Promoting deep learning in a constructively aligned system approach in a course in biomedical nutrition physiology

Tanja Kögel, Institute of biomedicine, University of Bergen and Institute of Marine Research, Bergen, Norway

Report for UPED basic ("kull 51")

Abstract

The discussed consists of several modules, teaching students the basic principles of biomedical nutrition physiology. This is achieved by a combination of background knowledge lecturing, critical reading of relevant scientific articles, the crafting of a hypothesis in a specialization topic and the analysis, presentation and discussion thereof. The course's design is leading the students to active learning in most modules. This year, I applied additional small changes, in order to further nurture deep learning. In this report, I describe the prevailing and added pedagogic tools applied and explain the underpinning theory, followed by a discussion based on my personal experience and the feedback provided by the students. The course's constructively aligned system seems very well suited to instill an overview over the field and to engage students to find their own area of interest in this increasingly complex research field, with reasonable teaching effort within four weeks total student working time. Furthermore, the course is expanding the expertise of both student and teacher, by inviting to creativity: to lay new paths, rooted in the firm soil of established knowledge.

Course introduction

Originally, Trond Brattelid designed and led the course "BMED 381" in biomedical nutrition physiology (5 ECTS) at the University of Bergen (UiB), Norway, starting in 2014. He provided me with a full description of the course, some of its pedagogic background principles and further tips on challenging and well-functioning aspects. With the preparation for the course in 2017, I took over and developed the course further. BMED 381 is a course available annually for students who have obtained skills in biology, biochemistry, molecular biology, cell biology, nutrition physiology - or equivalent - on bachelor level, preferably completed with a degree. The course's administration falls under the Institute of biomedicine. The aim of the course is to train the students to evaluate the effects of food and food supplements at a cell biological and physiological level in a broader scientific context relating to health and disease.

The course provides to the students a research-based introduction into biomedical subjects (biochemistry, molecular biology, cell biology, physiology) in connection with human nutrition physiology. Focusing on areas like metabolism, signaling pathways and gene regulation, basic mechanisms that involve and are affected by the diet composition, are explored. Students learn about the background of lifestyle diseases, genetic diseases, and the effects of undesired substances, such as toxicants, from the diet. The course aims at developing skills necessary for independent, critical research interpretation within this field, i.e. reading, interpreting and discussing scientific articles, writing and presentation.

Structure

2018

Eight students were registered for the final exam in *Biomedical Nutrition Physiology* this spring semester in 2018; one visiting student through an international agreement with The Faculty of Medicine, two Master students in Biomedical Sciences, two Master students in Clinical Nutrition, two Master students in Human Nutrition, and one visiting student at The Faculty of Medicine.

Modular structure

The course is build up as several modules. The modules are not arranged in a strictly consecutive form, but wisely intertwined, as described below.

Modules:

1. **Skill building lectures**, held by the course leader
    a. **Introduction and course structure**
    b. **Research ethics**
    c. **Basic statistics**
    d. **Reading of scientific articles** – article structure and content of the parts
    e. **Writing of review articles** (preparation for writing the course essay in the style of a mini-review article)
    f. **Crafting of poster presentations**
    g. Elevator pitch and **presenting posters**, exam preparation and questions
2. **Topic-lectures** are provided by active scientists as guest-lecturers and the course leader, who are introducing and providing an overview over the status quo in their field of nutrition research with the following topics:
    a. Dietary **fat/lipids** and their role in inflammation
    b. **Proteins** in the diet; implications for metabolic health
    c. **Carbohydrates/sugar** - their role in metabolism and obesity
    d. **Vitamins** and their role in development and inheritable epigenetics
    e. **Essential elements**, iodine and cognitive development in children
    f. **Undesired substances** in food, interactions with the hormone system
    g. Cell nutrition and **mitochondrial function**
    h. **Over-nutrition and cancer**
    i. **Microbiome** and nutrition
3. Short **oral article presentations** by student groups: As part of the course literature list, each lecturer of the topic-lectures provides one article from the research field of the lecture. Two tasks are based on those articles.
    a. During the course, three groups of students prepare each three 10 min oral presentations of the articles. They organize colloquia for this purpose. The students hold the presentations right after the respective matching topic lecture. Students rotate presenting, all students present equal shares during the course.
    b. All students read all of the nine articles and are asked to prepare three questions to the presenter(s) for each article/presentation. That usually enables the students to ask at least one question per student presentation that is different from the other student's questions and still makes sense to ask after the presentation.
4. All students need to find a supervisor for writing an essay in review style. Preferably, the supervisor is the future master supervisor or working in the same research group. Alternatively, one of the courses lecturers, or any other scientist from the topic's field with some experience in review article writing can assume this role. Together with the supervisor, the student pinpoints a topic for a review style essay, finds literature for that and phrases a testable hypothesis for the essay.
5. All students write an essay in review style, based on 10 (±2) scientific articles of 5 (±1) page. The course leader provides written feedback and is available for further questions.

