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Laboratory practices go on-line - revising the use of laboratory practices videos and understanding student preferences on video length and content

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Background

The Experimental Plant Science course (EPS) is a mandatory course for MSc in Agriculture students who select the Plant Science specialization (Appendix E: EPS course description). It is yearly placed over blocks 1 and 2 and has 15 ECTS, hence half time per block. The course is divided into 9 modules, where I participated in teaching "Natural transformation" and "Involvement of ethylene in plant senescence" sharing these with the module responsible Assoc. Prof. Henrik Lütken. The covid pandemic onset in early 2020 pressured all university courses to go on-line. Later that year it was still uncertain, due to a potential second wave, how the second semester courses would take place: on-line only, back to campus or in a hybrid format. Since the first course edition in 2011, on-line or hybrid teaching formats were not employed before. Therefore, I proposed to digitalize the laboratory practices in the "Natural transformation" module by recording videos corresponding to the activities students should develop in person at the campus during the study year 2020/2021. The main goal was to ensure that these laboratory practices would remain part of the course, regardless of its nature in-person or on-line; hence ensuring the course intended learning outcomes (ILOs) such as describe methods and techniques used in plant research, plan and conduct experiments within plant science (Appendix E). An important factor here is to consider if the original ILO's proposed for

an in-person laboratory practice would be achieved when employing an on-line approach. Most likely not completely as the hands-on practice has nuances that would not be experienced by the student by merely watching a video about the practice. Hence, simulations and videos about practical work has important limitations that were here acknowledged. At the end, it was possible to have the laboratory practices with limited number of students present at the same time. The videos then became complementary to the hands-on work and in a self-assessment, the videos were a side resource that could be further incorporated and used by the students as material for repetition, self-study and exam preparation. These prolonged benefits are an exclusivity of these video materials, possible due to its replay possibilities.

Goals

Re-evaluate the use of videos as supporting tool to the "Natural transformation" laboratory practices aimed at increasing the learning outcomes aligned with the course description (Appendix E). Provide an updated and improved series of videos on this laboratory practice for the 2021/2022 EPS course students. Implement a questionnaire comparing the two approaches and infer what is the optimal approach to use videos in this course context.

Given multiple backgrounds and different previous laboratory experience, some students lag or become/stay demotivated to engage during the exercises, which ultimately lead to poor course performance. This hypothesis is based on my own assumptions and experience over the years teaching on EPS course. Biotechnology is a hard topic, for several students, and having a chance to eventually re-watch a laboratory practice would increase the achievement of the ILOs from the course.

Implementation

It involved three steps:

- Evaluation of previous material 2020/2021
- Development strategy for novel approach
- Assessment of the different approaches in a focus group and consolidate EPS course videos usage

The initial 2020/2021 material evaluation consisted of collecting student data from the respective course evaluation year, a self-reflection on that year's preparation and implementation of this novel tool in the EPS course and a discussion with the module and course responsible about the 2020/2021 videos. Additional literature research on video-based teaching complemented the analysis. A study using podcasts as review material for different courses observed that these materials, recorded by both faculty staff and students, were mostly of short duration, ranging between 1-5 minutes (Carvalho et al., 2009). Based on these findings, a novel approach focused on re-recording the laboratory practice aiming at shorter video duration. Previously, the videos ranged from 5 to 12 min. Moreover, a further interactive aspect was incorporated by adding a quiz after each video, thus avoiding these videos standing alone within the course structure.

The assessment on the two approaches for video recording was structured as a course in Absalon. An initial introduction is laid out to inform the focus group about the UP project context and the expected tasks ahead. A total of 10 students were invited to participate, 7 MSc in Agriculture – Plant Science and 3 PhDs. The 3 PhDs were included in the project to test the Absalon course structure, which in turn gave a new angle for comparisons in the results between different educational level. Subsequently, the longer videos approach recorded in 2020 is presented, followed by the shorter videos recorded in 2021 combined with a quiz in between. A final questionnaire consisted of 19 questions about the videos, its uses and reflections on the methods.

Text answers were analyzed with TEXT2DATA in Microsoft Excel. This add-on provides sentiment analysis of text and is able to construct the usual word cloud where word size reflects frequency. The sentiment analysis is automatically incorporated in the word cloud with positive words in green, neutral ones in grey and negative words in red (https://text2data.com/Excel).

