Available online at www.sciencedirect.com

ScienceDirect

Currents in Pharmacy Teaching and Learning ▮ (2016) ▮▮▮–▮▮▮

Currents in Pharmacy Teaching & Learning

http://www.pharmacyteaching.com

Research Article

Designing and implementing an inquiry-based undergraduate curriculum in pharmaceutical sciences ☆, ☆☆

Irma Meijerman, PhD[a,*], Jan Nab, PhD[b], Andries S. Koster, PhD[a]

[a] *Department of Pharmaceutical Sciences, Utrecht University, Utrecht, The Netherlands*
[b] *Centre for Teaching and Learning Utrecht University, Utrecht, The Netherlands*

Abstract

To fulfill the requirements of the work field for creative, innovative, pharmaceutical scientists the Science Faculty of Utrecht University, The Netherlands, has designed and implemented a new bachelor program: The College of Pharmaceutical Sciences. A deliberate choice was made for a didactic approach of research-based, inquiry-based education in an authentic context throughout the whole curriculum. To further improve motivation of learning of students, autonomy and scaffolding were introduced. The first results show that the curriculum is successfully implemented and experienced positive by the students and teachers.

Keywords: Research-based teaching; Inquiry-based learning; Curriculum design; Undergraduate students; Pharmaceutical sciences

Introduction

The Science Faculty of Utrecht University (UU), The Netherlands, recently has taken the initiative to design and implement a new bachelor program in pharmaceutical sciences: the College of Pharmaceutical Sciences (CPS). The need for this new program arises from the fact that there is a gap between the type of expertise output from the universities and the demands of the industry for pharmaceutical science graduates. Several authors have indicated that the education of pharmaceutical scientists should involve more scientific breadth, multidisciplinary problem solving skills, communication skills, working in teams, dealing with professional and research ethics, developing leadership competences, project-management skills, self-organization, and creative, critical, and strategic thinking.[1–6]

These new requirements for pharmaceutical scientists arise from challenges that pharmaceutical industry, academia, and government face such as the decrease in the number of new drug launches, the increasing costs of developing new chemical entities, and many gaps between the need and availability of drugs.[7–9] The College of Pharmaceutical Sciences (CPS) therefore intends to train undergraduate students to become innovative and creative pharmaceutical scientists who can deal with the new challenges of drug discovery and development.[3]

The aim was to develop a program with a focus on the training for the discovery and development of new innovative drugs with an educational approach that stands out from other pharmaceutical science undergraduate programs. In addition, a deliberate choice was made to make the CPS a program for excellent students. Inquiry-based learning (IBL) was chosen as a basic principle for the design of

Abbreviations: AAPS, American Association of Pharmaceutical Scientists; BSA, binding study advise; CPS, College of Pharmaceutical Sciences; IBL, inquiry-based learning; LERU, League of European Research Universities; SDT, self-determination theory; UUPs, Utrecht University partners; UU, Utrecht University

☆The development of the CPS program was partly supported by a grant from the Sirius Program, Ministry of Education, Culture and Science, Netherlands (Grant no. 705A0 – 2033).

☆☆*Institutional Review Board*: The development and execution of the course, as well as the described research, was discussed by the members of the Educational Management Board of the Department of Pharmaceutical Sciences. This commission of professors and associate professors discussed the ethical issues, among other things, and they approved the research design.

* Corresponding author: Irma Meijerman, PhD, Department of Pharmaceutical Sciences, Utrecht University, Universiteitsweg 99, 3584 CG Utrecht, The Netherlands.
E-mail: I.Meijerman@uu.nl

