Lessons Learned from Implementing an Inverted Classroom Model

D. Schumann[*] , T. Kämpfer, M. Bleckmann, V. K. Kuprat

Institute for Production Systems and Logistics, Leibniz University of Hannover

Abstract

Für ein erfolgreiches Gelingen des Inverted Classroom-Konzepts ist die eigenständige Vorbereitung der Studierenden auf die Präsenzveranstaltung zwingend erforderlich. Damit die Studierenden für das Selbstlernen im Voraus motiviert sind, muss ein Mehrwert durch die Vorbereitung für sie entstehen. Dazu muss eine erfolgreiche Verzahnung der Selbstlerninhalte und der vertiefenden Praxisinhalte innerhalb der Präsenzveranstaltung erfolgen, damit die selbstgelernten Inhalte mit Beispielen verknüpft werden können und somit zu einem nachhaltigen Lernerfolg führen. In diesem Beitrag wird diese Herausforderung anhand einer beispielhaften Umsetzung eines Inverted Classroom-Konzepts für die Vorlesung „Produktionsmanagement und –logistik" an der Leibniz Universität Hannover verdeutlicht. Im Rahmen der Pilotierung des Konzepts wurde festgestellt, dass eine vollständige Digitalisierung der Lerninhalte zu keinem Mehrwert für den Lernerfolg führt. Somit wurden die Erfahrungen aus der Pilotierung analysiert und das Konzept entsprechend angepasst. Die Anpassungen ermöglichten eine auf die selbstgelernten Inhalte aufbauende Präsenzveranstaltung und führten somit zu einer erfolgreichen Verzahnung von Selbstlernphase und Vorlesung im Rahmen eines Inverted Classrooms.

For the inverted classroom concept to be successful, it is imperative that students prepare themselves for the classroom event. In order for the students to be motivated for self-learning in advance, an added value must arise for them through the preparation. To achieve this, the self-learning content and the in-depth practical content must be successfully interlinked within the classroom event so that the self-learned content can be linked to examples and thus lead to sustainable learning success. This paper illustrates this challenge by means of an exemplary implementation of an inverted classroom concept for the lecture "Production Management and Logistics" at Leibniz University of Hanover. During the piloting of the concept, it was found that a complete digitization of the learning content does not lead to any added value for the learning success. Thus, the experiences from the piloting were analyzed and the concept was adapted accordingly. The adaptations made it possible to build on the self-learned content in the classroom and thus successfully interlockthe self-learning phase and the lecture as part of an inverted classroom.

*Corresponding author: schumann@ifa.uni-hannover.de   This article was originally submitted in German.

1. The Inverted Classroom Concept

The approach of the inverted classroom model (also called flipped classroom) pursues a reversal of the classic lecture format. Here, students are supposed to acquire knowledge independently in advance of the classroom lecture in order to be able to use the classroom event more effectively and with active tasks [1]. In addition to the more intensive use of face-to-face time, this type of knowledge transfer also offers the advantage that students can learn more self-determined and at their own pace due to the availability of the learning content [2]. The independent preparation of the students for the face-to-face course is a central component of the concept and absolutely necessary for the successful implementation of the inverted concept. Increasing the student motivation required for this, is the biggest challenge in the inverted classroom model [3]. To implement such a model, it is first necessary to prepare and make available the previously analog learning content for the self-learning phase. This requires a switch from data sheets and exercises in print form to digitized learning materials. Today's learning management systems offer a wide range of options for this, such as learning videos with interactive elements or computer-supported methods such as learning paths [4].

The Institute of Production Systems and Logistics decided to take advantage of this concept for the lecture "Production Management and Logistics". To this end, a digital inverted classroom was to be implemented as part of a funded project. The project was made possible by a funding program to improve teaching at the Faculty of Mechanical Engineering at Leibniz University of Hanover. With the help of the funding, the previous lecture content could be transformed into digital learning content and the concept could be piloted during the semester. As part of the piloting, two of the eleven learning modules were implemented in an inverted format in order to first gain experience with the concept and to enable an evaluation by the students. The evaluation as well as the experiences of the teaching staff during the piloting were enormously valuable for rethinking the concept and thus for the complete transformation of the course. The concept of the pilot modules, the experiences through the implementation as well as the subsequent adaptations of the concept are described in this paper.

