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Does instruction video increase the learning outcome from laboratory exercises?

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Introduction

Laboratory exercises are included in many courses in the BSc and MSc programs at the Faculty of Science. The laboratory exercises aim to develop the practical skills of the students, but obviously the practical experience also contributes to the attainment of theoretical knowledge. The laboratory exercises at the BSc level are commonly fixed exercises, where the students have to follow a given protocol or manual prepared by the teacher or researcher. Experience tells us that if the students read the protocols, they often do it in a cross reading manner and not as thoroughly as we would like them to.

The technological development eases the accessibility of different media, such as smart phones, tablets, laptops etc., so the question to be asked is whether the use of instruction videos may increase the students preparation for and understanding of the practical laboratory exercises.

In order to investigate the use of instruction video, videos were prepared for three exercises from three different courses, namely Experimental soil analysis (ESA), Biochemistry, and Food Chemistry. In ESA especially one exercise is known by experience to take much longer time than the other exercises and leave less time for discussion of the theory, reflection on results and perspectives during the exercise. Hence, the teacher in this exercise feel a need for much better student preparation, in order to reduce the stress for the students and teachers. The Biochemistry course is attended by second year students, which do not have much experience in the laboratory. Therefore, reading the laboratory protocol can be challenging and

confusing to them, since they may not know many of the typical laboratory phrases/instrument names. Our experience is that the students often spend time reading the theoretical introduction to the exercise, but generally they did not spend much time on reading the part dealing with the practical work. Pre-laboratory questions are included with the aim of helping the students to get an understanding of the purpose of the exercise, and also to give them "tools" so they would easier understand how to solve different problems during the report preparation. In Food chemistry, the teachers often experience that the students does not understand certain parts of the laboratory-protocols and errors and mistakes, which cannot be corrected due to limited time, occurs. Hence, instruction videos, even though they only provide information which is already given in the protocol, may avoid a lot of mistakes during the exercise and optimize the time spend in the laboratory, both for students and teachers. The videos are designed to be a supplement to the protocol, and should thus not replace either the protocol or the actual practical exercise.

The overall aim of the present report was to evaluate whether instruction videos increase the learning outcome, both practical and theoretical skills, from laboratory exercises. This was investigated by exploiting the three hypotheses:

- The students are better prepared when entering the laboratory
- The teachers' workload is reduced
- The students' impression is that learning outcome (practical and theoretical) of the practical exercise increase

In order to be able to verify or reject the hypothesis, this report includes a brief introduction to some of the theoretical concepts related to learning and the use of instruction videos in teaching, as well as the results gained through questionnaires completed by the students attending the three courses, EAS, Biochemistry, or Food Chemistry. As the study was conducted on three different courses with very different number of students it was chosen to do the same quantitative and qualitative questionnaire at all three courses (Appendix A). Furthermore, the teachers of the exercises where interviewed regarding their experience on teaching with videos. The results of the three parts lead to a general discussion, as well as a conclusion and some perspectives.

Theory

Pedagogical theory on cognitive learning

Learning has been described by Piaget as a cognitive adaption process, were two opposite directed part processes takes place; i) the assimilation, where new experiences are adapted into the existing knowledge (the existing scheme), and ii) the accommodation, which constructs and develops new cognitive structures, so they fit into a new changed scheme (www.blivklog.dk). The two parts takes place concomitantly in a dynamic process, a state of equilibrium.

Similarly, Illeris (2007) describes four types of learning; i) cumulative, ii) assimilative, iii) accommodative, and iv) transformative. Cumulative refers to the learning where the new experiences do not fit into any existing scheme. Assimilative is, as described by Piaget, when new knowledge can fit into an existing scheme. Accommodative is when new experience extends, adjust, or reconstruct an existing scheme. Transformative means the concomitant reconstruction of multiple schemes.

Learning situations, competence stages and the use of instruction videos

Illeris (2007) also describes situated learning as the combination of two situations; i) the immediate situation where the learning takes place, and ii) the societal background or framework in which the situation enters into. For the immediate situation the laboratory exercises contributes to the immediate learning gained by the student, and for the societal aspect, the practical exercises contribute to the development of competences, which are essential for the student as a future employee, their organizations, companies, and the nation competitive position. There are massive societal interests in optimizing learning, and herein the acquisition of practical skills (Illeris 2007).