Results

Laboratory experiences are key in science education, promoting improved understanding of scientific concepts via hands-on learning (Hofstein & Mamlok-Naaman, 2007). However, novel forms to foster more engaging, interactive and challenging practices (Adams, 2009) are required to maximize the learning (Croker et al., 2010). A great example of a dynamic

range of pre-class materials, including videos, animations and simulations can be found at the Bristol ChemLabS project (https://www.bristol.ac.uk/chemistry/courses/dlm/). Such materials incorporate the use of multimedia to improve student preparation leading to more confidence during the laboratory practice (Adams, 2009). Digital video guides also embed other advantages such as learning independence, additional time to produce and evaluate data in class, higher-level interactions with the instructor and the material re-use for revision/exam preparation (Croker et al., 2010).

Evaluation of previous material 2020/2021

Reminder: Covid restrictions were being lifted, students and teachers had passed the first on-line teaching wave. There was a bit more of time to prepare for either fully online or hybrid courses in the second semester of 2020. Such environment allowed for the first time the use of videos as preparatory/substitution material for laboratory practices. In the A1 evaluation form, there was a good perception of this resource with students mentioning "a good idea to make videos describing methodologies" and "teachers can record experiments in advance" linked to "a great choice for review the detail of exercise and preview". It was also perceived as an important resource for "students who are no able to join the experiments". It was also noted that other sources of videos, presumably in the form of a teacher curated list of external links could also be useful to students. Overall, students' perception sounded positive based on the course evaluation, enabling the permanence of videos as a pre-lab tool.

Vast literature can be found on how laboratory experiences are key in science education, promoting improved understanding of scientific concepts via hands-on learning (Hofstein & Mamlok-Naaman, 2007). Nevertheless novel forms to foster more engaging, interactive and challenging practices (Adams, 2009) are required to maximize the learning (Croker et al., 2010). A great example of a dynamic range of pre-class materials, including videos, animations and simulations can be found at the Bristol ChemLabS project (https://www.bristol.ac.uk/chemistry/courses/dlm/). Such materials incorporate the use of multimedia to improve student preparation leading to more confidence during the laboratory practice (Adams, 2009). Digital video guides also embed other advantages such as learning independence, additional time to produce and evaluate data in class, higher-level interactions with the instructor and the material re-use for revision/exam preparation (Croker et al., 2010).

Further discussions were jointly taken with Prof. Renate Müller (course responsible at the time) and Assoc. Prof. Henrik Lütken ("Natural transformation" module responsible). I have raised the point of long preparation time to record and edit these videos including the voice over task, one of the longest steps. Moreover, a novel approach attempting to provide the most succinct pre-lab material could be the solution to both shorten video production time as well as provide a more concise material to the students. Based on that, it was agreed that shorter videos without a theoretical introduction (already provided in class) and no voice over could be a valid alternative. Additionally, I wanted to include quizzes in between the video series to engage the students further while highlighting key steps.

Development strategy for novel approach

The entire natural transformation experiment was implemented in a smaller scale, considering the two oilseed rape cultivars in a single stage (during the course the students have younger x older plants as well). New recordings were performed, and the video editing step aimed at shorter videos. Text and arrows were used as additional guidance within the video as substitution for the voice over. The format to present and evaluate the different formats to a selected focus group was as an Absalon course, as previously mentioned. The end-product can be found in the link: https://absalon.ku.dk/courses/57309

Assessment of the different approaches in a focus group and consolidate EPS course videos usage

In the context of EPS course, the use of videos was perceived as a valuable didactic tool by 85% of the students (Figure 1, A) and 71% said it is best to watch them before the laboratory exercise (Figure 1, B). Surprisingly 71% of the students have not been exposed to videos as didactic material before the focus group work (Figure 1, C) and the majority would like to see it in other courses as well (Figure 1, D). All students agreed that such videos were or would be part of their exam preparation (Figure 1, E) (all figures are seen in Appendix A-D).

The academic level of the 2020 videos was considered average given their educational background (Figure 2, A). The 2020 videos length was considered long or too long by 43% of the students, hinting that perhaps a time reduction could be considered (Figure 2, B). Most of the students

found the video content to satisfactorily cover the topics of "Natural transformation" (Figure 2, C). A general concern of non-native English speakers is speech clarity, during this assessment 85% of the students strongly agreed that I could do that satisfactorily (Figure 2, D). A question about what was good about the 2020 videos and why was posed next and a sentiment analysis of the provided answers showed 83% being positive (data not shown). The derived word cloud reflected the sentiment analysis with quotes like "really good", "good pronunciation" and "important steps" (Fig 2E).

