



Munich Personal RePEc Archive

## **E-homework with individual feedback for large lectures**

Fath, Julia and Hansen, Philipp and Scheicher, Christoph and Umbach, Tim

University of Cologne

2019

Online at <https://mpra.ub.uni-muenchen.de/107128/>  
MPRA Paper No. 107128, posted 12 Apr 2021 00:35 UTC

## E-homework with individual feedback for large lectures

Julia Fath<sup>1</sup>, Philipp Hansen<sup>2</sup>, Christoph Scheicher<sup>3</sup> and Tim Umbach<sup>4</sup>

**Abstract:** We implemented two different blended learning concepts using STACK. The aim was to enhance continuous learning activity of up to 1600 undergraduates in each of our courses right from the beginning of a term. In both scenarios, classroom exercises were partially replaced by voluntary e-learning tasks. In the first scenario, lecture hours were used to spend more time on difficult exercises in the classroom. In the second, lecture hours were reduced and bonus points for the final exam could be earned by submitting additional e-homework. E-homework with bonus points triggers active participation in the other (online and classroom) parts of the same course and therefore improves continuous learning.

Teaching in large groups is challenging in many respects. There are several features of conventional teaching settings affecting the learning outcome of students negatively, e. g. the lack of individual feedback to students regarding their performance during the semester or the missing opportunity for each student to participate actively ([NPB18]). In order to overcome those problems, we introduced e-homework including the STACK-question type ([Sa13]) into our courses in combination with new teaching formats during the summer term 2018. In this paper, we evaluate how the participation of the students during the semester changed after the reform and describe the consequences we draw from our experiences.

This paper is organised as follows: Section 1 describes the main characteristics of the courses and prior experience that led to our e-homework project with STACK. Section 2 contains information on the participants and the funding of the project at the University of Cologne (UoC). Section 3 highlights how e-homework with STACK changed the teaching concepts in two undergraduate courses. Section 4 reports the first experiences with the new teaching concepts and the impact on continuous participation. Finally, we conclude and discuss further ideas.

### 1 Relevant characteristics of the courses and prior experience

The courses involved in the project comprise five introductory courses of the Faculty for Business, Economics and Social Sciences. These mostly quantitative courses have a number of things in common and therefore face similar problems.

---

<sup>1</sup> University of Cologne, Department of Economics, Albertus Magnus Platz, 50923 Cologne, Germany.  
E-mail: [fath@wiso.uni-koeln.de](mailto:fath@wiso.uni-koeln.de)

<sup>2</sup> University of Cologne, Institute for Statistics and Econometrics, Albertus Magnus Platz, 50923 Cologne, Germany.  
E-mail: [p.hansen@uni-koeln.de](mailto:p.hansen@uni-koeln.de)

<sup>3</sup> University of Cologne, Institute for Statistics and Econometrics. E-mail: [scheicher@statistik.uni-koeln.de](mailto:scheicher@statistik.uni-koeln.de)

<sup>4</sup> University of Cologne, Department of Economics. E-mail: [umbach@wiso.uni-koeln.de](mailto:umbach@wiso.uni-koeln.de)

They are large undergraduate courses with up to 1600 registered students per term and up to 1000 students taking the exam. Due to the large number of participants, it is difficult to give students individual feedback regarding their performance, but also to receive feedback from students if they have problems with the learning material. Only few students dare to participate actively in large lectures.

Moreover, the audience is very heterogeneous. Students have different abilities and qualifications. They are enrolled in different bachelor programmes like Business Administration, Economics and Social Sciences where different admission standards apply. Although the courses are intended for first year students, many of them follow their own study plan and sometimes wait until their last semester to finish the courses. The resulting heterogeneity increases the need to give individual feedback to each subgroup if not to each student.

We suppose the previously mentioned characteristics to be important reasons for low grade averages and high failure rates in the exams for some of the subgroups. But the most important source might be the one we observed before the project was launched: Many students started to study only a few weeks or even only a few days before the exam. Earlier attempts to enhance the activity during the first weeks of a term included the introduction of pen-and-paper homework assignments as well as midterm exams. However, both are very labour intensive to grade. The homework came with the additional problem of cheating. It was easy for the students, as they could just copy the others' answers.

