hints on further research on the impact of undergraduate research and on the question how to evaluate these types of programs.

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