The Effectiveness of Peer-to-Peer Lecture Films in Inverted Classroom Teaching Scenarios

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Abstract: At HTW Berlin, Germany first year mechanical engineering students are taught material science as one of the fundamental courses with high work load in a blended learning environment with flipped classroom elements. Therefore peer-to-peer lecture films were established as source of theoretical background knowledge provided for self-study periods. Because the teaching method “inverted classroom” and class results directly relate to the quality of the video material one of the columns of lecture video production is the involvement of students in the lecture film production. First year students directly benefit from their fellow student learning experience, needs and perspective on teaching material. From the lecturers perspective students were generally more active and better prepared during class resulting in better grades. Practice examples introduce and evaluate both, the teaching method and videos.

Key words: Lecture video, blended learning, inverted classroom, first year students, material science.

1. Lecture Videos and Inverted (Flipped) Classroom Teaching Method

Material Science for mechanical engineering students at HTW Berlin is taught following the “inverted or flipped classroom” teaching scenario [1]-[7] having a positive effect on self-efficacy beliefs and intrinsic motivation in a blended learning setting [8]. The inverting-the-classroom teaching method benefits most if the material provided for self-studying, especially lecture videos in conjunction with more traditional teaching methods, is aligned with the overall course learning outcome [9].

Lecture videos establish short visualization of relevant course material and in-depth content [2], [6], [7]. They enable students to study independently in detail explaining scientific background. It does not only record an ongoing lecture (video lectures [10]). Lecture films provide an audio and visual stimulus covering different learning methodologies [6], [11], [12] producing deeper learning outcomes [13]. They are definitely a reinforcement –not replacement- for lectures [14] so long as any video included is analogous to the desired learning outcomes of the lecture [9]. Students place significant value on the use of videos [15], [16] and viewed them as easy to use and effective learning tools [17]. Regardless of lecture technique (in-front teaching or video support [18]) lectures demonstrating practical work enhance learning outcome [19]. Face-to-face time should therefore be used to establish a working routine covering practical work and tasks to be worked on.

Parts of this work has been presented at HEAd`18 (2018) and ICRTEL (2019) and is now revised with new findings regarding student responses

2. Implementing Lecture Films in the First Year Material Science Course

Student-produced lecture videos are implemented and integrated into the first year material science course gaining teaching benefits and effective operation of the lecture films because these are based on fresh experience when preparing for graded lab courses and specific topics in material science [6], [7].

First year mechanical engineering students have to study the scientific background of material properties in order to understand the material behavior in a mechanical design. In the inverted classroom teaching scenarios discussions among the students during the hands-on problems offered during face-to-face time are encouraged and essential to the success of the course. However, each student is responsible for her/his own learning process. Although a great variety of teaching material is provided [2], [4]-[6], lecture videos appeal to all students. Accompanying homework tasks or micro tests were assigned along with the lecture videos to guide students` self-study period. In class questions were answered and hands-on problems were solved preparing students for graded activities adding to the entire course grade [4]-[6]. To make inverted classroom teaching successful it is important to outline the method, set course rules and carefully explain the assessment of lectures, tests and glossary terms as well as the use of lecture videos beforehand.

3. Lecture Scenario: Defects in Crystals

The scientific background was assigned as self-study period, such as working through the Moodle-lecture, memorizing the most important facts and voluntarily reading of a simple and short scientific research paper dealing with microstructural properties. Most important are five lecture videos dividing the defect families (Lecture films: Defects in crystals (5 lecture films) (32:55 min), (https://www.youtube.com/playlist?list=PLUOlZMSZYz5wlO3gea5jLFhxgAr3IiOja). Along with the online lectures and lecture videos a homework assignment had to be done, a test had to be taken and one specific defect and its mechanism had to be explained in a topic related glossary. This was commented and corrected by the lecturer in the week of the homework assignment.

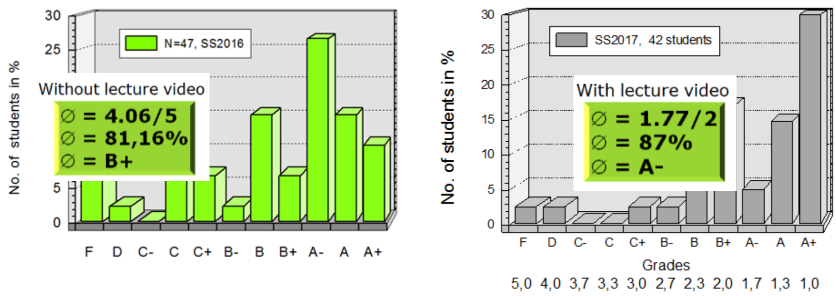

Fig. 1. Results: Test defects in crystals (8% of total grade) left without and right with lecture video use.

Via classroom response the lecturer got an overview of the student`s learning progress and the students could assess their own learning progress. Questions were answered in the plenum and important issues explained individually. Then students were divided into small groups with 2-3 students each. A special template had to be used to summarize one of the fifteen crystal defects, including: microstructural changes and impact on mechanical properties. To make sure all students had nearly the same level of scientific knowledge; students who were not able to work properly at home were asked to work on the lecture videos and take notes for approximately one hour. Later these students were intermixed with the groups working on the assignment. All students were then asked to prepare their results as hand in a one page precise summary according to the template and briefly present these in front of the class as well. These summaries were reviewed by the class and lecturer and uploaded in Moodle to be available to all students. Then a typical engineering problem focusing on plastic deformation was solved in groups of two students each. Discussions among the students were strongly encouraged and the results reviewed in the plenum. Starting summer semester 2017 a compulsory (night) test had to be taken worth 2 out of 60 possible points which proved very good understanding of defects and delivered better results than obtained the previous semester (Fig. 1).

