STACK in Econometrics

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Abstract: Due to the COVID19 pandemic, exams needed to be carried out digitally in spring term 2020. At the faculty of economics at the Bremen University of Applied Science, the instructors used for long time problems that are implemented in STACK. These STACK problems have been also used to conduct final exams without supervision. With the creation of STACK problems and exams in the lecture econometrics, a complete competency-based learning cycle is designed for students and captures their individual learning path. We also give a brief insight on the evaluation of the lecture. The results suggest that the implementation of STACK problems and exams within a blended-learning course has positive effects on student's learning outcomes.

Keywords: econometrics; competency-based problems; constructive alignment

1 Introduction

This paper presents some aspects of the daily routine about teaching economics with STACK. Usually, STACK is applied in mathematics and a variety of examples are provided for instructs in mathematics. We demonstrate the integration of STACK problems into economics lectures constructed according to the blended learning concept (BLC). Blended learning allows learners to design individual learning paths and to learn independent of time and location. Instructors support these learning processes through a variety of competency-based problems as well as exercises and individual feedback. The aim is to provide students with the best possible learning process tailored to their individual framework conditions and to top this with the successful completion of the examination. In addition we show a range of STACK applications in economics covering statistics, econometrics, finance and accounting. The applications demonstrate how STACK can be applied to create automatically evaluable problems of any structure. Finally, we show a few highlights of our study in which we measure the success of the blended learning concept used with competency-based tasks. We analyze to what extent the use of blended learning with STACK problems increases the learning success of the students depending on the teaching concept used. We show that students in the BLC are more successful and complete the course with a better grade.

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2   Course structure in econometrics

This section provides the typical course structure in economics using econometrics as an example. E-learning allows to learn independently of time and place of a class. In the last years the blended learning concept has spread also in higher education [MK14]. There is, however, no universal model of blended learning for all educational settings and the range of best practice examples are wide [ESS15].

2.1   2.1 Constructive Alignment

The didactic base is rooted in the concept of constructive alignment. Biggs [Bi96] combines constructivist approaches with those of instructional design in his conception of constructive alignment and describes it as an approach to event design that can be applied across disciplines. Constructive alignment of an event results from the consistent alignment of learning objectives (or intended learning outcomes), teaching and learning methods, and assessment methods. For this to happen, instructors make transparent to learners the learning objectives associated with a course or course unit and the steps required to achieve them. The instructors implement practice and learning scenarios that enable learners to train the competencies necessary to achieve the learning objectives. With regard to the design of an examination, it requires problems that tests for the competencies that have been announced, built up and trained in the course of the event. Among other things, an event constructed using constructive alignment promotes deep learning by students [Wa13], influences student learning strategies and learning outcomes [Ha21, LR13] – and is associated with high quality teaching overall [BC14].

The constructive alignment looks at the teaching-learning process from its ultimate goals and then develops appropriate didactic scenarios. In this view, the constructive alignment focuses on learners by orienting to their abilities and competencies during the teaching-learning process [Bi11]. Even if the planning and implementation of a course with the constructive alignment takes place on the micro level of the didactic design of a course, it is nevertheless integrated into larger processes and culture of a university (e.g. teaching reforms, individual factors of teachers, quality management) [BC14].

2.2   Blended Learning Concept

In the course 'Econometrics', the blended learning concept is a rotation model, which means that the students have a schedule with fixed face-to-face classroom time (in-class-time) and in-between periods of independent online study [De14]. The basis for the time structure of this course is the European Credit Transfer and Accumulation System, which is the standard in the European Union (and collaborating countries) for the comparison of the study attainment. The system is based on the workload of the students for reaching the goals

of the learning program [Ho08]. The workload contains the in-class-time and additionally the independent study for exercises, homework, exam preparation and learning. In Germany, a student can acquire 60 Credit Points (CP) per year, which translates into a workload from about 25 to 30 hours per CP. The course 'Econometrics' offers six CPs and have an workload of 150 to 180 hours in total.

The online module is created at the learning platform of the university, which is based on the open source software ILIAS (from the technical point of view, STACK is connected to ILIAS as a plugin). The module consists of different learning objects as the learning videos (recorded by the lecturer), including the handouts, literature overview, online exercises for monitoring of the learning process, forum for communication among fellow students and between students and lecturer, the data for students' software exercises and a guideline for self-study.

