Project Report **LectureLab**

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LectureLab

It is eight o'clock, Monday morning. The class starts in 15 minutes. 500 students and one professor who is supposed to teach them mathematics. This is a challenge, as there are 500 individuals and one cannot read their thoughts. Some of the students are finishing their coffee, many are yawning, rubbing their heads and quietly suffering under the prospect of differential equations.

It's hard to follow complicated algebra, sitting in a huge lecture hall surrounded by an anonymous crowd of fellow students, watching a tiny person in front of a large blackboard scribbling down random numbers or flipping through some complicated looking slides. It is very tempting to put off concentration for two more minutes and have a look at your favorite social network – just to see what happened on the weekend – to write messages and dwell in the smartphone distraction just a little longer.

It would be difficult to give a talk about any topic in front of such a huge indifferent mass of people. How would you feel expressing that a cure for cancer has finally been found, but everyone is more interested in their coffee? Is there a way to enhance conveying the fascination of mathematics to 500 students who are getting more confused and tired with every slide, filled to the last corner with complex formulas? In this technologically advanced world we live in, where communication around the globe is easier than ever before, there should be a possibility to interact better with 500 people. And it is possible – e-learning tools have been invented for that purpose. For example, questions can be asked to a crowd via a smartphone app in real time. A group of professors and students at TUM has started a pilot project to implement those tools.

"Well hello back everybody – please take out your smartphones." The professor earns some skeptical looks. "I explicitly ask you to use your phone and go on the internet." He has their attention now.

"I want to help you recap what we learned last week. I will ask you a question which you will see on the screen behind me. You can answer this question by following the link you see here. I will give you 30 seconds to answer this multiple choice question and afterwards a bar chart will show us how you answered." One minute later the results show that, surprisingly, 300 students participated. "Okay… so there still seem to be some misunderstandings on the topic of differential equations. I will go into that again for a minute because it is important for you to understand." The students are listening now and some even make some remarks in their lecture notes. At 9:30 the coffees are long finished and the lecture ends. This time the students stayed in the lecture hall until the very last minute. The professor smiles and packs his belongings.

Meanwhile from one student's point of view…

"To solve the differential equation you need to…". The voice of the lecturer blurs in my head as I try to follow his explanations. My attention fades and my eyes wander across the lecture hall – 500 fellow students and we all try to tackle another semester of complicated studies.

The subject matter is difficult and even if I try to write down everything the lecturer writes on the blackboard I understand only half of it. But maybe it's just me and at this pace… come on… will anyone really fully grasp this complex matter in such a short time? I am sure that if I revise the lecture again at home with more time and the necessary composure I might be able to finally understand how to solve differential equations.

Well… my experience tells me this isn't going to happen. So I should ask questions now – here in the lecture. But no one really does that – right? Don't I seem stupid if I am the only one raising my arm and asking the lecturer to repeat the last step? Moreover, maybe I even annoy him with my stupid question. He has a lot of teaching points to bring across this semester, he cannot always repeat the topic just because I am not able to understand. So I continue scribbling down the lecturer's remarks. I will figure it out eventually, the notes will help me with that and if everything else fails I can always ask Wikipedia – right? But then the lecturer wants us to use our smartphones and introduces us to e-learning tools. Unbelieving stares are the answer – also mine. But in the end everyone participates and tries out the new tools.

Now, with a new e-learning tool designed with both lecturers and students in mind, every time I have a question during the lecture I can type it into my smartphone and it will be sent to the lecturer. Every time we are scribbling down our notes and the lecturer pauses, he can look up the feed of questions on his phone or tablet. This way all of my urgent questions get answered during the lecture. I don't have to be afraid of asking because the tool works anonymously. When I encounter problems after the lecture going through my notes, I can put down my questions and ask them in the next lecture. Once the lecturer finds time and considers my question relevant he repeats and answers it for us all.

But it's not only me. My fellow students also regularly ask questions through this tool now and quite often I think – yes that is exactly what I was wondering for a while, but I couldn't really put it into a proper question. Sometimes we even surprise the lecturer and come up with a question he had never thought of. In these cases, he seems really excited about how well the tool works and encourages us to continue asking. I have the feeling that it also eases his work a little. He gets feedback on what topics are actually challenging for us – just by looking at the number of questions raised – and it seems to lower the number of students that come to him after the lecture with questions they didn't want to, or were afraid, to ask during the lecture. It seems like a win-win situation and my learning experience has definitely improved.