In order to gain new insight or new experience a disturbance is essential, and the art in teaching is to create the appropriate disturbance. It should not be too big and not too small. According to the theory of Dreyfus & Dreyfus (1980) and Illeris (2007), the chaos should be minimized for the unexperienced student. This also applies for a laboratory exercise. The level of disturbance must be appropriate, and sometime the gap between the protocol and the practical execution in the laboratory may be too big

a disturbance, where an instruction video may act as a buffer to adjust the disturbance to the correct level. The nature of this disturbance/chaos should be aimed at the understanding, or perspectives rather than confusion about the experimental work. Hence, the idea of introducing instruction video is to minimize the chaos related to the practical work, so that focus can be related to the theoretical understanding.

Likewise, the five-staged model proposed by Dreyfus & Dreyfus (1980), describes the need for strict guidelines for the student in the beginning in order to acquire skills. These five stages are divided into; novice, competence, proficiency, expertise and mastery. In order to move from the novice level to the mastery level concrete experience is needed, and it is important to design material for the student based on which level the student is. The novice has no experience and needs to have rules and be instructed in order to learn, and on this stage the task is learned in a context-free environment. The competence is acquired, after considerable experience with real situations, and the student is no longer working in a context-free environment. In the proficiency level the student has experience from many different situations, and has reached a level where he/she is able to recognize this type of situation viewed from a similar perspective. The expertise level is reached when the student has reached the stage where he/she, is able to reflect about what she/he is doing. The final stage, the mastery, the students has reached a level of expertise, where he/she no longer relies on rules, or guidelines, and is able to absorb from his own performance and find appropriate perspectives and actions.

In these laboratory courses we consider the students to be at the novice and competence levels. So here the students need specific guidelines and instructions, as well as repetitions of experiments. The videos made in this project, is thus meant to be a part of the instructions that the students need in order to move from the novice level to the competence level. The complete guidance of the students in the laboratory should decrease the chaos, if there are too many new elements it will become overwhelming for the students and nothing will be gained. At first the students need to follow strict guidelines, in order to be familiar with the different types of techniques, but these guidelines need to be coupled to an understanding in order to improve the performance and student motivation (Dreyfus 2004).

Teaching and learning using various media

Many different types of media that can be used to communicate teaching exist, and among these are; face-to-face communication, text and pictures, videos and film, computer software, and networks. Each media has benefits and disadvantages, and it is important to recognize which teaching situating the media is best suited for (Collins et al. 2000). Moreover, it is important to recognize new technology, rather than only sticking to the old classical way of teaching.

Using video is an excellent tool for visual learners, and the advantage of the video, is that the student can watch it anytime at the location of choice, and that they can repeat the video several times. Three different types of video genres exist, live action, animation and talking heads. The live action video gives the possibility for the student to see and recognize object/ full process. Talking heads may be used to make the producer (teacher) visible. Animation may give a better understanding, than if a picture is shown in a text book. Moreover, the video may preferable be combined with a speaker, which explain what is happening, at the same time it is shown (Collins et al. 2000).

The disadvantages with videos are that they are time consuming to produce, but once produced they can be used many times. Another challenge is how to make video that promotes the understanding, which deals with the type of illustrations/learning events added in the video.

Experimental soil analysis (ESA) instruction video

The ESA course is a first time running optional BSc course. Eight 3th year students from Natural Resources and Geography attended the course this fall. They do not have much experience in the soil physical laboratory, which contrarily to many other laboratories do not include many pipettes or solutions. However, this course is still more on how to comment/explain/elaborate on the results obtained than on how to do experiments in the laboratory.

Materials and methods

In this course the 8 min and 30 sec long live action instruction video with speak was made with Windows Movie Maker. The specific exercise

"Soil texture and soil classification" had 4 sub exercises, but the video only showed the 2 main sub exercises. The teacher responsible for the exercise showed each step of the laboratory exercise, alongside she was telling why she did what she did, mentioning the physical laws which allowed her to do what she did, and showing the equipment to be used. The video was uploaded to Absalon and the students were asked face to face to see it. However, problems with downloading the video occurred, so not everybody had the chance to see it. Three students saw it beforehand on their own, 3 was forced by the instructor to see it, and 2 students saw it afterwards.

The soil physic exercises are taught in a rotation manner so the groups (2-3 persons) do different exercises at the same laboratory week. The actual laboratory work was conducted Monday afternoon, whereas they had supervision time on the reports Wednesday afternoon; here each student answered the questionnaire (Appendix A) about the use of instruction videos.

The teacher was asked to note whether the students were more prepared than previously. However, it should be noted that her answers can be biased as the manual was rewritten and optimized before this course, and one group also had access to pre-laboratory consideration/questions do to a result of a midterm evaluation.

