EXPLORING INTERACTIVE H5P VIDEO AS AN ALTERNATIVE TO TRADITIONAL LECTURING AT THE PHYSICS PRACTICUM

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Abstract

Interactive learning materials can be a more efficient and engaging way of studying physics than lecturing. This research aims to explore the use of interactive H5P video as an alternative to traditional teacher-led class presentations at the university physics practicum. The quasi-experimental research design was implemented with 60 undergraduate students at the University of Latvia, during two introductory-level practical laboratory classes on the topics of mechanical bending and fluid viscosity. Knowledge tests were used to assess the learning outcomes, classroom observations provided an insight into students' group work with the video, a survey revealed student attitudes to the H5P video, as well as their preferences in preparation for the physics classes. Results show that both presentation formats contributed to reasonably high scores in the Exit ticket test at the end of the class. No statistically significant differences were found between the groups working in different conditions, implying that video was successfully used for a group activity to substitute lecturing in preparation for laboratory work. Potential applications of H5P video for individual and group work are discussed in line with the student preferences.
Keywords: *H5P, educational technology, interactive video, mixed methods, physics laboratory*

Introduction

Interactive methods and active learning through discussion with peers have been long recognized to be a more efficient way of learning physics than traditional methods, such as lecturing with a teacher standing in front of students and presenting information (Hake, 1998). Interactive methods flourished with the development of educational technology; multimedia tools, such as computer-based *PhET* simulations, *YouTube* videos, various quiz apps etc., have a positive effect on learning outcomes and attitudes. For example, compared to traditional lecturing, multimedia visualization can make students enjoy learning quantum physics (Nyirahabimana et al., 2023).

Video is advantageous for meaningful learning because dynamic visualization and narration output load both visual and verbal channels in the learner's information system (Mayer, 2009). On the downside, one risk associated with video in the educational process is passive watching (Richtberg & Girwidz, 2019). Higher engagement and knowledge acquisition have been reported for videos segmented in shorter clips (Guo et al., 2014), as well as videos with questions and visuals (Kestin & Miller, 2022). Some

https://doi.org/10.33225/BalticSTE/2023.111

general principles for effective educational videos (Brame, 2016) have been summarized on account of educational research, in particular, cognitive learning theories (Mayer, 2009). Furthermore, empirical insights have been formulated for specific applications, such as Massively Open Online Course (MOOC) lectures (Guo et al., 2014) or physics laboratory works (Lewandowski et al., 2019).

Appropriate design video can be as efficient for knowledge acquisition as traditional formats of learning materials, such as live lectures (Brockfeld et al., 2018) or printed text (Merkt et al., 2011). Yet the usefulness of video compared to the traditional formats remains debatable among teachers and learners. One reason why many prefer text over video can be that a text document is easier for skimming information and self-regulating their learning (Alexander, 2013). Probably, interactive video with advanced navigation and automated feedback might be able to compete with textual and lecture instructions better than traditional video.

Interactive video or *hypervideo* is a video, enriched with interactive features, such as hyperlinks, navigation controls, pop-up questions etc. Technically it is a traditional video with a layer of interactive content added in the post-production process, for instance, using *H5P* technology (www.h5p.org). *H5P* is licensed under the MIT license; it is free and open-source, easy to use, and has integrations in popular learning management systems, such as *Canvas*, *Blackboard* and *Moodle*. According to preliminary research (Richtberg & Girwidz, 2019), *H5P* video can find applications for physics learning in various contexts. To date, empirical studies on the *H5P* tool for learning physics at university are limited to a few (see e.g., Chong et al., 2019; Desai & Kulkarni, 2022; Kosmaca & Siiman, 2023).

In the current study, interactive *H5P* videos were designed for a group activity with discussion in class to explore how preparing with an *H5P* video in contrast to traditional lecturing may influence learning outcomes, how students interact with the video presentation in a group, and how they perceive learning with *H5P* video in general. Ultimately, the aim of this research was to explore the suitability of interactive *H5P* video as a tool for learning physics at the university. The following research questions (RQ) were formulated:

- RQ1: Can interactive *H5P* video of a pre-recorded presentation be as sufficient as a traditional class lecturing for achieving learning outcomes of practical work in physics?
- RQ2: How do students interact with an *H5P* video presentation during physics class?
- RQ3: What are student perceptions of *H5P* video in context with their learning preferences?