It is mandatory for the student to improve the article based on these comments. Upon a deadline, the student hands in the article the censurer, who judges whether the article is sufficient for the student to be submitted to the exam, taking into account the implementations of the improvements suggested by the course leader.

6. Students prepare a poster presentation based on the essay in power point.
7. The exam is a 5 min presentation of the poster, and a 10 – 20 minute discussion thereof, with the course leader, the censurer and the peers. The censurer, in consensus with the course leader, judges the presentation passed, corresponding to grades A – C, or not passed.

Figure 1 Modules of the course

Figure 1: *Illustration depicts the modules of the course BMED 381. Students are required to complete several tasks with sufficient quality (green box) to be admitted to the exam (orange box).*

The modules are organized in the following order: The skill building lectures introduction, ethics, reading scientific articles and statistics start the course. The course continues with blocks of topic lectures, followed by student's article presentations and discussions guided by the respective lecturers. In preparation for these blocks of topic lectures, student groups meet in student driven colloquia, where they organize and prepare the student's presentations. The skill building lectures about writing review articles and crafting poster presentations take place in between the subject lectures and seminars, in a compromise to be closer in time to the practical tasks they are about, but still allowing adjustments for the students to fit the work into their individual schedules. The students start writing their essays in parallel to the later subject lectures, and consecutively prepare their poster presentation.

New implementations

In 2018, I implemented the following new activities.

1) I asked all lecturers to prepare a few multiple choice questions. The same set of **multiple choice questions** should be asked **before and after** several of the lectures, in order to increase the attention to critical details. The lecturers received a short written instruction for how to prepare and as those questions using the web application "mentimeter". By the help of a short code, students can log in and complete the questionnaire on their computers or mobile devices. Answer statistics are provided by the app and can be used as a tool for discussion. Finally, I asked the teachers to provide these questions to me, so I could compile them and give them to the students after the course. With that, I get a tool to trigger the students once more to check if they remembered these critical details from the course by completing the quizzes, and to reinforce their learning.

2 and 3) I combined two techniques in one lecture: One is called "**flipped classroom**". For this technique, students prepare a part of the teaching material at home, which is then discussed in class. That way, less in class time needs to be afforded, and students can prepare at their own speed. However, the intensified discussion and unpredictability of its turns, requires the teachers to be

experts in the taught field, but that is beneficial in any case. Flipped classroom is applied in this course when the students prepare their lecture-connected short oral article presentations. The other technique is called the **"expert groups"** in "Introduction to the high/scope approach" of the Educational Research Foundation, chapter "Cooperative Learning Structures". The principle is that several groups work themselves towards the understanding of one or several connected subsets of challenges. The groups prepare a presentation of their subset, which can be in the form of bullet points or sketches on a blackboard or flip board, or an oral presentation. In the following, the whole group listens to the presentations of the fresh "expert groups" and can ask questions. I applied both techniques to the statistics lesson. In addition to providing background knowledge in a short lecture, I asked the students to prepare by reading a scientific article about fruit intake, containing the application of several common basic statistical tools in the nutrition field. Then I prepared three sets of questions that could only be answered upon profound understanding of the statistical terms:

Team violet: Basic understanding

- What was «n» in the article, what does that mean?
- What is the «mean»? How likely is it that two populations are different when the sample mean is different by two standard deviations?
- The significant year*parental educational level interaction was p = 0,01. What does "significant" mean? How likely is it that this interaction is true?
- What has mainly been compared? Why is it of interest to compare 2001 and 2008? (Norwegian government initiative).
- Have a look at table 2. How likely are the four sample differences to represent the population?

