STUDENTS' EXPERIENCES WITH SHORT VIDEOS IN A FLIPPED CLASSROOM DESIGN IN PHYSICS

K. B. Rolstad [1]
Department of Physics, Norwegian University of Science and Technology
Trondheim, Norway
orcid.org/0000-0003-3223-5165

T. H. Andersen
Department of Physics, Norwegian University of Science and Technology
Trondheim, Norway
orcid.org/0000-0002-4726-9686

Conference Key Areas: *Physics and Engineering Education, Teaching methods*
Keywords: *Flipped classroom, Short videos, Teacher collaboration, Physics, Multicampus*

ABSTRACT

We have implemented a methodology for using short videos as a part of a flipped classroom design in an introductory, multi-campus physics course for engineering students. These pre-recorded videos introduced theory and concepts to students ahead of in-class sessions, which enabled a reduction in the time used for traditional lectures. The time spent in classes puts emphasis on student activities, such as quizzes, Q&A sessions with the lecturer answering student-submitted questions, and problem solving.

[1] *Corresponding Author*
K. B. Rolstad
knut.bjorkli@ntnu.no

doi:10.5821/conference-9788412322262.1314

The physics course has a modular design for customized delivery to a multitude of study programmes and is coordinated by a team of teachers who provide localized classes at several campuses. Although teachers manage individual classes, the course uses an open learning environment which allows enrolled students access to all study materials published by any teacher.

We present results from a questionnaire investigating student experiences with the use of short videos, by measuring the overall level of satisfaction with the videos, as well as collecting students' comments to the videos. We investigate correlations between student satisfaction with the videos and the comments they make, and whether students whose teacher is featured in the video are more satisfied than students without a personal relationship with the featured teacher.

Students report overall satisfaction with video length and level of precision, while requesting more worked examples and detailed calculations. We identify a set of good practices for flipped classroom designs, based on the students' feedback.

1 INTRODUCTION

Active learning is found to promote students' performance in science, engineering, and mathematics compared to traditional lecturing [1]. A controlled study comparing students' self-reported perception of learning in an active learning environment with a traditional one showed that the students attending the active learning classroom learn more, but feel they learn less [2]. One way to implement active learning is through a flipped classroom design where students watch videos introducing new content before class and in class students are engaged in activities such as quizzes, Q&A sessions with the lecturer answering student-submitted questions, and problem solving. A recent study of students' perception of videos in introductory physics courses for engineering study programs showed that including videos in physics increases the probability of passing the course [3].

The focus of this paper is students' self-reported experiences with "low-budget", short videos used for introducing theory and concepts in an introductory physics course for engineering students, using a flipped classroom approach. The videos were "low-budget" in the sense of using a basic setup of recording a teacher writing notes on an interactive display. Furthermore, preparation time could be minimized because the teacher was intimately familiar with the course curriculum, being a member of the team of teachers delivering the course, and having taught the course earlier.

In our investigation we posed the following research questions:

How do students perceive the videos and what is the correlation between students' reported satisfaction with the videos, and the comments they give as feedback?

What is the effect of having your own teacher producing the videos, as opposed to a video produced by someone else?

2 BACKGROUND

The focus of this paper is a compulsory introductory physics course for engineering students, which is taught in parallel across three campuses by a team of six teachers (subsequently anonymized as teacher A-F) for a total of approx. 1000 students. The inaugural run of the course coincided with the outbreak of the COVID-19 pandemic in 2020, which enforced a digital transition of the course delivery. Building on experiences gained during the "emergency remote teaching" phase [4], a flipped classroom design was implemented in 2022. In this design, students watched short videos ahead of sessions, which introduced physics theory and concepts. The in-class/synchronous sessions (i.e., digital, physical or hybrid) briefly recapitulated key points from the videos, before proceeding to active learning activities like quizzes and problem solving.