Research Methodology

General Background

The mixed-method quasi-experimental research design was used to assess the use of interactive video with groups of students at the University of Latvia. Pre-recorded interactive *H5P* video presentations were introduced in the physics practicum to prepare students for laboratory work in person, as an alternative to class presentations used in the traditional lecturing approach (further referred to as traditional presentations). Data were collected via pre-and post-tests, classroom observations during regular practical classes in physics and student surveys. The scope of this study was limited to the first-year undergraduate students enrolled in the biology and biotechnology study programs, who participated in the regular practical laboratory classes in physics during the first semester of the academic year 2022/23.

Sample

Convenience sampling was used to select the research sample from the students taking practical laboratory classes as a part of their mandatory introductory-level physics courses. In total, 60 students (39 female, 21 male) took part in the study from September-December 2022. There were 25 biotechnology students in the Biophysics course and 35 biology students in the Physics for Natural Sciences course that participated in this research. They belonged to five study groups, coded as 1A, 2A, 3B, 4B, 5B. Participants were informed about the research at the beginning of the semester, before the class with *H5P* and at the end of the semester; in oral form and via written informed consent. Students were informed that their knowledge test scores would not impact the course results or relationship with teachers and that participation was voluntary. Attitude surveys were anonymous.

Instrument and Procedures

Knowledge tests and self-report questionnaires were the main instruments used to assess the knowledge acquisition and perception of interactive *H5P* video, they were supported by qualitative classroom observations.
First, at the beginning of the semester, students were administered two paper-based pre-tests.

1. The Half Force Concept Inventory (HFCI1) pre-test (Han et al., 2015), which consists of 14 multiple-choice questions, is based on the Force Concept Inventory (FCI) test (Hestenes et al., 1992). It is a recognized instrument for measuring the understanding of fundamental concepts in Newtonian mechanics.
2. In addition to the HFFCI1, students completed a test with 18 multiple-choice questions, which covered specific learning outcomes of the practical laboratory classes in the course (e.g., how to assess measurement uncertainties, how to experimentally determine the viscosity of a liquid using the Stokes method etc.). The questions were reviewed for face validity by four physicists experienced in teaching the course.

Next, during the classes with the *H5P* video, teachers observed the group work and took notes about students' interactions throughout the activity. At the end of the class, participants were asked to complete paper-based Exit ticket tests, which contained 10 True/False statements about the class topic. The Exit ticket items were created and reviewed for face validity by the course teachers. Finally, at the end of the semester, participants were asked to fill in anonymous questionnaires distributed via electronic *MS Forms*.

https://doi.org/10.33225/BalticSTE/2023.111

Interactive H5P Video Presentations

Interactive *H5P* video presentations were designed for two topics corresponding to introductory-level physics laboratory: Bending, where students explore the mechanical properties of a solid material in a three-point bending test, and Viscosity, where they determine the viscosity coefficient of a liquid material by the Stokes' method.

The teachers' created class presentation slides (*MS PowerPoint*) were used for the traditional live talk and as a base for interactive *H5P* video presentations. For each of the presentations (Bending and Viscosity), the teacher recorded the slides with her voiceover. Then the video was edited (*DaVinci Resolve*) and posted on *YouTube*. The total length of the video clips was 11 minutes for Bending and 13 minutes for Viscosity. An interactive layer was added to the *YouTube* video using the *H5P* plugin in *Moodle*. The interactions (multiple-choice questions with automated feedback, forced stops, labels and external hyperlinks) split the timeline of the video into 1-2-minute-long segments. The final presentations were posted on the course page in *Moodle*, where they could be accessed by the course participants.

The presentations were tested with students during regular 90-minute classes. At the beginning of the class with an interactive *H5P* video presentation teacher announced that instead of her conventional talk, there was a pre-recorded presentation. The task for the students would be to watch the presentation together and give their group answers to the questions appearing on the screen during the presentation. The video was accessed from *Moodle* on the class computer and projected on the big screen typically used for the demonstrations and class presentations. One student, who agreed to moderate the activity, had the computer mouse to control the video and interact with the questions appearing on the screen. Others were listeners, who could participate in discussions. The teacher, though she stayed in the class, did not interfere with the group during the activity, and only took the notes. After the video presentation ended, students were asked about any remaining uncertainties and were allowed to conduct their laboratory work in small groups. At the end of the class, they were asked to complete the paper-based Exit ticket.