Normally I used to go out of the lecture hall some minutes before the lecture ends to get a coffee before catching the bus, but now every minute of the lecture is more valuable than a coffee, so I stay till the end and so do the others. Impressed by the new possibilities we leave the lecture hall.

Abstract

LectureLab proposes an e-learning tool that improves professor-student communication during lectures, something which has been deteriorating in recent years as student numbers have increased rapidly.

A number of e-learning tools have been analyzed in detail and categorized with respect to both technical and didactical features. Moreover, three lectures were examined by applying different e-learning tools and surveying students' and lecturers' perspectives before, during and after using the tools. The surveys were qualitatively analyzed and highlighted both positive and negative aspects of the tools, such as an enhanced interaction between the lecturer and the students, but also potential disappointment if the interaction did not lead to the desired changes and enhancements. Other critical points such as the potential of the tools to distract students appear to be less important, according to the survey results. All in all, e-learning tools seem to be a promising add-on in lectures where interaction between the lecturer and the students is not possible on a personal level.

1. Introduction

In recent years many countries have begun to see the need to advance towards a knowledge society and thus political directions have fostered access to third level education in their education systems. This has resulted in rising student numbers especially at university level. This in turn has led to lectures with large class sizes and a more complex learning environment with less communication between lecturer and student (Milliken & Barnes, 2002). Moreover, the rapid development of information and communication technology and the concurrent emergence of so called "digital natives" entering universities have posed a new challenge to higher education (Benett, Maton, & Kervin, 2008). For example, the fact that students nowadays cannot go long without checking their mobile devices keeps lecturers struggling to catch the student's attention and engage them into the lecture (Yu & Conway, 2012).

Nevertheless this development has positive and negative implications. Negative, as increasing student numbers make it nearly impossible for lecturers to give lectures with a clear interactive component following the classical way of teaching. Positive, as

new technologies and the students' adeptness in using them has evolved and given way to the use of e-learning tools. Those tools are able to enrich the lecture by enhancing student collaboration, improving interactivity and encouraging active participation (Cleveland-Innes, & Emes, 2005). According to Ruiz, Mintzer and Leipzig (2006), correct use of e-learning tools has the potential to lead to a shift in education, "where educators will no longer serve mainly as the distributors of content, but will become more involved as facilitators of learning and assessors of competency" (207).

To leverage the advantages of e-learning tools for both the lecturer and the students one needs to understand their correct use and application in a classroom setting. Hence the project team LectureLab attempted to clarify the following research questions:

• What e-learning tools are available and what functionalities do they offer?
• What functionalities add an actual benefit to the learning experience?
• How can the lecturer use those functionalities effectively?
• How do students and lecturers perceive the influence and effectiveness of e-learning tools on their learning experience?

2. Goals and methods

The goal of this project was to analyze the impact of e-learning tools on the student-lecturer interaction in the context of a pilot project at TUM. The goal is to make a contribution to an improved student-lecturer interaction during lectures. The following sections present the methodology used to achieve this goal.

2.1 Study design

The present pilot project is an intervention study following a pre-test-post-test design. As is characteristic for intervention studies there was no control group, but in three participating groups the use of e-learning tools was tested in an intervention approach. Pretest data was collected with the help of a quantitative questionnaire (paper&pencil) from the participating student groups. Post-test data was then collected with a similar questionnaire in the last lecture of the semester, after the last possible intervention of the selected e-learning tools.

2.2 Sample and pilot study procedure

As preparation for the intervention study we carried out extensive literature research as a first step in order to assemble a pool of convincing e-learning tools. Besides user-friendliness and functionality, the tools had to be for free and unlimited in terms of the number of users. We classified the suitable tools into three different sectors: "poll system", "mood barometer" and "question tools". In addition to the literature research we interviewed seven lecturers from TUM, who are already using e-learning tools in their lectures. Additionally we interviewed two didactic and teaching experts from the ProLehre institute at TUM. The aim of ProLehre is to improve teaching quality at TUM. On the whole, we had eight qualitative interviews in order to prepare the pilot study procedure.

In the expert interview with ProLehre we were advised to include only younger students in the pilot project. This derived from the assumption that younger students have been less strongly influenced by the atmosphere in lectures and therefore should be less biased about e-learning tools. As there are very few first-semester students in the summer term we decided to focus on second-semester students. With the help of the university calendar we created a list of lectures in summer term for second-semester students. We selected three lecturers from different disciplines and invited them to participate in our pilot project. Fortunately, Dr. Tobias Lasser (Chair for Computer Aided Medical Procedures & Augmented Reality), Dr. Christian Karpfinger (Research group Algebra) and Prof. Dr. Gerhard Müller (Chair for Structural Mechanics) agreed to participate in the pilot project.

