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Planning and execution of a one-day PhD course employing the theory of didactical situations

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Introduction

In July 2009 I was involved in planning and executing a one-day PhD course in relation to the ULLA Summer School held at FARMA. ULLA is a biannual week-long summer school held jointly by several European institutions of higher learning. It focuses on an array of topics related to pharmacy in a broad sense including biology, chemistry and the social sciences. The title of the course was "Glia: from physiology to pathology". Including me (LKB) the course team consisted of four teachers and two technical assistants. As indicated by the title the course covered different aspects of biochemistry, physiology and pathophysiology related to glial cells, a specialized cell in the mammalian brain. Eleven students enrolled for the course; however, no information on the educational background of the individual students was available during the planning phase. This, plus the short time available (one day) presented us with significant challenges in terms of settling on a number of issues. Initially, we laid down the intended learning objectives (ILOs) based on our assumptions regarding the expectations from the students. This was not an easy task since we had no information on the composition of the student population; were they all chemists? or biologists? Thus, the problem that I will focus on here is

- how does one, under the conditions described above plan and execute a course with maximum student leaning output as related to the ILOs laid down

The planning phase

The three main issues related to the planning of the course were the following:

- The choice of specific topics to be covered
- The level of detail of the individual topics including description of the ILOs
- The teaching and learning activities (TLAs) including appropriate didactical considerations as related to the ILOs

The choice of topics

With regard to the topics we chose the pragmatic approach of only including topics that were within our fields of expertise in terms of research. One disadvantage of this decision was that the students would then only be introduced to a narrow aspect of glial biology; however, as it was a short course we thought it better to cover a few specific topics rather than trying to cover the whole field. One major advantage was that we could focus more on the quality of the teaching rather than preparing broad lectures that included topics that were really out of our field of expertise.

The final program consisted of the following components:

- Introduction to glial cells
- Glial cells, normal function
- Lab exercise
- Glial cells, pathological aspects
- Class exercise

First, a general introduction to the field was give followed by two separate lectures on the role of glia in normal function. The following lab exercises were designed to illustrate key points of these two lectures. The lab exercise included a subsequent class exercise in which the students were asked to interpret the results obtained employing knowledge acquired from the lectures. Finally, two lectures were given on pathological aspects of glial function. The rationale for this design was (1) that the students were given an overview of normal function before the pathology was discussed; (2) that the lab and class exercises were placed so that they provided a break from the lectures; (3) that the lab and class exercises would complement and expand on the aspects covered in the lectures; and finally, (4) that the program should present as a coherent series of TLAs going from the broad introduction (lecture) to the final class exercise where the students should be able to work independently (including *adidactical situations* as elaborated below) with the results from their lab exercise.

The level of detail

As mentioned, several factors made it rather difficult for us to describe the ILOs and settling on the level of detail for the course. We chose to assume that we were dealing with PhD students with a background in pharmacy. Thus, we would not expect them to have any detailed knowledge of glial cell function but merely a general understanding of biochemistry and a superficial knowledge of brain function. With that in mind we formulated the following ILOs:

By the end of the course, the students

1. ...should have a *superficial* understanding of glial biology
   - Know the different subgroups of glial cells
   - Basic knowledge of the amount and distribution of glial cells in the brain
   - Basic knowledge of the morphology of glial cells
   - Basic knowledge of the the role of glial cells in relation to neurotransmission
2. ...should have a somewhat *detailed* understanding of glial function within the narrow topics covered
   - Knowledge of the role of glial cells in neurotransmitter homeostasis including nitrogen homeostasis; specifically the “nitrogen problem” related to the glutamate-glutamine cycle
   - Knowledge of the energy-generating pathways fueling neurotransmitter (glutamate) uptake
   - Knowledge of current and future drug targets within intermediary metabolism and neurotransmitter (GABA) transport for treating epilepsy
   - Knowledge of the role of glial cells in neuropathic pain and putative drug targets

3. …should be able to independently *interpret* experimental data of low complexity with regard to glial function within the topics covered
   - Be able to interpret data from simple uptake assays of glucose and neurotransmitter uptake in cultured glial cells
   - Based on the use of specific inhibitors of glial metabolism, the students should be able to differentiate between the roles played by distinct energy-generating pathways for fueling uptake of neurotransmitter
   - Be able to suggest novel experiments to elucidate aspects of energy metabolism in cultured glial cells

Even though it was rather unconventional, we chose ***not*** to reveal the ILOs to the students. We did this because we thought it would be overwhelming for the students to be presented with ILOs for a one-day course that did not include an actual evaluation of whether they fulfilled these or not. Thus, the ILOs were only used as an *internal reference* for the teachers. The teachers aimed at fulfilling these ILOs and to set the level of the TLAs accordingly. We sent out a few review papers as pre-course reading material; however, we planned the teaching under the assumption that the students were largely unprepared.