http://dx.doi.org/10.1016/j.cptl.2016.08.001
1877-1297/

the whole curriculum. IBL is a research-based, student-centered pedagogy, based on authentic tasks and situated learning that has been shown to stimulate a deep learning approach.[10–15] A limited amount of studies on IBL in pharmacy or pharmaceutical sciences are reported. Sattenstall and Freeman[16] showed the effect of an IBL module in pharmaceutical chemistry for first year students. Students indicated that IBL encouraged them to learn and establish a link with the clinical context. Furthermore they developed several key skills such as working in a team. Meijerman et al.[17] describe the successful implementation of an IBL elective course on drug discovery and preclinical drug development in an undergraduate pharmacy curriculum. The students of this course are highly motivated and stimulated to use critical thinking and problem solving skills. IBL has also been shown to stimulate the development of professional skills in an undergraduate pharmacy program.[18] All of these examples of IBL are on a course level, and we are not aware of any designs using IBL-approaches in pharmaceutical science at the higher curriculum level. University College London has developed a framework, the Connected Curriculum, with the aim to ensure that all undergraduate courses allow students to learn through research and inquiry. However, this has not been worked out in a complete undergraduate program yet.[19] In this study we present the theory, design, and first results of the learning perceptions of our IBL-based undergraduate program, the CPS.

Research-based curriculum

The requirements for pharmaceutical scientists make it very clear that more is needed than just theoretical knowledge and basic laboratory skills. Higher-order thinking skills and a critical attitude are important, just as research skills such as defining a (multidisciplinary) research question, developing an experimental design, critically analyzing data and literature, and presenting and discussing results orally or in writing.[1,2,20,21] In addition, to be able to come up with new and innovative ideas for new drugs, students have to be creative, be able to think "outside the box," and recombine knowledge. Besides, pharmaceutical scientists are part of a scientific community that has its own vocabulary, implicit and explicit rules, observation methods, concepts, and models. This community of practice is a social learning system where people develop professional competencies and build up new knowledge and skills by experiences as part of the community.[22] Students should be trained to understand and become part of this scientific community. Teachers should be role models to students and, as such, introduce them to the culture of pharmaceutical science.

In addition, with the enormous and fast changes in pharmaceutical science and drug development in the last decades, the ability to handle new information has become more important. The speed at which new knowledge becomes available, and new data and ideas are generated and presented has increased tremendously.[23] Therefore, students must be trained to be able to deal with this fast development of knowledge, to value and critically analyze this knowledge, and implement this knowledge in their own research.

Many of the existing pharmaceutical sciences in bachelor curricula are traditional building block curricula, which devote a substantial part of their courses to basic theory. These curricula are designed to ensure that students have a thorough grounding in basic science before proceeding to application of concepts in the relevant discipline. Griffiths[24] described this traditional way of teaching as research-led; the curriculum has an emphasis on research content and the teacher provides the students their knowledge. This classification was used by Healey[25] to develop a matrix showing the link between curriculum design, research, and teaching (Fig. 1). Healey suggests that only few curricula fit in one quadrant, but that most traditional university teaching takes place in the bottom left quadrant of research-led teaching. To his opinion, higher education should place more emphasis on research-tutored or research-based pedagogies, as these approaches have the most benefit for student learning.[25]

Teaching undergraduates research skills in a research-based curriculum improves their understanding of science content, processing of scientific information and literature, critical thinking, motivation, learning, and collaboration skills.[21,25–30] Furthermore, by performing undergraduate research, students are becoming more confident to do pharmaceutical research and gain more interest in the discipline.[27,31]

Performing undergraduate research will also contribute to an informal learning process that is of great value for the personal and scientific professional development of the student; the student will find out what it is to "think and work as a pharmaceutical scientist" and become part of the scientific community.[22,27,31] Undergraduate research will also increase students' self-efficacy, and belief in their own capabilities. Bandura[32] describes that a good way of creating and strengthening self-efficacy is through experiences provided by social models. By bringing students into contact with scientific researchers, students can reflect their own performance and develop a sense of trust and believe that they can perform tasks related to the profession.

A research-based approach is also supported by the theories on the benefits of situated learning. In a situated learning environment, authentic contexts are provided to the students that reflect the way the knowledge is required in pharmaceutical sciences. The students participate in authentic activities, face multiple roles and perspectives, and have access to expert performances. By working on the authentic tasks, such as undergraduate research, collaborative construction of knowledge and reflection is supported and promoted.[33]

For the new pharmaceutical science program, like the CPS, the research-based approach is used as the theoretical model. Inquiry-based learning (IBL), a research-based teaching method, was chosen as the leading principle and format for the new curriculum.