Results

Do the students want to watch the video?

All students replied positively that they wanted to see instruction videos in the future. Seven out of 8 would like it to be on the practical part of the exercise – as many of them stated in different words that the instruction video had given them an overview over the exercise, and removed the visualization barrier so it was easier to focus on why they did what they did, and not solely on how to do each step in the manual. Six out of 8 of the students could see a potential in instruction videos with specific theory on some of the other exercises, which was more abstract than the examined exercise. Only 1 student wanted the video to include report issues and 1 student would like some perspectives in relation with the learning outcome of the course.

Five out of 8 students (not the same persons) marked that the subject, the quality of the video and the length of the video was important when they decided on watching instruction video in general. Those students who elaborated on this wrote that the video should not be too long – whatever that is.

Even though they were very positive about watching instruction videos 5 out of 8 did not manage to see it beforehand. The dominating reason (3 students) for not watching the video was problems with downloading the video from Absalon, one argued she did not have time, and one wrote that even though she was asked to watch it and knew it was important for this project, she forgot to do it.

Preparation time

Of the student who had seen the video beforehand (on their own and forced) 3 had used less time and 3 had used the same amount of time compared to the other exercises. They had used between 35 min and 120 minutes to prepare, and the one with preparation of 35 min had seen video beforehand.

How were the students' understanding of this exercise compared with the other exercises?

In general all participants felt that the video had increased their understanding of the exercise. Their arguments are given below in table 1.1.

When do the students feel they understand the purpose of the exercise and feel they have an overview of the exercise?

In ESA 3 students answered "after the experimental work", 2 answered "after the experimental work" or "during the reporting part" depending on the topic, 2 answered "during the reporting part" whereas 1 forgot to mark. Of those who saw the video, 3 answered that the video had change when they felt they understood the purpose of the exercises, as they understood why they were doing what they were doing, and therefore could focus on understanding. The other 3 said both yes and no as they argued that they had a much better overview of the exercise. However, the bigger perspective on why the exercise theme was important was understood when they wrote the report.

Note on the teachers' experience

The video had not helped shortening the time used for conducting the exercise. But the instructor pointed out that she had spent her time differently

Table 1.1. The students understanding of the instruction video exercise compared with other exercises. Person 1 and 2 saw the video afterwards. The statements are translated from Danish

1	Saw the video after the exercise, but it still helped as you can see how the various things is to be done and not just that they have to be done as the written manual often states.
2	The understanding of this exercise was good because I knew the theory from previously courses. Fine exercise instructions, although it was messy in the description of the exact execution.
3	The video was very clear and easier to relate to than written instructions as you see what happens.
4	Increased understanding! I have both read the instructions and watched the film. Watching the process as well as seeing the materials and equipment provided both better understanding and facilitate a better exercise execution.
5	The substance was easier to understand, but as I used less preparation time than normally, I was confused about the content of the exercise when entering the laboratory as it was confusing with the many sub exercises.
6	Too bad that there was only an instruction video for one part of the exercise – I still think that the part with the pycnometer was difficult.
7	Good, mostly because we were split up so one would make one part of the exercise and the other where doing other parts. I did not do the video part but it helped me to understand what had been done.
8	It was nice to have the possibility to see the instruments, it was a little demystified. It kept my attention on the things you read in the manual and heard during the exercise and on the things you should be aware of. Overall it was much better with the video.

than she was used to. Previously she used most of the exercise time on answering especially technical questions, but this year she spend more time on asking questions in regards to why the students they did what they did and on discussing what the result could be used for in a broader perspective ect.

Biochemistry instruction video

Materials and methods

In this course the instruction video was made with Screencast-o-matic, which is a power point slide show with a speaking voice added (animation video with speak). The video was send by email through Absalon to the students 1-2 days before they had the exercise.

The biochemistry laboratory exercise course covers 6 different laboratory exercises. Each exercise in the course is run 10 times during two weeks with 247 students in total and with 24 students each day. The instruction video was prepared for the exercise;“ Enzymkinetik, β-fructosidase fra

gær", and given to students at two different exercise days. At the end of the exercise, each student had to answer the questionnaire (Appendix A). The two teachers attending the exercises noted at which time the students started each of 4 parts within the exercise, and the laboratory teachers were asked to answer the following questions:

- Are there less mistakes/confusion during the exercises in the teams who have seen the videos compared with the teams who have not?
- Do you generally notice any difference between the teams which have seen the video and the teams which has not?

Results

Do the students want to watch the video?