The teaching and learning activities

Since we are experimental scientists, we decided early on that the course should include both lectures as well as practical exercises/tutorials. The purpose of these was to support the learning process related to ILO (2) and fulfill ILO (3). My specific responsibility was to give one of the lectures in the morning on a specific topic plus to plan and execute the lab and class exercises. For my part, I decided to plan the teaching according to the *theory of didactical situations* (TDS) by Guy Brousseau as described by Winsløw (2007) and Christiansen and Olsen (2006). In short, TDS is concerned with the creation of a so-called *didactical milieu* (DM) in which the students may work independently with a given problem in a way that enables them to reach the intended level of learning (that is, the ILOs) partly on their own. Thus, the teacher provides the DM by giving the students the first few pieces of the puzzle and then, during the so-called *adidactical period* the students may put the remaining pieces together themselves. During the adidactical period the students work independently of the teacher. At the end of the session, the teacher then ensures that the students arrived at the "right" answers; this might be done by discussing the output from the students in plenum. The central dogma in TDS is that the established "text-book" knowledge needs to be "personalized" by the students by providing the proper DM; i.e. the teacher should create a DM that enables the students to establish this knowledge on their own. The introductory lecture given prior to the adidactical period is referred to as *devolution*; here, some of the established knowledge is transferred from the teacher to the students and the ground rules for the adidactical period are laid down. The last part where the teacher is discussing the answers with the students is referred to as *institutionalization* of the knowledge they obtained during the adidactical period. The teacher should strive to put the knowledge obtained into the proper framework or context for the purpose of generalization.

Execution and intrinsic evaluation of the course

In practice, we planned the two morning lectures to give just enough information so that the students should be able interpret the results from the lab exercise on their own. In addition, I included an exercise during my lecture in which the students were asked to come up with one or more solutions to a problem. The students were presented with the problem and then given 10 min to think about the possible solutions. They were allowed to discuss the problem among themselves. The problem was designed to illustrate a central part of cellular metabolism and cellular interdependence between nerve cells and glial cells; basically, they were asked to imagine that they were *intelligent designers* and come up with the best way for the cells to deal with the issue. The students were very eager to take part in the discussions and they were able to come up with two solutions that were more or less identical to the "right" ones. The solutions are actually not "text-book" knowledge but rather issues that are still being debated within the field; thus, none of the students would be expected to have any prior knowledge about this. The objective of this exercise was to prime the students for the lab/class exercise ahead and to my best of knowledge we succeeded in doing that.

The lab exercises were kept very simple. All materials were provided beforehand and the exercise itself lasted about 40 min including introduction and execution of the experiments. The students were divided into three groups of three or four people. After the afternoon lectures, the students were handed the results of the experiments and given about one hour to interpret the results (the adidactical period; no teachers present) in the context of what they knew from the morning lectures and any other sources of information. They were also asked to come up with new experimental designs to elucidate aspects not covered in the experiments performed. After this the interpretations and ideas for new experiments were discussed in plenum. In practice each group presented their experimental results and their interpretations/hypotheses/ideas and then this was discussed in plenum in a milieu supervised/controlled by the teachers. Finally, the teachers gave a short, interactive lecture in which the experimental work and the theoretical matters were put in to a larger perspective focusing on how it relates to disease research and drug development.

As far as the teachers were concerned, we believe that the course was well-executed and succeeded in the goals (i.e. as related to the ILOs) that we set up. However, since there was no formal assessment of the students we have to rely on the course evaluation forms handed in by the students for evaluating whether we reached our goals or not. In general, the student evaluations were good which is best exemplified by the fact that all eleven students would recommend the course to others! Nine students thought the course met their expectations and only one student reckoned the level of the course was too high. Furthermore, the topics were characterized as either *interesting* or *very interesting* and only two students found that topics were missing (both would have liked more background information on glial cells). This is a clear indication that the level and topics were well chosen and by extrapolation that the ILOs were met. With regard to the teachers/teaching methods most students regarded these aspects as being of good quality; three students regarded the methods as being *excellent*. This indicates that the teachers did well; however, there is room for improvement. Since very few written comments were made it is hard to say exactly which parts of the teaching were good/excellent. It should be mentioned that only two of four teachers chose to do interactive lectures whereas the other two chose to do conventional lectures with a low level of student interaction. Thus, it is hard to know exactly how my own teaching was evaluated by the students.

Conclusion

Since the student evaluations suggested that the course was well executed, I believe that we succeeded in organizing a successful course under the conditions that the ULLA Summer School posed on the teachers/organizers. In summary, to organize a course under these conditions it is important to focus on a narrow rather than a broad aspect within the field. Furthermore, the level should be rather basic to fit with the average PhD student within the pharmaceutical sciences (in this case, basic knowledge of biochemistry and superficial knowledge of brain function); clearly, the ILOs and the TLAs should be chosen to reflect this. As a final point, one aspect that seemed to be important for the success of this course was the lab & class exercises organized according to TDS. Here, it is important that the individual elements are simple in the sense that they focus on central elements of the subject that may be generalized to the subject field.

Finally, I would like to state that I find TDS to be very suited for designing courses and teaching sessions at this level and that I plan to make use of the experiences gained from this course in my everyday teaching at university level.

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/