Before the actual start of the summer term we talked with each of the three lecturers twice. The first meeting served to introduce them to the study, while in the second a suitable e-learning tool was chosen. Additionally, we organized one meeting during the semester and offered technical support for the first lectures as well as meetings during the semester if required. After the end of summer term we reviewed each lecture asking the lecturers about their experiences (e.g. frequency of use, benefits, challenges, technical aspects).

2.3 Measurement tool

For the expert interviews we created an interview scheme, which was applied to all of our interviews. The questions focus on experiences with e-learning tools, their benefits and disadvantages, and advice on how to use them.

As a pre-test in the target population we designed a quantitative questionnaire with 14 items. Nine items were rated on a 5-point Likert-Scale (1 = extremely; 5 = not at all), four were measured on a frequency rating scale and gender was also requested. The final pre-test sample included n=909 students from three fields of studies.

The post-test questionnaire included 28 items. In addition to the pre-test, the items focused on the lecture situation without e-learning tools, on technical aspects (e.g. technical problems), on the use of the tool in the lecture (e.g. frequency), on students' participation and on questions specific to the used e-learning tool. The majority of the items were rated on a 5-point Likert Scale. In the final post-test sample, n=552 students completed the questionnaire.
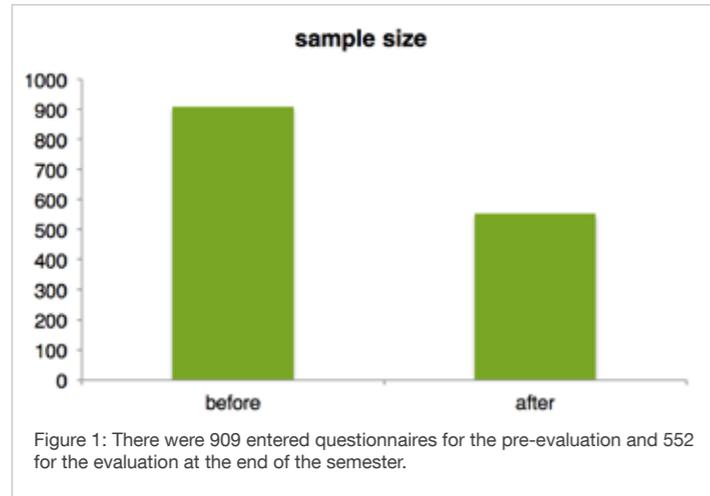
2.4 Analysis

The questionnaires were prepared with the evaluation software EvaSys. Therefore, the questionnaires could be scanned and evaluated automatically. Beside the economy of time, the risk of input errors in the database is reduced by using this software.

Results from the qualitative interviews with the three lecturers from the pilot projects were used to create the individual profiles of e-learning tools from the different sectors. Suitable quotations were chosen for these profiles, which will be communicated online by the ProLehre institute.
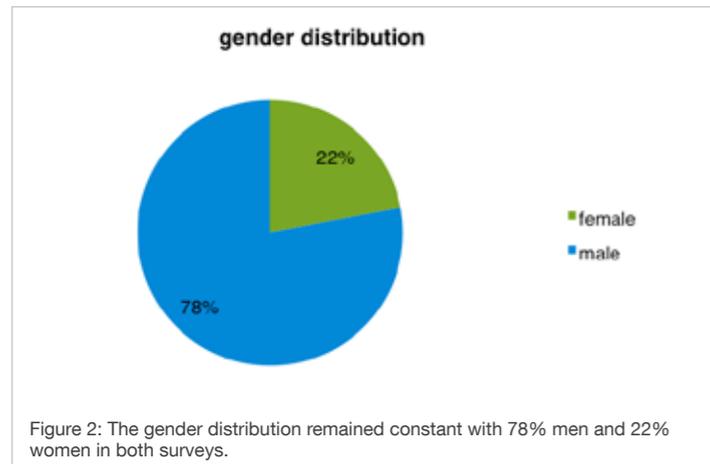
3. Results