The design of the course is presented in the Fig. 1. The course always starts with a kick-off lecture with a length 4 hours at the beginning of the semester. It is represented by the number 1 in the figure 1. During the kick-off, the lecturer explains the concept of the course and shows the online resources. For students it is crucial to understand the concept of blended learning. Persike and Friedrich [PF16] show that students act more conservatively in using digital media. Accordingly, a high private use of digital media does not correlate to the time in studying. In their learning process, the students do not use the digital tools that they do not know well in private. The role model of the lecturer makes the difference: when they use these methods and digital instruments in their courses the students adopt them and creating a more digital learning process.
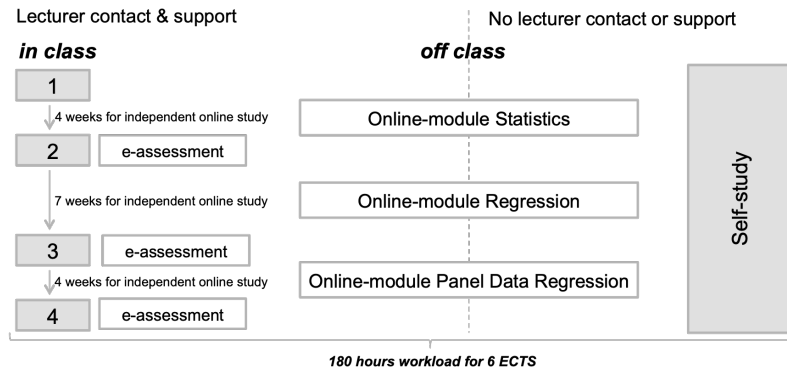

Fig. 1: Design Blended Learning Course "Econometrics"

After the kick-off lecture the independent online phase starts with a length of four weeks. The online module is guided by a text book, by the learning videos of the lecturer and by exercises. It follows the next face-to-face lesson (again a length of four hours), where the lecturer goes into the topic in more depth with practice problems. The next online module, lasts seven weeks and ends again with a class session. The course ends with a review session.

The course is split into two parts: with contact to the lecturer and without contact. According to the European Credit Transfer and Accumulation System, the presented course has 60 hours with contact to and support of the lecturer and up to 120 hours self-studying. The blended learning course has only 20 hours of class room time. Additional support and contact with the lecturer are organized by means of scheduled consultation hours exclusively for the blended learning students. Moreover, a forum on the learning platform and email-contact are provided.

To improve these rather large amounts of asynchronous communication in the self-studying online phases, we built up a large pool of exercises with STACK over the years. Due to the complexity of the subject and the desire for lasting student participation, interim tests have been installed to monitor the proceeding learning content. These are also mapped with STACK and correspond to the structure of the exercises. During each face-to-face lesson, short interim tests are written by the students covering the content of the previous online phase. The problems are based on the exercises in STACK and reproduce their familiar structure. It is important that the problems train different taxonomy levels: from remember to analyze and evaluate, the taxonomy levels are mapped to the learning objectives. The students are thus encouraged to continuously work on and practice the contents of the lecture in order to apply them to a practical example in an ongoing case study. STACK enables the mapping of complex problems as well as the different taxonomies with an automated feedback. This supports and promotes asynchronous learning.

3 Problems in STACK

There are many STACK examples in the community and we want to show some problems within the subject of economics. We describe the taxonomy level, which we use in different subjects to show the range of possible applications.

3.1 A classic accounting problem

The Fig. 2 presents a classic accounting problem replicated where students have to answer a question about business transactions and book accordingly. The mapping of accounts as well as debits and credits is relatively easy to implement with STACK. Here, a combination of drop-down fields and free-form text was used.

On the top of the problem, there are technical notes to show the students how to enter the data. That is an important step and consistently given through all problems. Due to the range of possibilities to enter the data, the students also needs to know, how the output of the results have to appear.

The taxonomy level of this accounting problem is apply. The students know the nature and structure of the problems very well and have practiced them in many forms in class. They apply their knowledge to a new set of facts in this problem.

Fig. 2: Accounting problem. The taxonomy level of this problem is "Apply".

The problem text translates to:

Book the posting records for the following business transactions from the perspective of the company. Since no financial statements are prepared during the year, accruals and deferrals only take place at the turn of the year.

a. The company delivered merchandise to a customer at a price of 20,000 EUR on target on 10-05-20X9. A discount of 5% is granted if payment is made within 14 days. Book the receipt of payment on the bank account from the companies point of view on 10-11-20X9.

b. The company has also leased a warehouse. At the beginning of the lease on 07-01-20X9, the annual rent of 38,880 EUR was paid and posted to equity. Make the adjusting entry as of 12-31-20X9.