Team red: Central expressions

- Besides the main comparison, what other determinants/variables have been observed? What is a determinant/outcome variable?
- What is a mediator? Use the example in the article or/and different examples to illustrate.
- (All causal relationships are predictive. Not all predictive relationships are causal.
- - Which mediators of fruit intake did the article depict? How would the differences in fruit intake of high- and low-SES groups be changed without the mediators?
- What is a bias? Which biases are discussed on page 7? Can you think of more?
- If a difference is statistically significant, does that mean the difference is important? (Refer to large n analyses – what happens with statistical significance if n is large?)

Team Green: Mostly statistic tests

- What is continuous data, what is categorical data?
- What is a normal distribution?
- When should a t-test be used to show the difference between means, when ANOVA? And why – explain the likelihood of Type 1 errors (what is a type 1 error)
- When should you use a parametric test (ANOVA) or a non-parametric test (Kruskal-Wallis)? Use expressions normal distribution, homogeneous variance, independent observation.

- If a dataset is not normally distributed, but you want to use a parametric test – What can you try?
- When you have discovered that some means are different – what can you do to find out which ones? (post-hoc)

Three teams of students discussed and tried to come up with solutions and explanations during the lesson. They could call on me to ask questions or get explanations during that phase. In the end of the lecture, each group presented to the other two groups, and tried to explain their questions, answers and what they found challenging or what was transforming their understanding.

4) I suggested optional **peer-review** of the essays with their fellow students. Interested students could swap their work with a peer, and take on the role of the reviewer, provide feedback and receive feedback. This change of roles and thereby perspective would increase the learning outcome.

Student evaluation

All students were asked to provide their feedback in a short survey at the courses website. Some of these questions were multiple choice questions, while others opened up for the students to give their own opinion as written text. The survey was opened 15 May until 27 May, while the oral exam took place 30 May. I could not access the results before after the exam, in order avoid preventing negative criticism for fear of consequences. I repeatedly informed about the survey during lectures and twice by email. 5 of 8 students (63%) gave their responses in 2018, representing three different study programs as well as one student not telling which group he/she belongs to. All of them found the academic contents to be appropriate and the general organization/structure of the course as OK (3:5) and well organized (2:5). The educational level of the teaching was ranked bad (1:5), average (2:5) and high (2:5). The total workload was ranked appropriate (3:5) and too much (2:5). Written comments were only provided by two students, who, amongst other, more practical comments, indicated that their interest for nutrition science has increased during the course.

Discussion of the course set up by pedagogic research principles

The roots of the theory - student focused as opposed to teacher focused

Most of the theory behind this report is well reviewed and put into context in Norwegian in the book “Når læring er det viktigste” (When teaching is the most important; Strømsø, Helge I. et al.). The roots of the theory behind this course set up are based on **cognitive constructivism,** whose founder is Jean Piaget (1896-1980). The theory construct has since gone through decades of development by many groups. Piaget described cognitive development to be dependent on four factors, biological maturation, experience with the physical environment, experience with social environment and a drive towards optimal balance between the individual’s cognitive knowledge construction and the environment (Schunk 2008). Through own exploration, students get the best basis to organize and reorganize their mental construction and scheme. Such skills, but also the general knowledge to build and apply those skills, are best achieved by **active implementation** of these skills. In this course, we have therefore kept the part of learning by classic front–lectures to a minimum – 20 of 125 - 150 hours. Even in those lectures, lecturers were encouraged to use flipped classroom measures, such as providing the students with texts to read and to let the students explain what they learned to their fellow students.

