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New course in Protein Structures in Drug Research

Peter Naur

Department of Medical Chemistry, FARMA, University of Copenhagen

Introduction

This project describes my reflections on my involvement in the planning, execution and student evaluation of the one-day course: "Three-dimensional Protein Structures in Drug Research". The course is part of the ULLA summer school for PhD students and since this was the first time the course ran I had a unique opportunity to influence the planning of the course. I was not formally responsible for organizing the course, however, the relevant person gladly gave me the chance to influence planning as much as I wanted to.

Background – The ULLA summer school

The ULLA summer school is a biannual event that aims to "widen [...] knowledge of updated key issues regarding for instance drug discovery, drug development and the economic and management issues" and "it gives postgraduates an optimal opportunity have a great time and to create an international network" (European University Consortium for Advanced Pharmaceutical Education and Research; 2002). ULLA is a collaboration between European pharmaceutical universities (originally Uppsala, London, Leiden and Amsterdam).

Student background

The summer school is aimed at PhD students and since the content of pharmaceutical education is (at least partly) regulated by an EU-directive the student population is relatively homogeneous.

This year's summer school was attended by 151 students and consisted of approximately 50 one-day courses in five days plus a social program.

This means that we as teachers should be prepared to deal with students that might (a) be here primarily for the social part of the summer school, (b) not have had this course as their first priority. Obviously, this means that we should put special emphasis on motivating the students for the teaching activities that we would like to undertake.

Theoretical considerations

Constructive alignment

The theoretical framework I chose to implement in the course is known as constructive alignment (Biggs and Tang; 2007). This is a concept that can be boiled down to one sentence: The most efficient learning takes place when you are doing what you should learn.

An example could be writing. The best way to learn writing is to actually do it. Obviously, there need to be some feedback so that spelling mistakes can be avoided, language can be improved and style can be made more elegant.

To teach within the framework of constructive alignment requires some considerations before planning the teaching. These will be summarized in the following sections.

Intended learning outcomes

Probably the most important step in all teaching is to identify what the students should actually benefit from your teaching. In the context of constructive alignment this is even more important to consider carefully. Since the whole point is that the students should do what they are intended to learn it is necessary to define the intended learning outcome (ILO) as something that can be performed. It cannot be a too diffuse outcome such as "the

students should be able to understand this and that", but rather must be concrete as in e.g. "the students should be able to write without making spelling mistakes". This is both a skill that can be acquired by the right tutoring and an action that can be performed while learning it.

Teaching and learning activities

Since the ILOs in constructive alignment has a built-in action this very much determines what the teaching and learning activities (TLA) should be. The idea is that the teaching should be primarily student centered so they are engaged in the activity they are supposed to learn. The teaching and learning activities is thus already defined in the intended learning outcomes.

Planning of the teaching

Before I was involved in planning the course a course description (appendix A) had been prepared. This formed the basis for the planning of the course and what the students would expect from it since the students had used this for applying for it. It also required that the students had a basic understanding of protein structures and together with the considerations in the section on student background this would ensure a relatively homogeneous student population.

Motivation

For reasons described previously it could be expected that the students would not be extremely motivated to be engaged in learning activities and particularly not in student centered activities. Therefore, we were keen on planning the teaching in a way that made the activities seem meaningful to the students. The way we did this was to use a recurring theme throughout the day. This theme was a piece of work from our own lab where exactly the methods that we would like to teach the students were used to derive some very interesting results. It was our hope that this would motivate the students to engage in the learning process.

Intended learning objectives

The course description in Appendix A describes a number of subjects that the course will cover. However, these points are not suitable as intended learning objectives. So the first part of the planning was to define a (low) number of learning objectives that could be used to design the teaching and learning activities. This resulted in the following ILOs:

The students should be able to:

1. design, perform and evaluate a crystallization experiment
2. analyze molecular contacts between proteins and drug related compounds
3. critically evaluate the quality of a protein structure in the Protein Data Bank

These three (or five, depending on how you look at it) learning objectives are relatively well-defined and easily forms the basis for TLAs. They are constructed in a way that the students will automatically encounter the subjects they have been promised in the course description.

Teaching and learning activities

As the theory in constructive alignment dictates, the ILOs stated above determines the TLAs that will take place. One general problem in this particular course is obviously that a rather broad range of subjects will be covered in only one day. This will automatically have the consequence that the ILOs will not be covered as thoroughly as we would wish. One could argue that this should make us lower the ambition level by cutting down on the number of ILOs. However, the nature of the course as a one day event where no one expects that the students learn the subject to a deep level of understanding, in our view, justifies the ambition level.

As described below the program for the day (Appendix B) was designed as a mix of laboratory and computer exercises interrupted by two lectures. One of these (45 minutes) was a case story where the story behind the recurring theme was presented, the other a short (20 minutes) theoretical lecture on protein-ligand interactions that was necessary for the understanding of the following computer exercise.

Let us take a look at how the ILOs were used to design TLAs one by one:

Design, perform and evaluate a crystallization experiment

This part was started by a short introduction (10 minutes) where some practical aspects of crystallography were covered as well as some theory behind protein crystallization. After this we used approximately 20 minutes on discussing how to set up a specific crystallization experiment where I tried to keep my mouth shut as much as possible. After that the students were handed a recipe for eighteen crystallization experiments where they were told to choose six to perform. Optimally they should have made the recipes themselves, but this was skipped due to time constraints. They then performed the actual crystallization experiment. Due to the nature of these experiments (the crystals take time to form) the evaluation was the last item on the program. The protein they performed the experiment on was the same as covered in the case story and as such a part of the recurring theme.

