

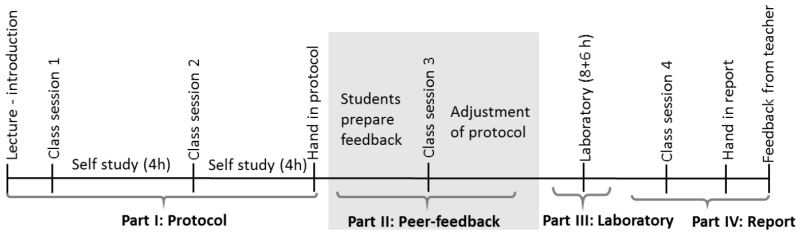
## **Improving the perceived learning outcome of peer-feedback in a second semester basic analytical chemistry course – students’ and teachers’ perspectives**

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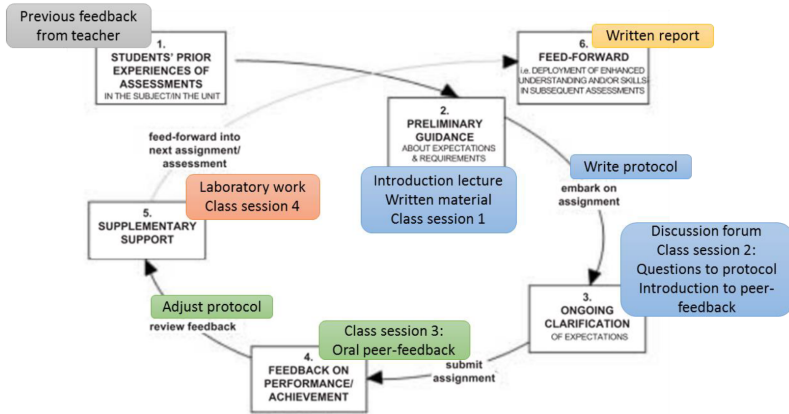
### **Background**

“Evaluation of pharmaceutical substances” is a 7.5 ECTS compulsory second semester bachelor course for pharmacy students with 220 students enrolled each year. In 2020, I was the course leader of this course. The course includes four theoretical modules and a final project. This university pedagogy (UP) project regards development of the final project, where the students work in groups of three and have to plan, execute and report an evaluation of a pharmaceutical substance based on standards in the European Pharmacopoeia (Ph. Eur.). The project contains four parts: Part I: Protocol; the students write a laboratory protocol based on Ph. Eur. including relevant theory and necessary calculations. Part II: Peer-feedback; the students give and receive peer-feedback on the protocol. Part III: Laboratory work; the students execute an evaluation of a pharmaceutical substance using their own protocol. Part IV: Report; the students write a report and receive written feedback from the teacher. Several teaching activities support the students through the project (figure 4.1). I gave the introduction lecture to all students and was responsible for all other teaching activities for one out of eight classes.



**Fig. 4.1.** Teaching activities during the project. Part II, Peer-Feedback is the main focus of this paper (grey box)

Formative feedback is an essential part of the project contributing to creation of an effective learningteaching environment (Hattie & Timperley, 2007). The teaching activities in the project fits very well in the feedback loop presented by Hounsell (Figure 4.2) (Hounsell et al., 2008).



**Fig. 4.2.** The feedback loop by Hounsell (Hounsell 2008) with teaching activities from the project. The colors refer to the different parts of the project, blue (2.-3.): Part I Protocol, green (4.): Part II Peer-feedback, red (5.): Part III Laboratory work, and yellow (6.): Part IV Report.

The project seems to include the needed activities to promote learning. However, in the student evaluation from 2019 (140 answers) 52% perceived the learning outcome of the project as “good” or “very good”. Asked specifically to elements of the project, 61% perceived the learning outcome of writing the protocol as “good” or “very good” while only 15% perceived the learning outcome from the peer-feedback part as “good” or “very good”. The students’ main complaint was that peerfeedback is useless because no one knows “the correct answers”.

The teachers was neither completely satisfied with the peer-feedback, they experienced the oral delivery of peer-feedback as shallow; many groups discussed format rather than content. Furthermore, the majority of protocols needed several corrections in the laboratory, in order to conduct the experiments correct. This indicates that the peer-feedback was not adequate or that the students did not adjust the protocols according to the received feedback.