Moving to the new video format, the same content was perceived of equally high or average academic level compared to the students' academic background (Figure 3, A). Moreover, the video length here was perceived as short or too short in the view of the MSc students while optimal for PhD students (Figure 3, B). The contents of the newer video format were sufficiently covered for the topic in question for 71% of the students, while MSc students most likely linked shorter videos with these lacking sufficient details (Figure 3, C). The addition of a quiz in between the videos had a positive effect on the students (Figure 3, D). The same question about was good and why was presented again; sentiment analysis of the students' answers showed a balance between positive and neutral/negative outputs. In the derived word cloud the words 'concise' and 'too fast' (Figure 3, E) align with duration output presented earlier (Figure 3, B). Shorter videos are of course faster and more superficial. In terms of preference, it was noticed a division between MSc and PhDs with MSc students preferring the longer 2020 video format while PhD students favored a shorter version (Figure 4, A).

The word cloud regarding why students preferred either format (Figure 4, B) indicated an equal distribution of positive, neutral and negative in the sentiment analysis (data not shown). A key message frequently mentioned was about the video speed, with a larger preference for a slower pace (Figure 4, B). When the students were asked about 'personal preference and what do you think suits best in the course context' a very positive outcome was observed with mentions of 'useful', 'interesting and vivid', 'really good', 'concise and direct' (Figure 4, C). In the final question about suggestions for improvement a repetition of predominant words used when describing their preferred format was observed (Figure 4, D).

Final considerations and perspectives

Pro's and con's were naturally found in both approaches to producing digital video guides for "Natural transformation" laboratory practice. A longer and more explanatory version produced in 2020 was preferred by MSc students (Figure 2, H). However, the lengthier video introduction overlaps quite vastly with the pre-lab lecture, thus becoming a bit repetitive. Hence it reflects the students wishes from the 2020 A1 and A2 EPS course evaluations for recorded classes availability. In this case, there was no theoretical lecture recorded for the module, potentially attracting the students to use the pre-lab video introduction as brush up for the topics. In general, this could be interpreted as conflictive with the initial video purpose to introduce the laboratory methodology, but it definitely also serves as a tool for reviewing the materials, use for exam preparation and lastly to ensure the course ILO's are achieved. The shorter videos produced in 2021 were preferred by PhD students (Figure 2, H). Interestingly reflecting how the higher formal education level led students to favor a more direct approach. A study using laboratory study videos as preparation material before a lab practice were not information dense at the beginning of the video and mostly of short duration, ranging between 6-9 minutes (Rodgers et al., 2020). A self-reflection on the videos produced in 2021 consider that I was too focused on reducing its duration, therefore a basic re-editing effort could partially revert the speed. Moreover, further modifications on the font color being difficult to read and removing (or lowering) the background music were also mentioned as improvements.

It has been quite a learning journey in terms of awareness in teaching. In grad school it is very natural to develop and implement teaching in a range of situations, e.g. explaining a method to a new colleague or contributing as teaching assistant to your supervisor's course. Pedagogy is implicit in these situations where you learn by observing and doing. Considering the above, this project development mimicked these early career steps. An initial idea of producing videos for a course commenced from observational and following personal concepts/previous experiences. To later include self-reflection work, peer discussions on the initial outcome, student feedback and literature search. This journey will be the legacy of UP in my career.

Discussion of UP project with colleague

1. Assoc. Prof. Henrik Lütken (now EPS course responsible) and I (now EPS "Ethylene Biology" module responsible) discussed that the diverging outcomes in terms of optimal video duration are expected, it basically impossible to cater for all student body wishes. Moreover, delivering facts is time consuming, hence we agreed that the 2020 videos are more suitable for the EPS course context. The idea now is to maintain the longer videos as integral part of EPS course and contextualize how the students can use and integrate the videos in their studies by providing a quick in-class introduction. Absalon offers different watching speeds in the video player, therefore if a student wants to go straight to the exercise she/he can either browse the video content or speed it up.