4. Evaluation and Discussion

Students rate the inverted classroom teaching method as time consuming but doable according to their learning progress and felt well prepared for the face-to-face tasks and hands-on problems (Figure 2). They also rated positive to be forced to study throughout the semester and therefore get a holistic approach towards material science and its meaning in mechanical design (Fig. 3).

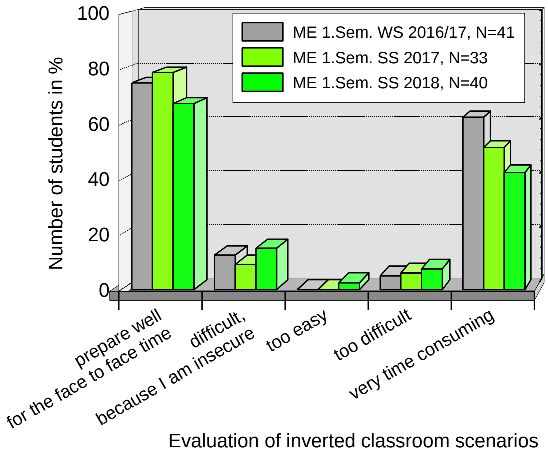

Fig. 2. Students` view upon inverted classroom teaching scenarios in material science.

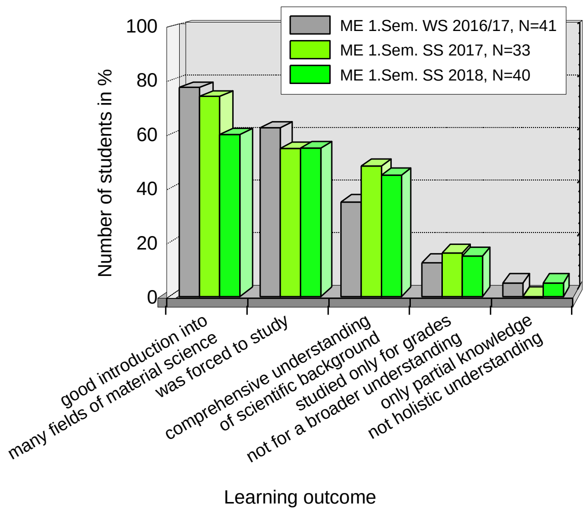

Fig. 3. Students` view upon their learning outcome in the first year blended learning inverted classroom material science course.

Lecture videos provide excellent requirements when inverting the classroom, because for especially complicated scientific background knowledge, such as atomic models in material science, they help students to understand and then apply their knowledge. The content of the lecture film needs to be accompanied by leading questions and/or self-assessing quizzes. Sometimes it is even very helpful to assign an overall leading questions with the lecture videos in inverted classroom learning scenarios. There is a big difference if students are assigned to watch some kind of lecture video (leaving students behind insecure whether the content is correct or useful at all) or if the lecture video directly supports the lecture content.

Also, the peer-to-peer approach is of great importance giving every set of lecture films a personal note and increasing the variety of lecture films (nothing is more boring to study than permanently same structures). Students also appreciate other students work and were emotionally involved during studying because other students worked for them to understand. This seems to be of little importance but it motivates students, especially those who did not so far gained profound self-directed learning skills. Students were aware that these lecture films have been peer-reviewed by the lecturer and therefore were reassured that the content was correct and did not end in a "learning-the-wrong-thing" disaster. To put effort into the wrong or even worse false content is one of the greatest fears of students. Therefore it is mandatory that the content is correct and approved by the lecturer and in alignment with the course scientific learning outcome.

Lecture videos generally appeal to many students and are therefore a probate media to encourage and support students to self-study und gain substantial knowledge in material science courses. Students accept videos as learning source and rate them highly beneficial in terms of time and place independent studying. Watching introductory videos for lab courses and lecture videos encourages students to work with other learning resources provided on the learning platform leading to more download activity. Notes and handwritten summaries were brought along, mind maps and summary sheets were downloaded and memorized. The additional learning material helped the different learning styles to understand the science behind the results introduced in class or produced in the lab. Pre-test results (classroom response) were partly improved and during group work groups worked homogenously with lots of inspiration. Students asked important questions, initiated discussions, were eager to dispose their knowledge and learn more of the details and even those students, who did not attend the lecture classes increased their understanding of complicated correlations.

5. Conclusion

Different lecture film formats produced as guided student projects (peer-to-peer approach) along with other teaching material, such as micro lectures, are "the heart" of the self-study period of inverted classroom teaching scenarios to first year mechanical engineering students. This blended learning concept of teaching materials science was assessed as beneficial in terms of student grades, concentration and attentiveness as well as ongoing lecture procedures during class. Students were generally well prepared and able to work on strategies to solve hand-on problems.

Although students rate the inverted classroom teaching method as time consuming, they felt well prepared for the face-to-face tasks lectures and being forced to study throughout the semester lead to theoretical knowledge that can actively be transferred to design problems. The lecture video introduced many fields of material science as well as deep detailed insights as long as the content is peer-reviewed by the lecturer, is in agreement with the learning outcome and the overall scientific route of the course. The role of lecture films may be described as substantial in terms understanding, flexibility and joy of learning progress. The peer-to-peer approach plays an important role as it adds to the large variety of teaching materials and learning styles and moreover addresses the learner personally giving the feeling there was another student (peer) explaining.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

The author conducted the research and analyzed the data, wrote the paper and approved the final version.

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