## 2 The e-homework project with STACK

To overcome the difficulties of large, heterogeneous classes and just-in-time-learning, we looked for ways to automate the grading procedure, to give individual feedback to students, to receive information about how well the students are doing with a certain task and to make cheating more difficult by randomising assignments. We therefore decided to implement new teaching concepts with online homework on the UoC e-learning platform ILIAS using STACK-questions.

The project 'individual e-homework with immediate feedback'<sup>5</sup> started in 2017 and is financed by central university funding and by the Faculty of Management, Economics and Social Sciences. At the UoC, there exists a periodical call for proposals of innovative teaching projects. Every two years, about ten of those projects are chosen by the Rectorate to receive monetary support for a maximum of two years.

Members of different areas work together on the project. It involves the responsible teaching staff of the five courses Mathematical Methods for Economists, Introduction to Microeconomics, Descriptive Statistics, Statistical Inference and Introduction to Economics. Due to the funding, the project can be supported by two doctoral students for programming

<sup>5</sup> *Individuelle E-Hausaufgaben mit sofortigem Feedback*, further information available in German: <https://www.portal.uni-koeln.de/13398.html>

the electronic questions over a period of two years. Occasionally, student assistants take over some easy programming tasks.

To launch the project, we initially needed to introduce STACK into the e-learning environment at the UoC. Special support for the implementation was provided by the CompetenceCenter E-learning (CCE) of the university. Within the project, the CCE also developed a manual on STACK for ILIAS<sup>6</sup> and started to offer STACK training courses, which meanwhile are also supplied outside the UoC. The CCE established a permanent support infrastructure for STACK-questions at the UoC and therefore is prepared for the increasing number of lecturers introducing STACK-questions into their online teaching.

Furthermore, system developers of FAU Erlangen-Nürnberg are creating special STACK-features for the UoC, also financed through project funding. These include green- and red-coloured backgrounds for correct and false answers respectively, step-wise feedback, which only asks for certain steps of a calculation if the first answer is incorrect, and more.

### 3 New teaching concepts with STACK

We decided to use STACK because one of its critical advantages compared to other solutions<sup>7</sup> is that it is available as a plug-in for ILIAS. Therefore, students' user accounts for ILIAS can also be used for e-homework and students are already familiar with the surrounding of their online exercises.

STACK is a valuable element of the e-homework, since it allows for computer-aided assessment of mathematical questions ([Sa13]). Cheating by copying others answers becomes more difficult, because STACK leaves the opportunity to generate individual versions of the questions. Collaboration on the e-homework is desirable, in order to exchange ideas on how to solve the individual problems. Suitably programmed STACK questions give an automated, yet individual feedback to students (see figures 5-8 for some translated examples). Implemented in ILIAS, they also deliver detailed statistics on how students perform. For an example of a statistical evaluation of one exercise with bonus points see table 1.

A further important element of the new teaching concepts are the so-called bonus points. Students can receive a reward for the correct answers to their weekly e-homework, which are used to improve their grades in the final exam. Participation in this scheme is voluntary, however.<sup>8</sup>

---

<sup>6</sup> See [MSJ18].

<sup>7</sup> We found that only WebWork and STACK met the previously mentioned criteria for our project. Among these two, we decided on STACK after testing and soliciting feedback from students.

<sup>8</sup> The most important characteristics of the bonus point scheme in this context are:

- (1) They can only be considered if the final exam is passed in the first place.
- (2) The bonus points may not exceed 10% of the achievable points in the exam.
- (3) Even without bonus points, students still have the opportunity to receive the best grade.

We first introduced e-homework with STACK-questions in our undergraduate courses in mathematics and microeconomics. The exercises were programmed during the winter term of 2017 and are part of these two courses since the summer term of 2018. So far, we have developed roughly 50 questions for microeconomics like those shown in figures 7 and 8 in the appendix. For mathematics, we have constructed 95 questions similar to those shown in figures 5 and 6. Currently, we are developing further STACK-assignments for the two undergraduate courses in statistics, which will presumably be introduced in early 2019. Over the course of the project, we regularly update our existing exercises with new STACK features while receiving continuous support from the CCE.

