19

Enhancing congruity of the course "Protein chemistry & enzymology for biologists"

Henriette Elisabeth Autzen

Department of Biology
University of Copenhagen

Introduction and aim

The undergraduate course NBIB16002U Protein Chemistry & Enzymology for Biologists (PEBio) is an elective course for undergraduate students on the biology program at UCPH but is open to students from other programs. Students typically follow PEBio in their fourth semester, a few in their sixth semester. The course was established approximately 6 years ago by lecturers in the Section for Biomolecular Sciences (BMS) and designed with the purpose of expanding upon the knowledge gained from first year biochemistry and allowing biology students to specialize in the subject of protein chemistry and enzymology. PEBio is a spin-out course, originally designed in parallel with an almost identical, obligatory, second semester course for the molecular biomedicine students, for whom their version of the course is part one of two. While the curriculum for the two courses were the same, the four-hour written exams were not: It is open-book for the biology students, while it is closed-book for the molecular biomedicine students. The biology students always performed much worse than the molecular biomedicine students as evident from a high failure rate at the ordinary exam (some years up to 40%) and observed by lecturers during teaching. In addition, poor student evaluations have always placed PEBio in 'Category C', calling for significant changes or adjustments of the course. Consequently, the course has seen numerous adjustments and redesigns over the years, but to little avail.

Biggs and Tang's (Biggs & Tang, 2007) concept of 'constructive alignment' prescribes that the relationship between the intended learning out-

comes (ILOs), learning activities and assessments for a course must be aligned for the teaching-learning environment (TLE) to work optimally. Based on this model, Hounsell and Hounsell (Hounsell & Hounsell, 2007) introduced 'congruence', as a broader framework for analyzing TLEs, highlighting multiple levels of congruence should be considered when designing and achieving high-quality learning. **I hypothesized that working on several dimensions of congruence in PEBio would lead to better student evaluations and a higher pass rate at the final exam compared to past years.**

Method

As the newly appointed course responsible, I reshaped and restructured PEBio that I taught in block 3 of the academic year 2021/2022. Specifically, I worked on the following four dimensions of Hounsell and Hounsell's (Hounsell & Hounsell, 2007) congruence: 1) Course organization and management; 2) Teaching-learning activities (TLAs); 3) Students' backgrounds and aspirations; and 4) Assessment and provision of feedback to students. These new initiatives are elaborated upon below, discussed based on literature, and analyzed using formal and informal student evaluations, and my own observations. Finally, I will discuss the outlook of the course PEBio and its further development in the light of the new data.

Course structure

PEBio consists of 14 lectures (45 min each) and 26 theoretical exercises in colloquia (45 min each) during block 3 (8 weeks). I teach with two other professors, sharing the load approximately 10:40:50. In the class-based teaching, the students go through written exercises and problems centered on the curriculum covered in the lecture the previous week. The curriculum is primarily contained in the textbook previous exam sets, and theoretical exercises developed by BMS lecturers throughout years.

Lectures: The 14 lectures cover nine major themes, with the textbook as the primary literature and occasional supplementary literature. As such, the course follows what has been termed the 'content-centered-approach' by Fink (Fink, 2003). However, rather than following the textbook slavishly, we expand on the subjects by including examples that are not in the

textbook, and in many cases examples that relate to the research that is going on in BMS (research-based teaching) or is met in our everyday lives. By doing this, we aim to show the students several ways to approach the subject and hope to engage a wide spectrum of different students or learners that are represented in the class. Importantly, we use the lectures to convey the intended learning outcomes (IOLs), to provide the students with an overview of the course and the subject, and to convey our expectations of them - both in terms of the subject and in terms of their participation.

Theoretical exercises: The students are given a compendium when the course starts which includes problems for the 26 theoretical exercises. Each subject is covered by 10-15 individual problems that are summarized in chunks of two or three hours. We expect the students to come prepared to the theoretical exercises, having already found solutions to the problems beforehand. With this expectation, we aim to ensure that the time in class is spent on discussing the solutions of the problems and that everyone leaves class with the experience of landing at "the right solution". Indeed, as solutions are not made available online, the students are required to show up to class to get solutions to the problems.

Course redesign

There are several areas of improvement to create better constructive alignment for PEBio. Together with my two co-teachers, I identified which development points we should focus on this year, which was my first year as course responsible. In brief, I implemented the following changes: 1) I redefined the curriculum with another textbook than used previously in the course and I wrote a compendium on structural biology, a topic that was poorly covered by the previous and the new textbook; 2) I made a completely new course website on Absalon (Canvas) with a dynamic home page that changed every week and included summaries of the curriculum; 3) I made all my lectures from scratch, following the new textbook and including clicker questions; 4) I redesigned or rephrased the problems for the theoretical exercises following the new textbook and made quizzes on various subjects in the curriculum and published them on Absalon for the students to use for practice. In the following, I argue for these changes based on literature.

