

## Inverting the classroom using on-demand lightboard micro lecture films (learning glass)

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### ***Abstract***

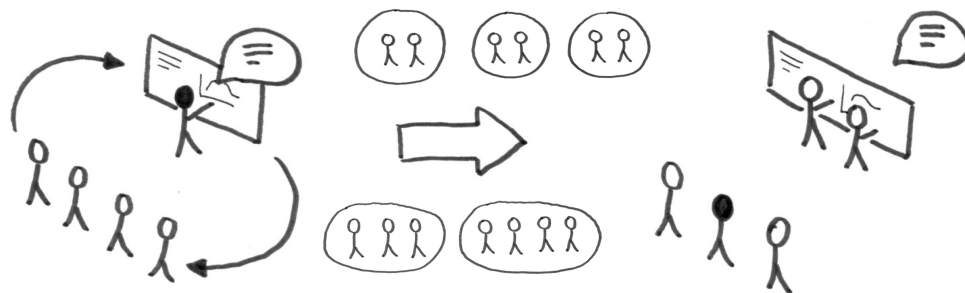
*Critical thinking and self-directed learning are corner stones to prepare first year mechanical engineering students for the demands of the employment market. Creating a positive learning environment presupposes solutions to mechanical engineering problems related to material science. The blended learning environment embeds inverted classroom teaching scenarios as the opportunity to gain higher learning outcome and self-reliant study skills. Inverting the classroom is a method to let the students study the basic scientific background of engineering materials on their own and then work practically during face-to-face time. Because during digital self-study periods (especially during the Covid-19 pandemic) students often feel lonely lightboard videos were provided in addition to traditional lecture material. Short lightboard videos (<10 min) are produced easily on student demand on a glass panel (learning glass). Here, the lecturer always keeps eye contact with the audience and students feel addressed in person. As students were able to manage the input the learning outcome is directly related to the teaching material.*

**Keywords:** *Light board, inverted classroom, flipped classroom, blended learning, first year students.*

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## 1. Introduction

Nowadays information is readily accessible and not centered in one expert or lecturer. Decentralization and globalization expects students to acquire autonomy and to appropriate their own learning process: Huguet et al. (2017). Problem-solving and communication skills are already important for first year students, because collaborating, thinking innovatively and knowing how to solve problems are considered to be 21<sup>st</sup> century essential skills: Efstratia (2014). One constructive teaching approach is the inverted classroom teaching model: Berret (2012), Brame (2015) having positive effect on self-efficacy beliefs and intrinsic motivation: Thai et al. (2017). *The flipped classroom constitutes a role change for instructors, who give up their front-of-the-class position in favor of a more collaborative and cooperative contribution to the teaching process: Educause (2016) (Figure 1)*. Students are given more of the responsibility for the learning process and therefore engage in critical thinking: Kaya et al. (2014), Pfennig (2017). Students take over active parts in hands-on work and communication and become devoted to their learning and even determined activators of the face-to-face time. Deeper learning outcomes: Simon et al. (2010) are produced. *What the flip does particularly well is to bring about a distinctive shift in priorities—from merely covering material to working toward mastery of it: Educause (2016)*. However, Setren et al. (2019) assign success only for MINT courses and show no evident success of the method for economic related teaching.



*Figure 1. The principle of inverting the classroom. Instructors give up their front-of-the-class position in favour of a more collaborative and cooperative contribution to the teaching process*

Inverting the classroom comprises of the scientific input during defined self-studying phases. During face-to-face time more time is given to explore science, to raise questions and discuss details as well as to communicate in an appropriate scientific pathway in equal measure: Pfennig (2016), Pfennig (2019), Pfennig (2022), Setren et al. (2019), Berret (2012), Brame (2015). Lively taught science as means of medium to catch and/or raise students' attention may result in good grades. This paper discusses the advantages of lightboard (learning glass) videos as means of teaching material in inverted classroom teaching scenarios over lecture capturing: Crooka and Shofield (2017) or even lecture videos: Pfennig (2019).