### 3.1 Implementation in the course Mathematical Methods for Economists

Figure 1 shows the structure of the course Mathematical Methods for Economists. A new topic is introduced in a conventional classroom lecture. The lecture already includes the presentation of an example calculation. After the lecture, the students can work on STACK-assignments relating to that specific topic.<sup>9</sup> Since the winter term 2018/19, students can receive bonus points for the final exam. Following the lecture and the STACK-assignments,

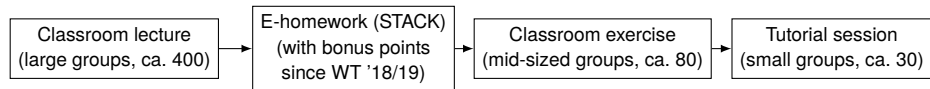


Fig. 1: Mathematical Methods for Economists: Order of events of each learning unit

more advanced (paper-based) assignments are discussed in classroom exercises. This gives room for a more intensive discussion of complex tasks, since the easier examples are already covered in the electronic exercises. Finally, students can visit a tutorial session, in which additional exercises are independently solved in small working groups.

In the winter term of 2018, we changed the set-up of the course with respect to the STACK-assignments. In contrast to the preceding summer term, students can now earn bonus points for their final exam. The e-homework with bonus points comprises 13 (weekly) tests. Each test contains about five STACK-questions and is online from Thursday 7.30 pm to Monday 7.30 am. During this time, students can access the test 42 times<sup>10</sup> and receive different random numbers with each attempt. Eventually, the best attempt counts for obtaining the bonus points. After the deadline of the test, students receive the sample solutions for their attempts.

The idea behind this approach is that students shall practise the contents of the lecture successfully, regardless whether they need many attempts or not. After submitting an attempt,

<sup>9</sup> For examples, see figures 5 and 6 in the appendix.

<sup>10</sup> In this respect, we chose the number 42 in order to guarantee that students have a sufficient number of attempts to practise the content while preventing them from refreshing the test until they obtain a convenient combination of random numbers. The number 42 refers to “the answer to the ultimate question of life, the universe and everything” ([Ad79, p. 3]).

the students get direct feedback on what is wrong and right and additionally receive hints in case of typical mistakes. This kind of feedback is supposed to support the students when making a new attempt. In this regard, STACK is well suited for our purposes, since similar exercises with different random numbers leave the opportunity for students to practise difficult questions, while making cheating more difficult.

### 3.2 Implementation in the course Introduction to Microeconomics

To introduce e-homework into the microeconomics course, half of the classroom exercises were replaced by STACK exercises. In contrast to the math course, there exist two types of STACK exercises at the same time: one type without bonus points and one type with bonus points. Overall, microeconomics contains 12 learning units with bonus points. Each unit follows the same general template, as can be gleaned from figure 2.

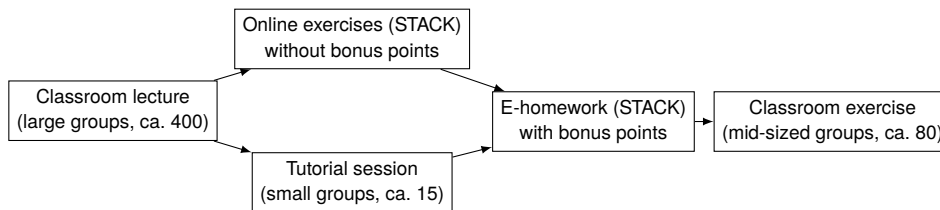


Fig. 2: Introduction to Microeconomics: Order of events in each learning unit

After the conventional classroom lecture, students answer some small comprehension tests online and perform several STACK exercises, which can be repeated as often as wanted. Students get feedback with immediate detailed individual hints for improving their entries. STACK is a very powerful tool in this regard, as its feedback-tree logic allows for almost arbitrarily detailed feedbacks. We do not use random numbers at this stage, but rather numbers that make the mental calculations fairly easy. One advantage of this is that students do not need a calculator, which they are not allowed in the final exam. No deadline for submission exists. For an example exercise see figure 8 in the appendix. The feedback to these questions plays an important role, as they are meant to teach new concepts instead of testing knowledge and ability. At the same time, students also solve pen-and-paper exercises under the supervision of student tutors in small groups. This phase is concluded with an e-homework with bonus points. Students have only one try and there is a deadline every Monday night at 3 am, about one to two weeks after the topic was introduced in the lecture. Here, the possibility to draw random numbers in STACK to generate individual exercises becomes important to prevent cheating (see figure 7 in the appendix for an example) and stimulate cooperative exchange between students. Finally, the students visit a classroom session, in which the e-homework is discussed. In addition, the contents of the learning unit are summarised and a broader and deeper reflection of the topic rounds off the learning unit. Since the introduction of the e-homework, we are able to offer a larger number of these final sessions in parallel, leading to smaller groups and a more lively debate.