On day 1 (Thursday afternoon) 62% of the student had watched the instruction video which they received Monday morning by mail. In order to increase the number of students having watched the video, the video was send by mail Wednesday morning to the students having laboratory work Friday morning (day 2). However this did not improve the number of student having watched the video, in fact most of the students from the second day (Friday) showed up in the laboratory without having watched the video. The laboratory teachers encouraged the students to watch the video at the end of the experiment, and then give their opinion of the video by filling out the questionnaire. This encouragement from the laboratory teachers lead to an increase in students who had watched the video, but at the end of the day only 50% of the student did manage to watch it. The group of students which did not watch the video was then used as a control group.

The way the video is distributed seems to be a big issue. The reason for not watching the video was for most part of the students that they did not check their Absalon mail and thus was not aware of the existence of the video. Some also answered that they simply forgot to watch it, only a few students argued that they were not interested in watching a video. However, all the students did state that they think inclusion of instruction videos in other courses would be a good idea. The majority wanted the instruction videos to deal with the practical part of the experiment and specific theory, but there were also a great deal of the students who would like the instruction videos to handle the reporting part as well as perspectives.

Preparation time

Independent of having watched the video or not, then the students had spent less time spend on preparing for this particular exercise compared with other laboratory exercises in the biochemistry course. The main reason for this was according to the student that the laboratory protocol easier to read and more understandable. A few students also answered that this topic (enzymes) is their favorite topic.

How were the students' understanding of this exercise compared with the other exercises?

All the students who had watched the video felt they had a better understanding, and stated that it was because of the video. On the other hand, some of the students who did not watch the video also felt that they had a better understanding (22-25%) or a good understanding (44-50%) and 25-33% of these students felt their understanding of the exercise was similar to the understanding they had in other exercises (Table 1.2).

Table 1.2. The student' understanding of the instruction video exercise compared with other exercises.

	Video	Better	Fine	Similar
Tuesday	Yes	100%	0	0
	No	25%	50%	25%
Friday	Yes	67%	25%	8%
	No	22%	44%	33%

When do the students feel they understand the purpose of the exercise and feel they have an overview of the exercise?

The majority state that they get the overview after doing the reporting part. Interestingly, the most of the students who have watched the video, answered that they get this understanding already after having made the experimental part of the exercise (Figure 1.1).

Note on the teachers' experience

The teachers found the laboratory was calmer on the Tuesday where 62% had watched the video, and they experienced less questions and different

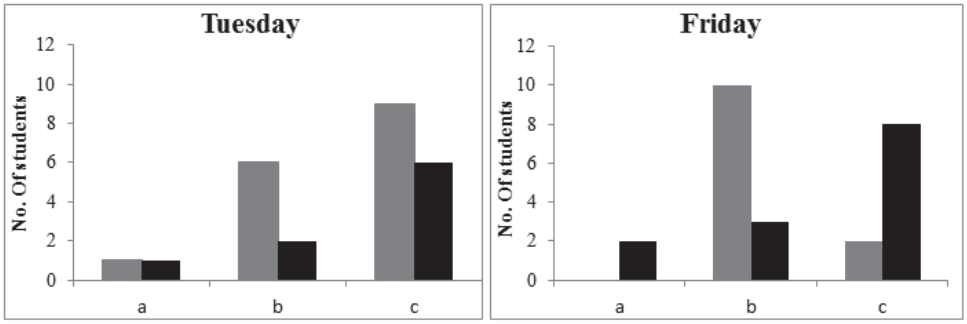

Fig. 1.1. Student answers to the question; When do you usually feel you have an understanding and an overview of what the exercise is about" A: After having read the protocol; B. After having made the experimental work; C. During the reporting part. Gray: Did watch the video, Black: did not watch the video.

types of questions, compared with the other days, showing that the students were less confused about the exercise.

The teacher noted at which time the students started with each of the individual tasks in the exercise, but there were no difference in time when compared with the other 8 days where the exercise was running in the laboratory, and thus, the instruction video had no effect on the amount of time used in the laboratory.

Food chemistry instruction video

The food chemistry course in mandatory for second year students enrolled in the Food Science and Technology programme. This is one of the first courses the student attend where food products is the main focus, and at this point the students have obtained some experience in the laboratory during their previous courses, e.g. Biochemistry mentioned above. The intended learning outcome from the laboratory exercises in this course is i) to be able to work in a laboratory with selected experimental techniques and methods used to examine and evaluate food and food products, and ii) to analyze and disseminate own experimental results. Here the students are at a level, where they from their experience e.g. in Biochemistry are expected to know how the basic laboratory equipment works. However, in Food Chemistry they will still meet new types of experiments, equipment, apparatus, and other types of analyses.