*The aim of this project was to improve the perceived learning outcome from peer-feedback on a laboratory protocol from the students and teachers’ perspective.*

## **Interventions**

The merits of using peer-feedback in higher education have been acknowledged for some time. Peer-feedback facilitates learning when giving as well as receiving feedback (Hvass & Heger, 2018; Nicol et al., 2014). In this course, the intention of using peer-feedback is to promote deeper learning as the students are obliged to work with the content of the protocol repeatedly; during production of their own protocol, when giving feedback to peers, and again when receiving feedback from peers and adjusting their protocol prior to laboratory work. When providing feedback, the students also learn to evaluate their own work, a competence they will benefit from later on in their studies (Liu & Carless, 2006; Nicol et al., 2014). In addition, being able to produce and receive feedback is a key skill for a pharmacist in their professional career. Despite the numerous theoretical advantages of using peer-feedback, successful implementation is not straightforward. Peer-feedback requires a number of interdependent elements and detailed planning is critical. Müllen suggests nine practical points for successful implementation of peerfeedback in higher education (von Müllen, 2019). Prior to actual giving feedback to peers, it is very important to clarify

the rationale for peer-feedback several times (Panadero et al., 2016). Furthermore, explicit definition of the criteria and objectives for the product is important as well as framing of the peer-feedback and clear instruction on how to give feedback (von Müllen, 2019). During the feedback process, the teacher should test the feedback, ensure the academic level and facilitate self-feedback. Furthermore, it is important that students are motivated to use the received feedback (von Müllen, 2019). Based on these inspirations and the course evaluation from 2019, I planned the following interventions.

### **Preparing the students to give feedback**

I decided, that we already did explain the purpose and relevance of peer-feedback sufficiently (introduction lecture, written material, and class session 2). I prepared a question guide (appendix A) to clarify the criteria for the protocol and to help the students give feedback, it was introduced during class session 2. Furthermore, I added information on what good feedback is, and prepared a short exercise on how to give feedback.

### **Framing of the peer-feedback process**

Previously, the peers exchanged protocols by email or by upload and download at Absalon, making it difficult for the teachers to know if the protocols were exchanged as intended. This year we used Peergrade.io for the peer-feedback process. The students uploaded their protocol in peergrade.io through Absalon and the program automatically distributed the protocols to peers to give written feedback. Detailed instructions on how to use peergrade.io were prepared, uploaded at Absalon and introduced in class session 2.

### **Quality of feedback**

Previously, the students should prepare feedback at home to one peer-group working with the same project and give oral feedback during class session 3, in presence of a teacher. In order to ensure that every group would receive at least some good feedback, I reduced the number of projects and let the students give feedback to and receive feedback from two peer groups working with the same project as themselves. In addition, the responsible teacher for each class distributed the projects among the groups, in order to ensure at least one competent group in each peer-group. To motivate the

students to spend a sufficient amount of time giving feedback, I reallocated four hours scheduled study time from preparation of the protocol and dedicated it to give written feedback in peergrade.io. This also served as an indication on the expected period required for giving feedback.

## Quality of feedback

The entire project was carried out while University of Copenhagen was locked down due to COVID-19 pandemic; this required conversion to online teaching and some adjustments of the planned teaching activities. Part I: "Writing the protocol" was carried out almost as planned. I converted the introduction lecture to a 15 min video presentation and a follow-up quiz at Absalon. We replaced class session 1 with the opportunity to ask questions in discussion fora at Absalon. The teachers answered questions every day during part I. The changes I already prepared for Part II: "Peer-feedback" facilitated an easier conversion to online teaching. The most severe consequence for the project was cancellation of Part III: "Laboratory work". The students were deprived the chance to apply their protocol, to get hands on experience with the analyses and they lost 14 hours of interaction with their teacher and each other. In the laboratory, I believe we have an informal and safe learning environment, where the students ask multiple questions to the protocols and the experiments, and thereby the teachers give extensive oral feedback. To compensate for this loss of both practical work and feedback, I thought it was important that each group also received detailed feedback on the protocol from a teacher. Thus, class session 3 "Discussion of peer-feedback", was cancelled and the teachers provided written feedback based on the peers comments. I was aware that this could undermine the peer-feedback as the students might rely more on the teachers' feedback than the feedback from peers. However, in the given situation written teacher feedback was the easiest to implement on a short notice. Part IV: "Report" was completed with theoretical data and the student received written feedback from the teacher.

## Evaluation

The students' perception of peer-feedback was evaluated as part of a course evaluation questionnaire on Absalon (84 students), and interviews with two

student groups (2+3 students) (interview guide appendix B). The interviewed students were from the class I was responsible for; I choose two groups which I expected to have attended the teaching activities and representing top and medium academic level. The teachers' experiences were evaluated in a course team meeting.

