# Chapter #18

# SELF-PRODUCED VIDEOS IN A FLIPPED CLASSROOM FOR ENGINEERING STUDENTS AND NURSING STUDENTS

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**ABSTRACT**
The study investigates the differences in nursing and engineering students' perceptions of videos made by the teachers as part of a flipped classroom, and whether these videos contribute to a good learning environment. The sample consists of 21 engineering students, 17 nursing students and 17 pre-engineering students. Overall, all three student groups are satisfied with the quality of the videos. The nursing students watched videos more before the learning sessions than the other two groups. All students think videos produced with simple tools are technically satisfactory and make it easier for the students to understand the material, which leads to increased learning outcomes. They express that videos are more motivating, and that they learn more from watching a video than reading course material. Nursing students expressed a higher degree of agreement with replacing traditional lectures in other subjects with videos. All student groups think the learning environment has been good. The results indicate a connection between the learning environment being good and the videos working satisfactorily.

*Keywords:* inverted classroom, teaching videos, learning outcomes, learning environment.

## 1. INTRODUCTION

Campus Førde at the Western Norway University of Applied Sciences (WNUAS) offers nursing education, engineering education in electrical engineering and a one-year preparatory course for engineering education (pre-engineering course). This study investigates the difference in the use of self-produced videos as part of a flipped classroom in three different subjects. These subjects are Control Systems on engineering education, Communication and Norwegian on the pre-engineering course, and Anatomy/Physiology on nursing education. Control Systems is taught in the fourth semester of the engineering education. Teaching has traditionally been classroom-based, with classes of 30 - 40 students and a lot of blackboard teaching. Learning sessions have been a combination of problem solving and review on the board. Communication and Norwegian largely consisted of presentations and related exercises. Anatomy/Physiology is part of the course in Anatomy, Physiology, Biochemistry and Microbiology that is taught in the first semester of the nursing education. Lectures have traditionally been the most widely used teaching form in this topic, but the number of lectures has been reduced in favor of learning sessions in smaller groups.

## 2. BACKGROUND

### 2.1. What is a flipped classroom?

The concept of a flipped classroom, also called an inverted classroom, is used in different ways and has varying content, and it is difficult to point to a common model (Bachnak & Maldonado, 2014). A flipped classroom means that what has traditionally been done in the classroom is done at home, and what has traditionally been done at home is done in the classroom, but it also means more than this (Sams & Bergmann, 2013). A review article by Bishop and Verleger (2013) examines a number of studies of the flipped classroom method, and they chose to describe it as a form of teaching that consists of individual computer-based learning outside the classroom and student-active/group-based learning in the classroom, but not all concepts referred to as a flipped classroom include these elements Common to the models referred to as flipped classroom, however, is that the learning that takes place outside the classroom is a preparation for student-active learning in the classroom. For the model to work, the students must have worked with the subject matter beforehand. The guidance in the classroom is based on the understanding that the students bring with them when they come to the learning session, on the basis that activating pre-understanding is important for constructing new and meaningful knowledge (Pettersen, 2005). This means that the students prepare, preferably by watching one or more videos before the learning session in the classroom. The learning session is spent on task solving and group work, and the teacher goes from being a lecturer to becoming a supervisor (Blair, Maharaj, & Primus, 2016; Sams & Bergmann, 2013). In a flipped classroom, the teacher is also more available to communicate with the students, which makes it easier to use teacher immediacy behaviors. This, combined with a good teacher-student relationship, has also been linked to motivation in learning (Estepp & Roberts, 2015).