1. Changes to the curriculum. This also entailed changes in the course plan which were designed based on the points highlighted by Jørgensen (S. Jørgensen, 2015). As Jørgensen put it, the teacher should take the student's

competences and learning into account. Thus, I decided to tailor PEBio to the biology students by organizing the course and the curriculum according to my understanding of their educational background. For instance, the textbook that I decided to use in the course this year, is one that the students already own and are familiar with from a first-year course (General Biochemistry). I decided to do this rather than asking them to purchase a new, similar textbook, which has been the case previous years. Furthermore, I familiarized myself with the curriculum for the course General Biochemistry such that I know which parts of the PEBio curriculum are repetition and therefore may be expanded upon in greater detail and which parts are entirely new and should be introduced more carefully. I hope that my detailed understanding of where the students come from academically will offer constructive alignment between PEBio and the other courses contained in the study program for the biology students. Finally, recognizing that the textbook had a poor coverage of structural biology, I wrote a compendium, introducing them to this subject, which is central to protein chemistry.

2. New course website. During my pre-project (*University teachers: Student expectations against reality – the "implied teacher")* that I did together with other participants of the UP course, it became evident to me, that most students, regardless of their study level, value a teacher that is capable of providing them with an overview of the course, and the red thread of its curriculum. Therefore, I aimed at using Absalong to provide them with this. For instance, the course plan changes from week to week: Some weeks have two double lectures and a single two- or three-hour theoretical class session. Other weeks have a single double lecture and two sessions of two- or three-hour theoretical classes. This can often lead to confusion among the students (and fellow teachers) and for this reason, I spent a significant time on providing the students with an overview of every week on Absalon, whose front page changed each week (see Appendix A). In brief, each week had its own module, and hand-outs for lectures and theoretical classes had their own sub-sections within the modules. One module was used as a point of reference for the rest as it provided an overview of the entire course (see Appendix A). Likewise, a module was dedicated entirely to the old exam sets. Content became available as it became relevant during the course.

3. Lectures and clicker questions. This year was the first ever to have lectures dedicated to and designed for the biology students. I think this will be for the better as the biology students and the biomedicine students have very different academic backgrounds and aspirations. This year was also

my first year as a lecturer on this course, so I prepared my eight lectures from scratch, as it was not straightforward to use lecture slides from previous years coving similar subjects with an entirely new textbook. I set up all lectures with the same outline: Introduction; list of ILOs; textbook material (with little or no text) with quizzes; summary; and finally, a repetition of the ILOs. Every 45 minutes were split into two or three chunks separated by one or two on-class assignments that resembles assignments that they meet in their theoretical classes the following week. I did this by setting up the assignments as multiple-choice questions with voting using Mentimeter. The question types followed many of the suggestions summarized by Mathiasen (Rienecker & Bruun, 2015), including both introductory questions and more 'advanced' questions allowing time for discussion. My aim with this type of lecture outline was to facilitate student learning by means of repetition and recognition between the lectures and the theoretical exercises. Furthermore, with the anonymous voting during the lectures, it seemed like all students were encouraged to participate despite potential lack of confidence or shyness which is prevalent in some students, particular in an elective course where they know few or no other students. Finally, it seemed like the "breaks" during the lectures facilitated student discussions and helped them to stay focused.

4. Theoretical exercises and quizzes. In evaluations from previous years, it was requested that a given lecturer go through the assignments that are within their subject themselves, creating congruence between the lectures and theoretical exercises. Thus, this year, the teachers were responsible for selecting and reviewing the tutorial assignments that deal with their own topics. As for my own exercises, I introduced and made many new problems to better fit them with the new textbook and curriculum. The purpose of the theoretical exercises is to facilitate student engagement with the subject through integration and synthesis of knowledge and to provide the students with instant feedback. Importantly, it is not feasible to provide detailed, written feedback in a class of this size. Unfortunately, this may leave some students in doubt on whether or not they have understood the subject or assignment correctly as many assignments have more than a single answer. Fortunately, there is enough time to repeat questions providing more than a single person with feedback in-class. While we aim for preparing the students for the exam, the wording of the questions is often very different from typical wording in problems encountered in exam sets.