The videos were 5-10 minutes in length and were produced by one member of the teacher team. The videos used a simple, inexpensive format which enabled rapid production: The teacher filled in partially pre-written notes on a table-mounted interactive display, with audio narration - only a small number of videos showed the teacher. A screenshot of one of the videos is shown in Fig. 1 below:

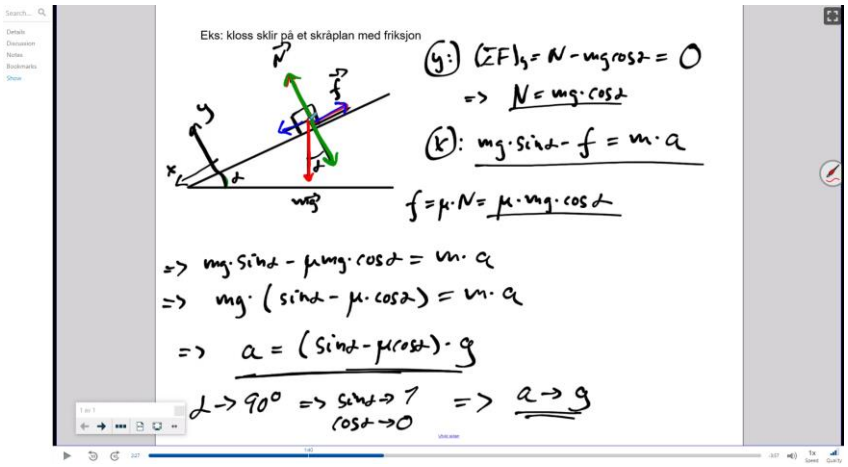

Fig. 1. Screenshot of one of the videos

Although all the involved teachers covered the same curriculum using the same set of videos, there was some variation in how in-class sessions were conducted: Some classes were given digitally; some in medium-sized classrooms; some in large lecture theatres. Furthermore, individual teachers had considerable autonomy in choosing how to present or approach any given subject during in-class sessions.

3 METHODOLOGY

3.1 Data collection

Data was collected by means of an anonymous online questionnaire, as part of a course evaluation from which only the subset of the questions regarding the videos is addressed in this paper. The questions, none of which were mandatory, were formulated as follows:

- What was your level of satisfaction with the videos? (Likert scale 1-5)

- How have you used the videos? Options: Preparation ahead of sessions/ Repetition or recap between sessions/ Aid for doing assignments and exercises/ Not used videos/ Have you used the videos in other ways than listed above? (Text answer)
- Satisfaction with teacher instruction in synchronous sessions (Likert scale 1-5)
- What worked well/less well with the videos? Suggestions for improvement? (Text answer)

3.2 Analysis

Likert-scale questions were analysed to check whether means between different student populations differed significantly, using an Aspin-Welch t-test [5]. The qualitative answers to how the videos had worked were coded inductively [6]. Codes were derived from the data and afterwards gathered into the three categories: *Appreciating short and precise videos*, *Wishing for more structure and better legibility*, and *Wishing for more examples.* To make a systematic overview, these three categories were correlated to the students' Likert scale answers of their overall satisfaction with the videos.

4 RESULTS

4.1 Student satisfaction with the videos

This section details the students' answers to the questionnaire. A total of n=259 students completed the survey, corresponding to a response rate of approx. 26 %.

The distribution of scores awarded to the videos by the students, on a 1-5 Likert scale, is shown in Fig. 2 (n = 246):

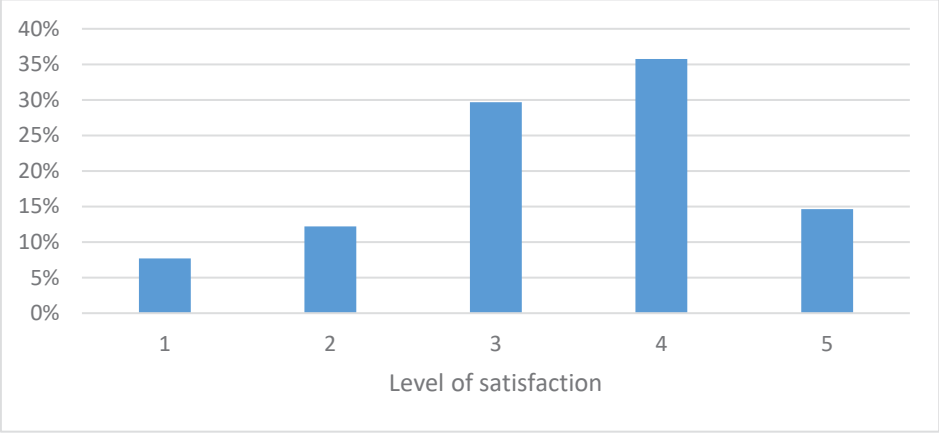

Fig. 2. Student answers to the question "What was your level of satisfaction with the videos?" (1-5 Likert scale; 1 = very dissatisfied, 5 = very satisfied)

The questionnaire did not specify which criteria the students should use to indicate the level of "satisfaction" with the videos, so implicitly Fig. 2 is a measure of "general student satisfaction", incorporating aspects like video and audio quality, clarity of the presentation, and the perceived learning effect. With an average score of 3,4 and a standard deviation of 1,1, students were generally satisfied with the videos.