### 2.2. Students' perceptions of the flipped classroom

A large review of research on the inverted classroom concluded that students are generally positive about this form of learning, but that opinions are somewhat mixed, and some are negative (Bishop & Verleger, 2013). Students may also find studying subjects on their own challenging and therefore prefer learning from the instructor inside class (Cabi, 2018). Many also prefer a mix of a flipped classroom and traditional lectures (Zappe, Leicht, Messner, Litzinger, & Lee, 2009). One study showed that students on a mathematics course were more satisfied with a flipped classroom model than with traditional lectures. One reason was the emotional safety of the learning environment. The students also felt that the peer and instructor relationship was better and that they were recognized as individuals (Steen-Utheim & Foldnes, 2018). The flipped classroom model has a positive effect on the performance of the students and seems to be useful for all disciplines. However, the effect seems to be stronger for the engineering sciences than the health sciences (Strelan, Osborn, & Palmer, 2020). A comparison of the flipped classroom approach and lectures showed that engineering students obtained better results with the flipped model. However, students with average and lower grades did not like this model (Kanimozhi & Rabi, 2019). A survey of engineering students at Texas A & M International University who used the flipped classroom on a course in electronics, showed that 67% wanted to continue with the flipped model, while the rest would rather have traditional lectures (Bachnak & Maldonado, 2014). Another survey of engineering students showed that flipped classrooms meant that lecturers could cover more and that the students did just as well as students who had more traditional classes. Initially, the students struggled with the new program, but mastered it quite quickly (Mason, Shuman,

& Cook, 2013). A review of flipped classroom teaching models in nursing education showed great variation in conceptualizing and operationalizing the model, as well as in student perceptions. The students' concerns were increased workload and distancing from the instructor. However, several of the studies included in this review showed increased course satisfaction (Njie-Carr et al., 2017). A study of students in a psychotherapy class found that 2/3 of the students preferred the flipped model to conventional teaching (Røe, Rowe, Ødegaard, Sylliaas, & Dahl-Michelsen, 2019).

### 2.3. Use of videos in the flipped classroom

Students who receive videos as a supplement come better prepared for the guidance than those who only get text material in advance (De Grazia, Falconer, Nicodemus, & Medlin, 2012). In a study of nursing students at Hawaii Pacific University, 85% thought it was extremely or very useful to watch videos (Critz & Knight, 2013). Videos can be recordings of whole lectures or short clips (Kay, 2012). Students want short videos that engage them (Long, Logan, & Waugh, 2016). Under Cognitive Load Theory, videos should be short and focus on one learning goal, followed by learning activities (Fyfield, Henderson, Heinrich, & Redmond, 2019). A large study from the United States showed that what engages students most is informal, short video recordings with tablet teaching, as well as videos like those at Khan University. They appreciate these videos even more than pre-recorded high-quality lecture videos (Guo, Kim, & Rubin, 2014). However, a study from Norway (Nielsen, 2020) shows that long videos are watched, but in several rounds, not in one.

Video clips are an important resource for teaching the Internet generation, taking advantage of students' different learning strategies so that each student's results improve (Berk, 2009; Johnston, Barton, Williams-Pritchard, & Todorovic, 2018). There are many digital lectures on the Internet, but each lecturer has their own style and it may take a long time to find suitable videos. The time it takes to find a good video online can be as long as the time it takes a lecturer to make their own (Raths, 2014). They can start with simple tools and become more advanced over time (Sams & Bergmann, 2013).

A study from Denmark found that 82% of the students on an anatomy course watched the assigned videos before class. 97% of the students agreed that watching the videos was a good preparation for class activities (Mikkelsen, 2015). 89% of the students in an engineering class watched videos prior to class (Garrick, 2018). Students in a science class were somewhat positive to pre-class videos, but also showed some strongly negative attitudes. The students could not ask questions and they had to spend more time studying outside class than before. These videos varied in length from 20 minutes to 40 minutes (Xiu, Moore, Thompson, & French, 2019).

## 3. OBJECTIVE

The objective of this study is 1) to investigate the differences in students' perceptions of teacher-produced videos as part of a flipped classroom in nursing education and engineering education, and 2) to investigate whether these videos contribute to a good learning environment.

## 4. METHOD

### 4.1. Self-produced videos

The study was conducted in the spring semester of 2016 for the engineering students, and in the autumn semester of 2016 for the nursing students.

There are nine major topics in Control Systems, with two or three videos for each main topic, about 20 videos in total. The students were to watch the videos before the teaching and learning sessions and review the theory, followed by solving problems in the classroom with access to guidance.

In Communication and Norwegian, the students received short videos they watched at home or at the start of the class. During the class, the students worked on different tasks, oral and written, in both Norwegian and English. There are four main topics in the subject, and each topic had three to five videos.