References

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A

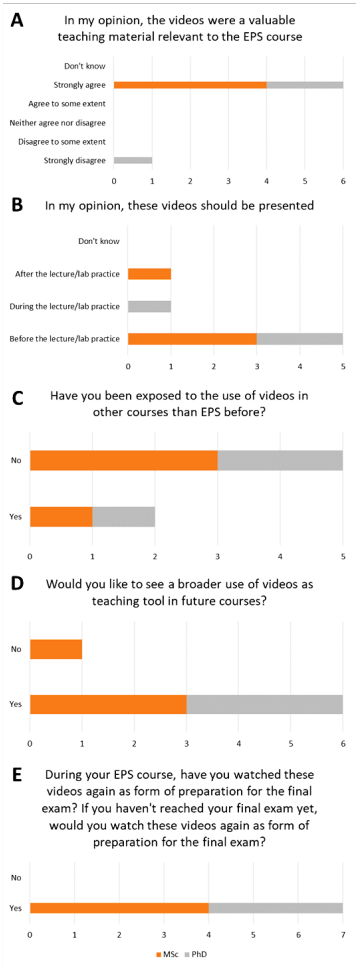

Figure 1. MSc and PhD focus group on two different approaches of creating video guides for laboratory practices – General questions.

B

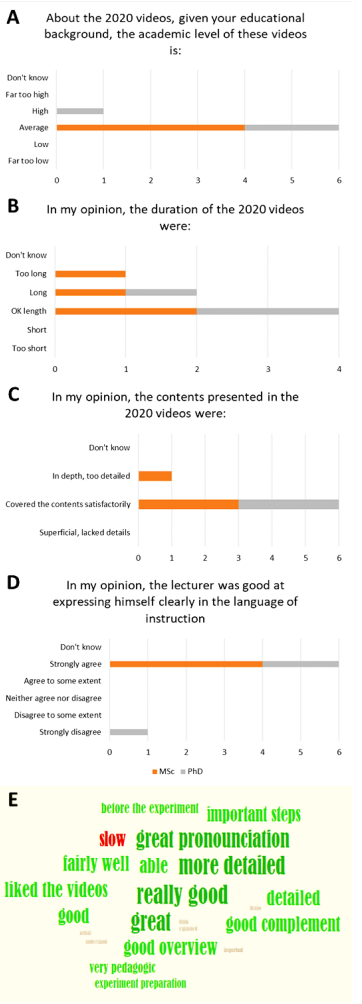

Figure 2. MSc and PhD focus group on two different approaches of creating video guides for laboratory practices – Questions about the 2020 videos. (E) What was good about the 2020 videos? Why?

C

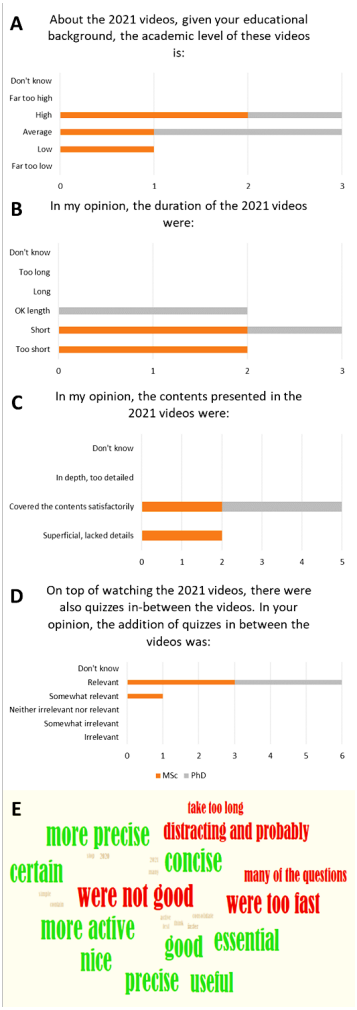

Figure 3. MSc and PhD focus group on two different approaches of creating video guides for laboratory practices – Questions about the 2021 videos. (E) What was good about the 2021 videos? Why?

D

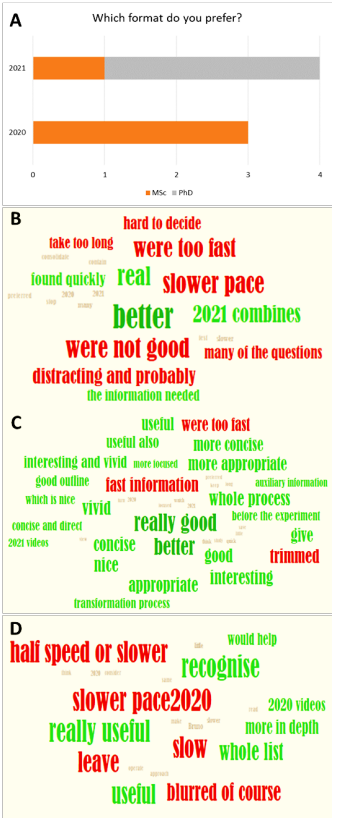

Figure 4. MSc and PhD focus group on two different approaches of creating video guides for laboratory practices – Parallel analysis of 2020 x 2021 recording approach. (B) Why? (C) Both 2020 and 2021 videos covered the same laboratory practices, however in the 2020 videos a longer and more didactic approach was preferred, while in the 2021 a more concise and direct approach was selected. Could you comment on how this differences are perceived in terms of personal preference and what do you think suits best in the course context. (D) I would like to suggest the following improvements.