## 4 First experiences

To examine the effects of the project, we recorded the participation in the online exercises (see figure 3 and 4), looked at achieved bonus points and conducted a classroom survey in the two previously described courses (see table 2 and figure 9 in the appendix). The acceptance of e-homework with STACK-exercises is very positive in general. Nevertheless, we find that the manner in which the exercises are implemented has a great effect on the participation of students. Figure 3 shows the user traffic in June 2018, thus at the end of the summer term. Note the three different ILIAS-courses with STACK-exercises in place: The solid yellow and the dotted blue line display the traffic of the two STACK-exercises in microeconomics, with and without bonus points, respectively. The dashed red line represents the traffic for mathematics. The horizontal axis depicts the calendar days and the vertical axis shows the clicks per day. At this time of the semester, there were roughly 500 active participants in each of the courses. The differences in participation are obvious: The yellow

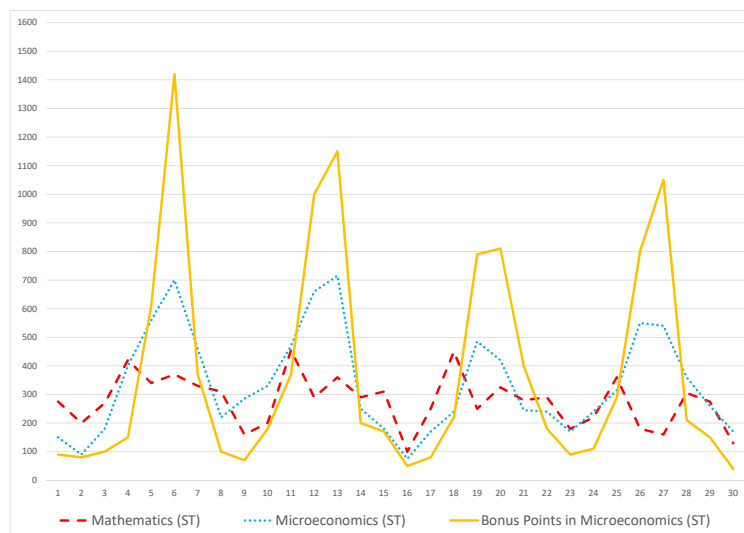


Fig. 3: User traffic June 2018.

graph shows peaks of up to 1400 clicks on days of submission deadlines for the bonus point exercises in microeconomics. The dotted blue line exhibits peaks on the same days, however at a significantly lower level. We interpret this as follows: While students try to solve the exercises that yield bonus points in microeconomics, they search for hints and explanations in other course materials. The survey showed that students ask for support of their tutors or look into the lecture script whenever they encounter problems with the bonus exercises. A similar notion may explain the peaks of the dotted blue line. In June 2018, the dashed red line, representing the number of clicks in mathematics, mostly falls behind the user traffic in microeconomics. Small peaks are recorded on Mondays when the new questions were put online. The dips in all three lines display the lower activity on weekends.

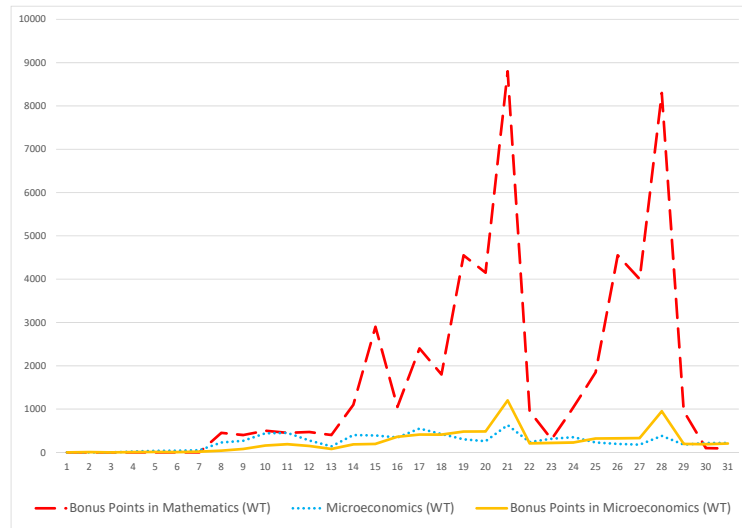


Fig. 4: User traffic October 2018.