In Anatomy/Physiology, "The senses" was selected as the theme and 18 short video clips replaced four hours of lectures. After watching the videos, the students met in groups for two hours of guidance. The teacher who met the students for guidance was the same teacher who had produced the videos.

Some of the videos were made using software that captures the PC screen, while the lecturer talked. The tool that was used is called Screencastomatic (Screencastomatic, 2021) which can record both audio and video, combined with PowerPoint. Screencastomatic and a camera were used to record the preparation of notes on paper. Other videos in the project were recordings, most often of blackboard teaching, made using a rotating camera. We used a Swivl robot (Swivl, 2018), which is a tool that, in combination with a device such as an iPad, records videos. The Swivl robot is rotatable and can follow the movements of the lecturer, who wears a marker that the Swivl robot follows. A built-in microphone records what the lecturer says. The Swivl robot produces mp4 files, a format that is compatible with most platforms, including smartphones. All the videos used in Anatomy/Physiology were made this way, except for one video made using an animation program. The animation video was made with a Bamboo drawing board with SmoothDraw and recorded using a program that captures what is on the screen. This video was saved as a WMV file, and all the charts used were in versions that are available online for free.

### 4.2. Statistical analysis

To evaluate the project, students answered a questionnaire designed for this study (Table 1). The sample consists of 21 engineering students, 17 nursing students and 17 pre-engineering students. Of these, one engineering student and one student on the pre-engineering course only answered the first three questions, so the sample size for these student groups is respectively 20 and 16 students.

All statistical analysis was done using the *Stata 14* statistical program, except for correlations and graphs which were processed using the *R* statistical program version 3.3.2. Descriptive statistics have been used for all questions. A binomial test has been carried out on the answers to question 4 of the questionnaire, where the students responded to several statements (shown in Table 2). Furthermore, the interrelationship between the various statements in question 4 is examined using Spearman's rank correlations, where the students' response to one of the statements is compared to the response they provided for each of the other statements. Spearman's rank correlation is based on the ordinary properties of a variable, and uses the Spearman's rank correlation coefficient.

The Kruskal-Wallis test was used to investigate whether there are differences between the answers the different student groups gave to questions 1, 2, 3, and 4 in the questionnaires. In this test, the students' answers are ranked together, and the results show the average ranking for each of the student groups. Fisher's exact test was used to analyze the question of whether the students want to replace lectures with videos/guidance on other topics (question 5).

*Table 1.*
*Questionnaire to the students.*

1. **How many hours do you spend on your studies per week? (including time in class, this semester)**
Response options: Less than 20 hours / 20-30 hours / 30-40 hours / More than 40 hours / Don't know
2. **To what extent have you used the videos before the learning sessions?**
Response options: To a very large extent / To a rather great extent / To a rather small extent / To a very small extent / Not at all
3. **To what extent have you used the videos after the learning sessions?**
Response options: To a very large extent / To a rather great extent / To a rather small extent / To a very small extent / Not at all
4. **Below are several statements. Please state to what extent you agree or disagree with these statements. If you have not used the videos, do not respond to the rest of the questionnaire.**
Response options: Totally agree / Partly agree / Indifferent/ Partly disagree / Totally disagree

a) The videos were easy to understand.
b) The videos worked technically satisfactorily.
c) The videos made it easier to understand the subject matter.
d) The videos made me well prepared for the learning sessions.
e) The model with videos and learning sessions is more motivating than lectures.
f) The model with videos and learning sessions gave me greater learning outcomes than lectures.
g) I learn more from regular lectures than from the model with videos and learning sessions.
h) The learning environment during the hours with learning sessions was good.

**5. Do you want to replace lectures with videos and learning sessions in other subjects?**
**Response options: Yes / No / Don't know**

6. **Suggestion for improvements** (Free text reply)
7. **Other comments** (Free text reply)

## 4.3. Ethical considerations

Norwegian Center for Research Data (NSD) found that the project was not subject to ethical review. The students received information in writing and/or orally about the project. The questionnaires were answered anonymously.