E Experimental Plant Science course description

University of Copenhagen - Courses

LPLK10392U Experimental Plant Science

EXPAND ALL

Volume 2022/2023

Education

MSc Programme in Agriculture

Content

The course offers the opportunity to gain experience in conducting experimental work with the aim of achieving advanced as well as practical insight in plant science. Previous acquired knowledge and skills will form the basis for the experimental work. The experiments cover a range of established methods, state-of-the art and cutting edge technologies used to study plants, their development and function. The course is placed at the beginning of the MSc education programme and runs over two blocks to allow studying the processes involved in growth and development of plants also over longer time periods.

The main focus is on how to apply acquired knowledge in an experimental setup; this comprises knowledge gained in earlier courses which will be combined with research topics in current plant science. The conducted experiments are research based and will include an array of tools and methodologies useful to analyse and examine plants in different settings and with different aims.

The aim of the course is to give students in depth knowledge and understanding of key physiological and molecular function of plants and plant organs, from molecular and cellular perspectives to whole plant level. Learning, understanding and practice is obtained by combining knowledge about plants within a number of selected themes with appropriate methods and technologies used to analyse plants and plant products. The methods and technologies acquired in this course are useful in research and plant production; they can be applied in the laboratory, in the field or in ecosystems. The methodology covers a broad range from molecular tools to measurement of physiological processes, growth and development.

The themes are:
- Genetic modification and gene expression
- Leaves, climate and photosynthesis
- Roots, water and nutrients
- Plant development and senescence

Learning Outcome

The aim of the course is to give the students thorough knowledge and skills within modern plant science. The course intends to illustrate established methods and presents novel technologies within plant biology. The students will learn to work with a range of plants, from model plants to plants in a production context an in ecosystems. During the course they will use a number of tools to understand plant functions and to analyse plant growth and development. The students will become familiar with measurement of physiological and molecular processes e.g. photosynthesis, as well as genetic analyses e.g. genetic plant improvement and gene expression studies.

After completion of the course the students should be able to:

Knowledge:
- Describe basic and advanced analytical methods and techniques within plant science.
- Identify methods and approaches which can be used in the analysis of problems within plant science
- Describe methods and technologies used in research and in plant production to solve specific scientific problems
- Describe how to plan and conduct an experiment or research based project, from background and problem statement to interpretation of data and report writing.

Skills:
- Plan and conduct a scientific experiment within plant science
- Analyse, evaluate, discuss and come to a conclusion based on data obtained from own experiments or data and results obtained from others
- Interpret and evaluate the results presented in scientific articles and take a critical and creative standpoint to the presented scientific problems
- Present, analyse and communicate results from conducted experiments and critically set the results in a perspective
- Critically evaluate the limits and possibilities of new methods and technologies in relation to experimental evidence in a scientific context

Competences:
- Work independently and in a group to plan and conduct experiments related to research based problems and questions
- Transfer results and practice from experimental work to knowledge and understanding of scientific subjects
- Critically interpreter data, draw conclusions and present results to various target groups
- Reflect about obtained results and derived knowledge in relation to plant science, usefulness in plant production and relevance for industries and society

Literature

Scientific research articles and review papers will be part of the curriculum. Further information will be available on Absalon.

Recommended Academic Qualifications

Cell biology; Biochemistry; Plant Biology; Soil, Water and Plants
or similar qualifications.

Academic qualifications equivalent to a BSc degree is recommended.

Teaching and learning methods

The teaching will be a combination of experimental work supplemented with introductory lectures and seminars. The teaching and several experiments are research based. Case studies, seminars and journal clubs, and excursions to e.g. ecosystems, field settings or companies will be included to give a complete and up-to-date picture of plant research. The core of the course will be conducted as a series of experiments, supplemented with theoretical background. Lectures and seminars are based on articles from the scientific literature or may arise from case studies.

Workload

Category	Hours