Data Analysis

Individual scores of the students participating in the pre-tests (the HFCI1 and the laboratory learning outcome test) and post-tests (Exit tickets) were calculated from the response values 0 (Incorrect) or 1 (Correct). The values for the mean score and standard deviation were determined from the individual total scores, which indicate the proportion of correct answers. The group scores were compared using a two-tailed Mann-Whitney U test with the significance level set to .05. The responses to the questionnaire were converted from a 5-point Likert scale to values from 1 (Strongly Disagree) to 5 (Strongly Agree).

Research Results

Effectiveness of Interactive H5P Video for Achieving Learning Outcomes

The scores of the HFCI1 pre-tests were in the interval 29-30% for the two A groups and 18-27% for the three B groups, matching typical results for non-calculus-based groups (18-37%) at the University of Latvia (Cinite & Barinovs, 2021). The results of the laboratory learning outcome pre-test for the two A groups (50%) were slightly higher than for the three B groups (35-42%).

Quantitative analysis of the Exit ticket scores compared the groups of students in terms of their conceptual understanding of the two physics practicum topics (Bending and Viscosity) at the end of the class. Table 1 summarizes the group scores on Bending, which was tested first with the A1 and A2 groups. Both groups achieved relatively high scores (76% and 81% out of 100%); the mean score for Interactive video presentation was slightly higher than for Traditional live presentation. There was no control group; yet two students were absent on the day of the class and performed the bending experiment separately, without any presentation. After just the practical measurements, the Exit tickets scores (proportion of the correct answers) for these two students were only 10% and 30%, much lower than for any of the students working with the class presentation.

Table 1

Exit Ticket Group Scores in the Practical Class on the Topic of Bending

Condition	Group	*M* (*SD*), %
Traditional live presentation	1A (n = 10)	76 (16)
Interactive video presentation	2A (n = 9)	81 (11)

Note: Mean scores (*M*) represent the proportion of the correct answers to True/False statements. *SD* – standard deviation.

For the second practical work (Viscosity), the conditions were swapped: 1A group worked with an interactive *H5P* video but 2A received a traditional class presentation. Here the mean score of the group on the Interactive video condition was again higher compared to the other group (Table 2) as well as to themselves working with the traditional class presentation on Bending (Table 1). Mann-Whitney U tests were performed to evaluate whether the group 1A and 2A Exit ticket scores differed. The results indicated that there was no significant difference between the Bending scores ($U = 37$, $p = .56$), as well as the Viscosity scores ($U = 82$, $p = .16$) of 1A and 2A. The result is not significant at $p < .05$.

Table 2
Exit Ticket Group Scores in the Practical Class on the Topic of Viscosity

Condition	Group	*M* (*SD*), %
Interactive video presentation	1A (n = 11)	83 (18)
Traditional live presentation	2A (n = 11)	71 (18)
Interactive video presentation	3B (n = 11)	73 (7)
Interactive video presentation	4B (n = 11)	73 (20)
Traditional live presentation	5B (n = 9)	69 (15)

Note: Mean scores (*M*) represent the proportion of the correct answers to True/False statements. *SD* – standard deviation.

The interactive video presentation on the topic Viscosity was also tested with the B groups, which worked with another teacher. Like the A groups students, the two B groups working with the interactive video (3B and 4B) showed similar score results as the group 5B working with the traditional live presentation (Table 2). This suggests an interactive video presentation can be as sufficient as a traditional class presentation for achieving learning outcomes of practical work.

Students' Interaction with an H5P Video Presentation During the Class

Teacher notes during the interactive video presentation activity gave an insight into possible scenarios for the student group work with interactive video presentations: 1A, 2A, 3B and 4B. From observations with those groups, the activity was similar to that of a traditional class presentation. Students watched the video with attention and took their notes, as usual. Some took pictures of the screen with their smartphone cameras. Questions appearing on the screen engaged students in a group discussion. Each question took approximately 10 seconds to process it individually first, and then about 1-2 minutes to discuss and select answers as a group. For the discussion students often referred to the theoretical overview in *PDF*, which was a complimentary learning material available in the course page on *Moodle*.