The entire course is set up with a **student-focused strategy**, in order to guide the students out of a passive role and into active participation. By letting go of the teacher focused approach, where teachers need to shine with a perfect talk, and instead giving way to the student focused approach,

where the focus is on what the student learns, we probably achieve deeper learning. That way, the lecturer can focus on following up the student's understanding of the material. This task requires less course-specific preparation but requires more flexibility by the teacher in the lessons. Together with the teaching skills of lecturers – e.g. structured presentations with clear voice and clear visual aids - this course aims at a systemic approach, where teacher's skills, student's ability and diligence are put to synergy by guiding the students into an active working approach optimize the learning outcome (Biggs 1999).

Empowerment through skill building

In other words, we aim to not merely improve the transmission of expert knowledge to the less-expert students, but to exceed this goal, by encouraging the students to grow past the expertise of their teachers in one area. In order to arrive at that goal, students are required to research literature of the ongoing field actively. This should result in learning and cognitive development, according to Vejleskov 2010. The students are not left unguided with this task, as all modules aim at **enabling the students** to continue their research independently, i.e. profess in their field, with increasing level throughout the course: Foundational knowledge is presented in the form of lectures and articles to provide the basic understanding for a broad field of learning (Fink 2013). The presentation of the accompanying articles by students necessitates engagement into cognition. Hopefully ignited interest for specific aspects, is then not left at that, but further enhanced by the requirement for each student to form a hypothesis and test it by assessing published studies, in the form of the essay. For that, students need to define a focus of interest themselves, using the top down information of the course lectures only as a basis for the broader knowledge necessary to anchor a specialty and as a starting point for skill development (Biggs 1999). That process is paralleled by the provision of skill building lectures providing the necessary tools for these tasks. The skill-building modules in this course empower the students to study and perpetuate science on their own, to interpret scientific knowledge in the field of nutrition correctly, precisely and critically, and to present it understandably. Thereby, students can achieve and produce knowledge by constructing their own view of the field.

The students apply the practical skills of scientific writing and presentation, right after the lecturing of these topics. Both skill building lectures and the application of the skills, help the students to gain understanding of that subject's underlying conceptual structure (Fink 2013). The skill-building lectures include a lot of dialogue and questions to and from the students. Ditto, the exam includes an open dialogue between student presenter and censurers, to which all students attend. By the constant dialogue, the principle of the student focused approach is applied as it is again ensured that the awareness is not only on what the teacher is teaching, but rather on what the students are learning (Marton and Booth 1997).

Such a system is somewhat opposed to the traditional approach, where the objectives nominate professional competence on graduation, but declarative knowledge is the output of the teaching, leaving the student not prepared for **professing**, if the student does not develop the techniques by their own volition. Professional practice, as taught in this course, provides knowledge of techniques as tools that the students put into practice immediately (Biggs 1999). Thereby, the students are not only filled with knowledge, but also enabled to expand their knowledge by themselves. This is increasingly crucial, as in our times, knowledge is expanding swiftly and has arrived at an amount of knowledge in many disciplines that has rendered it is impossible to cover all niches in general topic courses. We solve that problem by enabling students, assisting them to find their niches of interest. It can be likened unto building a matrix, where students and professionals act as increasingly interconnected and expanding networks of knowledge with their nuclei of specialization.

Constructively aligned system – A learning portfolio-inspired formative assessment to enforce deep learning

The modular structure of the course, where one building brick fits with another to support higher cognition is streamlined in a way, that even the exam is part of that process. Together, that forms a **constructively aligned system** according to Biggs (1999). It aims at organizing the learning context so that all students are **chaperoned to use higher order learning processes**. All the components in the system address the same agenda and support each other. This course setup has also been inspired by the "learning portfolio" exam, a similar principle recommended to academic teachers by the University of Bergen in a one-day event seminar. Much of the principles introduced in that seminar were based on the book "Eksamens-revolusjonen" (Exam revolution) by Arild Raaheim, 2016, who also was a speaker at the teacher seminar. As far as deemed possible for a course of four weeks total student working time, the principles thereof were implemented. Specifically, three steps provide a scaffold around which this course is build: 1) Stating the desired outcomes in the course description and introductory lecture. In doing so, we specify our objectives. 2) The essay and the poster presentation are **formative assessment** tasks that are criterion-referenced to our objectives. 3) All student activities in all modules encourage students to engage in learning activities that are likely to lead to an achievement of our objectives (Biggs 1999).