## **Results and discussion**

### **Preparing the students to give feedback**

The question guide for peer-feedback (appendix A) was the main change in introduction of peer-feedback to the students. The intention was twofold: to clarify the criteria for the protocol, and to help the students give relevant and detailed feedback to the protocols.

Unfortunately, none of the interviewed students used the question guide during preparation of the protocol; they did not realize during the writing process, that it would be valuable. I introduced the question guide in class session 2, but not in details. In the next course, I will allocate more time for presentation of the question guide, emphasize that it is available and useful while writing the protocol. The students appreciated the question guide when giving feedback. 87% of the students perceived the question guide as “medium”, “good” or “very good”. One student elaborated that the question guide entailed her group to work more in depth with the feedback, which was one of the purposes of the question guide.

S3: “It (the question guide) was good. I think it would have been difficult to give feedback without it. . . . We wouldn't have commented in that many details without it.” (Translated from Danish)

I realized that the questions in the question guide could be answered with “yes” or “no”, which could limit the usefulness of feedback. However, this was not considered a major problem from the teachers view, as the majority of students replied with detailed answers and suggested concrete improvements to peers. In the future course, I intend to refine the question guide to include more questions that are open-ended.

### **Framing of the peer-feedback process**

210 students participated in the peer-feedback in peergrade.io, and all groups except one, handed in a protocol on time. All groups gave the required feedback before deadline. This indicates that the instructions about

the practicalities of peer-feedback were sufficient. The teachers were positive about the use of peergrade.io. It was timeconsuming to set up peergrade.io for 210 students, but it turned out to work very well for the purpose.

### **Quality of feedback**

From the teachers' perspective, the quality of the feedback did improve as compared to previous years. The teachers had the perception that the students put more effort into giving feedback. This could be due to the dedicated study time to give feedback or that students feel they have to perform better when giving written feedback compared to oral feedback. All interviewed students appreciated the scheduled study time to give feedback, and thought the timeframe was appropriate.

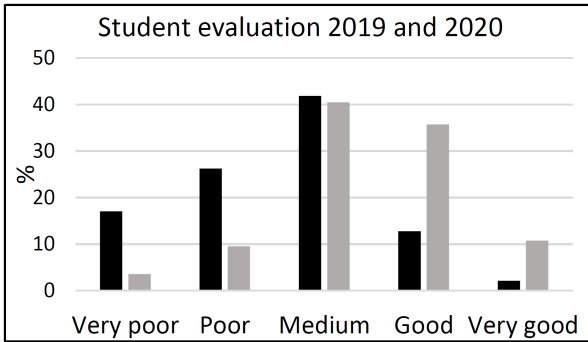
One student mentioned that quality of the feedback was very dependent on the peers.

*S1: "One protocol was very poor; we did not learn much from that. The other was good and we saw a different way to organize the protocol. There were also some differences in their theory, reactions and calculations. In that way we indirectly learned something that we could use in our protocol". (Translated from Danish)*

Thus, it seems important to control the grouping of peers and let students give and receive feedback from more groups in order to ensure feedback of an acceptable quality for all groups.

### **Perceived learning outcome**

The overall aim of this project was to improve the students' perceived learning outcome from Part II: "Peerfeedback". Figure 4.3 shows the results from the student evaluation questionnaire from 2019 and 2020. The perception of the learning outcome improved in 2020 as 47% rated the learning outcome as "good" or "very good" compared to 15% in 2019. This indicates that the interventions did improve the students' perception of the learning outcome from peer-feedback. However, the lower number of student responses in 2020 may have affected the overall picture.



**Fig. 4.3.** Question “Your perceived learning outcome from the peer-feedback process”. Black: 2019 (140 students), grey: 2020 (84 students).

One student explained how the peer-feedback process promoted deeper learning:

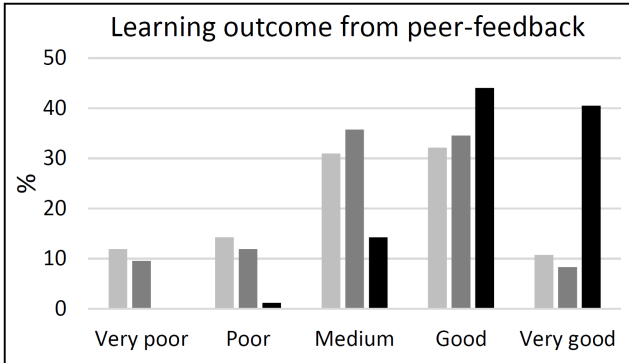
*S4: “I think it was good that we had to work through everything several times. We have discussed the subjects of the protocol both when giving feedback and receiving feedback. I think we learned a lot from that” (Translated from Danish)*

The student also recognized how the peer-feedback process entailed learning beyond the course objectives.

*S4: “We learned a lot as a group. We realized our strength and weaknesses and I am sure we will benefit from that later on.” (Translated from Danish)*

The students’ perceived learning outcome from giving and receiving peer-feedback as well as receiving feedback from the teacher are shown in figure 4.4. 74% of the students perceived the learning outcome of giving feedback (light grey) as “medium”, “good” or “very good” while 79% perceived the learning outcome of receiving feedback from peers (dark grey) as “medium”, “good” or “very good”. 99% of the students perceived the learning outcome from teachers’ feedback as “medium”, “good” or “very good”, 85% of these answered “good” or “very good”.





**Fig. 4.4.** The students perceived learning outcome. Light grey: From giving feedback to peers. Dark grey: From receiving feedback from peers. Black: Receiving feedback from teacher.

The results indicates that most students recognize peer-feedback as a valuable learning activity, but they appreciate the feedback from teachers the most. One student explained:

*S5: "I don't think we would learn as much without the teacher feedback. It verifies the feedback we received from peers and motivates us to implement it in our protocol. If the teacher didn't give feedback it would be easy to give up as you don't know whether you or the peer got it right." (Translated from Danish)*

This comment indicates that the teachers' feedback is important for the students' continuous engagement in the protocol. As we expect the students to adjust their protocol in details after peerfeedback, we may need to give some kind of verification of the peer-feedback. It was very timeconsuming for the teachers to give detailed written feedback, and it will not be possible in the future. I will consider how to balance the teachers' workload and still give the students some additional feedback to the protocol in future courses. One approach could be to use flags in peer-grade.io and give the students the opportunity to mark e.g. 3-5 peer comments. The teacher could either reply directly to each group on the flagged points in peer-grade.io, or draw general issues from the flagged comments and discuss these with the entire class during class session 3.

## Conclusion

The interventions of the peer-feedback activities worked according to the plan under the circumstances of COVID-19 pandemic lockdown. Students as well as teachers appreciated the stricter and clearer framing of peer-feedback in peergrade.io, the allocated study time to give feedback, and the question guide. The students' perception of the learning outcome from peer-feedback was better than previous and the quality of feedback improved according to the teachers. However, the students appreciate the teachers' feedback the most and it may have a motivating effect that I will consider in future development of the course. Based on the evaluation, the interventions were a success and I will refine and apply it further on.

## Perspective

The COVID-19 lockdown severely altered the project as the laboratory work was cancelled. It is not possible to tell how that affected the learning outcome or how the lockdown affected the students' perception of peer-feedback in general. The students may have had more time to bury in the protocol and the peer-feedback. Furthermore, students may have perceived the peerfeedback as an attractive variation of the flow of online teaching entailing some engagement with classmates, which they probably missed after several weeks of isolation at home. The absence of direct contact between student-student and student-teacher must have affected the learning outcome somehow. It will be interesting to see if the perceived learning outcome is different when teaching are back to normal in future courses.

I would like to implement peer-feedback more in the course. Even though the students prefer the teachers' feedback, peer-feedback seems to promote deep learning more efficiently. Furthermore, reduction in the teachers' workload is required in this course. I would like to introduce peer-feedback gradually in the reports for module 1-4. The teacher will support the increasing peer-feedback, i.e. random test of the peer-feedback could form the basis of a teacher driven discussion of the main points of each report in a class session.

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## A Question guide for peer-feedback / Spørgsmålsguide til peer-feedback projektprotokoller

### 1. Identifikationer

- Er der redegjort for de(t) kemiske princip(per)?
- Er alle relevante reaktionsligninger opskrevet? Er de korrekt afstemte?
- Er funktionen af samtlige reagenser beskrevet?
- Er analyseforskriften beskrevet korrekt og med så mange detaljer (koncentrationer, stofmængder, glasudstyr, andet udstyr, antal replikater m.m.), at analysen kan udføres alene ved brug af forskriften?
- Er beregninger for stofmængder korrekte?
- Er der kommenteret på mulige fejlreaktioner?

### 2. Assay

- Er der redegjort for det kemiske princip for titreringen? Er reaktionsligningen korrekt afstemt?
- Er ligevægtskonstanten for titreringen angivet eller beregnet? Er det vurderet om ligevægtskonstantens størrelse er stor nok til en kvantitativ bestemmelse?
- Er funktionen af samtlige reagenser beskrevet (evt. inkl. virkningsmekanisme for indikator)?
- Er det forventede ækvivalensvolumen beregnet? Hvis ækvivalensvolumenet er større end 8-9 mL skal mængden af råvare reduceres, er der beregninger og forklaringer til reduktion af råvaremængden og nyt forventet ækvivalensvolumen?
- Er analyseforskriften beskrevet korrekt inkl. evt. tilpasning af råvaremængde samt totalvolumen, og med så mange detaljer (koncentrationer, mængder, glasudstyr, andet udstyr, antal replikater m.m.), at titreringen kan udføres alene ved brug af forskriften?

### 3. Alternativt Assay

- Er der redegjort for det kemiske princip for titreringen? Er reaktionsligningen korrekt afstemt?
- Er ligevægtskonstanten for titreringen angivet eller beregnet? Er det vurderet om ligevægtskonstantens størrelse er stor nok til en kvantitativ bestemmelse?
- Er funktionen af samtlige reagenser beskrevet (evt. inkl. virkningsmekanisme for indikator)?
- Er det forventede ækvivalensvolumen beregnet? Hvis ækvivalensvolumenet er større end 8-9 mL skal mængden af råvare reduceres, er der beregninger og forklaringer til reduktion af råvaremængden og nyt forventet ækvivalensvolumen?
- Er analyseforskriften beskrevet korrekt inkl. evt. tilpasning af råvaremængde samt totalvolumen, og med så mange detaljer (koncentrationer, mængder, glasudstyr, andet udstyr, antal replikater m.m.), at titreringen kan udføres alene ved brug af forskriften?

### 4. Vandindhold – Karl Fischer og Loss on Drying

- Er det beregnet teoretisk vandindhold, både %w/w(H<sub>2</sub>O) og m(H<sub>2</sub>O) i den mængde af råvaren der er taget i arbejde? Er beregningerne korrekte?
- Er reaktionsligningen for Karl Fischer opskrevet? Korrekt afstemt?
- Er det forventede ækvivalensvolumen for Karl Fischer titrering beregnet?

- Er analyseforskrifterne beskrevet korrekt, og med så mange detaljer (koncentrationer, mængder, glasudstyr, andet udstyr, antal replikater), at analyserne kan udføres alene ved brug af forskrifterne?

#### **5. Sikkerhed / brug af kemikalier**

- Er sikkerhedsforanstaltninger ved arbejde med de enkelte stoffer beskrevet?
- Er håndtering af kemikalie- og reagensrester beskrevet?

#### **6. Generelle kommentarer**

- Er der en forside med projektets titel, navne på studerende og disses underskrift?
- Er der en indledning med beskrivelse af projektets formål?
- Er der i indledningen en opsummering af hvilke analyser, der skal udføres? Angivelse af referencer for alternative test/assay?

## B Interview guide

### Forberedelse/undervisning

1. Har I set videopræsentationen til projektet?
2. Har I læst vejledningen til projektet i kompendiet?
3. Har I lavet introquizen til projektet?
4. Har I brugt diskussionsfora – aktivt/passivt?
5. Deltog I ved klasseseminar 11: ”peer feedback og spørgsmål til protokol?”
6. Følte I jer klædt på til at udarbejde forsøgsprotokollen? Hvad manglede? Var noget overflødig?

### Peer-feedback - læring

1. Hvad er jeres oplevelse af at bruge peer-feedback?
2. Synes I, at I var i stand til at give konstruktiv feedback til jeres medstuderende?
3. Hvad fik I ud af feedback-rubrik spørgsmålene?
4. Hvad fik I ud af at læse de andre studerendes protokoller?
5. Hvad fik I ud af at give feedback til medstuderende?
6. Hvad fik I ud af at få feedback fra medstuderende?
7. Hvad synes I om, at revidere jeres protokoller efter feedback?
8. Hvordan kunne peer-feedback bruges i forbindelse med udarbejdelse af rapporten?
9. Hvilke dele af peer-feedback processen gav højest læringsudbytte?

### Underviser feedback

1. Hvilken betydning havde underviserens feedback? Var den nødvendig?

### Perspektiv

1. Overordnet indtryk - hvordan var peer-feedback nyttigt til indlæring?
2. Kan I forestille jer at man kan bruge det endnu mere på kurset?
3. Kan I forestille jer, at den erfaring I har fået her kan bruges fremadrettet?