Figure 4 reveals the substantial changes in the number of clicks when bonus points were introduced in mathematics in October 2018. The number of clicks in this course increased almost twentyfold in comparison to the user traffic in June 2018. Simultaneously, the solid yellow and the dashed blue lines, representing the number of clicks in microeconomics, exhibit the same peaks as before. In the winter term, the number of active students in mathematics doubled from 500 to 1000. However, this only explains a small share of the dramatic increase in traffic. The remaining share of the increase must be caused by the bonus points and the limited time, in which students have access to the bonus point exercises. All other course components did not change since the summer term.

The tremendous difference in user traffic between the bonus point exercises in mathematics and microeconomics is caused by several reasons: The e-homework in mathematics typically comprises five STACK-questions, while the e-homework in microeconomics contains one question. Moreover, the e-homework in mathematics may be repeated 42 times during the access time, while students in microeconomics have only one attempt in a considerably longer access time.

Considering the achieved bonus points in both courses, a similar picture emerges. In the summer term, 742<sup>11</sup> of the microeconomics students participated in the e-learning program and obtained on average 4.23 out of 6 possible bonus points. However, the students' results are fairly heterogeneous, as the standard deviation of 1.97 would suggest. Similarly, in the mathematics course, 841 participated this winter term, achieving on average 7.46 out of 9

<sup>11</sup> For technical reasons, we define a participating student as one who has obtained at least 0.5 bonus points, assuming that everybody who actively tried to solve the questions got more than zero points overall.



possible points, with a standard deviation of 2.28. Overall, these numbers suggest that the bonus point program did indeed incentivise learning. This is also supported by the fact that only 9.3 percent of those who took the microeconomics exam at the end of the last summer term had no bonus points.

Finally, in order to gain insight into the students' impressions regarding the e-homework with bonus points, we conducted a survey within the sixth week of the winter term during the classroom lectures in mathematics and microeconomics. In total, 1006 students from both courses answered this questionnaire. The main results are as follows and support what we found before (for detailed results see table 2).

- More than 50 percent of the respondents report to collaborate with other students to solve their e-homework. About three-quarters use other course materials in case they need help to find the correct solution.
- Unsurprisingly, almost all students like the bonus point models. Three-quarters of the students always do their e-homework. Likewise, three-quarters indicate that they would do less e-homework in case there were no bonus points.
- More than 80 percent of the respondents state that the bonus point models influence their learning behavior. A majority notes in a free text box that the bonus point models lead to more regular learning.
- When asked how our e-homework could be improved, 16 percent stated they found it difficult to enter their results into STACK, 8 percent asked for more tries in microeconomics and 7 percent would like more detailed sample solutions.

## 5 Conclusion and further developments

The first experiences with STACK-assignments during the summer term show that e-homework with bonus points is effective in enhancing active participation of students in large courses. As a consequence, e-homework with bonus points was introduced in Mathematical Methods for Economists this winter term.

We observe positive external effects with respect to other parts of the course: In the classroom, students participate more actively, ask more questions and give more feedback on the course content in comparison to former semesters, in which our courses had the conventional order of a classroom lecture followed by classroom exercises.

Thinking of further developments in the teaching of the courses, e-homework may therefore be a helpful element when establishing an inverted classroom for large groups. This is currently in the planning stage for the mathematics course.

The positive results of the project lead to its permanent application in mathematics and microeconomics. Moreover, e-homework is going to be introduced into the courses

Descriptive Statistics and Statistical Inference next summer term and into Introduction to Economics the following winter term. Together with the substantial help of two research and teaching assistants, a sufficient voluminous pool of STACK questions for the five large courses will have been created at the end of September 2019 within a period of two years. Certainly further work on STACK questions is necessary in the future to add or enhance questions or to eliminate possible mistakes.