2. Approaching with pilot modules

The lecture "Production Management and Logistics" has long been an integral part of the curriculum for various mechanical engineering courses and has around 200 participants per semester. The current structure of the course is a weekly 90-minute lecture. This is supplemented by 45-minute exercises in which practical example problems are worked through. As an elective module, the lecture can be taken by both Bachelor and Master students from different disciplines. Thus, the challenge arises that the students have different levels of knowledge and thus the individual learning speed can differ greatly due to possible lack of prior knowledge. Therefore, it was planned in the concept to make all contents available through videos and learning texts in order to enable independent learning in self-study. This released capacity in the lecture session, which was intended to deepen the content and to provide an outlook on practical examples and later fields of application. Lectures on current research projects at the institute were also integrated for this purpose. Furthermore, the students were actively involved by means of live-questions and live-calculations of in-depth tasks. During the test phase, one of the two classroom sessions on the respective pilot modules was held digitally (via BigBlueButton) and the other was held in the lecture hall. Both formats are possible for an implementation of the face-to-face event. However, the format should be suitable for the planned content and activities such as group work or surveys.

During the implementation of the pilot modules, the digital execution of the face-to-face event could not prevail: Originally planned group work phases could not be carried out in a target-oriented manner, as a large part of the participants left the digital learning space when the work phase started. The reason for the lack of participation in the group work was presumable a lack of preparation on the part of the students as well as the low inhibition of leaving the digital event. Lessons learned from

this is that such group work and the preparations required for it should be announced in advance. Likewise, the inhibition threshold for participation in group work appears to be lower in the context of face-to-face versus digital events.

The pilot modules were transformed into digital learning units and made available on a learning management platform (Ilias). In the process, the entire content of the previous lecture script was transferred into interactive learning videos as well as learning texts with partially interactive illustrations. For a better division for the acquisition of the contents, the entire lecture module was divided into smaller knowledge units. A module thus consisted of 3-5 knowledge units, whereby the knowledge units were oriented to the contents and thus the scope could be different. To assess the learning effort, the knowledge units were weighted with so-called effort points. A learning video for a knowledge unit was accordingly 15-30 minutes long. The associated learning text overlapped completely with the learning video in terms of content in order to ensure barrier-free learning on the one hand and to allow individual learning preferences on the other. At the end of an entire module, a final module test could be taken.
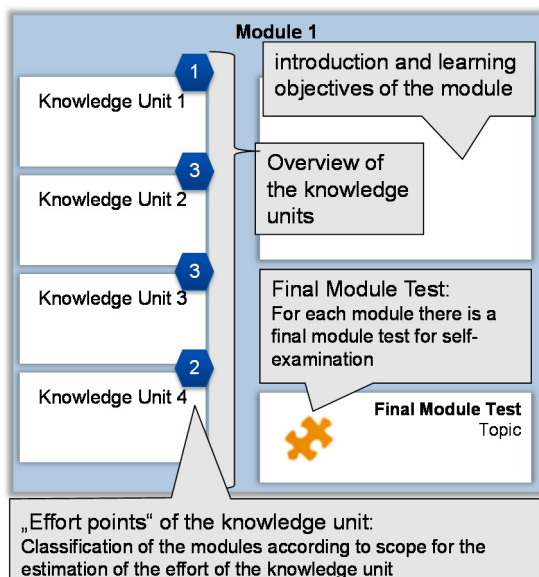

Fig. 1: Structure of a module

The design and question format was similar to the later online exam, so that students could already get used to the exam format. The design and structure of the modules were also to

be uniform and visible for each module as an initial screen in the learning management platform. This initial screen showed an overview of all the module's content and was intended to serve as a guide for students to work through the learning content. The structure of this initial screen for a module is shown schematically in Figure 1.

3. Evaluation and experiences from the pilot modules

The pilot modules were evaluated by the students in active surveys and by the teaching staff themselves. The feedback from the students was very mixed. In addition to much positive feedback, there was also strong negative criticism. Of the participants in the evaluation, more than half rated the concept as good, 15% of them even as very good. Some students stated that they were not comfortable with self-learning in advance (18%), 2% of the respondents even found the learning materials difficult to understand. 22% of the students honestly stated that they had not looked at any learning content at all until the face-to-face event. Figure 2 shows the results of the evaluation graphically.

Fig. 2: Results of the student evaluation (Question: How was the self-learning in the Inverted Classroom format?