Materials and methods

The practical part of Food chemistry consists of 4 laboratory exercises conducted within 4 weeks. Exercise 1-2 in week 1 and 2, and exercise 3-4 in week 3 and 4. The approximate hundred students are paired and distributed in teams which perform the exercise either Monday (16 students), Tuesday (32 students), Wednesday (16 students) or Thursday (32 students). For exercise 3 "Lysinducerede oxidative ændringer i mælk og forsæbning af mælkefedt" in Food chemistry, an instruction video of 15 minutes duration was prepared and uploaded to Absalon in week 2, and reminders to watch the video were sent by email through Absalon to the students the day before they were going to perform the exercise. As it appeared that the students had problems downloading the video, it was launched in the end of week 3 on www.youtube.com (http://youtu.be/lXFiiba_89A) and on the Department of Food Science web-page (http://food.ku.dk/uddannelse/bsc_msc/). The video was prepared in Windows power point, Windows Movie Maker, and Screencast-o-matic with voice-over added (mixed live action and animation video with speak). The exercise consisted of four parts which were recorded individually and the combined into one video including:

- Introduction in power point summing up the basic theoretical background, safety issues, and purpose of the exercise.
- Video showing the four parts of the exercise.
- Remark on how to organize the time spend in the laboratory.
- Description of pre-laboratory exercise.

At the end of the exercise, each student were asked to fill in the questionnaire (Appendix A).

Results

Do the students want to watch the video?

Of the 96 students attending the practical exercises in Food Chemistry, 67 filled in the questionnaire after carrying out exercise 3. Of the 67 students, 81% had seen the entire instruction video before the exercise. The remaining 19% had not seen the video due to technical problems with downloading the video, and a few complained about the video being too lengthy.

Preparation time

In average the student had spent 45 minutes preparing for the exercise, where they normally spend in average 44 minutes for laboratory exercises.

How were the students' understanding of this exercise compared with the other exercises?

The students were asked how the understanding of the content and execution of the exercise was compared to other exercises in the same course, and the majority (75%) clearly felt that the understanding was higher compared to other exercises due to the instruction video. The students felt that having seen the instruments and apparatus helped them feel more comfortable and secure when performing the exercise.

> *"Meget bedre! Jeg vidste hvordan tingene (udstyr, maskiner) så ud, og hvordan tingene skulle udføres."*

When asked if there were other things that may have affected the understanding obtained, the majority pointed that the quality of the manual had influenced the overall understanding (Figure 1.2). However, the students did not agree on whether the manual was of good or bad quality.

> *"God udførlig manual"*
> *"Manualen var ikke særlig god. Meget i tvivl om udførsel af eksp. arb. + spm. − hvad er det præcist vi skal svare på."*

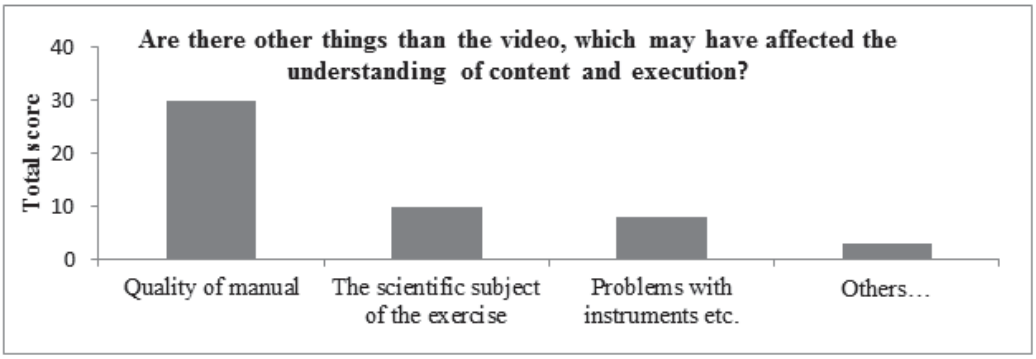

Fig. 1.2. Total scores to the question: "Are there other things than the video, which may have affected the understanding of content and execution?"

When do the students feel they understand the purpose of the exercise and feel they have an overview of the exercise?

When asked when the students normally obtain overview and understanding of the exercise, most students replied either after executing the experimental work or during the report writing (Figure 1.3).

