

Restructuring the PhD course in *Drug Delivery* for a better alignment and congruence

Aneesh Thakur

Department of Pharmacy
University of Copenhagen

Introduction

The course alignment is important to establish the desired outcomes of teaching and learning in terms of contents as well students' understanding (Biggs & Tang, 2003). Therefore, any gaps and misalignments in a curriculum should be identified. A means to identify the gaps or misalignment in teaching, learning, and evaluation is to delineate the congruence of their purposes, processes and content. Hounsell and Hounsell (2007) recognized six dimensions of congruence within teaching-learning environments in higher education: (i) congruence of course organization and management, (ii) congruence of teaching-learning activities, (iii) congruence of learning support, (iv) congruence of assessment and feedback, (v) congruence with students' background and aspirations and (vi) congruence of curriculum, aims, scope and structure (Hounsell & Hounsell, 2007). Herein, the restructuring of alignment and congruence of *Drug Delivery* course is discussed in the context of students' background knowledge and assessment and feedback.

The *Drug Delivery* course offered to PhD students at the Department of Pharmacy is a popular course that receive good evaluations year to year. This course is available to all PhD students as well as non-PhD students from industry. Every year, the course also attracts students from universities outside Denmark and their background knowledge and skills vary widely. Although prior knowledge of pharmaceutical sciences is not a requirement for joining this course but a knowledge of basic drug delivery concepts is advantageous to complete the course. The perceived main challenge of this

course was that some students have pre-existing knowledge and skills in drug delivery while others have no prior knowledge and experience in drug delivery. To overcome this challenge, I developed tutorials on relevant concepts in drug delivery and evaluated students' learning of these concepts. In previous course evaluations, some students also asked for better explanation of written assignments and their evaluation. Thus, I introduced peer evaluation and feedback to support student learning. The overall aim of the project was to align congruence with students' background knowledge and assessment and feedback to teaching and learning activities.

Methods

The course

The *Drug Delivery* (PhD courses KU.dk, 2013) is a 4.2 ECTS course run in Block 4 (one week in May) for PhD students who have completed undergraduate courses in pharmaceuticals, chemistry or biology. The course is relevant for PhD students from the Graduate school of Pharmaceutical Sciences (Drug Research Academy) and all other graduate programmes at University of Copenhagen.

The course is an intense one-week course with lectures (25 hrs), group work (6 hrs) and exercises (group presentation) (2.5 hrs) followed by four weeks to write a report on a selected scientific paper discussing various drug delivery concepts learnt during the course. The lectures include theoretical concepts in drug delivery but are primarily based on examples from scientific literature and pharmaceutical industry. Course is usually in-person but was transformed into an online format over Zoom for the past two years (2020-21) due to COVID-19. The assessment of the course is based on the evaluation of the written report assessed with passed/not passed. The students additionally get feedback on their written reports to improve upon if not passed in their first attempt or in general to reflect upon the strength and weaknesses of the report.

The Intended learning outcomes (ILOs) for the course are:

1. To give participants an in-depth overview of important fundamental principles for drug delivery.
2. To present methodologies for optimizing delivery of different drug classes ranging from small molecules to complex biopharmaceuticals (peptides, proteins, nucleic acids and vaccines).

The students

Thirty PhD students participated in the course held online from May 17-21, 2021. The class consisted of PhD students with a very diverse educational background (Figure 1A), counting students from universities in Denmark and outside Denmark. All students were enrolled in a PhD program at university except one participant that was employed in a biotech company in Denmark. The PhD students were involved in diverse research areas including pharmaceutical sciences, pharmacology, biotechnology, immunology, chemistry, biomedical science, neuropharmacology, nanotechnology, material science, and clinical medicine (Figure 1B).

Student-centered exercises

Two interventions were tested during the course this year following discussion with a course co-organizer, who supported the idea of these new exercises.