Each group designated moderators to input responses into the interactive video. Although the moderators' conduct differed slightly across groups. The moderator in the 2A group did not urge any correct answer based on their opinion but rather selected answers given by the rest of the group. Before submitting each answer, they checked with the group that everyone agrees. The same was true for groups 3B and 4B. A similar scenario was observed in group 1A, with one difference in that they were somewhat less active in the discussion part. In the beginning, almost everyone tried to contribute to finding correct answers, though such activity gradually decreased towards the end of a 13-minute video. This coincided with the group 1A moderator taking the initiative to come up with their personal opinion on the correct answers for each of the questions. Then the rest of the group would just silently agree with the moderator.

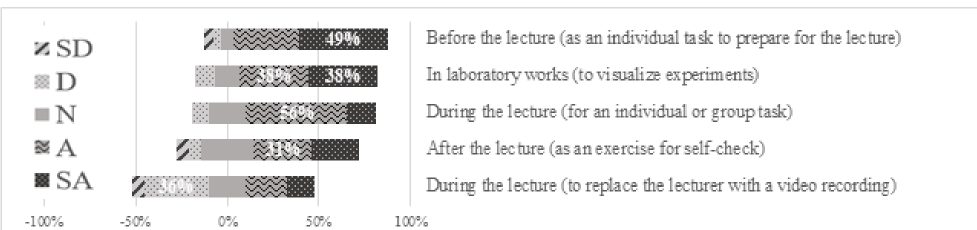
All of the four groups working with the interactive video presentation managed to complete the 11–13-minute video presentations in approximately 20 minutes, which is similar to the amount of time typically spent on a traditional live presentation (15-25 minutes). For all four groups, the task was self-explanatory and clear, students did not require any assistance from the teacher to organize their work. In the final frames of the video, the goal, tasks and procedure for the practical work were described. Students did not express any uncertainties and showed readiness to proceed with the practical work measurements.

Student Perceptions of H5P Video

At the end of the semester, participants of this study were asked to fill out an anonymous survey, to show their attitudes towards the *H5P* video and preferences for the preparation format for the practical classes. Figure 1 shows the distribution of responses (n = 45, response rate 75%) to the question "Where do you think interactive videos can be useful in the learning process?" on the Likert scale for agreement. Students would agree most with the option that the *H5P* video can be useful as an individual task to better prepare for the lecture and to visualize experiments in laboratory works. The option for using the *H5P* video during the lecture, for example, as individual or group assignments showed a reasonably high agreement rate, although, more than 36% of the respondents would disagree that *H5P* could help replace the lecturer with a video recording.

Figure 1

Respondents' Position on the Usefulness of Interactive Video



Note: Responses express agreement with the statements on the Likert scale. The bars represent the proportion of responses in each of the scale categories (Strongly Disagree (SD), Disagree (D), Neutral (N), Agree (A), Strongly Agree (SA)). Mode values for each of the statements are denoted with the percentage of total responses (n = 45).

The preferences among A and B groups regarding the preparation format for laboratory work in the physics practicum were divided. Half of the respondents (50%) would prefer to prepare as a group during the class, another half – individually, either before (41%) or during the class (9%). Theoretical overview in textual *PDF* format was ranked as their first format preference, traditional *MS PowerPoint*– second, and interactive *H5P* video presentation – their third preference. Apparently, the popularity of the *PDF* format could be explained by the proportion of students preferring individual over group work.

Finally, respondents of the survey reflected on their experience with the physics classes and attitude to the used learning materials in general. A few selected feedback responses are quoted below:

- "It was most convenient to use presentations that could then be reviewed again at home. The biggest plus was that they were both discussed in the lectures and available afterwards."

- "I liked that there was quite a lot of material available to prepare for assignments, supplement knowledge before the lesson, and if questions arose after the lesson, you could find questions mainly in all theoretical materials."
- "I liked doing lab work in a free way, that is, going through it at my own pace. The use of video did not cause any technical problems."
- "...I did not like that the theoretical descriptions contained a lot of information that was not necessary for the experiment."
- "I found the reference video/audio material very helpful. You can find out which areas need improvement, and you can revise several times if you don't understand at first."

Such responses show that students value the instant availability of learning material and an opportunity to build personalized learning paths by choosing the format, going through and revising the materials at their own pace. Interactive video can be a suitable tool to fulfil these wishes.