4.2 Students' usage of the videos

The flipped classroom approach was presented to the students at the beginning of the term, with particular emphasis on how the students were expected to use the videos to prepare for sessions.

The various usage scenarios for the videos are summarized in Fig. 3 below:

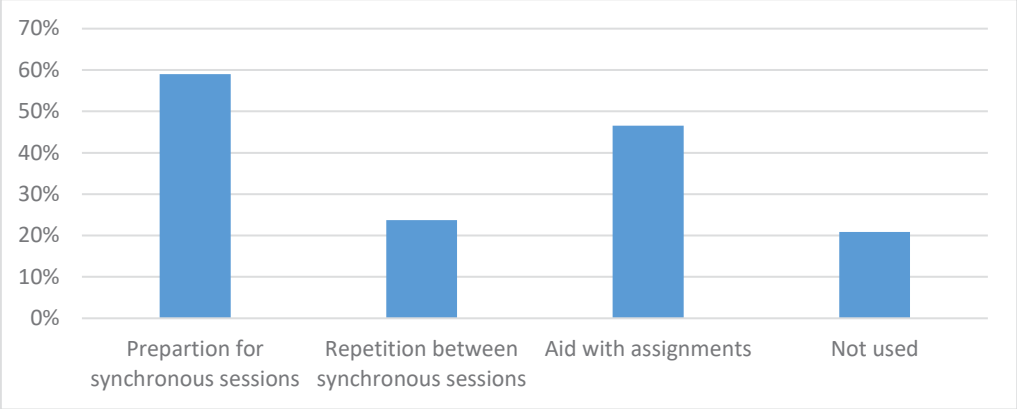

Fig. 3. Student answers to the question "How have you used the videos?"

In this respect, Fig. 3 above shows that some 60 % of the students used the videos "as intended".

Additionally, a significant proportion of students used the videos for repetition between synchronous sessions, and as an aid with assignments. No additional use cases were identified by the open question.

4.3 The effect of having your own teacher producing the videos

Of the six teachers in the teaching team, only teacher A was featured in the videos. Teacher A also gave synchronous sessions like the rest of the team, and was thus a "familiar face" for a subset of the students. The respective levels of satisfaction with the videos of teacher A's students vs. students taught by teachers B-F are shown in Table 1 below:

Table 1. Student level of satisfaction with videos: featured teacher (A)'s students vs. students taught by other teachers (B-F), as well as teachers B-F combined

Teacher	A	B	C	D	E	F	B-F
Student's level of satisfaction with the videos (1-5 Likert scale)	4,1	3,0	3,0	3,4	3,1	3,3	3,2
Standard deviation	0,9	1,2	1,2	1,1	1,2	0,9	1,1
No. of students	48	36	14	30	42	76	196

As shown in Table 1, teacher A's students and B-F's students have average levels of satisfaction of 4,1 and 3,2, respectively. Employing the Alpin-Welch test to compare averages, assuming independent populations with unequal population standard

deviations, the observed difference is indeed statistically significant (p-value = $1{,}3 \cdot 10^{-7}$).

To investigate possible origins of the observed difference in level of satisfaction with the videos, data for the reported levels of satisfaction with teacher instruction in the synchronous sessions were compiled into Table 2 below:

Table 2. Students' level of satisfaction with teacher instruction for teachers A-F, and B-F combined

Teacher	A	B	C	D	E	F	B-F
Student's level of satisfaction with teacher instruction (1-5 Likert scale)	4,1	2,9	2,6	4,0	3,6	4,2	3,7
Standard deviation	1,0	1,2	1,1	0,8	1,0	0,9	1,1
No. of students	50	39	16	30	44	80	209

While teacher A was indeed highly rated, teachers D and F were given similar high ratings by their students – and so perceived teaching ability does not explain the difference in student satisfaction with the videos in Table 1.