1. Congruence with students' background knowledge

To align the student background knowledge in Pharmacy/Pharmaceutical Sciences with the ILOs, a list of important 'keywords or key concepts' in drug delivery were provided to the students (Appendix A). These keywords were uploaded in Absalon about 2 weeks before the start of the course. These keywords were available to students to work through in their own time before the start of the course. To verify, if the students have understood the basic terms or concepts in drug delivery, a self-evaluation quiz was prepared and launched on Absalon (Appendix B). This self-evaluation quiz consisted of 20 multiple-choice questions with one or two correct answers. Students' have to complete the self-evaluation quiz before the first day of the course. These keywords or concepts were reiterated during the first day of the course.

Aim: The overall aim of this intervention was to align students' background knowledge w.r.t. the keywords or drug delivery concepts used during the course or introduced by the teachers. Students' should familiarize themselves with these key concepts and evaluate their learning through a quiz. This tutorial could also be used as a reference during the course.

2. Congruence of learning support

To support student learning in the form of access to guidance and feedback, peer evaluation and feedback for the written essay was included in the

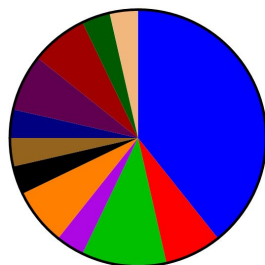
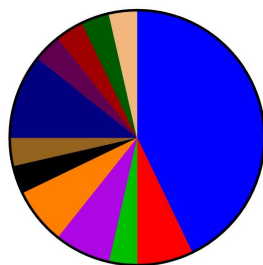
A**Master****B****Research area**

Figure 1. (A) Students' educational background *i.e.* field of their Master education and (B) current research area of their PhD program.

course. This exercise was briefly introduced on day 1 of the course and described in detail during the middle of the course. Following last day of the course, peer feedback (Peergrade) was launched in Absalon and students' were allowed around 2 weeks' time for the evaluation and feedback after the submission deadline for the written essay. Each student had to evaluate one peer essay. Criteria for feedback was also provided to the students (Appendix C), which was used by students and teachers for the feedback

on the written essay. These criteria also served as a guide for students when writing their essay.

Aim: The aim of this intervention was to align students' learning through a better explanation of written assignment and its assessment. Criteria laid for the peer evaluation and feedback could inform students' own writing.

Evaluation of the new format

Evaluation of the new format of student exercises was based on (i) oral evaluation in plenum, (ii) an anonymous questionnaire sent to all participants on Absalon after the final day of the course, and (iii) an anonymous survey (Google Forms) circulated after the end of the peer evaluation and feedback. Questionnaire in Absalon included an overall evaluation of the course as well as focused on the new format of exercises.

Results

All course participants took active part in the plenum evaluation of the course and 29 of the 30 course participants answered the online questionnaire (Absalon) after the course. After the peer feedback, 18 of the 30 course participants answered end of the peer feedback survey on Google Forms. The outcome from the questionnaire and survey is presented below for the two student-centered exercises.

Students find drug delivery keywords and self-evaluation quiz relevant

To align student background knowledge with the ILOs in the *Drug Delivery* course, important drug delivery concepts and keywords were provided before the start of the course, which was followed by a quiz for students to self-evaluate their understanding of keywords.

Twenty-five of the 30 course participants attempted the self-evaluation quiz on Absalon (Figure 2). The average score of course participants in the quiz was 84%.

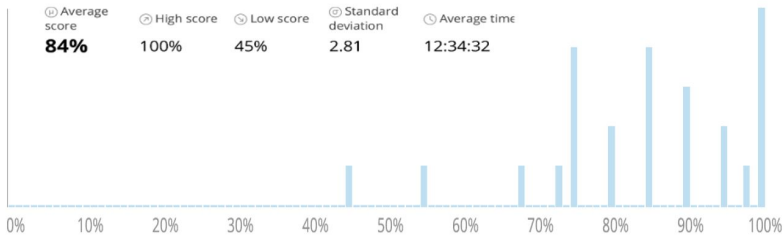


Figure 2. Summary of self-evaluation quiz.