3.2   A classic ecomometric problem

An econometric problem is shown in the Fig. 3. The students need to connect between ideas, utilize critical thinking, and break down knowledge into the sum of its parts. The taxonomy level is analyze. The problem shows a simplified real case and the students need to calculate with excel support and have to fill in the free-form text. Alternatively, the students can use the STACK functions to calculate the probabilities from the cumulative distribution function.

Fig. 3: Econometrics problem. The taxonomy level of this problem is "Analyze".

The problem text translates to:

"The library wants to provide the best possible supply of e-books for students. At the same time, it has a tight budget and can only buy a certain number of accesses to the e-books. However, it also knows that the books sit unread on the server most of the time and does not want to buy too many e-books. The library makes the following considerations. It is assumed that there are 50 students of a hypothetical lecture who study each day within a period of 10 hours. The students can study in every hour and every day of the week. In the hypothetical lecture, there is only a recommended textbook. The probability of learning in any hour is the same for all hours and independently distributed.

- What is the probability that more than 3 students will want to read the textbook in any single hour during the week?

- What is the probability that more than 3 students want to read the textbook in any single hour if the students study only on weekends?

- The library wants to have a probability of no more than 1% that more students want to read the textbook than there are number of e-books. What is the minimum number of accesses the library should purchase in the original consideration? "

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4   Empirical case study

The application of the blended learning courses and STACK exercises have been evaluated at our university. We analyze to what extent the use of blended learning with STACK problems increases the learning success of the students. The aim of our study in general is the analysis of the effects of a blended learning course (BLC) on students' learning outcomes relative to students engaged in traditional face-to-face course (F2F) with support of different teaching methods. The students are randomly assigned to the BLC or to the F2F. The course is thought parallel as both, the blended learning and traditional face-to-face course by the same lecturer and the content of each course is identical. Each course has the same text book, covers the same chapters, provides the same handouts, the same quizzes and the same problem sets as well as the exam concept. The problem sets and the quizzes in BLC are delivered online with automated online-feedback. The students in traditional

F2F are engaged in the traditional weekly discussion about the problem sets with teaching assistants.

The main difference between the BLC and the F2F is the delivery of the lecture by the instructor. The instructor gives weekly lectures in the traditional F2F and the students can interact with the instructor during the regular weekly class sessions. For the BLC, the weekly lecture is provided by an individual learning path with a huge range of online learning material. The class sessions are offered not weekly but monthly. During the class session, the instructor begins by answering questions about the materials and giving mini-lectures targeted to troublesome items, about the students asked questions in online forums.

The Tab. 1 reports the summary statistics for the variable SCORE for all students ($Score_{All}$), for students in traditional face-to-face classes ($Score_{F2F}$) and for students in blended learning courses ($Score_{BLC}$). The summary statistics given in the table are the median, the average, the lower and upper quartiles, maximum and minimum values, the standard deviation (SD) and the number of observations.

The variable SCORE is the student's success in the final test and is measured as the points achieved by the student divided by the total points in the test. We assume that SCORE is an imperfect measure of the learning outcome but that it has a positive correlation with the increment of the student skill. The positive correlation with the true dependent variable is a necessary and sufficient condition for unbiased estimate.

Tab. 1: Summary statistics for the student success in face-to-face and blended-learning courses

	$Score_{All}$	$Score_{F2F}$	$Score_{BLC}$
Median	0.70	0.53	0.77
Average	0.67	0.56	0.74
Lower Quartile	0.50	0.36	0.62
Upper Quartile	0.87	0.80	0.93
Max	1.00	0.93	1.00
Min	0.07	0.10	0.07
SD	0.25	0.24	0.22
# Obs	279	129	150

Our data sample consists about 300 students, who voluntarily participated in the survey. The number of students in observation exceeds the majority of related studies.

The SCORES vary substantially with a standard deviation of 0.25, which is more than a full letter grade. More surprisingly is the large difference of more than 0.20 in the median and average SCORE between F2F and BLC. The result suggests that an average student in a F2F barely passes the class while an average student in BLC do well in the final exam. The difference in average SCORES is significant with a t-stat of 6.69. We run a boot-strapped test as well and used different control variables.