In addition to the general assessment as a closed question, further feedback could be given in open questions during the evaluation. There were many positive voices for the interactive videos as well as the availability of all learning content in digital format. The main negative feedback was that some students described the concept as "distance learning" and questioned the usefulness and function of the

face-to-face course. In addition to the students' evaluation results, the success of the pilot modules could also be verified by means of the recorded learning times in the learning management system. This recording unfortunately showed that only a fraction of the students spent enough time on the learning platform in advance of the face-to-face lecture to fully view all learning content. A large proportion of students spent only very small amounts of time on the learning platform, or the time spent increased immensely during exam preparation. These experiences made it clear that the implemented concept as an inverted classroom had failed in this form. Due to the lack of processing of the learning content, the students were not adequately prepared for the face-to-face event, so that they could only comprehend the in-depth studies with difficulty, as they lacked the necessary basics. The following reasons were identified for the low processing rate:

On the one hand, the learning workload was significantly increased, as the learning videos per module alone were in some cases over 90 minutes in total length. In addition, students had to add their own learning and preparation time, the time for the classroom sessions, and the completion of the final module test. On the other hand, it was not clear to the students how they should prepare for the face-to-face event and on which foundations it would be based.

Another learning effect resulted from the learning videos. Recording the videos involved an enormous amount of work, since on the one hand a complex technical set had to be set up due to the high quality requirements. On the other hand, the recording itself took a long time, as special attention had to be paid to the expressions and explanations. This special attention is very important for the learning videos, because in contrast to the live lecture, no follow-up questions are possible in case of misunderstandings, but the students can watch the video again at any time, so that ambiguities and misleading formulations in the audio track of the learning videos must always be avoided. In retrospect, it was determined that the pilot modules focused exclusively on the transfer of previous learning content into videos and less on the review of learning content in terms of scope or supplementation. The result of the video recordings was thus a complete recording of the previous lecture content, so that the goal of interlocking self-study and classroom instruction was not successfully achieved. The complete digital availability of the lecture leads to major problems for the face-to-face lecture in the lecture hall. Neither a simple repetition of the digital content nor an additional consolidation is useful for the content transfer [4]. Repetition would make part of it obsolete, so presumably many students either go to the course unprepared or do not attend it at all. A too intensive consolidation brings the danger that the main goal of the learning module is neglected and thus reduces the learning effect.

Consequently, the experiences from the implementation of the pilot modules have shown that a mere transfer of the previous content into digital formats does not lead to a functioning inverted classroom. Instead, it should be examined exactly which of the contents should be learned in advance of the lecture as preparatory basics in self-study. In this way, the self-study content can be taken up in the lecture and brought into an overall context with the new content from the lecture. If these overall connections become clear in the classroom lecture and the students thus experience a learning effect, they are also motivated to prepare the content. The following chapter describes how the existing concept can be adapted for this kind of interlocking of self-learning content and classroom lectures.

4. Concept adaptation by interlocking self-study and classroom events

The experiences from the implemented pilot modules show that a revision of the concept is necessary. Instead of a complete transfer of the lecture into digital learning units, only basic parts are to be shifted to self-study. Thus, the lecture in the lecture hall remains for the most part, but can integrate an active involvement of the students due to the freed up time as well as deepen it with practical examples. The digital learning platform, which was set up for the two pilot modules, will not be set up in this

form for the other modules, but will only show the self-learning content. The division of the modules into smaller knowledge units will also not be implemented further. In the original concept, this division had the goal of better dividing the content and the required learning effort time for the entire module. Since in the new concept the entire module content is no longer available digitally for self-learning, this division no longer serves the purpose. However, there will still be a similar overview per module as shown in Figure 1. Instead of the knowledge units, the content to be acquired in the self-learning phase will be shown in this overview page. The presentation of the module learning objectives as a central element will remain. These should serve both in advance as a preview of the upcoming content, as well as in the follow-up as a control of what has been learned for orientation. The future sequence within the framework of the inverted classroom concept is shown in Figure 3.
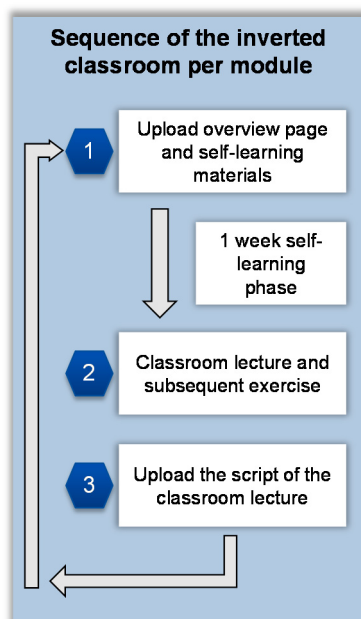