Of the 29 students answering the online questionnaire on Absalon, 93% agree that the drug delivery keywords and the self-evaluation quiz were relevant and this student-centered exercise worked well (Figure 3). Additional information in the form of written feedback from students was also obtained. When analyzing the comments, it becomes apparent that overall, the students’ positively perceive the introduction of keywords and self-evaluation quiz. One student elaborated this by saying ‘*S1: The drug delivery keyword document is awesome! Such a good intro to the course.*’ While another student said ‘*S2: The keywords were generally really good, but there could have been a greater focus on the terminology on the first day.*’ There were no comments in the students’ course evaluation that reflected either non-familiarity with the drug delivery concepts or keywords used during the course or about a better introduction to the drug delivery concepts.

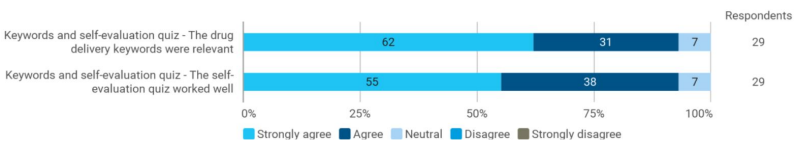


Figure 2. Evaluation of keywords and self-evaluation quiz.

Majority of students find peer feedback to be useful

To support student learning, a peer evaluation and feedback was included and the criteria for peer feedback was also provided to the course participants. Eighteen of the 30 students answered the online survey via Google

Forms (Figure 4). Fifteen students (83.3%) find the peer feedback exercise either extremely useful or very useful while two students (11.2%) find it not that useful. When analyzing the aspects of the peer feedback that the students perceived as working well, positive words such as ‘good’, ‘useful’, ‘helpful’, ‘constructive’ appear frequently (Appendix D). On analyzing the comments in more detail, it becomes apparent that overall, students’ perceptions of this activity were positive with students seeing this exercise aligned with the teaching-learning activities. However, few students did not identify peer evaluation useful but reported it a time consuming exercise.

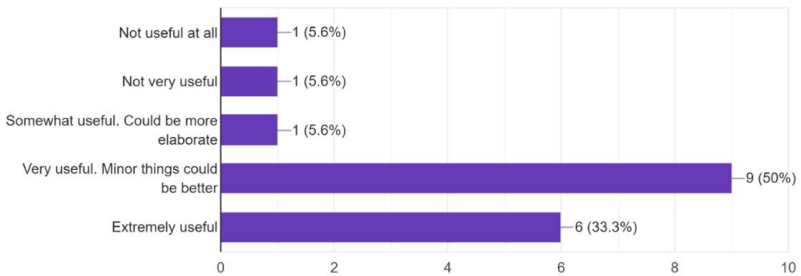


Figure 4. Evaluation of the peer feedback received.

Discussion

Students enter the university with diverse skills and prior knowledge. This diversity causes heterogeneity that poses challenges for university education, as differences in prior knowledge have been shown to significantly influence the quality of learning and student achievement (Dochy, 1996). In order to achieve aligned teaching, there must be a maximum consistency throughout the system (Hounsell & Hounsell, 2007). The current *Drug Delivery* course uses appropriate teaching methods (*e.g.* lectures, group work, and exercises) that overall enable the ILOs to be met. Consequently, the course receives good evaluations year to year (Appendix E). However, the course has some congruence challenges that relate specifically to students’ background knowledge on basic concepts in drug delivery. Given that diversity, the extent of congruence with students’ background knowledge in this course was a dimension, which merited attention. Herein, I attempted to address this issue for a better course alignment and congruence.