With regard to future research, it would be interesting to investigate the effect of e-homework with bonus points on final grades and failure rates. We are currently examining whether the availability of data is adequate for answering this question. In addition, we consider the possibility of conducting an electronic exam with STACK.

## Acknowledgements

We thank Tobias Mai and Morten Brekke for many helpful comments. Further thanks go to Eva Mix, Mario Josupeit and Mark Kusserow who made the use of STACK possible at the University of Cologne.

## References

- [Ad79] Adams, D.: The Hitchhiker's Guide to the Galaxy. Pan Books, London, 1979.
- [MSJ18] Mix, E.; Schmeißer, L.; Josupeit, M.: Einführung in STACK - Die Verwendung der STACK-Frage in ILIAS, University of Cologne, 2018, URL: [https://github.com/mathsmoodle-qtype\\_stack/blob/master/doc/content/de/Erklaerung-STACK-3.pdf](https://github.com/mathsmoodle-qtype_stack/blob/master/doc/content/de/Erklaerung-STACK-3.pdf).
- [NPB18] Nortvig, A.-M.; Petersen, A. K.; Balle, S. H.: A Literature Review of the Factors Influencing E-Learning and Blended Learning in Relation to Learning Outcome, Student Satisfaction and Engagement. *Electronic Journal of e-Learning* 16/1, pp. 46–55, 2018.
- [Sa13] Sangwin, C.: *Computer Aided Assessment of Mathematics*. Oxford University Press, Oxford, 2013.

## Appendix

*Results of 11<sup>th</sup> bonus point question  
January 14<sup>th</sup> 2019*

Participated	379
Submitted answers	344
Points on average	0.752
<i>If handed in:</i>	
Points on average	0.785
Share without points	0.215
Share with full points	0.785
Average time needed	00:17:15

Ranking	Group	Pct. solved on average
1	Business studies 2	86.25%
2	Business studies 3	83.78%
3	Economics 3	80.39%
4	Business studies 1	79.69%
5	Economics 2	75.00%
6	Economics 1	69.23%
7	Economics 4	64.86%

Tab. 1: Statistical analysis of a STACK question in Introduction to Microeconomics

Exercise 4.07

Give all solutions to the linear equation by using **Gaussian elimination**.

$$\begin{bmatrix} 1 & 1 & 3 \\ 1 & 0 & -1 \\ 8 & 8 & 25 \end{bmatrix} \cdot \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} = \begin{bmatrix} 2 \\ 6 \\ 24 \end{bmatrix}$$

With the help of the first row, convert the other rows so that the first column contains the first unit vector. **Don't apply any further conversions.**

1	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
0	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
0	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>

With the help of the second row, convert the other rows so that the second column contains the second unit vector. **Don't apply any further conversions.**

**Exercise information:** If necessary, first convert the second row appropriately.

1	0	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
0	1	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
0	0	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>

With the help of the third row, convert the other rows so that the third column contains the third unit vector.

1	0	0	<input type="text"/>	<input type="text"/>
0	1	0	<input type="text"/>	<input type="text"/>
0	0	1	<input type="text"/>	<input type="text"/>

Fig. 5: One example of an exercise in Mathematical Methods

Exercise 3.04

**Exercise information: round all results to the next integer. Continue calculating with the rounded results.**

a) Mr. I. bought a house and took out a loan of 600.000 Euro with an interest rate of 1%. What is the amount of the annuity when the loan should be paid off at the start of his retirement in 35 years?

$A =$

b) 10 years later Mr. I. realises that he unfortunately missed that the fixed interest rate from his loan in part a) now expires. How many percent must the annuity increase when the new interest rate is 5% and he still wants to pay off the loan at the start of his retirement?

Calculate the present value of the payments in the first 10 years.

$W_{\text{payments}} =$

Now, calculate the debt levels after 10 years.

debt level =

Then calculate the annuity after 10 years with the new interest rate of 5% and unchanged lent term.

$A =$

His annuity increases by  %.

c) Mr. I. then realises that he cannot afford the higher annuity. For how many years (rounded) Mr. I. has to pay off the loan, if he still pays the annuity of part a)?