Analyze molecular contacts between proteins and drug related compounds

This exercise was a recycled one that has been used with success in another course. During the exercise the students are guided through the steps of analyzing a protein-ligand complex much the same way as we "professionals" would do it. This is the only part of the course that is not specifically designed for this course and therefore the subject protein is not part of the recurring theme, but a closely related one.

Critically evaluate the quality of a protein structure in the Protein Data Bank

In this exercise the students were asked a number of questions that were designed in such a way that they were required to discuss among themselves the concepts that were presented. These concepts are obviously the ones that are important for evaluating quality of protein structures. During the exercise the students compared a high and a medium quality structure and in this way they should learn how to distinguish between these types. The exercise ended with a plenum where doubts were clarified.

Student evaluation

Just prior to the end of the day the students were handed a questionnaire for evaluation of the course. The results are summarized in Appendix C.

Overall the evaluation seems to be quite positive. Personally, I am quite pleased that only two persons found that the level of the course was too high. Looking through these two particular evaluations it is evident that the two students are generally displeased with the course and they also give a reason: They are annoyed at a particular computer program they have encountered during an exercise. This identifies the two persons and I remember the incident that created the frustration which was that they did not ask for the readily available help (we were three teachers for seventeen students) and instead became obsessed with a particular problem. I really do not know how to avoid a situation like that.

Since this project is an exercise in employing efficient teaching methods it also seems pleasing that the response to the question how they would rate the teaching methods employed in the course is so positive. However, I know why they are so positive because several students told me during the day: “Ah, finally some lab work”. I would also have been satisfied with a slightly less positive response as this is not a popularity contest, but a question of making teaching and learning activities that are efficient.

A Appendix: Course description (excerpt)

Course for ULLA Summer School 2009

Course title (short and descriptive):

Three-dimensional protein structures in drug research

Course leader:

name: **Karla Frydenvang**
title: **Associate professor**
organisation: **Biostructural Research, Dept. of Medicinal Chemistry, FARMA, KU**
e-mail: **kf@farma.ku.dk**

Teaching staff (names on 1-2 colleagues, who you plan to organise the course with):
Professor Jette Sandholm Kastrup
Post doc Peter Naur

Specific facilities needed (besides room, blackboard, overhead projector, and projector/beamer):
Laptop computers

Course description (max. 1/2 page or 300 words):

The last decade has brought tremendous progress in our understanding of the structural and mechanistic details of many proteins. This insight has greatly advanced the ability to perform rational drug design of compounds with improved selectivity profiles and/or pharmacological properties. Unlike the traditional drug discovery method – defined as the trial-and-error testing of arbitrary compound selections for a given biological function – structure-based drug design begins with a knowledge of the specific target, e.g. structure of the specific protein of interest, and hereafter tailoring compounds with certain properties based on this knowledge.

The aim of the course is to introduce experimental methods, which can be used to analyze molecular characteristics of biologically important molecules, and to understand the interactions between ligands and drug related compounds.

The course will cover the following aspects:

- **crystallization of proteins with drug related compounds**
- **evaluation of results achieved from x-ray structure determination of proteins**
- **introduction to important databases**
- **analysis of molecular characteristics of biologically important molecules**
- **analysis of interactions between proteins and drug related compounds**
- **structure-based drug design**

The course will have lectures in the morning session and practical workshops on crystallization of a protein with a drug related compound and computer analysis of protein-compound interactions in the afternoon session.

B Appendix: Course program

Three-dimensional Protein Structures in Drug Research

ULLA Summer School – Copenhagen 2009

Friday July 3rd

Program:

9:00 – 9:15:	Introductory remarks
9:15 – 10:30:	Exercise in crystallization
10:30 – 10:45:	Coffee break
10:45 – 11:15:	Exercise in crystallization - continued
11:15 – 12:00:	Case story – Search for a ligand for GluRdelta2
12:00 – 13:30:	Lunch
13:30 – 13:50:	Introduction to protein-ligand interactions
13:50 – 15:00:	Computer exercise on protein-ligand interactions
15:00 – 15:15:	Coffee break
15:15 – 16:15:	Computer exercise in protein structure databases and structure quality evaluation
16:15 – 17:00:	Evaluation of crystallization experiment

Teachers:

Assoc. Prof. Karla Frydenvang, kf@farma.ku.dk

Post.doc. Peter Naur, pna@farma.ku.dk

Professor Jette Sandholm Kastrup, jsk@farma.ku.dk

Department of Medicinal Chemistry, Faculty of Pharmaceutical Sciences,

University of Copenhagen, Universitetsparken 2, DK-2100 Copenhagen, Denmark.

C Appendix: Student evaluation

2. Did the course meet you expectations	No	To some extent	Yes	Absolutely	No answer
		3	9	5	1
3. How would you rate the course material	Poor	Satisfactory	Good	Excellent	
	2	3	10	3	
4. How would you rate the level of this course	Too low	Good	Too high		1
		14	2		
5. How would you characterize the topics addressed at this course	Not interesting	Interesting	Very interesting		1
		10	7		
6. Did you find any topics missing in this course	No	Yes			
	18				
7. How would you rate the teaching methods of this course	Poor	Adequate	Good	Excellent	1
		1	12	4	
8. How would you rate the teachers at this course	Poor	Satisfactory	Good	Excellent	1
		1	12	4	
9. Would you like to recommend this course to others	No	Yes			
	1	17			
10. Did you look at the course material prior to arrival	No	Yes			
	11	7			

All contributions to this volume can be found at:

http://www.ind.ku.dk/publikationer/up_projekter/2008-1/

The bibliography can be found at:

http://www.ind.ku.dk/publikationer/up_projekter/kapitler/2008_vol1_bibliography.pdf/