Fig. 3: Sequence of the Inverted Classroom

One week before the lecture of the respective module, the overview page with the learning objectives of the module as well as the self-learning content as "homework" to prepare for the lecture is published. Within the lecture the self-learning contents are deepened by examples or exercises and new contents are explained and both are put into an overall context. Without preparation of the basics, the understanding of the overall context can be

achieved only with difficulty and it will not be possible to perform the exercise tasks. The shown script will be uploaded on the learning platform only after the lecture, because during the lecture questions will be asked in the auditorium, whose solutions can be seen in the following pages. The questions refer to the self-learning content to be prepared. In addition to oral questions, internet-based tools for answering the questions on students' mobile devices will also be included. At the end of the lecture, the self-learning content of the following module will be announced and the overview page as a guide for self-learning will be made available on the learning platform. Following the lecture, the respective final module test is activated so that students can test their learning success.

Interactive learning videos will continue to be part of the self-learning materials. However, these deal with models and tools that are to be applied at several points and thus partly serve as preparation several times. Instead of digital learning materials, an existing textbook will be used as lecture-accompanying literature. This lecture-accompanying book describes the Hanoverian supply chain model, on which the lecture is oriented [5]. For the self-learning phase in preparation for the lecture, explicit pages are designated in advance that explain basic content required for understanding the more advanced content in the lecture. Another advantage of the textbook accompanying the lecture is that students can also independently review the content discussed in the lecture. Thus, in the adapted concept, the self-learning phase consists of both some book pages and short general learning videos on the most important tools required for production management. Both the textbook and the learning videos thus bridge the gap between self-study and classroom instruction. Overall, the amount of preparation is significantly reduced and requires about one to two hours of effort, so it should be easily doable within a week. The self-study phase in advance and the basic knowledge acquired in the process enables a shortened lecture, so that full 90 minutes will no longer be required in the future. The time freed up can thus be used for more in-depth study and practical examples. Furthermore, group work phases will be used to carry out

smaller exercises during the lecture. More extensive exercises will be calculated in the exercise hour following the lecture. The concept adaptations required for the implementation of the inverted classroom model for the course "Production Management and Logistics" are illustrated in Figure 4.
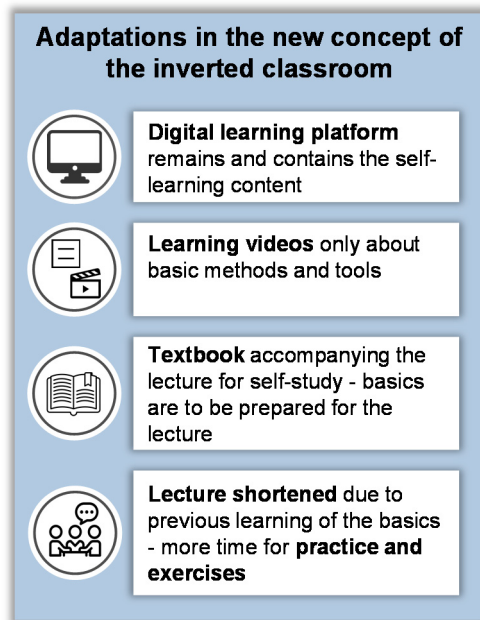

Adaptations in the new concept of the inverted classroom

Digital learning platform remains and contains the self-learning content

Learning videos only about basic methods and tools

Textbook accompanying the lecture for self-study - basics are to be prepared for the lecture

Lecture shortened due to previous learning of the basics - more time for **practice and exercises**

Fig. 4: Overview of the adjustments

The described adaptations ensure that the classroom lecture builds on the content learned in advance by the students themselves and that there is no mere repetition of this content. In addition, the in-depth lectures should particularly emphasize the necessity of self-learning through examples and exercises in order to increase the students' motivation for this. If this succeeds, the concept of the inverted classroom model is successfully implemented and enables both effective learning and learning at one's own pace through the lecture-accompanying book.

5. Conclusion and outlook

When new concepts are introduced as part of improvement measures for teaching, it is generally recommended to first test the implementation with pilot modules. Due to the extensive piloting of the original concept, weaknesses and errors could be uncovered. The teaching concept presented here could be

tested, evaluated and purposefully transformed into an improved course through the procedure described. The concept adjustments were implemented in the current semester and the feedback so far has been very positive. This is reflected in particular by the active participation in the exercises on the self-acquired basics. A renewed evaluation of the concept is still pending and will be conducted at the end of the semester.

Literature

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