Since not all of the collected data is relevant for the analysis, not all parts will be presented. No distinctions are made between the three different courses that are part of our project. Instead, the data sets are combined in order to obtain the largest sample size possible and lessen the impact of peculiarities of the single lectures.
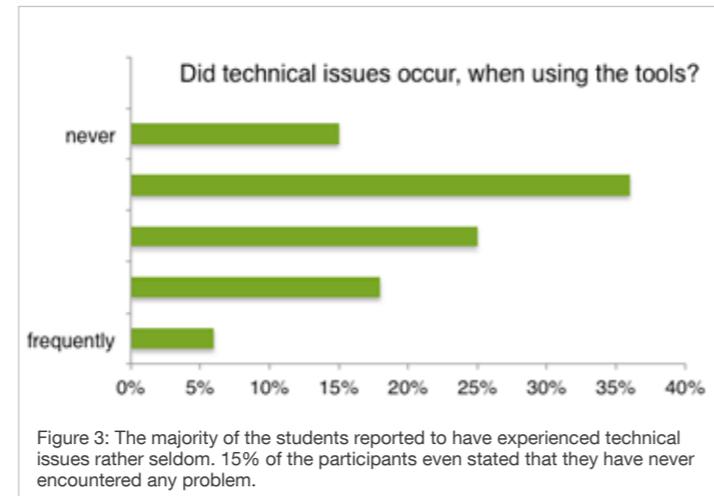
This results in 909 entered questionnaires for the pre-evaluation and 552 for the evaluation at the end of the semester. This remarkable decrease is mainly due to the falling attendance over the duration of the course.
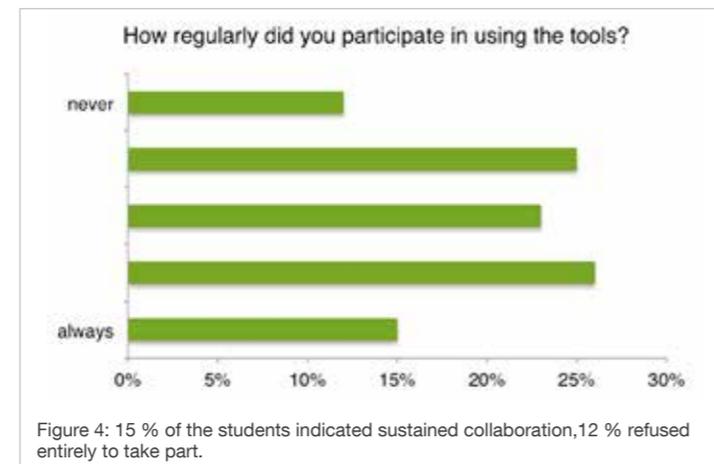

Figure 1: There were 909 entered questionnaires for the pre-evaluation and 552 for the evaluation at the end of the semester.

However, the gender distribution remained constant with 78 % men and 22 % women in both surveys (Figure 2).

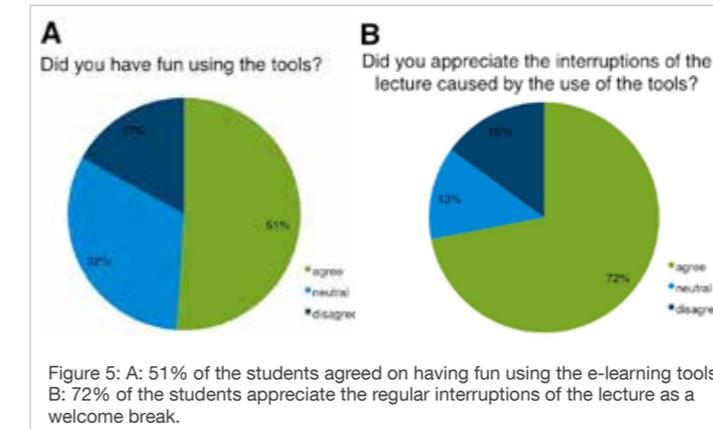Figure 2: The gender distribution remained constant with 78% men and 22% women in both surveys.

Although there have been several technical issues with the e-learning tools in use, the majority of the students reported that they seldom experienced these. Fifteen percent of the participants even stated that they have never encountered any problem (Figure 3).