Results I: Student evaluations

31 students were enrolled in PEBio in the academic year 2021/2022, but it had about 25 active participants based on counts in class. The students were asked to answer four evaluations: A1, A2, and B (standard forms designed by UCPH) and a custom A3 evaluation scheme created by myself. Due to space limitations, only selected questions and answers from the student evaluations are given in Figure 1 and discussed further below. Unfortunately, only 10 out of 31 students responded to the standard forms despite several reminders were given throughout the evaluation period, while only five students answered the A3 form (16%). Thus, I will discuss potential strategies for increasing the number of student evaluations moving forward. Based on the evaluations, PEBio is yet again placed in 'Category C', with 30% or more answering in the highest category in questions 2.1 and 2.2, and more than 30% answering in the two lowest categories in questions 2.3, 2.6 and 2.8. It is noted that due to the low response rate, three students are enough to decide the course category.

There is a discrepancy between the assessment of the academic level of the course, as well as the hours that the student is expected to spend on the course (18 hours/week) and the number of hours that the students actually spent. 40% spent 15 hours or fewer, 40% spent the expected number of hours (16-25 hours/week), while 20% spent more (26 hours/week). This observation is remarkable as more than 70% of students perceive the level of the course as too high, and 50% think the workload is too large.

The majority of the students believe that they have had access to the necessary information about the course. In the custom questionnaire when asked about the course website, all five students thought that it worked really well (Appendix B).

Alarmingly, as many as 60% believe that they have not achieved the competencies described in the learning objectives. This is too high and means that we need to reassess the ILOs together with the new curriculum. Importantly, students somewhat agreed that the teaching material was relevant in relation to the course and four out of 10 thought that the course was profitable.

Unfortunately, 40% of the students believe that they have not received relevant feedback to their written or oral work. It was even stated by some that '*teachers did not use the whiteboard enough when going through the problems for the theoretical exercises and merely repeated answers orally*'. My own belief is that students should formulate their own answers and

Figure 1. Highlighted student evaluations from form A1.

write them up on the board in order to engage in an active learning process. This is also something I highlighted in class when asking students to come up to the whiteboard to answer the exercises. Next year, we will make sure that answers are all put on the whiteboard by students. Another way to give students more feedback on their academic level is to incorporate more quizzes on Absalon (automated feedback), during the lectures (summative or formative) or somehow include peer feedback. This year I had two quizzes on Absalon but could include more. In this regard, it is important to identify exactly what the purpose of the feedback is, which is something I will discuss with my two co-teachers before next year.

Results II: Exam fail rate

27 students attended the ordinary exam, of which 26 passed (3.7% fail rate). The grade distributions for the ordinary exams since 2017 are given in Figure 2. The distribution is much better compared to the previous years in that this year fewer students failed, and more students got grades equal to or higher than 7. For instance, 37% were awarded a grade of 10 or better, while 40% received a grade of 7. As an example, in 2020, no students got

a grade higher than 7 and 27% of the students failed the ordinary exam. Of course, it is not clear whether this difference reflects the academic level of the students, the exam set for this year, the teaching or other aspects of the course. However, taken together with the student evaluations, there is clearly a discrepancy between the perceived and actual difficulty of the course and based on this data alone, the PEBio course is a bigger success than previous years. It should be noted that after the re-exam, which ended up being an oral exam, two more students passed the course. Thus, out of the 31 students initially signed up for PEBio, 28 students completed it.

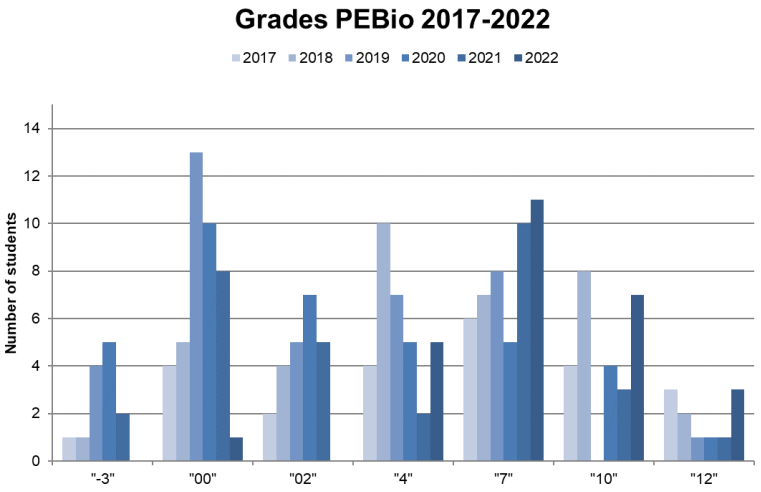


Figure 2. Grades given at the ordinary exam in PEBio since 2016/2017 till 2021/2022.

Conclusion and outlook

PEBio has undergone a significant change, which the teachers believe will benefit the students in the long run. These changes have probably given rise to the somewhat lukewarm evaluation of the course as it usually takes a few iterations to fully develop a new course. Despite the mixed evaluations, the fail rate is significantly lower this year than past years.

Curriculum. I intend to use the same textbook in the academic year 2022/2023 as it was my impression that the students had an easier time relating the PEBio course content to their previous course in General Biochemistry. The learning objectives for PEBio will be rewritten to accommodate the this change and to be defined according to Bloom's revised taxonomy (Andersson & R, 2013). Moreover, my co-teachers and myself have identified a few topics that we think are too specialized for the students to learn. Instead, energy will be spent on expanding the other topics and enforcing the red thread in the course.

Feedback from teacher to student. For the problems whose answers are unambiguous, we will upload the final answer to Absalon based on heavy requests from the students. This way, the students can check whether they are on the right track and then they can get the extended answer by attending the theoretical exercises. One may argue that it will potentially weaken the students' desire to participate in classroom instruction and teaching, but in any case, it is their own choice and very much a wish of the students to be given a list with the 'correct answers'. It is my impression that to some students, it is frustrating and confusing when there is more than a single answer to a question or ways of phrasing the same answer. I am strongly considering ways of implementing peer feedback in PEBio after successfully implementing it in another course that teach, however, I think automated feedback is the easiest to implement in PEBio all things considered (Christensen, 2015).

Strategy to increase number of student evaluations. The response rate in the student evaluation is low and time and resources must be spent on getting more students to evaluate the course. I plan to do this by asking for feedback by the end of my lectures as proposed by Horst *et al.* (Christensen, 2015) using a voting system. I am also considering allocating 15 minutes to evaluations in the end of the course as part of one of the final lectures or a theoretical exercise and spend time on discussing them on-class before the evaluation period ends. A way of encouraging the students to evaluate the course could be to include an overview of points that have been implemented as a follow-up on past evaluations, making the students realize that as a teacher we actually care about and use their evaluations.

References

Andersson, L., & R, K. D. (2013). *A taxonomy for learning, teaching, and assessing: A revision of bloom's taxonomy of educational objectives*. Pearson Education Limited.

Biggs, J., & Tang, C. (2007). *Teaching for quality learning at university* (3rd). Open University Press/McGraw Hill.

Christensen, G. (2015). Teaching evaluation. In L. Rienecker, P. Jørgensen, J. Dolin, & G. Ingerslev (Eds.), *University teaching and learning* (1st ed., pp. 409–422). Samfundslitteratur.

Fink, L. (2003). *Creating significant learning experiences: An integrated approach to designing college courses*. Jossy-Bass.

Hounsell, D., & Hounsell, J. (2007). Teaching learning environments in contemporary mass higher education. *Bjep monograph series ii* (pp. 91–111). British Psychological Society.

Jørgensen, P. S. (2015). Session planning. In L. Rienecker, P. Jørgensen, J. Dolin, & G. Ingerslev (Eds.), *University teaching and learning* (1st ed., pp. 149–164). Samfundslitteratur.

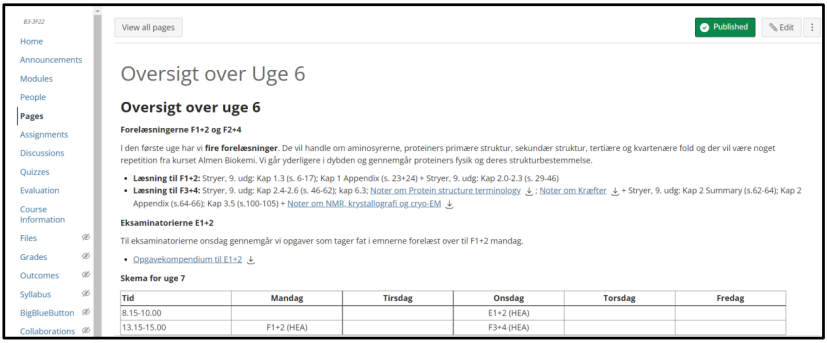
Jørgensen, S., P. (2015). Course planning. In L. Rienecker, P. Jørgensen, J. Dolin, & G. Ingerslev (Eds.), *University teaching and learning* (1st ed., pp. 165–174). Samfundslitteratur.

Rienecker, L., & Bruun, J. (2015). Feedback. In L. Rienecker, P. Jørgensen, J. Dolin, & G. Ingerslev (Eds.), *University teaching and learning* (1st ed., pp. 259–280). Samfundslitteratur.

A Screenshots of the course page on Absalon

The modules list.

The outline of a typical overview module page, which worked as the home page according to the course plan.



B Answers to custom evaluation scheme A3