**Exercise information:** Indicate the number of years (commercially rounded to whole years) he has to pay off the loan, or write 'never' if he is never able to pay off the loan.

Fig. 6: Another example of an exercise in Mathematical Methods

10. Bonus exercise Welfare Theorems

Consider an exchange economy endowed with two goods, good 1 and good 2, and two consumers, consumer  $A$  and  $B$ . Assume that the initial endowments are given by  $(\omega_1^A, \omega_2^A) = (9, 14)$  and  $(\omega_1^B, \omega_2^B) = (8, 5)$ . The utility function of  $A$  is  $u^A(x_1^A, x_2^A) = x_1^{0.8} \cdot x_2^{0.2}$  and the utility function of  $B$  is given by  $u^B(x_1^B, x_2^B) = x_1^{0.7} \cdot x_2^{0.3}$ .

What would be an allocation in the **core of the economy**, given that  $x_1^A > 0, x_2^A > 0, x_1^B > 0, x_2^B > 0$ ?

$(x_1^A, x_2^A) = ($    $,$    $)$

$(x_1^B, x_2^B) = ($    $,$    $)$

No, although this allocation is feasible and  $A$  as well as  $B$  would be better off, the allocation is not efficient.

The total endowments  $\omega_1, \omega_2$  are distributed among the consumers, however, the  $MRS$  at this point is not equal for  $A$  and  $B$ .

$MRS_A(8.5, 9.5) = -\frac{0.8 \cdot 9.5}{0.2 \cdot 8.5} = -4.47$

and

$MRS_B(8.5, 9.5) = -\frac{0.7 \cdot 9.5}{0.3 \cdot 8.5} = -2.61$ .

Hence, gains from trade are possible. Since your solution was an allocation which is feasible and makes both consumers better off, you still get 50% of the bonus points.

Fig. 7: Example of an exercise with bonus points in Introduction to Microeconomics

Welfare Theorems

Consider an exchange economy endowed with two goods, good 1 and 2, and two consumers, consumer **A** and **B**. The initial endowments of each good are  $\omega_1 = \omega_2 = 10$ . What would be a feasible allocation in this economy?

$$x^A = (x_1^A, x_2^A) = ( 5 , 5 )$$

$$x^B = (x_1^B, x_2^B) = ( 5 , 5 )$$

Correct, this allocation is feasible.

The following inequalities need to hold for a feasible allocation

$$x_1^A + x_1^B \leq \omega_1$$

$$x_2^A + x_2^B \leq \omega_2$$

Assume that consumer **A** and consumer **B** have the same utility function  $u^A(x_1, x_2) = x_1^A \cdot x_2^A$  and  $u^B(x_1, x_2) = x_1^B \cdot x_2^B$ . Their initial endowments amount to  $x^A = (2, 8)$ ,  $x^B = (8, 2)$ . Is this allocation efficient?

No, it is not efficient..

Correct, this allocation is not efficient. Although the initial endowments are distributed in a way such that all available goods are consumed (remind yourself that with strictly monotone preferences a Pareto improvement is possible as long as not all goods are consumed), however, the **MRS** is not identical for both consumers.

At this point, it holds that  $MRS_A = -\frac{8}{2}$  and  $MRS_B = -\frac{2}{8}$ . Hence, both consumers would be better off by trading. For instance, **A** could increase his utility by trading some of good 1 for some of good 2 with **B**.

Please compute the set of all pareto-efficient allocations on the contract curve. We seek for a relation which gives all pareto efficient bundles of goods from the point of view of consumer **A**.

Please write  $x_1^A$  as  $x_1$ :

$$x_2^A = 3^{x_1}$$

How can we state the pareto-efficient bundles from the point of view of **B**?

Please write  $x_1^B$  as  $x_1$ :

$$x_2^B = 3^{x_1}$$

False.

In case of normal preferences, two requirements need to be fulfilled for efficiency.

First, the total quantity of goods must be consumed, hence, the following holds

$$\omega_1 = 10 = x_1^A + x_1^B$$

$$\omega_2 = 10 = x_2^A + x_2^B$$

Second, the **MRS** of **A** and **B** must be identical for the specific bundle.

In your solution, both criteria are not fulfilled.