Figure 3: The majority of the students reported to have experienced technical issues rather seldom. 15% of the participants even stated that they have never encountered any problem.
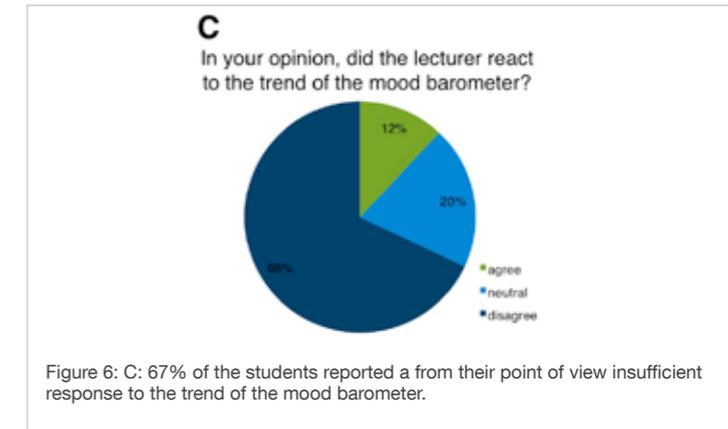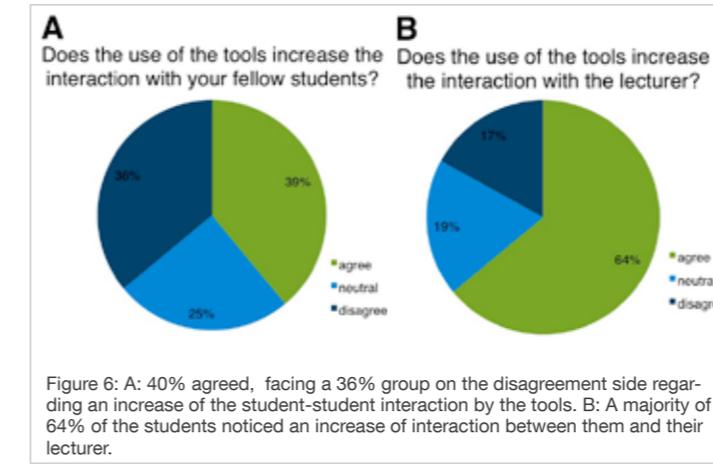
The participation of the students in the usage of the tools is quite symmetrically distributed between the two extremes of the scale, yielding 15 % who indicated sustained collaboration and 12 % who refused entirely to take part (Figure 4).
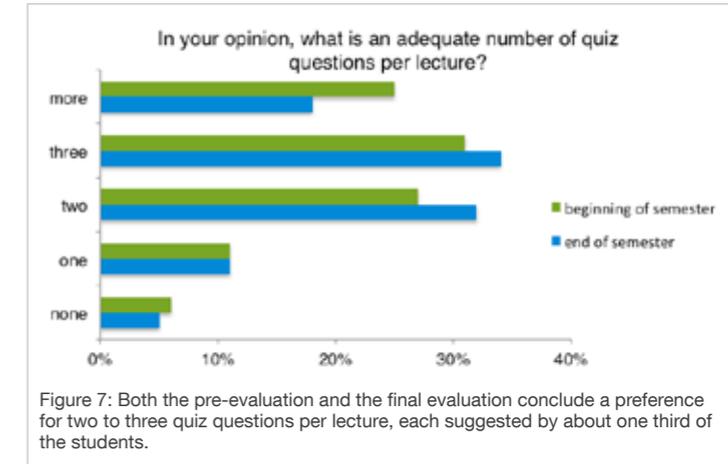

Figure 4: 15 % of the students indicated sustained collaboration,12 % refused entirely to take part.

Fifty-one percent of the students agreed on having fun using the e-learning tools and 72 % appreciated the regular interruptions of the lecture.

Figure 5: A: 51% of the students agreed on having fun using the e-learning tools. B: 72% of the students appreciate the regular interruptions of the lecture as a welcome break.