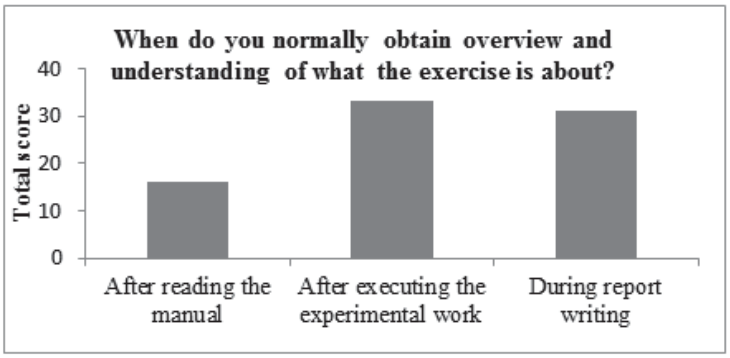

Fig. 1.3. Total scores to the question: "When do you normally obtain overview and understanding of what the exercise is about?"

After using the instruction video for the preparation, this had changed for 66% of the students. They felt that the video increased their knowledge by visualizing the practical part, but did not improve the knowledge obtained about the theoretical part.

"Video har hjulpet på den praktiske forståelse, altså udførslen af øvelsen."
"Kun i forhold til det eksperimentelle, ikke selve teorien."

When asked, what would make the students watch instruction videos for preparation of practical exercises in this course or other courses, the students replied that especially the quality of the video was essential, but also the subject, duration, and expectations from the teacher was of relevance (Figure 1.4).

Do the students feel that instruction video is a good format for preparation of laboratory exercises, and how may the format be further developed?

More than 92% of the students agreed that instruction videos would be a good idea for other exercises in the course, and they suggested that the

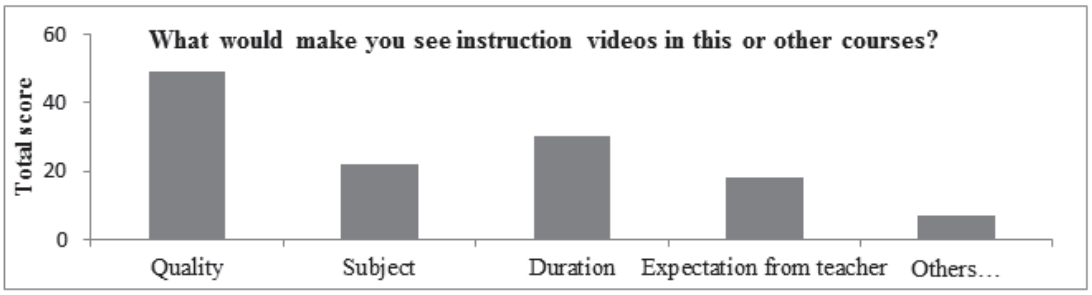

Fig. 1.4. Total scores to the question: "What would make you see instruction videos in this or other courses?"

development of the instruction video format should focus on especially the practical parts, but also the theory, data analysis, and perspectives (Figure 1.5).

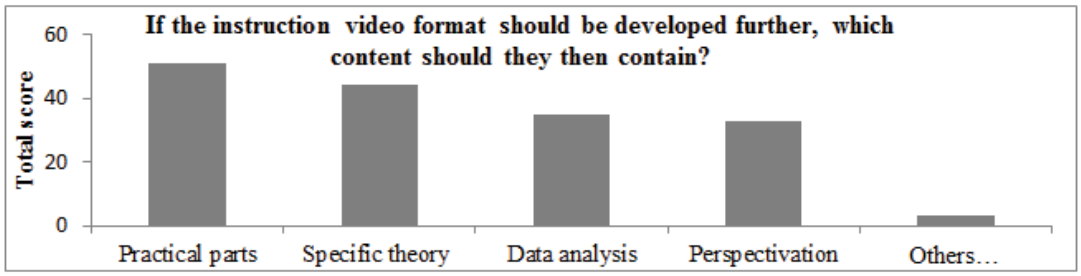

Fig. 1.5. Total scores to the question: "If the instruction video format should be developed further, which content should they then contain?"

Note on the teachers' experience

A small focus group interview with three teachers was carried out. The teachers did not observe that the students had finished earlier, or that fewer mistakes had occurred for those who had used the video as preparation. All in all it was very difficult for them to evaluate any effect of the instruction video.