Various strategies could be adopted to abridge knowledge gap and engaging with students' diverse needs and interests such as tutorial systems or group-based practical activities, self-test question banks and supplementary teaching-learning resources, as well as an approachable and supportive teaching staff (Hounsell et al., 2006). Herein, I adopted tutorial system and self-test question bank approach. While supplementary teaching-learning resources in the form of review articles covering important keywords used in the course are available to students on Absalon, however, one of the common feedback from students year to year was the non-familiarity and a better introduction to drug delivery concepts. Both tutorials and self-evaluation quiz were launched before the start of the course with the objective to familiarize students with non-pharmaceutical background to the most relevant concepts and keywords in drug delivery. As course organizer, I was aware of the challenges posed by these more diverse student intakes, but was also mindful of the practical constraints on the extent to which the students' needs could be appropriately met during the course duration. Overall, tutorials and self-evaluation quiz worked well and recognized as useful by students.

Peer evaluation and feedback provides a structured learning process for students to critique and provide feedback to each other on their work. It is supported by the conception that students' interaction can lead to enhanced understandings and improved learning experiences (Falchikov & Goldfinch, 2000; Moore & Teather, 2013). It enables students to take an active role in the management of their own learning based on the feedback (Carless et al., 2011). In this project, peer evaluation and feedback worked well as majority of students gave and receive useful feedback from their peers. However, few students did not find this exercise useful but rather time consuming and few others were unable to critically evaluate the written reports. These issues could be due to a lack of clarity regarding the feedback criteria, mid-course description of peer feedback, non-familiarity with feedback process, lack of anonymity, or cultural differences. It is important to provide training activities to teach novice students how to assess their peers' work and provide constructive feedback (Sluijsmans et al., 2002). Similarly, peer evaluation activities should be aligned with core learning goals so that it is clear to students how the activities benefit their learning and are not perceived as an add-on assignment with little value (Moore & Teather, 2013). The student-assisted course design approach (Birgbauer, 2016) as adopted in this project warrants continuous tracking of student

learning and collection of evaluation data on students' competencies and learning outcomes.

Conclusions and future perspectives

The *Drug Delivery* course has some congruence issues most notably the students' background knowledge. Although the course is consistently positively evaluated and recommended by students, the decision to implement new student-centered exercises in the form of tutorials was based on the students' course evaluations from previous years. A new exercise in the form of peer evaluation and feedback was also tested. The ultimate goal is to offer students a coherent, connected and integrated learning experience irrespective of their prior knowledge. The students responded positively to the new format of course and appreciated tutorials in the form of keywords, and peer evaluation and feedback.

While majority of the students reported the peer evaluation and feedback to be useful, a few students did not see any additional benefit of peer feedback or identified it as a time consuming exercise. In the future, therefore, peer feedback exercise could be introduced along with the description of written examination in Absalon before the start of the course. This would ensure that students know what to expect from the overall course assessment. Most of the students gave constructive peer feedback based on the prescribed criteria. However, some students were unable to critically evaluate the written reports of their peers, which could be due to a lack of clarity regarding the feedback criteria, lack of anonymity, or cultural differences. Thus, in future, it could be useful to consider these aspects. Overall, the new format of teaching material and exercises tested in this project was a success and an improvement over the existing format, which offers promise to continually develop this course for a better alignment and congruence.

References

- Biggs, J., & Tang, C. (2003). *Teaching for quality learning at university*. Buckingham. Open University Press/Society for Research into Higher Education.
- Birgbauer, E. (2016). Student assisted course design. *J Undergrad Neurosci Edu*, 15, 3–5.