The physics class consisted of both 1st-year and 2nd-year students, the latter of whom were familiar with a flipped classroom approach in an earlier course. The Alpin-Welch t-test found no statistically significant differences in the level of satisfaction between 1st- and 2nd-year students (p-value = 0,66).

4.4 Students' comments to the videos

The students' comments to the question, What worked well/less well with the videos were categorised into the three categories, *Appreciating short and precise videos, Wishing for more structure and better legibility*, *Wishing for more examples.* These categories are described in the following.

Most students who write comments appreciated the fact that the videos are short and precise: "*The videos are concrete and give an overview of the most important things, I like that very much", "Nice introduction to the topics",* or *"I like that the videos are short".* Students considered the videos "information-dense" and would sometimes pause the videos: *"A lot of learning in a short time".* The students also appreciated that the videos *"Are right to the point and explain the content in a good way".* The students favourably compared the short videos with much longer videos used in other courses, in which the length (from 25 minutes up to 2 hours) would make students lose focus and induce boredom.

Students were ambivalent about the teacher narrating and writing over pre-written notes: It was appreciated that this helped keep the videos short, but negative student comments to this approach were gathered into the second category: *Wishing for more structure and better legibility.* Students in this category commented on a lack of structure in the videos, and the use of handwritten notes: *"It is very nice that the*

videos are so short, but it is difficult to follow when the text is already written, and the teacher only explains what is written". The handwriting itself was criticized by some: "*The handwriting is messy".* Other criticized the structure of the video: *"I do like the concept of flipped classroom, …, I find the videos chaotic, and they are overwhelming when you do not know the content. I feel the videos are more suited for repetition after the live sessions, not as preparation"*. Students who were focused on applications rather than understanding of physics commented e.g., *"It is difficult to follow the short videos, and it is unclear which of the formulas that are useful"*.

Comments in the last category, *Wishing for more examples,* opined that videos should contain more worked problems and examples: *"I think the videos should contain calculation exercises as well as more thorough explanations",* and *"It would have helped with more practical examples"*. These comments indicate that students would have liked to see worked problems and calculations in the videos, contrary to our intentions of using the videos to introduce the theory, while using the synchronous sessions to work on problem sets.

Correlating student comments within the three categories with the level of satisfaction with the videos, gives the distribution shown in Fig. 4:

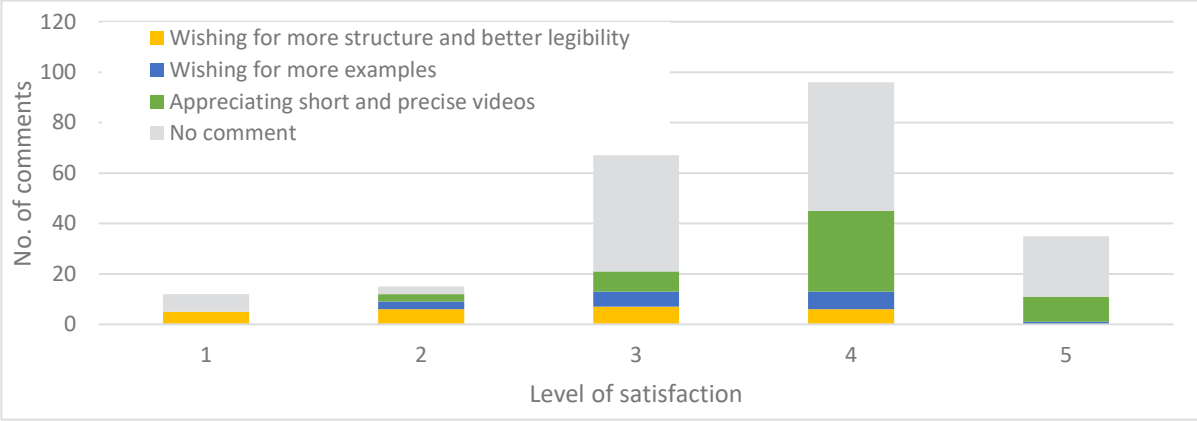

Fig. 4. Students' comments categories grouped by answer to the question "What was your level of satisfaction with the videos?" (1-5 Likert scale)

Dissatisfied students (score = 1) all belong in the category Wishing for more structure and better legibility, whereas "reasonably satisfied" students (score 2-4) are present in all three categories. Higher levels of satisfaction correlate with greater appreciation for short and precise videos. Note: A single student's comment can contribute to more than one category.