The objectives of implementing introduced skills and learning goals into consecutive presentation, explanation or discussion throughout the entire course, forces the students into expressing their understanding – a powerful learning activity. The assessment, which is split into several tasks, tells us how well the objectives have been met. Such assessment tasks include a) the student's oral presentations of the articles supplementing the lectures, b) the discussions thereof, c) the flipped classroom presentations within the lectures, e) the review-essay f) the improved review-essay and g) the final exam, the poster presentation. Learning takes place, when students feel free to focus on the task, without too high stress levels. Therefore, students have the possibility to start on their tasks earlier than strictly necessary, but are made aware of when the latest recommendable starting time approaches. I also present them with my estimation of hours of workload the assigned tasks usually take. Furthermore, the assessment increases in severity in line with increasing skills of the student, allowing for experiencing mastery before grading. The first assessment aspect, a mild one, is a mandatory attendance rate of 75%. This is followed by mandatory presentations and discussions. The essay then, needs to be good enough to be admitted to the exam, but has one round of feedback and mandatory improvement as a learning-inducing buffer. Finally, the poster presentation is graded passed or not passed. That way, the assessment includes mostly formative aspects, guiding the students, but also a mild form of summative evaluation, the lowest possible grading. That increase gives the student the chance to start relaxed and open minded and increases the pressure gradually. The final determination of the master performers can be left to the master thesis and later career. The concept of the course, including all assessment steps, is explained to the students in the introductory lecture. That way, even students with the only ambition to pass, who mainly focus on the assessment, will be learning what the objectives say they should be learning, and should be guided away from a surface approach, towards sufficiently deep learning (Briggs 1999). The assessment in this practice has two functions: to tell us whether or not the learning has been successful, and in conveying to the students what we want them to learn (Biggs 1999). Learning is further enforced, when students understand where they should arrive and experience the need to get there. That need is communicated by feedback in the discussions and on the essay.

However, despite the application of all learning ideals, sometimes the simple **enforcement** of declaring tasks **mandatory** has the greatest effect. The reason for that may be a naturally inclination to take on a passive role - because of shyness, fear to fail, or maybe energy conservation. Active implementation

of new skills requires tangible use of energy, probably in order to build the new nervous connections that are built with learning. It is therefore necessary to nudge some of the students out of their comfort zone. Some students have already learned to nudge themselves; others need encouragement or even force to achieve that. In my experience, getting most students to actually heed feedback on an essay and work on improvement is only possible with providing a straightforward demand of improving the text. Upon a mere recommendation, few students will work through the comments. Earlier, students only had to improve their text if the text was judged not suitable to be admitted to the poster presentation exam. By rendering the improvement round mandatory for all students in 2017, we have seen a vast improvement of all texts, of students writing at all levels. I experienced something similar in one further aspect of the course. To declare the preparation of questions to the student presenters of the articles as a mandatory task for all students in the audience has proven to be an important tweak to animate students. Since we implemented that measure in 2017, we got feedback from the lecturers that the students are participating in the scientific discussions more actively.

According to the student feedback in the questionary, I have several possible interpretations for the low rate of students making the effort providing written feedback in addition to simply crossing of the multiple choice feedback, despite repeated friendly requests. They are all speculations. However, also here, mandatory requests might be necessary.

A keystone for an arch of knowledge

The repeated discussions and **changes of perspectives** – being the presenter and the listener – encourage the student to **relate, apply and theorize, rather than merely memorize** (Biggs 1999). To some degree, this measure also leads to the activation of Skinners operant conditioning, sometimes called instrumental learning, in the form that students and lecturer provide positive feedback (reward) and negative feedback, which can be perceived as punishment. The requirement of the students to find a topic and supervisor, and to formulate a hypothesis for their review-essay themselves, encourages forming a personal **keystone** for a particular arch of knowledge the student is constructing (Biggs 1999). They get the chance to work on something they care for, or even to find something to care for in the first place. When students care about something, they are more likely to find the energy they need for learning more about it and making it a part of their lives. Without the energy for learning, nothing significant happens (Fink 2013). Working on that topic around the keystone is **problem-based learning**, which requires the student to question, speculate and generate solutions, using higher order cognitive abilities (Biggs 1999). By not providing them with all articles needed for the essay, but helping them find them and providing guidance about if the topic is broad or narrow enough and feedback about their choices, the students get a facilitated chance to be a **self-directing learner**. It is however necessary to reserve enough time for these activities in the course's schedule. With that structure, students build up a valuable knowledge base of relevant material and apply the knowledge. This kind of learning enables students to continue learning in the future and do so with greater effectiveness. Teaching and learning thereby gets a synergistic quality that can include the teacher's growth in addition to the student's (Fink 2013).