## 5. RESULTS

Table 2 shows the combined responses of the groups to questions where the answers are easy to put together. The "completely agree" and "partially agree" responses are combined as "agree", while the "completely disagree" and "partially disagree" options are combined as "disagree". Students who answered "indifferent" or "don't know" are not included.

*Table 2.*
*Student responses.*

| **Questions.** | **Agree % (n)** | **Disagree % (n)** |
|---|---|---|
| The videos were easy to understand | 100 (51) | 0.0 (0) |
| The videos worked technically satisfactory | 98.0 (49) | 2.0 (1) |
| The videos made it easier to understand the subject matter | 100 (47) | 0.0 (09 |
| The videos made me well prepared for the learning sessions | 97.6 (40) | 2.4 (1) |
| The model with videos and learning sessions is more motivating than lectures | 79.4 (27) | 20.6 (7) |
| The model with videos and learning sessions gave me better learning outcomes than lectures | 76.0 (19) | 24.0 (6) |
| I learn more from regular lectures than from the model with videos and learning sessions | 60.7 (17) | 39.3 (11) |
| The learning environment during the hours with learning sessions was good | 100 (41) | 0.0 (0) |

Table 3 shows the differences between the groups. A Kruskal-Wallis test has been performed by grouping the students' responses. For example, for the variable "The videos were easy to understand", "totally agree" has the lowest weight and "totally disagree" the highest weight, and then the average weights shown for the different student groups. As before, the students who answered "indifferent" or "don't know" are not included.

There is a significant difference in how much time students spend on their studies ($p = 0.002$). A p-value less than 0.05 indicates a significant difference. The nursing students spend the most time, the engineering students the least. There is also a significant difference in the use of the videos before learning sessions ($p = 0.000$). Here, the nursing students use the videos more than the two other groups. However, after the learning sessions, the engineering students use the videos more than the other groups, but this difference is not significant ($p = 0.069$). The nursing students are most in agreement with the rest of the statements, with the exception of "I learn more from regular lectures than from the model with videos and learning sessions". The differences between the student groups are significant ($p < 0.05$) for all statements, except for "Videos made it easier to understand the subject matter".

26.7% of the engineering students, 94.9% of the nursing students and 71.4% of the pre-engineering students want to replace lectures with videos and learning sessions in other subjects. *Fisher's exact test* shows that there is a significant difference between the groups for this question ($p = 0.001$). In this test, "do not know" answers are ignored.

*Table 3.*
*Comparison of the different student groups' responses to the questions.*

| **Questions.** | **Group, mean rank.** Lower number values indicate a higher degree of agreement. | | | **Kruskal-Wallis test.** A p-value less than 0,05 is a significant difference. | |
|---|---|---|---|---|---|
| | Nursing | Engineer | Pre-course | Chi-squared | p-value |
| Time spent (hours/week) | 24.0 | 17.8 | 33.8 | 12.47 | 0.002 |
| Use of video before learning sessions | 12.7 | 35.0 | 32.3 | 23.69 | 0.000 |
| Use of video after learning sessions | 30.9 | 20.9 | 30.5 | 5.35 | 0.0069 |
| The videos were easy to understand * | 19.0 | 27.7 | 33.4 | 10.79 | 0.005 |
| The videos worked technically satisfactory * | 20.4 | 29.2 | 29.8 | 6.46 | 0.040 |
| The videos made it easier to understand the subject matter * | 21.3 | 28.7 | 29.5 | 4.63 | 0.099 |
| The videos made me well prepared for the learning sessions* | 15.7 | 30.5 | 30.6 | 14.53 | 0.001 |
| The model with videos and learning sessions is more motivating than lectures * | 19.1 | 32.6 | 26.7 | 7.92 | 0.019 |
| The model with videos and learning sessions gave me greater learning outcomes than lectures * | 19.7 | 31.9 | 25.7 | 7.11 | 0.029 |
| I learn more from regular lectures than the model with videos and learning sessions** | 31.2 | 18.5 | 28.9 | 8.90 | 0.012 |
| The learning environment during the hours with learning sessions was good ** | 20.4 | 24.9 | 33.2 | 6.69 | 0.035 |

Table 4 presents the interrelationships between the statements in question four. They can tell us something about which aspects of the learning model relate to each other, such as whether there are associations between technically satisfactory videos and learning outcomes.