Start by computing the **MRS** in a general form. Subsequently, equate them. With the two equations from above, you can derive an equation system with three equations and 4 unknowns

$$x_1^A, x_2^A, x_1^B, x_2^B$$

Hence, you can eliminate  $x_1^B$  and  $x_2^B$ . Subsequently, you can solve for  $x_2^A$ .

Fig. 8: Example of an exercise **without** bonus points in Introduction to Microeconomics

## Fragebogen zu den E-Hausaufgaben

(Mit der Abgabe des ausgefüllten Fragebogens erklären Sie sich einverstanden, dass dieser zur Verbesserung des Moduls im Allgemeinen und der E-Hausaufgaben im Speziellen, sowie zu Forschungszwecken verwendet werden darf.  
Bitte achten Sie zur Gewährleistung Ihrer Anonymität auf eine möglichst neutrale Handschrift.)

**1) Wie bearbeiten Sie die E-Hausaufgaben?**

- alleine    erst alleine, bei Schwierigkeiten frage ich Kommiliton\*innen    in einer Lerngruppe  
 Mit Hilfe von Online-Foren und sozialen Medien    Sonstiges: \_\_\_\_\_

**2) Wo schauen Sie nach, wenn Sie nicht weiterkommen?**

- Veranstaltungsunterlagen    Lehrbuch    frage Lehrperson    frage andere Kommiliton\*innen  
 Internet    Sonstiges: \_\_\_\_\_

**3) Wie regelmäßig bearbeiten Sie die E-Hausaufgaben?**

- immer    oft    teilweise    selten    nie

**4) Wie würde sich dies ändern, wenn Sie keine Bonuspunkte erhalten würden?**

- ich würde sie regelmäßiger bearbeiten    kein Einfluss    ich würde sie seltener bearbeiten

**5) Vergleichen Sie diese Vorlesung mit einer Vorlesung bei der es keine Bonuspunkte gibt:**

- a) Finden Sie das Bonuspunktemodell gut?    ja    nein  
b) Hat die Vergabe von Bonuspunkten Einfluss auf Ihr Lernverhalten?    ja    nein

**6) Falls Sie 5 b) mit ja beantwortet haben, welchen Einfluss hat die Vergabe von Bonuspunkten auf Ihr Lernverhalten?**

**7) Wie können wir die E-Hausaufgaben technisch und/oder inhaltlich verbessern?**

**8) Weitere Kommentare?**

Vielen Dank für Ihre Mitarbeit!

Fig. 9: Survey questionnaire

Total: 1006 Questionnaires	Share of answers in pct.
(free textbox answers only reported if response > 5 percent)	
<b>1) How do you solve the e-homework?</b>	
Alone	34.99
Alone at first and if I get stuck I ask fellow students	53.58
In a group with fellow students	9.54
Online-forum and Social Media	15.11
Other methods	2.19
<b>2) Where do you search for help if you can not solve the tasks directly?</b>	
Course material	76.14
Textbook	7.36
Instructor	1.89
I ask fellow students	53.68
Internet	58.75
Other methods	3.58
<b>3) How regularly do you solve the e-homework?</b>	
Always	75.94
Often	11.83
Sometimes	6.86
Rarely	3.68
Never	1.59
Not specified	0.10
<b>4) How would your behavior change if you would not get any bonus points?</b>	
I would solve them more regulary	3.98
No influence	21.87
I would solve them less often	73.96
Not specified	0.30
<b>5) Compare this course with a course without the bonus points scheme</b>	
a) Do you like the bonus points scheme?	
Yes	95.73
No	3.68
Not specified	0.60
b) Does the bonus point scheme have an influence on your study behavior?	
Yes	83.00
No	16.60
Not specified	0.40
<b>6) If you answered 5b) in the positive, which influence has the bonus point scheme had on your study behavior (free text box)?</b>	
A more regular learning behaviour over the course of the semester	57.55
Additional motivation	14.51
More learning by repetition	9.84
<b>7) How could we improve the e-homework technically and/ or regarding to content (free text box)?</b>	
Simplification of the technical input	16.00
Allow for more repetitions (especially after formatting errors)	8.25
Showing the correct approach to solve the task/ more extensive solutions	7.55
<b>8) Further comments</b>	

Tab. 2: Survey Results