Figure 6: C: 67% of the students reported a from their point of view insufficient response to the trend of the mood barometer.
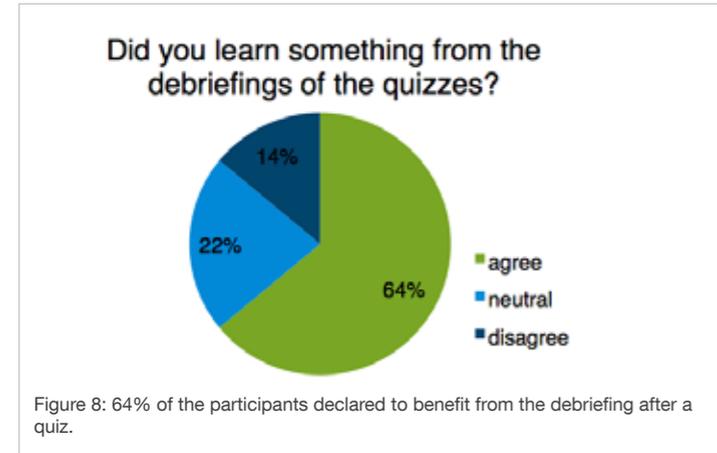
With 40 % on the agreement side facing a 36 % group on the disagreement side, opinions on whether the tools affect the interaction between the participants and their fellows are quite discordant, but a majority of 64 % of the students noticed an increase of interaction between them and their lecturer. However, 67 % reported that, from their point of view, there was an insufficient response to the trend of the mood barometer.
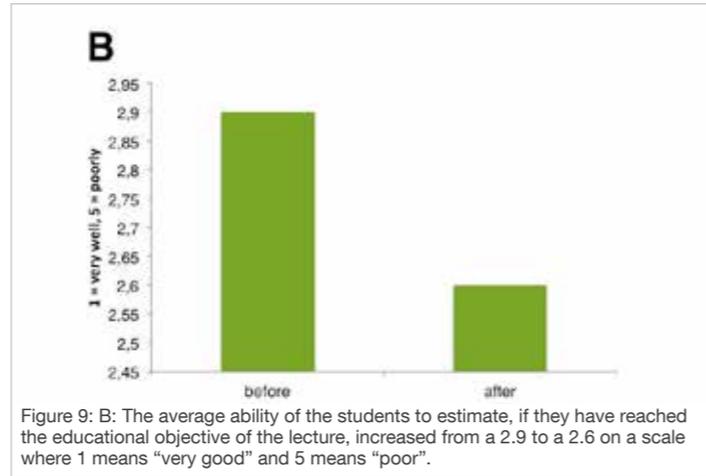
In both surveys, the students were asked to estimate the optimal number of quiz questions per lecture and both the pre-evaluation and the final evaluation concluded a preference for two to three questions, each suggested by about one third of the group (Figure 7).

Figure 6: A: 40% agreed, facing a 36% group on the disagreement side regarding an increase of the student-student interaction by the tools. B: A majority of 64% of the students noticed an increase of interaction between them and their lecturer.

Figure 7: Both the pre-evaluation and the final evaluation conclude a preference for two to three quiz questions per lecture, each suggested by about one third of the students.

Sixty-four percent of the participants declared a benefit from the debriefing after a quiz (Figure 8).