Even though the numbers show that the majority of the students wanted to replace lectures with videos and learning sessions in other topics, it is important to note that there is not a significant majority for all student groups together ($p = 0.121$). The most significant difference between the nursing students and the engineering students is that the number of nursing students who want to continue with the flipped classroom model is much higher. *Fisher's exact test* shows that there is a significant difference between groups for this question ($p = 0.001$). Students who responded "do not know" are not included in this test.

*Table 4.*
*The interrelationship between the statements about the learning model in question 4 of the questionnaire.*

| **Pairing statements together** | | **Spearman's rank correlation coefficient** |
|---|---|---|
| The videos were easy to understand | Technically satisfying videos | 0.66 * |
| The videos were easy to understand | Videos made it easier to understand the material | 0.75 * |
| The videos were easy to understand | Video made me well prepared | 0.58 * |
| The videos were easy to understand | Video / learning sessions more motivating | 0.19 |
| The videos were easy to understand | Greater learning outcomes than lectures | 0.28 * |
| The videos were easy to understand | Learn more from lectures | 0.07 |
| The videos were easy to understand | Good learning environment | 0.49 * |
| | | |
| Technically satisfying videos | Video made it easier to understand the material | 0.79 * |
| Technically satisfying videos | Video made me well prepared | 0.63 * |
| Technically satisfying videos | Video / learning sessions more motivating | 0.42 * |
| Technically satisfying videos | Greater learning outcomes than lectures | 0.35 * |
| Technically satisfying videos | Learn more from lectures | -0.12 |
| Technically satisfying videos | Good learning environment | 0.58 * |
| | | |
| Video made it easier to understand the material | Video made me well prepared | 0.71 * |
| Video made it easier to understand the material | Video / learning sessions more motivating | 0.24 |
| Video made it easier to understand the material | Greater learning outcomes than lectures | 0.45 * |
| Video made it easier to understand the material | Learn more from lectures | -0.03 |
| Video made it easier to understand the material | Good learning environment | 0.53 * |
| | | |
| Video made me well prepared | Video / learning sessions more motivating | 0.45 * |
| Video made me well prepared | Greater learning outcomes than lectures | 0.51 * |
| Video made me well prepared | Learn more from lectures | -0.30 * |
| Video made me well prepared | Good learning environment | 0.55 * |
| | | |
| Video / learning sessions more motivating | Greater learning outcomes than lectures | 0.65* |
| Video / learning sessions more motivating | Learn more from lectures | 0.047* |
| Video / learning sessions more motivating | Good learning environment | 0.25 |
| | | |
| Greater learning outcomes than lectures | Learn more from lectures | 0.44* |
| Greater learning outcomes than lectures | Good learning environment | 0.39* |
| | | |
| Learn more from lectures | Good learning environment | -0.05 |

**Indicates significance of at least 5%.*
*Each line in the table shows the Spearman's rank correlation coefficient for the relationship between the students' responses to two of the statements. The Spearman's rank correlation coefficient is between -1 and 1, where -1 means that the students provide completely opposite responses to two questions, 0 means that there is no association between the responses to the two questions, while 1 means that there is full correspondence between the responses to those two questions. All correlations calculated are for the 52 participants who answered all the above questions.*

## 6. DISCUSSION

The objective of this study is to investigate the difference in students' perceptions of teacher-produced videos as part of a flipped classroom in nursing education and engineering education, and to investigate whether these videos contribute to a good learning environment.

First, not all topics provide suitable content for an educational video. In the end, teachers must decide what could work in a video for their students. The technology must not be in control (Sams & Bergmann, 2013). As regard the scientific usefulness of the videos, our study found that the students thought the videos were easy to understand and that they made it easier to understand the subject matter. They also believed that the videos were good preparation for the learning sessions. This result corresponds with earlier findings (De Grazia et al., 2012; Garrick, 2018; Mikkelsen, 2015) The length of the videos may have contributed to their increased usefulness, as they were rarely longer than six to eight minutes and usually dealt with only one theme. For example, in anatomy, one video was about the sense of smell and another video about the sense of taste, each being about three minutes long. Students prefer short videos, preferably about just one topic at a time (Fyfield et al., 2019; Long et al., 2016). However, long videos are watched, but not in one go (Nielsen, 2020).