## 2. Setting of inverted classroom scenarios in first year materials science

Material science for first year mechanical engineering students at HTW Berlin is taught via the “design-led” teaching approach: Ashby et al. (2013) that has been explained in detail by: Pfennig (2016), Pfennig (2022). Because blended learning reveals a higher learning performance compared to the e-learning setting: Thai et al. (2017) the best teaching environment was provided implementing a blended learning setting. Micro-projects were combined with inverted classroom teaching scenarios and were included in the blended learning materials science course: Pfennig (2016), Pfennig (2019), Pfennig (2022) described the course structure and the alternative grading system based on a portfolio in detail.

The inverted classroom teaching method requires and at the same time enables individual self-directed, location-independent and asynchronous studying. To most of the students the important advantage are the teaching materials provided online and the possibility to study the science on their own independent from place and time and according to their individual tempo in self-chosen study groups. Simple methods such as “Think-pair-share” or “peer instruction”: Simon et al. (2010) and (digitalized) classroom response offer a quick overview of students’ state of knowledge enabling the lecturer to respond easily to the needs of the class. During face-to-face time students and lecturer discuss difficulties and thoughts, answer questions and work on engineering related problems (Figure 2).

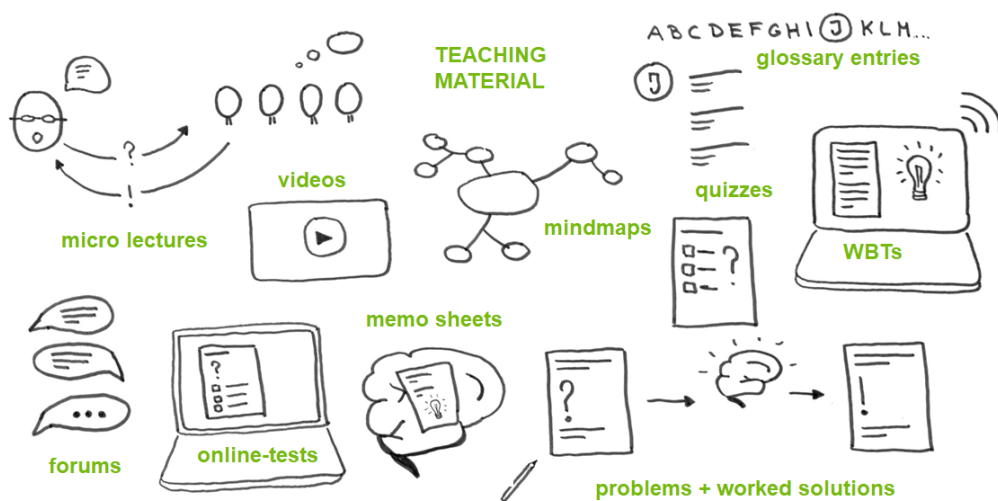


Figure 2. Change of roles: Students learning session and presentation in class after preparing scientific backgrounds at home.

## 3. The importance of teaching material

Teaching first year students challenges lecturer, because diversity of the class is high. Besides the different educational and family backgrounds offering various level of understanding some students ignore the significance of the scientific basics. To motivate students and guide their learning progress seems to be one of the main outcomes of a first year class. Students motivation, performance and learning outcome is directly related to the teaching material provided Pfennig (2019), Pfennig (2022), Kaya et al. (2014). This unconditionally has to be congruent with the class progress and learning outcome. Otherwise students do not relate the study material to their personal success and knowledge.

Teaching material was partly generated by higher class students (peer-to-peer approach): Pfennig (2019). Generally, it is provided online via Moodle to offer all students the same preconditions. The teaching material addresses many learning styles, all focusing on the same learning outcome. However, different students show manifold learning preferences that have to be met to succeed in a blended learning setting. Figure 3 visualizes the teaching materials and activities offered in the first year material science course. This Figure emphasizes the strength of visualization – that can be of high use in a first year class. Learning outcome of certain themes is much higher when difficult scientific explanations, especially models, are visualized and assigned to distinct symbols and proceedings.