- Carless, D., Salter, D., Yang, M., & Lam, J. (2011). Developing sustainable feedback practices. *Studies in Higher Education*, 36(4), 395–407.
- Dochy, F. (1996). Assessment of domain-specific and domain-transcending prior knowledge: Entry assessment and the use of profile analysis. In M. Birenbaum & F. Dochy (Eds.), *Alternatives in assessment of achievements, learning processes and prior knowledge* (pp. 227–264). Kluwer Academic/Plenum Publishers. https://doi.org/10.1007/97894-011-0657-3_9
- Falchikov, N., & Goldfinch, J. (2000). Student peer assessment in higher education: A metaanalysis comparing peer and teacher marks. *Review of Educational Research*, 70(3), 287–322.
- Hounsell, D., & Hounsell, J. (2007). 7 teachinglearning environments in contemporary mass higher education. *Bjep monograph series ii*. Student Learning; University Teaching: British Psychological Society.
- Hounsell, D., McCune, V., Hounsell, J., & Litjens, J. (2006). *Biosciences subject overview report*. Universities of Edinburgh, Durham; Coventry. <http://www.tla.ed.ac.uk/etl>
- Moore, C., & Teather, S. (2013). Engaging students in peer review: Feedback as learning. <https://litec.curtin.edu.au/events/conferences/tlf/tlf2013/refereed/moore.html>
- PhD courses KU.dk. (2013). Drug Delivery. <https://phdcourses.ku.dk/DetailKursus.aspx?id=107969&sitepath=SUND>
- Sluijsmans, D., Brand-Gruwel, S., & Merriënboer, J. (2002). Peer assessment training in teacher education: Effects on performance and perceptions. *Assessment & Evaluation in Higher Education*, 27(5), 443–454.

B Self-evaluation quiz

Self-evaluation quiz

© 2016 by All rights reserved. All rights reserved.

Self-eval (2) of 150

Quiz instructions

Question 1

The study of drug absorption, distribution, metabolism, and excretion is an important to know as a pharmacist answer

Pharmacokinetics
 Pharmacodynamics
 Pharmacology
 Pharmacy

Question 2

The pKa value indicates the relative concentration of drug in the (2) correct answer

Mucosa
 Blood stream
 Liver
 Absorb tissue
 Kidney

Question 14

Which one of the following is the correct definition of bioavailability (one correct answer)

Bioavailability is the proportion of drug administered that reaches the systemic circulation.
 Bioavailability is the amount of drug that reaches the systemic circulation after oral administration.
 Bioavailability is the amount of drug that reaches the systemic circulation after intravenous administration.
 Bioavailability is the amount of drug that reaches the systemic circulation after subcutaneous administration.
 Bioavailability is the amount of drug that reaches the systemic circulation after intramuscular administration.

Question 15

Given the elimination curves in the figure below, which one of the following represents a correct oral dosing regimen

Question 3

Which one of the following is NOT a pharmacokinetic parameter (one correct answer)

Weight change following therapy
 Steady-state concentration, C_{ss}
 Clearance, Cl
 Elimination half-life, $t_{1/2}$

Question 4

Which one of the following does NOT come under a pharmacokinetic property of drug (one correct answer)

Clearance
 $t_{1/2}$
 Volume of distribution
 Bioavailability
 C_{ss}

Question 5

The purpose of oral administration of drug is to (one correct answer)

Achieve a desired concentration in the site of action
 Avoid first-pass metabolism
 Avoid hepatic and renal excretion
 Avoid drug degradation

Question 6

Drug that has low oral bioavailability is more likely to be (one correct answer)

High lipophilic
 High ionized
 High protein bound
 High molecular weight
 High water soluble

Question 16

Biological half-life of a drug is (one correct answer)

Half of the amount of drug in the body
 Half of the amount of drug in the plasma
 Half of the amount of drug in the blood
 Half of the amount of drug in the tissue

Question 17

Which one of the following is NOT a correct definition of drug half-life (one correct answer)

Half-life is the time required for the concentration of drug in the plasma to decrease by 50%.
 Half-life is the time required for the concentration of drug in the blood to decrease by 50%.
 Half-life is the time required for the concentration of drug in the tissue to decrease by 50%.
 Half-life is the time required for the concentration of drug in the body to decrease by 50%.