General Discussion

Do the students want to watch the video

When asking the students if they would like to have more videos in the future, the majority of the students think it is a very good idea. However, not all of the students watched the video before attending the laboratory exercises. There were some technical difficulties, but a lot of the students replied that they simply forgot to watch it, or didn't watch it because it was too long, which witness a low motivation to watch the video. Since so few students watched the video in ESA and Biochemistry, another approach was used in Food Chemistry. Here the video was mentioned at lecture, where it was stressed how important it would be to watch the video, and also, the day prior to the exercise, the students were reminded by email about the video. This had some effect, since here 81% of students had watched the video before attending the laboratory exercise. The same pattern was seen in the Biochemistry course, where the video was mentioned to the students on the Tuesday team when they were in lab a week before the exercise, but the Friday team only received an email about the video. The result was that half of the students from the Tuesday team had watched the video, but almost nobody from the Friday team had.

It would be interesting as a follow-up of the present study to interview the students about their preparation habits, and how they decide on what and how to prepare for the individual parts of their courses. Such information could be extremely useful for the preparation of lab exercises and also other teaching activities.

Effect of the video on preparation time, and time spend on laboratory exercises

The student used less preparation time for the examined exercise in two of the courses. However, it cannot be concluded that it was because of the video, as the main reason might be easier readable protocols and understandable subjects. In the Food Chemistry exercise, the students had used the same amount of time for preparation as usually. However, visualization of the practical part of the exercise helped the students to get a better understanding of what was going to happen in the laboratory, and thus reduced the confusion they would otherwise have had when only reading the protocol.

There were no effect on the time spend on the practical part, as watching the video did not reduce the time in the laboratory. This was in part due to the fact that the students still need to acquire the practical skills by hands-on and repeated experimental work in order to achieve experience to reach the level of competence.

However, in the Biochemistry exercise less chaos was observed in the laboratory, the students were calmer, and it was clear that they had knowledge about how the laboratory exercise was build up and was less confused. The video helped to visualize the experiments, which is often difficult for students since they are not familiar with new methods. Furthermore, the teachers in both Biochemistry and ESA observed that the nature of questions asked had changed, and that students who had watched the video asked questions, which showed a deeper understand of the experiments, compared with students who did not watch the video, similar results were seen in the study by Nielsen & Eriksen (2014).

Effect of the video on gaining overview and understanding of the content of the exercise

In all courses the students felt that by watching the instruction video as a part of their preparation their understanding of the content and execution of the exercise had increased. Especially, seeing the instrument and apparatus before going in the laboratory made them feel more comfortable and secure when carrying out the exercise. In any situation of teaching it is important to consider which learning types the teaching activity relates to. Commonly teaching will be assimilative, but sometime there is a gap in order for the new experience to fit into an existing scheme (Illeris 2007). When the students read a laboratory protocol, they may be familiar with some of the concepts and techniques described, but many details will be unknown for them and difficult to imagine, when not having the laboratory experience. Using instruction video in the preparation for laboratory exercises may cover that gap partly, as the students are able to visualize the unknown techniques or instruments before actually performing the exercise. Another aspect is that students learn differently, and instruction video may catch the attention of student which learn better visually rather than by reading. The results of the present study also showed that the majority of students felt that they gained overview much sooner in the process when using the instruction video in their preparation. According to Dreyfus & Dreyfus (1980) the students need to move from novice to mastery by passing all the stages in between. This

study shows that instruction video may facilitate this process and make the path through the at least the lower of the five stages easier.

Future use of instruction videos

From the quotes (e.g. Table 1.1) it was found that most students felt they learned from the videos. However, there are still a number of issues to be solved before instruction videos add significantly learning abilities to the didactic room in the laboratory. First of all if we do want to create a better learning environment allowing for more reflections on the subject taught the students should have easy access to the instruction videos create. There was a clear tendency in our data regarding the difficulties of getting knowledge about where to access the video (the students did not check their Absalon e-mail), they could not access the video because it was uploaded in a format which was not accessible to all devices or they just forgot to look at it even though it was an outspoken and clear demand from the teachers. The fact that it was far from everybody that saw the videos, will lessen the surplus of reflection the students could have gained if everybody had seen the video. Hence, in order to use instruction videos and get the most out of them some requirements should be met. The videos need to be of good quality, not too long, mainly but not solely focusing on the practical work and easy to access on any electronic device, as well as the students need to be motivated as discussed previously. Furthermore, it should be noted that if the intention with the videos are to create a flipped classroom environment the videos should also be mandatory to watch before entering the laboratory. A way to make the students watch the video could be to add a pre-lab quiz, as a set of questions in the pre-lab section, which can only be answered after having watched the video.