*Figure 3. Teaching material*

#### **4. Advantage of lightboard videos**

Micro lectures with self-guiding tests: Pfennig (2018) offer high quality self-study material. However, most inverted classroom lectures will be accompanied by lecture videos, such as lecture capturing or demonstrating videos: Pfennig (2019). Capturing lectures seems to be a low-threshold method to provide lectures and content to students although recordings of lectures comprise at least five different techniques: Crooka and Shofield (2017). Lecture videos provide an audio and visual stimulus covering different learning methodologies: Gulley and Jackson (2016). Presupposed the video included is analogous to the desired learning outcomes of the lecture: Al-Jandan, Farooq and Khan (2015) lecture videos are definitely a reinforcement, rather than a replacement for lectures: Havergal (2015).

However, the biggest disadvantage is that the lecturer generally turns her or his back towards the students. From earlier surveys it is known that students prefer lecture videos where human

contact is made: Pfennig (2019). Therefore, lightboard teaching videos offer a successful solution to teach short sequences online and face students directly at the same time (Figure 4). The lightboard at HTW Berlin was successfully designed and developed in a mechanical engineering student peer-to-peer project.

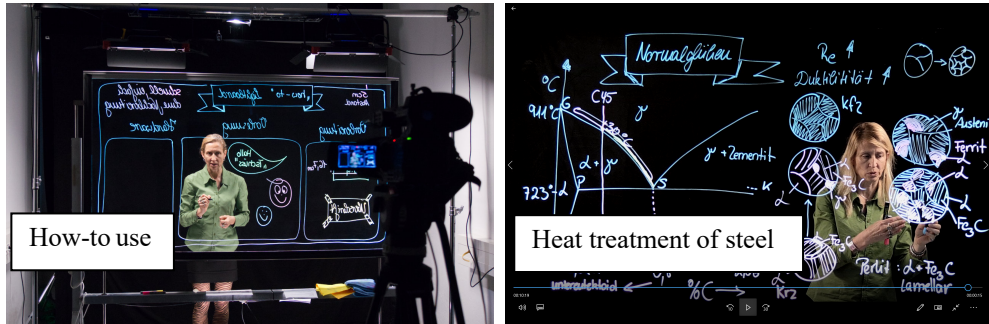


Figure 4. Examples of lightboard videos at HTW Berlin.

A lightboard consists of a high quality optiglass panel which is surrounded by LED lights. Extra strong lights enable for high quality contrasting and clear colors of the video. Fluorescent pens highlight the writing that is done in light absorbing surrounding. A camera is positioned properly (centered on the entire glass board) before the lecturer. The video is inverted after filming either using camera software or post production software. The production of lightboard videos is of low threshold. The contents of the lecture should fit on one 16:9 screen – just as the black board offers in ordinary class rooms. They are easy to make, because a lightboard video is a replica of a scientific panel painting such as usually developed analogously in class. The equipment is easy to use. However, there are a couple of recommendations to be met:

- Plan on less than 10 minutes for one video, best is 4-5 minutes. Otherwise divide in 2 parts
- Face forward as much as you can
- Smile as much as you can
- Leave 5 cm spacing from the edge to ensure your writing fits the screen
- Use proper spacing, colors and distinct headings
- Do not erase errors (it appears human) and students feel addressed personally
- Do not plan on 2 panel screens. One should do to cover your contents
- Speak slowly and clearly
- Introduce the video and finish with a “good bye”
- Wear solid and middle dark colors (green, dark red), no patterns

#### 4. First evaluation of implementing lightboard videos

Material science has a high work load for first year students and a very theoretical subject. However, most of the students rate the different learning materials beneficial for their learning progress. The lightboard videos were considered as bridge between the self-study period at home and contact time in class. Joy of studying is enhanced when students feel addressed in person, because the lecturer always faces the audience and “keeps eye-contact” with students – especially during the Covid-19 pandemic (Figure 5). Also, the restriction to one blackboard panel picture and time limit less than 10 minutes have a lasting effect in terms of facilitation and personal learning progress. Students feel secure with the quantity of the material as well as the quality because delivered directly by the lecturer similar to in-class lectures. Therefore, most of the students studied widely using the ca. 50 lightboard videos even suggesting themes and questions they came along during preparation time. Because more students were engaged in the learning procedure the class was more homogeneous. The most important advantages mentioned by the students (besides eye-contact) is that the lightboard videos (along with other digital teaching materials) are independently reusable. Another advantage is that students may post technical terms or sequences of the lecture they considered difficult and a lightboard video can be made right away without any preparation and very little post production. Lightboard videos may be produced on-demand and are therefore considered very powerful and successful teaching material. Note, that after the pandemic students did not relate to the lightboard videos as important because they experienced face-to-face time again.