Applying different skills on the same subject to deepen knowledge

The article preparation, lectures and student presentations with consecutive mandatory discussion prepare and train the students minds towards a combination of broad understanding and critical thinking, and provide anchor possibilities to develop special interests. The necessity of finding a topic and supervisor require creativity and action, and the writing of the review, require in depth understanding and learning to the point where they can be summarized and defended in a poster presentation. Applying different skills on the same subject deepens knowledge and invites to check the truth (compare to Fink 2013).

Multiple choice questions to emphasize threshold concepts

The multiple choice questions, asked before and after the lectures, should ideally be coined to emphasize **threshold concept** gems. Threshold concepts and **troublesome knowledge** are defined in Meyer and Land (2003) as core learning outcomes that represent "seeing things in a new way" and knowledge that is conceptually difficult or counter-intuitive, respectively. By successfully leading the attention towards typical threshold concepts, learning will more likely be a way of interacting with the world in the sense of a change in the conceptions of phenomena – the student who has accomplished learning will see the world differently from before (Biggs 1999). The way the information is structured and, from then on, thought with, brings conceptual change.

I also had asked multiple-choice questions about my subject lecture in 2017, but only in the end of the course. I was upset over almost half of students not answering correctly to a critical one, but it was too late to do something about it with that group of students. I am not sure about how much they would have appreciated a post-course email about my special aspect, at least, such behavior of course leaders is not customary. This year, I asked before and after my lecture, and in the end of the course, and the correct answer rate was higher as compared to the correct answer rate to the same questions the year before. However, that might be biased by a number of factors such as my own awareness and effort to explain better, increased repetition, and different students.

In my new experience, this activity is entertaining and animating for the students and does help focus the students on critical aspects. I was happy to witness that students did mention, in my lectures, their threshold knowledge from a point a different teacher made in a multiple-choice question.

The multiple choice questions were not applied consistently by all teachers, nor did all provide me with their questions to be put into the final quiz. I believe that we teachers need adaptation time to the new learning strategies, especially in a multi-lecturer course such as this. By keeping making an effort in applying new teaching tools, I believe an improvement can take place.

Flipped classroom/Gallery walk applied to a basic statistics lecture

For some of the skill building lectures I use a flipped classroom technique in 2018. I decided the statistics lecture would benefit most of such an approach for the following reasons. The thinking about societal problems relevant for this course, such as overweight, imbalances between macronutrients or intake of toxic substances and their correlation with diseases are part of the course's curriculum. These relations have many confounders that need to be taken into account, and to be understood in order to be able to do so. Understanding the possibilities, limitations and pitfalls of the statistics behind, is both difficult and crucial for many specialists in that area. Numbers cannot be avoided in this context, even though they are more difficult to interpret for most people than language-based descriptions. This might be due our culture, where language is treated as the most important of all mediating tools used to construct such abstract, research and social-cultural based thinking, which is called higher mental processes by Vygotsky (1978). Even though unavoidable, numbers still need language to be set into context. To facilitate these challenges, I concluded that the statistics lesson would especially benefit from active learning and group conversations, in order to utilize the zone of closest development provided by the sharing of thoughts with peers. One technique, introduced in the UPED course as «gallery walk», or "expert groups" proved useful:

Each of three teams discussed and prepared answers to the questions provided in the chapter "New implementations", and explanations for these answers. In the final part of the lesson, the groups presented their results to the whole class. The technique was called «gallery walk», as the results can be visualized on a blackboard or flipboard, and the listening groups walk by to visit the presentations. At the same time, the movement can contribute positively to wakefulness.