Technical issues are one of the main reasons why videos are not used (Kay, 2012). The videos must be easy to play and in a format that works on different platforms, including smartphones (Garrick, 2018; Heimly & Bertheussen, 2016). Our study shows a clear correlation between the videos being technically satisfactory, easy to understand and making it easier to understand the subject matter. This does not mean, however, that it is necessary to strive for a flawless recording. Our opinion is that the videos must be of sufficient quality, but they do not need to be perfect. Teaching situations are not usually perfect either; a lecture is not streamlined, errors are made, and some time is wasted (Heimly & Bertheussen, 2016). The videos in our study were made with easily accessible tools that a teacher can operate without the assistance of others, and the students, overall, clearly stated that these videos were technically satisfactory. This is in line with what previous research and experience have shown (Guo et al., 2014). Expensive and advanced equipment are not necessary for making videos that work well technically (Sams & Bergmann, 2013). Videos recorded with simple and inexpensive equipment and where the teacher has good eye contact with the viewer can be more engaging for the students than videos produced in a professional studio (Guo et al., 2014).

A flipped classroom is not primarily about the videos themselves. The relationship between teacher and students and how time is spent in the classroom are crucial factors (Blair et al., 2016; Estepp & Roberts, 2015; Sams & Bergmann, 2013). This means that the learning environment in the classroom is important for how well the model works. A significant majority of the students in our study agreed that the learning environment during the learning sessions was good. None of the students disagreed. We must be cautious about discussing the reasons for this, as we did not ask the students why they perceived the learning environment as good. However, for the nursing students, one reason may be that the class was divided into smaller groups, which may have led to a better relationship between the students and instructor and lowered the threshold for speaking and asking questions. According to earlier research, these are reasons why students favor this model over traditional lectures (Steen-Utheim & Foldnes, 2018).

The connection between the videos and the classroom context is important, and it is interesting to look at how the videos affect the content of the learning sessions. Success is not about the videos alone, but how they operate in combination with sessions in class (Steen-Utheim & Foldnes, 2018). For all the student groups in our study, there are significant links between the videos being technically satisfactory and easy to understand, and how the videos provide the students with good preparation for the learning sessions. Our study also showed correlations between a good learning environment and the videos being satisfactory, both academically and technically. These factors may contribute to the videos functioning in symbiosis with the in-class sessions. Our study also showed that students felt they had better

learning outcomes if the videos were easy to understand, technically satisfactory, and helped the students understand the material better. Other studies show that use of videos is motivating (Berk, 2009; Kay, 2012) and the students in our study who believed that video is more motivating were largely the ones who experienced greater learning outcomes through using videos than by attending lectures.

Although all student groups provided good feedback, there are significant differences between the groups. The nursing students were more likely to watch videos before the learning sessions than the engineering students were. It is therefore not surprising that more nursing students expressed that they felt this was a good way to prepare for the learning sessions. This is consistent with earlier studies which show that nursing students thought it was very useful to watch videos before class sessions (Critz & Knight, 2013; Mikkelsen, 2015). When it comes to the engineering students, our findings contrast with Garrick (2018), who found that 89% of engineering students watched videos prior to class (Garrick, 2018).

Video clips can make a difference to the students' motivation and attitude to the subject (Berk, 2009; Johnston et al., 2018), and a clear majority of nursing students in our study thought the use of videos was more motivating than lectures. The nursing students were also generally the most satisfied with the videos, and more likely to agree that the videos were easy to understand and technically satisfactory than the other two student groups. The nursing students also expressed a higher level of agreement with the videos and learning session model providing better learning outcomes than lectures, while only a minority of engineering students agreed. This contrasts with earlier studies that showed that the benefit of a flipped classroom model may be greater for engineering students than for students in health sciences (Strelan et al., 2020). Unlike the nursing students, only a minority of engineering students believed that the model in our study was more motivating than lectures.