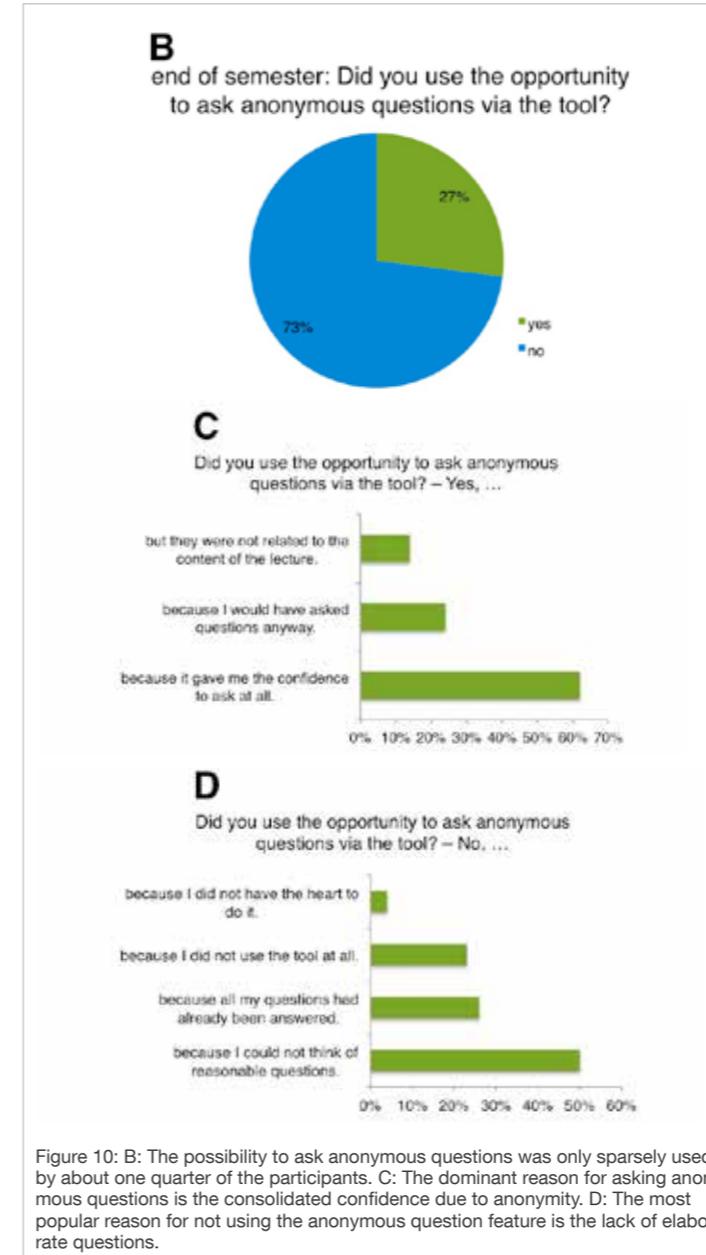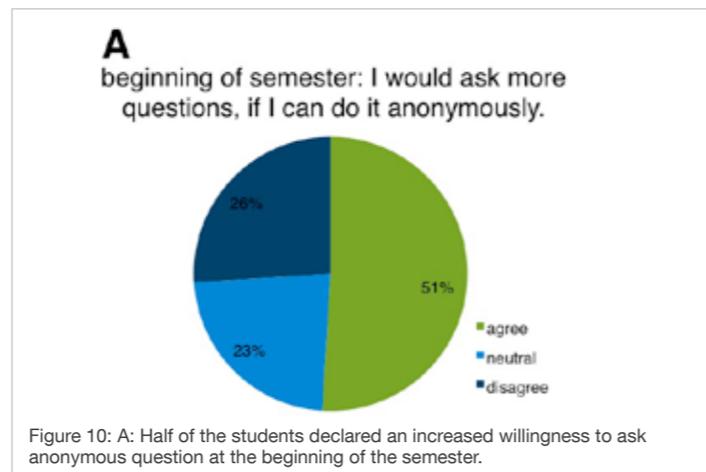Figure 8: 64% of the participants declared to benefit from the debriefing after a quiz.

The quizzes also help the students assess their state of knowledge, as 60 % indicate. The average ability of the students to estimate, if they have reached the educational objective of the lecture, increased from a 2.9 to a 2.6 on a scale where 1 means "very good" and 5 means "poor" (Figure 9).

Figure 9: A: 60% of the students indicate that the quizzes help to assess their current state of knowledge.

Figure 9: B: The average ability of the students to estimate, if they have reached the educational objective of the lecture, increased from a 2.9 to a 2.6 on a scale where 1 means "very good" and 5 means "poor".

The possibility to ask anonymous questions was only sparsely used by about one quarter of the participants, although half of the students declared an increased willingness to ask questions under these circumstances at the beginning of the semester. The most popular reason for not using the question feature is the lack of elaborate questions, whereas the dominant reason for doing so is the consolidated confidence due to anonymity (Figure 10).

Figure 10: A: Half of the students declared an increased willingness to ask anonymous question at the beginning of the semester.

Figure 10: B: The possibility to ask anonymous questions was only sparsely used by about one quarter of the participants. C: The dominant reason for asking anonymous questions is the consolidated confidence due to anonymity. D: The most popular reason for not using the anonymous question feature is the lack of elaborate questions.

4. Discussion

In the following, the results of the surveys, which have been conducted during the last months, shall be discussed. Before starting, the analysis shall be critically examined. First of all, the examination was limited to three lectures, which were all located in the natural-scientific field. Thus, the sample number was very limited and the results probably cannot be extended to other types of lectures, such as humanities ones. Another substantial limitation of the examination is the lack of a control group as the lectures could not be divided, with one part using e-learning tools and another part not using them.

Moreover, the questionnaires were invented by members of the LectureLab team and were not reviewed by experts. Therefore they were not validated and do not comply with the scientific quality criteria of objectivity, validity and reliability (Kirk, Miller 1985). Additionally, the selection of the lecturers, using the tool, was not randomized as they were chosen on the recommendation of teaching-experts from ProLehre, who had worked with these lecturers before. As not only the e-learning tools themselves but also how they are applied can alter their impact a lot, this biased selection of participating lecturers limits the examination. The results of this examination can therefore not be applied to every lecture and every type of lecturer. However, the number of participating students and their gender-distribution can be seen as representative for TUM and therefore the results of this examination may serve as an indicative trend.