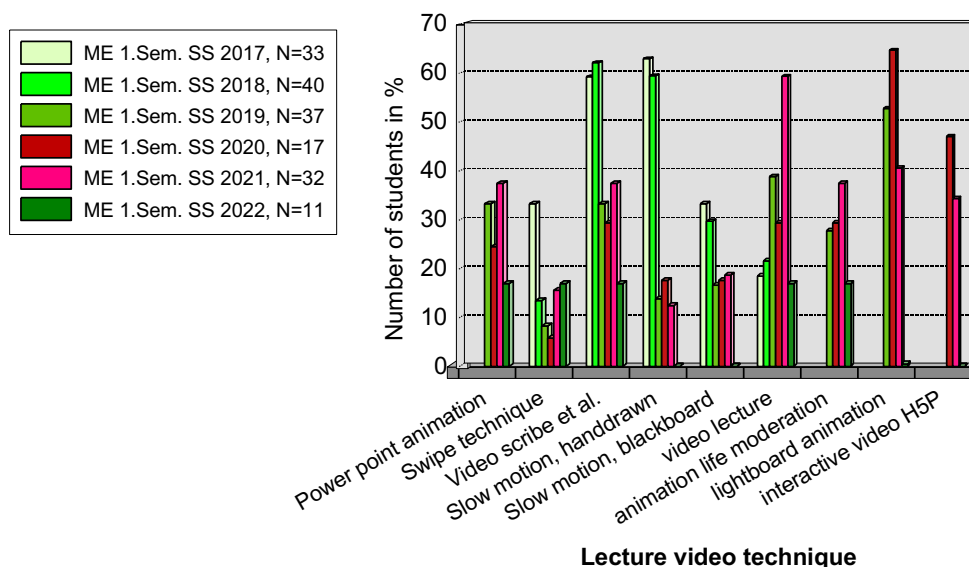


Figure 5. Preference of video technique. Lightboard videos were established first in SS2019. SS2020 and SS2021 were taught fully online.

During plenary sessions students acted lively and were eager to dispose and share their knowledge, collaborate and learn more of the details. During face-to-face time a strong structure of the problem based work (e.g. templates, clear work order) and always transparent and steady course demands are essential regarding learning outcome and better grades: Efstratia (2014). Drawback of this modern teaching method is the very high preparation time. Venturing into an alternative method may discourage lecturer because they are expected to manage additional activities, demands and collaboratitive student work: Efstratia (2014). There is always the risk of losing students who are not willing to study at home. Implementing lightboard videos as teaching source however showed that more students were prepared and also positively willing to work with other material provided online.

## 5. Conclusion

Inverting the classroom involves students to take over the responsibility for their own learning process. This modern teaching method is assessed as beneficial in terms of student grades, learning output and understanding of scientific background, concentration and attentiveness as well as both joy of studying and teaching. However, the success of the method is directly related to the teaching material. During self-study periods students need strong guidance, transparency of the grading system and to overcome the feeling of loneliness. Therefore, lightboard teaching videos are a good alternative to conventional lecture capturing videos because the lecturer always keeps eye contact with the audience and students feel addressed more personally. Lightboard videos bridge self-study periods at home and contact-time in class. Provided directly by the lecturer and restricted to one blackboard panel of less than 10 minutes teaching students feel secure with the quantity of the material as well as the quality.

Most important advantages comprise of 1. the low threshold – everyone can start right away, 2. lecturers “keeping eye-contact” with students, 3. offering good pace for student learning (short in-put videos that are less than 10 minutes long), 4. being immediately producible on student demand, 5. only little post production time being necessary. Overall lightboard videos are attributed to a lasting effect in terms of facilitation and personal learning progress.

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