The nursing students reported that they were more likely to watch the videos before class than the other students were. One explanation may be the way the videos were made, which is linked to the specifics of the subjects (Kay, 2012). Anatomy is a visual subject, with many illustrations that can work well in a video. The anatomy videos for nursing students were short and made using a camera to record tablet teaching. The satisfaction of the students in our study with this video format corresponds to a major review of flipped teaching in the United States, which showed that short, informal tablet recording videos are the most engaging (Guo et al., 2014).

The engineering students were generally more inclined to have lectures than the other student groups, and there are a range of reasons why students prefer lectures rather than videos (Kay, 2012; Njie-Carr et al., 2017; Xiu et al., 2019). One reason why many of the engineering students in our study preferred lectures may be that they are most accustomed to blackboard teaching, and that the videos do not reflect the usual teaching situation. Working with control systems includes many mathematical calculations, and most videos were recordings of calculations on paper without the video showing a picture of the lecturer (talking head). The students want to both see and hear lecturers, so that the videos become more similar to other teaching situations (Guo et al., 2014; Sams & Bergmann, 2013).

The nursing students, more than the engineering students, wanted to replace more of the lectures with videos. The difference between the student groups is significant. We theorized that the engineering students, who are more technically oriented, were more accustomed to finding and using videos in their studies. There are many videos on YouTube about most technical topics, and videos support multiple learning strategies (Berk, 2009). Based on this, we assumed that the engineering students would prefer their study material in video format. Previous studies have found that engineering students preferred videos (Garrick, 2018) and that the effect of the flipped classroom seems to be stronger for

engineering sciences than the health sciences (Strelan et al., 2020). The results of our study, however, were different. If we see the students' responses to this question in association with their responses to other questions, this is not as surprising as it might be at first glance. One explanation could be how technically satisfactory the videos are; while all the students were satisfied with the technical level of the videos, the nursing students were more satisfied than the engineering students. This could be because of the technical differences between the videos, but it could also indicate that the engineering students, with their technical competence, have higher expectations for technical quality than the nursing students. Another potential explanation could be the format of the videos. As mentioned previously, engineering students are mostly accustomed to blackboard teaching, while most of the videos showed recordings of computer screens or notes. Videos should therefore look more like the usual teaching situation and visualize the material in a good way (Guo et al., 2014).

### 6.1. Limitations of the study

The size of this study is a limiting factor. Another factor that creates uncertainty is that participation in the learning sessions for engineering students and nursing students was not compulsory, and we do not have exact figures for how many people participated. Therefore, we do not have exact figures for the number of questionnaires received in relation to how many people participated in the actual learning sessions. 41 engineering students and 76 nursing students were enrolled for the final exam, but the response rate cannot be calculated based on these figures because the classroom teaching was not compulsory. Another weakness is that we did not use a questionnaire that had been previously validated.

## 7. FUTURE RESEARCH DIRECTIONS

The experience from this study will provide a platform for our future work. We will make videos that will better support the learning process and we will experiment with new tools to further increase our experience. For engineering education, more visual videos with talking heads will be made, corresponding to previous experiences. Expanding the project with professors and student groups from other programs may be relevant, as well as establishing an interdisciplinary research group with participants from all the university's campuses. Future research should investigate ways of producing videos in the engineering sciences and health sciences which, in combination with classwork, enhance the learning process.

## 8. CONCLUSION

In this study, we have investigated differences in students' perceptions of teacher-produced videos as part of flipping the classroom for nursing students, engineering students, and students on a preparatory engineering course. We have also investigated whether these videos contribute to a good learning environment.

The results indicate that there is a connection between the standard of the learning environment and the satisfactory functioning of the videos, both academically and technically. Motivation affects learning, and the students who thought that the model with videos was more motivating than lectures are largely the same as those who experienced greater learning outcomes.

All student groups perceived the learning environment as good, although there were differences. The nursing students were more satisfied with the videos and learning sessions than the engineering and pre-engineering students. Compared to the other student groups, the

nursing students believed that the flipped classroom model provided greater learning outcomes and was more motivating than normal lectures.

The nursing students watched videos before learning sessions to a greater extent than the two other student groups and wanted to replace more lectures with videos. One reason for this may be that the nursing students watched more visual videos than the other student groups.

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