4.5 Students' suggestions for improvements

Students felt that structure could be improved by *"Handwriting text and calculations live instead of using pre-written text"*, and that the tradeoff in terms of *"It takes a little more time"* would be worthwhile.

Some students suggested that videos contain a list of recommended textbook exercises, relevant to the theory presented in the video, at the end.

A few students reported a dislike for the flipped classroom approach altogether, in favour of traditional lectures – in line with findings in [6], where flipped classroom is found to be less advantageous for certain groups of students.

5 DISCUSSION

5.1 General analysis

Overall, the students were satisfied with the videos, highlighting their short duration and precise, to-the-point presentation. Except for the students most satisfied with the videos, students across all satisfaction levels suggested improving the video structure, to make it easier to understand the logic of the learning material.

Comparing Tables 1 and 2, we conclude that familiarity with the teacher featured in the video, rather than exceptional instructional skills, is key to student satisfaction.

5.2 Suggestions for good practice in video-led flipped classroom designs

Based on Fig. 4 and the students' comments on the videos, we can suggest certain good practices for flipped classroom designs:

- A simple, low-cost setup with a digital writing surface (e.g. interactive display or tablet) is enough to produce videos of adequate quality.
- Video length vs. legibility: Keep videos short, but avoid static slides. Spending some extra time to write live text will increases legibility and makes it easier for students to follow the logic of the presentation.
- Video structure: Give a very brief overview of the video at the beginning, and point the students towards further study material (e.g. exercises) at the end.
- If the students are unfamiliar with the methodology, the teacher should demonstrate how to work with the videos by showing the first few of them in the classroom. Additionally, students need to be repeatedly reminded how they are expected to work outside the synchronous sessions, and the rationale behind the chosen approach.

5.3 Study limitations

The authors are aware of several methodological limitations to this study:

- The 26 % response rate is low.
- 20 % of the students participating in the survey, reported not using the videos.
- Even though the research questions focused on the videos and pedagogical approach in which they were used, it's difficult to decouple the significance of individual teacher performance during the synchronous sessions.

6 ACKNOWLEDGMENTS

The authors are grateful to all students who participated in the survey, and they also wish to thank all the members of the teacher team for their cooperation. We also thank reviewer 2 for providing constructive feedback that helped us clarify the last point in section 5.2.

REFERENCES

[1] Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., Okoroafor, N., Jordt, H. & Wenderoth, M. P. (2014). Active learning increases student performance in science, engineering, and mathematics. *Proceeding of the national academy of sciences of the United States of America, 111*(23), 8410–8415. https://doi.org/10.1073/pnas.1319030111

[2] Deslauriers, L., McCarty, L. S., Miller, K., Callaghan, K., Kestin, G. (2019). Measuring actual learning versus feeling of learning in response to being actively engaged in the classroom, *Proceedings of the National Academy of Sciences*, *116*(39), 19251-19257. https://doi.org/10.1073/pnas.1821936116

[3] Perez-Navarro, A., Garcia, V., Conesa, J. (2021). Students perception of videos in introductory physics courses of engineering in face-to-face and online environments. *Multimedia Tools Applications 80***,** 1009–1028. https://doi.org/10.1007/s11042-020-09665-0

[4] Andersen, T. H., Rolstad, K. B., Korpås, G. S. (2020). Designing good practices for teaching and managing multi-campus courses. Proc. of the conference, 48th SEFI conference, 601-608.

[5] Illowsky, B., Dean, S. (2013). Introductory statistics, OpenStax, https://openstax.org/books/introductory-statistics/pages/10-2-two-population-means-with-known-standard-deviations

[5] Robson, C. and McCartan, K. (2016). Real world research. (4th ed.) John Wiley & Sons Ltd.

[6] Setren, E., Greenberg, K., Moore, O., Yankovich, M. (2021). Effects of Flipped Classroom Instruction: Evidence from a Randomized Trial, *Education Finance and Policy*, *16*(3), 363-387. https://doi.org/10.1162/edfp_a_00314