Question 8

Which one of the following drug administration routes does NOT include an absorption phase (one correct answer)

Intravenous
 Intramuscular
 Subcutaneous
 Oral

Question 9

What are the factors of drug binding to α_1 -Globulin in the Rhizomuscularis Distribution System of the liver (one correct answer)

High lipophilicity, high ionization
 High lipophilicity, low ionization
 High lipophilicity, low ionization
 Low lipophilicity, high ionization

Question 10

Which one of the following is not the site of the liver in generally site of first pass effect (one correct answer)

Liver
 Kidney
 Spleen
 Intestine

Question 18

Highly lipophilic molecules are (one correct answer)

Highly protein bound
 Highly water soluble
 Highly ionized
 Highly water soluble

Question 17

Which one of the following is NOT a correct definition of drug half-life (one correct answer)

Half-life is the time required for the concentration of drug in the plasma to decrease by 50%.
 Half-life is the time required for the concentration of drug in the blood to decrease by 50%.
 Half-life is the time required for the concentration of drug in the tissue to decrease by 50%.
 Half-life is the time required for the concentration of drug in the body to decrease by 50%.

Question 11

Which one of the following statements are false (one correct answer)

The first pass effect is the first pass effect.
 The first pass effect is the first pass effect.
 The first pass effect is the first pass effect.

Question 9

Which one of the following is not a correct answer

Intravenous
 Intramuscular
 Subcutaneous
 Oral

Question 10

Which one of the following statements is not correct (one correct answer)

The first pass effect is the first pass effect.
 The first pass effect is the first pass effect.
 The first pass effect is the first pass effect.

Question 18

Highly lipophilic molecules are (one correct answer)

Highly protein bound
 Highly water soluble
 Highly ionized
 Highly water soluble

Question 19

Highly lipophilic molecules are (one correct answer)

Highly protein bound
 Highly water soluble
 Highly ionized
 Highly water soluble

Question 20

Highly lipophilic molecules are (one correct answer)

Highly protein bound
 Highly water soluble
 Highly ionized
 Highly water soluble

Question 11

Which one of the following statements are false (one correct answer)

The first pass effect is the first pass effect.
 The first pass effect is the first pass effect.
 The first pass effect is the first pass effect.

Question 12

Which one of the following is not the site of the liver in generally site of first pass effect (one correct answer)

Liver
 Kidney
 Spleen
 Intestine

Question 13

Highly lipophilic molecules are (one correct answer)

Highly protein bound
 Highly water soluble
 Highly ionized
 Highly water soluble

Question 14

Which one of the following is the correct definition of bioavailability (one correct answer)

Bioavailability is the proportion of drug administered that reaches the systemic circulation.
 Bioavailability is the amount of drug that reaches the systemic circulation after oral administration.
 Bioavailability is the amount of drug that reaches the systemic circulation after intravenous administration.
 Bioavailability is the amount of drug that reaches the systemic circulation after subcutaneous administration.
 Bioavailability is the amount of drug that reaches the systemic circulation after intramuscular administration.

10/15/2016 10:00:00 AM

C

Description of written examination and criteria for peer evaluation and feedback

Description of Exam

The examination is an important and integral part of the course; without it, you cannot pass the course unless specific agreements have been made with the course organizers.

The evaluation is based on a written essay (or term paper) of at most 10 pages, in which you should discuss a relevant research paper that you choose (should address principles relevant to drug delivery) with respect to the various keywords we discussed at the start of the course.

The essay itself should be built up as follows:

- Title page, including your name
- A summary of the paper (max 2 pages)
- A discussion of the drug delivery concepts used in the paper, using the keywords discussed on Day 1 of the course (max 3 pages)
- A discussion of the relevant drug delivery topics discussed at the course, but not in the paper, in relationship to the paper (max 2 pages)
- A conclusion (max 1 page)
- References (max 1 page)

The essay should be uploaded on Absalon no later than Friday June 18th, 2021, at 12.00. We will have the essays evaluated before July 2nd, 2021.