The students were actively discussing for the entire allotted time, occasionally engaging me with questions and clarifications. They generally come up with good explanation, explained in terms their peers could understand. The method also uncovered the aspects that were more difficult for the students to understand and provided me with the opportunity to spend time explaining especially those aspects. In a traditional front-lecturing–only situation, I would probably not have uncovered these understanding or knowledge gaps.

The topic of statistics is also well-suited to generate an experience of a cognitive conflict, also called dis-equilibrium, such as that the outer world does not fit to existing cognitive scheme. In such a condition, the student is more prone to reconstruct his or her cognitive scheme based on the learned experienced new reality, a process called accommodation. A change of idea or understanding takes place. The other possibility would be the change of reality to fit to the students' cognitive scheme, also called assimilation. This scenario is highly unlikely or unrealistic in most situations, but in research, a new hypothesis can be formed, and it this hypothesis is confirmed, a change of the field's answer to a problem might become established. This could be seen as an undercategory of changing the reality. Assimilation and accommodation are complementary processes, as pointed out by Beins 2012.

Student to student peer review

Even though a peer-review round between students promises a high learning output, due to the change of perspective and critical thinking required, the practical implementation did not take place this year. I could not make this mandatory, as the workload of the course is appropriate for the allocated 5 ECTs without it. Pointing out the benefits to the students has proven not to outweigh the additional work for them. One of the students was willing to follow the recommendation, but found no reviewing partner in the group. Increasing the amount of ECT's in order to be able to make peer-review mandatory did not fit into the faculty's program, nor did it meet the student's wishes, as assessed by my 2017 course evaluation questionary.

Conclusion

The courses structure is functioning well in its present form, fostering learning by active implementation of introduced key skills and feedback based improvement in a student focused constructively aligned system. The learning portfolio-inspired assessment enforces deep learning, and the task of finding an individual topic encourages the finding of a keystone for an arch of knowledge. Applying different skills on the same subject should deepen knowledge. The addition of the multiple-choice questions, flipped classroom techniques and "expert groups" added extra fun and increased focus of the students, as subjectively observed by myself. Very mandatory/schematic implementation of such pedagogic techniques is not feasible for this course, where 8 of 15 lectures are held by different guest lecturers, as not all of them are equally motivated or feel they have the time to follow that up. This is not necessarily bad. Exposing students to different forms of teaching can also contribute to learning. However, encouragement of the lecturers might implement such measures in increasing parts of the course over time.

References

Beins. B.C. (2012) Jean Piaget. Theorist of the child's mind. I W. E. Picren, D.A. Dewsbury & M. Wertheimer, Portraits of pioneers in developmental psychology (s. 89 – 108). New York: Taylor & Francis.

Biggs, John (1999) What the student does: teaching for enhanced learning. Higher Education Research & Development. Vol 18, No. 1.

Fink, D. L. (2013) Creating significant learning experiences, revised and updated, Jossey-Bass, A Wiley Brand

Marton, F. and Booth S.A. (1997). Learning and awareness. Hillsdale, NJ: Lawrence Erlbaum Associates.

Meyer J.H.F. and Land R. (2003) "Threshold concepts and troublesome knowledge: linkages to ways of thinking and practicing within the disciplines" in "Improvising student learning – Ten years On. C. Rust (Ed), OCSLD, Oxford

Raaheim, Arild (2016). Eksamens-revolusjonen – Råd og tips om eksamen og alternative vurderingsformer.

Schunk, D.H. (2008). Learning theories: An educational perspective. Upper Saddle River, NJ: Prentice Hall.

Strømsø Helge I., Lycke Kirsten Hofgaard and Lauvås Per (red.) Når læring er det viktigste – Undervisning i høyre utdanning, Cappelen Damm Akademisk

Vejleskov, H. (2010) Teorier om kognitiv udvikling som inspirasjon for pedagogikken. I N.J. Bisgaard & J. Rasmussen , Pædagogiske teorier. Værløse: Billesø og Balzer

Vygotsky Lev Semjonovitj (1978) Mind in society. The development of higher psychological processes. Cambridge, MA: Harvard College.