We also calculated the average SCORE for all students, who participated in the final exam but did not participate in the survey. The SCORE difference between BLC and F2F is

virtually the same. Moreover, about 90% of the students, who visit the course, took the final exam. It follows that, most likely, the variable SCORE is not biased by the students not participating in the survey.

5 Conclusion

The paper presents how the didactic spectrum of examinations is expanding due to digitization. Against the backdrop of media change, the altered availability of knowledge, changing competence profiles and a new culture of digitality, examinations in the higher education context can be rethought. How can examination formats and scenarios be coordinated with the respective learning objectives? The crucial factor is the fit of the examination form to the teaching-learning objectives. This also means that a large variety of examination forms is necessary in order to be able to adequately map the increasing number of teaching and learning objectives. A solution is the wide range of application and variation of STACK problems.

The design of versatile exercises with different taxonomy levels pick up the students in their individual learning process and prepare them ideally for the examinations, which do not only test the reproduction of knowledge. The competence-oriented examinations can be designed with the help of STACK problems that seem to not decrease the student's success in the test relative to the traditional examination formats. Our results suggest that the implementation of STACK problems within a blended learning course has positive effects on student's learning outcomes.

The developments towards individualized learning and the use of constantly evolving adaptive technology enable diverse forms of testing with regard to the heterogeneity of the target groups. However, the technology, which does not serve as an end in itself, but can only be effective by supporting teaching and testing in the best possible way, places high demands on teachers and also students. The goal should be to enable adaptive learning (a combination of adaptive technology and personalized learning - more info on this [Br20]) and to design exams adequately with regard to learning outcomes.

We will continue to collect data over the next terms to expand our research and are intending to implement a STACK working group at our university that supports each other, as well as building up question pools from very different disciplines.

Bibliography

[BC14] Biggs, John B; Collis, Kevin F: Evaluating the quality of learning: The SOLO taxonomy (Structure of the Observed Learning Outcome). Academic Press, 2014.

[Bi96] Biggs, John: Enhancing teaching through constructive alignment. Higher education, 32(3):347–364, 1996.

[Bi11]   Biggs, John B: Teaching for quality learning at university: What the student does. McGraw-hill education (UK), 2011.

[Br20]   Brown, Malcolm; McCormack, Mark; Reeves, Jamie; Brook, D Christopher; Grajek, Susan; Alexander, Bryan; Bali, Maha; Bulger, Stephanie; Dark, Shawna; Engelbert, Nicole et al.: 2020 Educause Horizon Report Teaching and Learning Edition. Technical report, EDUCAUSE, 2020.

[De14]   DeNisco, Alison: Different faces of blended learning. District Administration. Retrieved from bit. ly/1jAWlVA, 2014.

[ESS15]   Erpenbeck, John; Sauter, Simon; Sauter, Werner: E-Learning und Blended Learning: Selbstgesteuerte Lernprozesse zum Wissensaufbau und zur Qualifizierung. Springer-Verlag, 2015.

[Ha21]   Hailikari, Telle; Virtanen, Viivi; Vesalainen, Marjo; Postareff, Liisa: Student perspectives on how different elements of constructive alignment support active learning. Active Learning in Higher Education, p. 1469787421989160, 2021.

[Ho08]   Hochschulrektorenkonferenz, H: Bologna-Reader III. FAQs-Häufig gestellte Fragen zum Bologna-Prozess an deutschen Hochschulen. Bonn: HRK Bologna-Zentrum, 2008.

[LR13]   Larkin, Helen; Richardson, Ben: Creating high challenge/high support academic environments through constructive alignment: student outcomes. Teaching in higher education, 18(2):192–204, 2013.

[MK14]   Mayrberger, Kerstin; Kumar, Swapna: Mediendidaktik und Educational Technology. Zwei Perspektiven auf die Gestaltung von Lernumgebungen mit digitalen Medien. 2014.

[PF16]   Persike, Malte; Friedrich, Julius-David: Lernen mit digitalen Medien aus Studierendenperspektive. Berlin: Hochschulforum Digitalisierung, 2016.

[Wa13]   Wang, Xiaoyan; Su, Yelin; Cheung, Stephen; Wong, Eva; Kwong, Theresa: An exploration of Biggs' constructive alignment in course design and its impact on students' learning approaches. Assessment & Evaluation in Higher Education, 38(4):477–491, 2013.