Peer Feedback

Please note that after the submission deadline on June 18th, 2021, you are required to provide peer review for the written essay (or term paper) of one other participant (deadline 30th June, 2021). In order for this to work, it is very important that you deliver the feedback on time.

Criteria for feedback

We will be using the following criteria in the peer-feedback you will give and get from the other participants. You can also use these criteria as a guide when writing the essay:

- 1. Essay follows the prescribed format:** Does the essay includes an overall summary of the paper, discussion of drug delivery concepts, conclusion and references? Is the essay well structured or are there sections you would have liked to have more information about in the essay?
- 2. Essay includes discussion of drug delivery concepts in the research paper:** Does the essay includes drug delivery concepts used in the research paper, using the keywords provided before the course and discussed on Day 1 of the course? Are the used drug delivery concepts in the research paper clear? Are there alternative keywords that could be used? If so, what are they?
- 3. Essay includes discussion of drug delivery concepts discussed at the course but not in the research paper:** Does the essay discuss relevant drug delivery topics discussed at the course, but not in the research paper, in relationship to the research paper? Is it clear what the author thinks were the most relevant drug delivery concepts or keywords missing in the research paper? Does the author take drug delivery concepts from the course or keywords from the Day 1 of the course into consideration? Are there alternative keywords that could be used? If so, what are they?
- 4. Essay includes general reflections:** Does the author use the drug delivery concepts or keywords discussed during the course to highlight general points about the principles relevant to drug delivery in the research paper? Are there aspects of the essay that inform your learning of the drug delivery concepts? If so, what aspects do you find most relevant?

D

Anonymous end of peer evaluation and feedback survey using Google Forms

S1: The feedback came with good examples and suggestions to what could have been elaborated. Very constructive and helpful.

S2: The peer feedback was good to give a general overview on the essay, and I found out what I missed in the essay. Since the concepts are broad, it is not easy to cover everything on the course, but a more detailed feedback is appreciated.

S3: The feedback was constructive and useful.

S4: It is nice to know what other students think about your report.

S5: It was nice to see another essay and get notes on my own. It was good that there was specific points to give feedback on. The feedback I got was very constructive, and good points were given on what I could have done better/included in my essay, which were very nice.

S6: It was both fun and useful to read another student's essay and have another student read your own. Knowing we would receive peer-feedback also made me think more about how I was writing my essay.

S7: As first my experience in peer review, I may comment that being able to analyze a work allows to have a deeper critical thinking in the concepts related to the course. Not only because you get more knowledge, you also understand how you could have complemented your own work, then in science two perspectives are better than one. In the same way, when you receive a feedback, a person with similar or different background may contribute in your analysis and help to find pros and cons. As Ph.D. students this is enriching for our careers. And very importantly, a feedback from the professors may help establish a more constructive opinion and evaluation of the feedback.

S8: The feedback came with good examples and suggestions to what could have been elaborated. Very constructive and helpful.

S9: It was helpful and I was able to see that the reviewer took some time and effort to read the essay.

S10: Feedback giver really read carefully.

S11: Personally, I got nice and fruitful comments with some good points. But since the feedback is very dependent on the individual student, I could imagine variations in quality.

S12: The student-student feedback was very helpful because it was much more thorough. However, I believe the ECTS points should be increased when this extra task (and therefore hours) are added to the course.

S13: The feedback was not very elaborative it was more like only positive comments, without digging into anything specific.

S14: It does not give any extra value to the written essay.

S15: Although I see the benefits of the extra task of evaluation, I think it is a bit much to ask of us, since this course is already quite intensive in regards to workload. Furthermore, I am not sure I feel competent enough to evaluate another person's report.

E Anonymous end of PhD course evaluation 2021

The PhD course in general:

