

Improving the learning outcome for students in Human Physiology by a problem-based learning approach

Rasmus Kjøbsted

Department of Nutrition, Exercise and Sports
University of Copenhagen

Preface

A problem-based learning (PBL) approach can be defined as teacher-constructed problems presented to a small group of students whose mission it is to discuss, describe and produce tentative explanations for the given problem or case study (Norman & Schmidt, 1992). Although PBL does not seem to improve general problem-solving skills, evidence suggests that PBL enhances retention of knowledge, intrinsic interest in the subject matter as well as self-directed learning skills (Norman & Schmidt, 1992). In this project report I will therefore investigate how PBL is adapted and perceived in classroom teaching of university students studying human physiology for the purpose of accommodating learning and specific intended learning outcomes (ILOs).

Background

“Human Physiology I” is a mandatory course introduced to all students enrolled in the Human Physiology masters programme provided by the Department of Nutrition, Exercise and Sports, University of Copenhagen (course description can be found at kurser.ku.dk). The course includes approximately 60 students primarily derived from the bachelor programme in “Exercise and Sport Sciences” held by the same department. Personally, I

have been responsible for teaching the students how physical activity affects insulin sensitivity during a 3-h lecture in addition to a 30-min session with follow-up questions. The course has been running for >20 years and is made up of classical lectures (~3/4 of the time), a few practical exercises, teacher-led discussions (~1/4 of the time) and three written assignments.

Prior to the start of the course this academic year (2021/2022), I examined the course evaluation from the past two years (2019/2020 and 2020/2021) in order to uncover possible educational elements that needed to be prioritized to further accommodate learning. Interestingly, I discovered that 30-40% of the students found the academic level of the course too high in relation to their own proficiencies (**Figure 1**). This may pose a challenge for some students in regards to achieving the ILOs of the course, which is an important issue to meet as the students must apply these ILOs later on in their education to critically and analytically address general issues in physiology particularly in relation to physical activity.

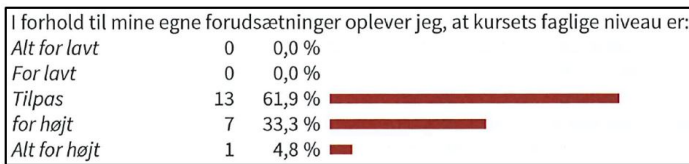


Figure 1. Extract of the course evaluation in ‘Human Physiology I’ from the academic year 2020/2021.

The course evaluations also indicated that the students found it difficult to keep up and concentrate when the lectures took place for several consecutive hours. One student mentioned: “*It was much easier to concentrate during shorter screencasts than the 3-hour long Zoom lectures*”. Another student wrote: “...it can be tough to follow a lecture for 2-3 hours online” and a third student argued “...that the distribution of lectures and group work ought to be altered”. These comments should not come to a surprise as it has been documented that students are (to a large extent) only able to concentrate for up to 20 minutes at a time (Rienecker et al., 2013, p. 182). It is therefore important to introduce breaks and variation during teaching activities as this has been shown to make the students cognitively active and sharpen their attention for the purpose of accommodating the ILOs (Rienecker et al., 2013, p. 183). From this it can be deduced that

a series of "classic" lectures over a period of consecutive hours are not preferable for student learning. In contrast and as mentioned above, PBL seems to promote student learning as it is typically characterized by increased involvement of the students who need to perform a number of various cognitive processes including identification, definition, and formulation of the problem-based work (Rienecker et al., 2013, p. 215-217). Based on the student course evaluations, the theory behind PBL and the principle of 'constructive alignment' between teaching and test forms described in the course description, I have chosen to reconstruct a 3-h lecture series so it accommodates student learning and lecture ILOs to a greater extent (Appendix A).

Purpose

The overall purpose of this educational experiment is to provide the students with the ability to gain new knowledge and skills on a highly specific physiological matter using PBL with the intention of accommodating the intended learning outcomes.

Problem-based teaching in Human Physiology I

The educational experiment was sought implemented by a six-step teaching practice that took place in the period before as well as during the actual reconstructed 3-h lecture (3x 45 min). The following describes the six steps in chronological order:

1. The students are introduced to the lecture via a ~15 min webcast, which they have to watch before the day of lecture. The webcast is uploaded to Absalon two days prior to the lecture.
2. During the first hour on the day of lecture, the students are re-introduced to the ILOs by the teacher followed by a short recap of the webcast with Q&A. In the end of the first hour, students are introduced to the problem-based work.
3. Following a 10-15 min break, the students are placed in groups for a period of 30-40 min to discuss and prepare presentations based on the problem-based work (hand outs/downloads). A minimum of 2 individual groups is working on the same problem. During this step the teacher visits all groups to facilitate the problem-based work.

4. All groups are gathered in plenary to present solutions to the problem-based work. One group presents a solution to a problem while another group, which has been working with the same problem, provides critic/feedback to the presenting group. A break of 10-15 min are provided to the students during the ~1-hour session.
5. The teacher makes a joint summary when all solutions to the problem-based work have been presented (10-15 min)
6. During the last 10 min of the lecture, the students are asked to evaluate the today's teaching via an online questionnaire (menti.com).

Reflections on teaching and evaluation

Problem-based work is often performed in groups due to learning-related reasons. Thus, group work provides students with the ability to give and receive feedback as well as get further and deeper into the problem-based work (Rienecker et al., 2013, p. 218). However, problem-based group work may also be time consuming due to the great number of cognitive processes the students need time to fulfill. One way to secure enough time for problem-based work during teaching is by taking advantage of concepts from the ‘flipped classroom’. Here, the students are placed in the center of learning with the teacher as a facilitator that (typically) takes place on the basis of a prior watched video presentation/webcast (Schunk, 2016). In my teaching, I wanted to combine the “flipped classroom” concept with problem-based work for a number of reasons. Initially to reduce time spent doing “classical” lecturing but also because students find webcasts rewarding and helpful when they study. In the course evaluation from the past two years one student mentioned: “. . . *I think the webcast videos have been really rewarding*” Another student wrote: “. . . *webcasts as means to prepare for classes and lectures that are recorded and uploaded have been very helpful*”. Secondly, to introduce the ILOs at two different occasions (webcast and lecture) and thirdly, to provide the students with the possibility to give and get feedback on presentations - a key element in problem-based work (Rienecker et al., 2013, p. 217-218). The latter I also prioritized in order to increase the “constructive alignment” between the teaching activities and the test form as described in the course description.

In regards to documentation and evaluation of my teaching, I sought to reflect on my own teaching in real time while noting any topics I wanted to discuss with my respective UP supervisors. In addition, my academic

supervisor was present during most of my 3-h lecture, which allowed us to evaluate my teaching in the following days. I also recorded my lecture (video), which provided my pedagogical supervisor the opportunity to offer constructive feedback on my performance as a teacher. As previously mentioned, I also wanted to evaluate my teaching at the end of the 3-h lecture using an online quantitative and qualitative questionnaire that the students had to complete before leaving the class. Lastly, I briefly asked the students in plenum what they had found positive and negative about the 3-h lecture and my teaching. Altogether, these initiatives were meant to provide me with the best possible evaluation of my teaching.

Results and discussion of teaching outcomes

Online questionnaire

A prerequisite for my lecture to become successful was that the students had spent preparation time on watching the webcast prior to attending my lecture. Since the webcast lasted ~15 min, my hope was that all students had used >15 min in their preparation for my lecture. Based on the online questionnaire, I observed that ~75% of the students had used >15 min and thus, likely watched and used the webcast to prepare for my lecture (**Figure 2**).

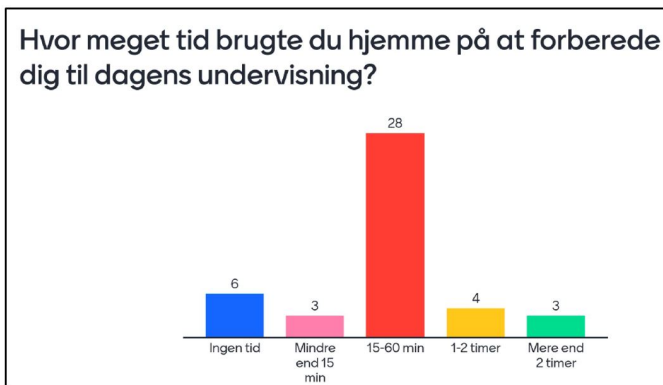


Figure 2. How much time did you spend preparing for today's lecture? (derived from the online questionnaire)

Looking at how the students actually experienced the webcast, it seemed clear that the webcast provided the students a relevant introduction to the lecture, overview of the ILOs as well as an assurance of what was going to happen on the day of lecture (**Figure 3**). Webcasts may therefore be used to accommodate learning by providing a possibility to shift the attention from the two lower taxonomic levels (i.e. remember and understand) to the upper more demanding taxonomic levels during the actual lecture (Schunk, 2016). Interestingly, most students seem to prefer webcasts prior to all lectures (**Figure 3**), which may indicate that webcasts impart the students with a greater and better understanding of the taught subject that in the end stimulates the students. General use of webcast may therefore constitute an excellent tool to improve student learning. On the other hand, webcasts do not allow the students to ask questions and test their understanding of the subject nor provide an opportunity to disseminate the information (Mathiasen, 2019). For this reason, I deliberately included time in my lecture (step 2) during which the students could ask questions about the webcast.

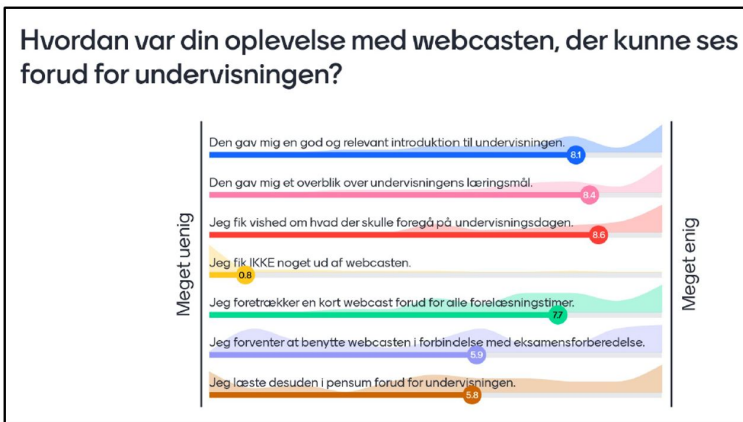


Figure 3. How did you experience the webcast prior to the lecture? Agree or disagree answer (derived from the online questionnaire)

Following the webcast evaluation, the students were asked to evaluate the 3-h reconstructed lecture. Importantly and to a large extent anticipated, the problem-based group work had been important for the students to fully

understand the content of the lecture (**Figure 4**). This may in part be related to my efforts in trying to align the content of the webcast (step 1) and introduction lecture (step 2) to the group work (step 3) (cf. **Figure 4**). In addition, the students seemed to have understood the ILOs of my teaching, which may increase student motivation to commit themselves to learn the intended (Andersen, 2010). However, it is important to bear in mind that highly detailed ILOs yields less freedom for personal approaches and innovation and thus less room for teachers' and students' own reflections and solutions to problems. In the end, this may compromise teaching if the purpose of the university pedagogical effort is to help create reflection and awareness of the complexity that any teaching situation consists of (Andersen, 2010).

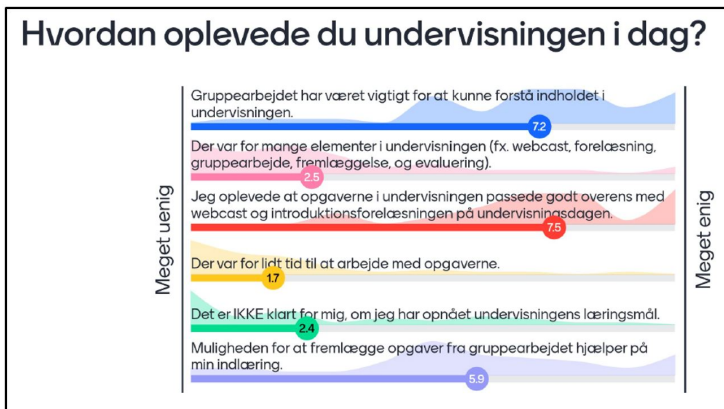


Figure 4. How did you experience the today's lecture? Agree or disagree answer (derived from the online questionnaire)

It was important for me to include breaks and variation in my teaching (see step 1-6) due to the documented drop in concentration observed in students shortly into lecturing (Rienecker et al., 2013, p. 182). On the other hand, I also feared that implementing a high degree of variation in my teaching could distract the students and thus, compromise learning. Yet, most students seem to endorse implementation of several teaching elements during a lecture (**Figure 4**), which I interpret as if the students found my teaching both motivating and rewarding. Extracts from the online qualita-

tive questionnaire (Appendix B) seem to support my belief. One student wrote: “*Nice varied teaching – good with a break from lecturing.*” A second student wrote: “*I think the teaching was enlightening and a great variation from the classical lectures*”. On the other hand, a third student wrote: “*I would have preferred more actual lecturing. . .*”. To me this clearly shows that every student is different and prefers his/her own way of being taught. This also implies that one must remember that it is likely impossible to implement university teaching that embraces individual needs of all students at the same time – which may actually not be a desired didactic goal in itself either.

Reflections with academic supervisor

A topic discussed between my academic supervisor and me relates to the use of (problem-based) group work in my teaching. We agreed on that group work holds significant opportunities for student learning. Thus, not only are students able to improve learning via group discussions but students also learn more by explaining themselves to others while misunderstandings are straightened out more often (Rienecker et al., 2013, p. 192). Group work also makes it possible to conduct differentiated teaching. Accordingly, I spent more time guiding “weaker” students while the “stronger” students were offered extra tasks that were meant to test them at higher taxonomic levels. This way it seemed that no one got bored during the problem-based group work.

Another topic we discussed was the principle behind ‘constructive alignment’ in relation to my idea of adding in student presentations during my lecture. In my case, the students had to present and conclude on original scientific data in front of an audience, which constitutes a large part of the work performed in academic research environments as well as in the life science industry. From my observations during the lecture, I believe the students found these presentations challenging but also rewarding. In the online questionnaire one student wrote: “*Great having oral presentations – it provides a good learning opportunity having to communicate orally - just as it will also take place during the examination in Human Physiology.*” Therefore, in teaching I strongly advocate for a closer association between the Teaching Learning Activities (TLAs) and the test forms as such didactic strategy is meant to promote the development of educational skills that students are expected to apply and use after they graduate (Biggs & Tang, 2007).

A perspective conclusion

From my own perspective as well as the student evaluation, I believe that this educational experimental has been successful in promoting student learning by taking advantage of a problem-based learning approach in a group work setting. However, there are still matters to consider. One relates to the fact that only one or two students in each working group were responsible for presenting the group's findings. As a teacher, one must therefore ensure that everyone in a working group is offered the opportunity to present during the whole course, so that it is not only the academically strong or loud and eloquent students who stand as "winners" in the end. A second matter relates to overall student motivation, which in my opinion is one of the most significant driving forces that have a positive impact on learning outcomes. Through fruitful discussions with my academic supervisor, I realized that as a teacher one could stimulate student curiosity and motivation simply by linking the ILOs to relevant everyday events. This is indeed one highly valuable concept that I will strive to implement in my future teaching.

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Læringsmålene

- Have kendskab til de specifikke definitioner der gør sig gældende i forbindelse med diagnosticering af type 2 diabetes mellitus (T2DM)
- Identificere forskellige behandlingsstrategier for T2DM baseret på de organ-specifikke defekter der fremtræder i sygdommen.
- Reflektere over og præsentere mulige molekulære mekanismer i muskulaturen, der kan forklare hvorledes fysisk aktivitet forbedrer sukkerstofsiftet i blandt andet patienter med T2DM.

B

Har du ét forslag til forbedring af undervisningen?



Fedt med mundtlige fremlæggelser - det giver god indlæring selv at skulle formidle mundtlig - ligesom det også vil foregå til eksamen af Humanfysiologi 1.

Tak for god undervisning

ndæ

ikke

Fin varierende undervisning - godt afbræk fra forelæsning

Ingen bemærkninger. Rigtig god undervisning

Strukturen i dag var virkelig god!!!

Jeg kunne godt have tænkt mig mere reel forelæsning/gennemgang af mekanismer

Bare vær mere lige på, du behøver ikke spørge om vi har spørgsmå. Dem skal vi nok stille, ellers godt gået

Læng din webcast direkte på kursus hjemmeside, istedet for inde i filer. Bk mig

God undervisning

Beskeder i announcements er rigtig lette at overse, så jeg tror mange ikke så den, fordi de ikke vidste den var der

Nøj, det var fedt

Der gik lidt meget tid med presentation af læringsmål/agenda. Det er rart med en introduktion, men hold den kort, og så lad os gå direkte på det svære stof. Jeg tror bachelordstuderende vil have større glæde af agenda/intro, men på kand. vil vi igang.

Niksen biksen Karen Blixen

Jeg synes det kunne være fedt lige at opsummere læringsmålene sammen til sidst, så man kunne sikre sig at man havde forstået dem rigtigt og fået det rigtige ud af undervisningen

Lidt længere intro/forelæsning før gruppearbejde. Ellers en god undervisning

Mere intro til figurer mm før gruppearbejde

Tag lidt mere styring på dannelse af grupper/gruppeinddeling. Ellers super godt

Ville være godt med lidt mere powerpoint tekst, så det er lidt lettere at huske efter timen.

Jeg synes undervisningen var lærerig og en god afveksling fra de klassiske forelæsninger.