By being invited at every lecture to answer questions about the last one or about general problems, the students deal with the learning matter very frequently. Therefore it is expected that students who participate in polls by e-learning tools during the lecture not only save the matter in their long-term memory more frequently (Lee, 1973), but are also much better in their self-assessment. They have to ask themselves very frequently if they know the learning matter and therefore it is no surprise that the majority of the students state that their self-assessment has been enhanced by the use of e-learning tools.

Additionally, the students stated that they could extend their knowledge by the use of the e-learning tools. This was also expected, as every encounter with a problem evokes thoughts around the present problem, establishing links between different aspects and thereby deepening the understanding.

To have an opportunity to ask questions anonymously seems to be not enough of an incentive actually to do so. The participation in the use of the tools in general was relatively limited. The majority of the students stated they would use the chance to ask questions via an e-learning tool but did not do so in the end. As the major reason they stated that they did not know how to formulate a good question. This clarifies a problem, which might be rooted in the fact that students nowadays are not instructed in how to ask questions as there is almost no space for it in normal lectures and even during high school. Maybe a workshop at the start would be a way out of this problem. In this workshop the students would learn how to phrase a question in a way that is precise and clear, as described in a study by Marbach-Ad and Sokolove (2000). A major point of such a workshop would also be that every student asks questions there and learns the value of doing so and that almost every question is worth while.

The possibility of students being distracted by the tool cannot be ruled out, but it appears to be a relatively small problem. The majority of the students stated that the use of the tools during the lecture felt like a small rest for them. However this may be due to the fact that the flow of knowledge is paused in the periods where questions are asked. Even if these periods involve a much more intense engagement with the learning matter the students might experience this independent, active thinking as a rest, as to follow another person stating complex facts and to embed these facts into the network of already existing knowledge might appear more exhausting to them, a situation which is described in literature as very positive for the learning process (Rusbult, 1989). Thus, the fact that the students experience these periods as a rest does not inevitably mean that they get distracted.

Moreover, the students stated that using the e-learning tools is fun for them. A positive attitude to this method of teaching is absolutely necessary for its success, as otherwise they would simply reject it. Furthermore, the interaction between lecturer and student should take place in a positive atmosphere in order to establish a fruitful relationship.

An e-learning tool which has the potential to enhance but also to endanger this relationship is the mood-barometer. By letting the lecturer know if they can follow his/her thoughts the relationship between the students and the lecturer becomes less distant, a potentially positive fact. But the use of this tool by the students is linked to the expectation that the lecturer will refer and react to it, by altering the way of presenting or repeating the latest thoughts. Most of the students stated that the lecturer did not react to the information given by the tool. Therefore it has to be noted that the mood barometer tool, in particular, can also lead to student disappointment and can thereby harm the relationship between lecturer and the students. These concerns of course only apply to the mood-barometer tools and not for example to the poll-system tools.

Even though the students were reserved in asking questions via e-learning tools, they stated that the interaction between the lecturer and themselves was enhanced - thus the main aim of the project was achieved.

5. Outlook

All in all e-learning tools appear to enhance the learning experience during lectures for numerous students. As the present analysis is limited, more examinations employing a higher number of lectures and including comparable control groups have to be conducted to come to a final evaluation. However, this analysis shows that e-learning tools are a promising approach and should be employed in lectures. In order to further analyze their impact and allow more students the pleasure of facilitated interaction with the lec-

turer, the tested tools are offered to TUM-lecturers by the official department of didactics in lectures, named ProLehre. In close cooperation with the project team a brochure was established which interested lecturers can use to inform themselves further and get help in deciding which tool is best for their lectures.

Thus, ProLehre will carry on encouraging lecturers to use these tools and will provide tips and information arising from the present examination. Moreover, with the medienzentrum of TUM a clear decision-tree of the available e-learning tools was set up online, which enables lecturers to find the right tool for themselves within a few minutes, without engaging in a time-consuming research. Turning from student-lecturer interaction and coming to student-student interaction, another online tool was established by a project team of the center of digital technology and the management of TUM (CDTM).

Their tool feedbackme helps students to enhance their presenting skills by getting feedback from their fellow students. This tool might be combined with the e-learning tools, examined in this study to render the lectures at TUM even more attractive and effective for the students. This example shows that in the field of online-tools for lectures much is yet to come and the data of this study strongly implies that it is worth developing this trend in TUM lectures.

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