Nielsen & Eriksen (2014) successfully introduced a slightly alternative approach during an experiment which was conducted at the University College Sjælland. They added QR codes to the instruments in the laboratory and when the students scanned the codes, videos were accessible and the students could even add their own notes to the videos. The study showed that the use of instruction videos accessible in the laboratory for the students to see on either tablets or smart phones during the exercise increased the time for reflective discussion and dialog between students and teachers (Nielsen & Eriksen 2014). Hence, such system could be interesting to look more into as it overcome the problems that not all students has seen the videos beforehand.

Conclusion

The first hypothesis; that students are better prepared when entering the laboratory, could not be verified or rejected. There were other factors which had an effect on the students understanding, like improved laboratory manuals, and generally better understanding of the subject. But in all three courses, there was a tendency of improved understanding when the student had watch the video, as the students had concrete ideas about how the experimental work was to be carried out.

The second hypothesis; that the teachers' workload is reduced must be rejected as the teachers workload was not found to be reduced. But there was a tendency of improvement, since the nature of questions asked to the teachers witnessed of an improved understanding of the practical work. Without the instruction video, time was spend on *how to do*, while when the students had seen the video, the time was used for *discussions on why*.

The third hypothesis, that the students' impression is that the learning outcome (practical and theoretical) of the practical exercise increase, was verified as all the students who had seen the video answered that they had a better understanding of what was going to happen in the laboratory. Furthermore, it was the students' impression that they obtained the overview of the exercises during the practical part rather than during the writing of the report as for exercises without instruction videos.

Perspectives

In this study the effect on learning outcome was investigated on basis of the students own experience, and indirectly from the experience of the laboratory teachers. It would be interesting, to continue the studies and get a deeper insight into how the learning outcome has improved – by preparing an experiment where the students understanding was measured directly.

Furthermore, in the future we would work on the quality of the videos, for instance by asking the "it learning center" for help. This is a trivial task, but as the students ask for quality this might be important anyway. However, one should still remember that the video should not be more "perfect" than it is still possible to adjust it over the years. Another issue which should be approached is the classical question when working with flipped classroom – how do we get the student to view/do the pre-class preparation - so we as teachers do not have to repeat our self in the class but instead can be able to

elaborate, discuss and increase the room of didactic when being together. In this study we found that even though many students would like to see more videos in the future, we as teachers must be able to motivate the students to not only saying that they would like to watch the videos, but actually watch them as they can be time consuming to produce. An answer to this could be small instruction videos “on site” in the laboratory for the students to see while performing the exercises, this may also free some instructor time, which then can be used for discussion instead.

A Spørgeskema angående brug af instruktions videoer i laboratorieundevisningen

1. Har du set hele videoen? Ja____ Nej_____
Hvis nej, hvorfor ikke:_____
_____

2. Hvor lang tid brugte du på at forberede dig til øvelsen?
_____

3. Hvor lang tid bruger du normalt på at forberede dig på laboratorie øvelser?
_____

4.Hvordan har din forståelse af indholdet og udførslen af denne øvelse været i forhold til de andre øvelser i kurset? Begrund!
_____
_____

4A. Er der andre ting end videoen, der havde en indflydelse på det (sæt gerne flere kryds)?
a. Kvaliteten af manual
b. Øvelsens faglige emne
c. Problemer med instrumenter eller lignende
d. Andre ting
_____

Begrund dine/dit kryds:
_____
_____

5. Hvornår opnår du normalt overblik over og en forståelse af hvad øvelsen går ud på:

a. Efter at have læst øvelsesmanualen
b. Efter at have udført det eksperimentelle arbejde
c. Under rapportskrivningen

Har videoen ændret på det?____ja_____nej_____

Hvordan?_____
_____

6. Hvad vil få dig til at se instruktions videoer i dette kursus og på andre kurser:
a. Kvaliteten
b. Emnet
c. Længden
d. Forventninger fra underviseren
e. Andet

7. Kunne du forestille dig at instruktions videoer generelt ville være en hjælp til andre øvelser på kurset?
_____
_____

8. Hvis vi skulle udvikle instruktions video formatet, hvilket indhold skulle videoren have)
a. Praktisk udførsel af øvelsen
b. Specifik teori bag øvelsen
c. Efterbehandling af opnåede resultater
d. Perspektivering af øvelsen i relation til kursets læringsmål
e. Andet

Skema til undervisere:
Noter tid på hvornår holdende er færdige med deres øvelser?
Er der færre fejl ved udførsel for de hold der har set videoen?
Kan I generelt mærke forskel mellem de hold der har set videoen og de hold der ikke har?

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http://www.ind.ku.dk/publikationer/up_projekter/2015-8/

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