Discussion

The aim of this study was to explore the use of interactive *H5P* video as an alternative to traditional teacher-led class presentations at the university physics practicum. The statistical tests did not indicate significant differences in scores of the Exit ticket tests on the condition of Interactive video presentation compared to the Traditional presentation scores. This could mean that such a design of an interactive *H5P* video presentation (pre-recorded slides with voiceover and embedded questions) can be as efficient as a live presentation for the acquisition of knowledge in practical classes of an introductory-level physics course. The videos were designed following the principles of multimedia learning (Mayer, 2009) and efficient educational videos (Brame, 2016). Enriching the presentations with questions to viewers segmented the video to manage cognitive load and promote active learning in contrast to passive watching. Embedded questions have been demonstrated to support knowledge acquisition and to harness learners' engagement with an educational video in physics (Kestin et al., 2022).

The multiple-choice questions also initiated group discussions during the task of watching the video. The observed scenario of working with the task was approximately similar in each group; however, it was noticed that some groups were more active in discussion than others. Although the *less active* groups managed to achieve similar test scores as the *more active* groups, student involvement in group work activities can be desired in contemporary physics class. Since collaboration is among important 21st century skills that can be acquired in the physics class (Bao & Koenig, 2019), it would be useful to research how collaborative learning scripts can be advanced, for example, with an interactive branching scenario video (Kosmaca & Siiman, 2023). Introducing group tasks can facilitate a student-centered learning environment, which aligns with the directions of the physics education transformation in Latvian universities (Cinite & Barinovs, 2021).

The participants of this study acknowledged the use of interactive video in the study process, similarly to previous studies surveying students about *H5P* for physics learning (Desai & Kulkarni, 2022; Kosmaca & Siiman, 2023; Richtberg & Girwidz, 2019). Though, traditional learning material formats, such as *PDF* text documents, were selected more often as their first choice for laboratory work preparation, presumably because printed instructions are perceived as a more efficient medium in terms of locating information (Alexander, 2013). According to received feedback, students value learning materials that can be used at their own pace. Moreover, they expressed higher agreement that *H5P* video can be used before the lecture than during the lecture. The ability to "go at your own pace" has been previously mentioned among students' perceived advantages of an interactive video pre-lab activity in the introductory physics laboratory course (Lewandowski et al., 2019). Altogether, it can be inferred that tasks with interactive videos suited for individual learning would be appreciated. To further explore the usability of the interactive *H5P* videos created at the University of Latvia, they can be tested for watching individually in comparison with the *PDF* text format.

A major limitation to the generalization of the current study results was a relatively small sample size obtained by convenience method, which could leverage outcomes of statistical analysis. Besides, interactive videos were designed for only two laboratory work topics. These limitations could be addressed in future research by using probability sampling and performing measurements with larger groups of students, as well as using interactive video presentations throughout the semester.

Conclusions and Implications

Interactive *H5P* video presentations were successfully applied for the group work activity at the physics practicum. Similar knowledge test scores suggest an interactive video with embedded questions can be used as an alternative to lecturing in preparation for a laboratory work in physics. Student survey shows that students positively perceived this format of instruction. Interactive *H5P* video is seen as a useful tool for a group task during the lecture; though, participants of this study would not agree that it can substitute the lecturer.

Teachers wishing to integrate *H5P* videos (along with other formats of learning materials) in their classes should consider student preferences. The survey respondent preferences were divided in half between individual and group preparation for the laboratory work. Therefore, it would be beneficial to design educational videos suitable for individual as well as group learning. This research could further develop to investigate possible effects of the interactive video design on various learning outcomes, create new scenarios for the individual or group work supported by interactive video, and measure student satisfaction or collaboration during such activities.

Declaration of Interest

The authors declare no competing interest.

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Received: *April 19, 2023* Accepted: *May 12, 2023*

Cite as: Kosmaca, J., Cinite, I., & Barinovs, G. (2023). Exploring interactive H5P video as an alternative to traditional lecturing at the physics practicum. In V. Lamanauskas (Ed.), *Science and technology education: New developments and Innovations. Proceedings of the 5th International Baltic Symposium on Science and Technology Education (BalticSTE2023)* (pp. 111-121). Scientia Socialis Press. https://doi.org/10.33225/BalticSTE/2023.111