Encouraging deep learning with E-Learning: Final project report

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Monday, 08 August 2005

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Introduction

Brunel's nationally endorsed aim to make Higher Education more accessible demands learning environments that are more flexible than before. Students should be able to study at the time and place convenient for them in a format appropriate to their needs. The Virtual Learning Environment (VLE) seems to answer this demand. Although software applications are available (e.g. WebCT, Blackboard) to support these environments, the teachers are left with the more challenging question of how to use these environments effectively. This motivated the project described in this report. The project set out to empirically establish a set of guidelines for an effective and easy-to-use web-based e-learning environment that is based around digital video material. Teachers that use the guidelines should have available successful e-learning strategies to support students learning and to cope with increasing diversity in students' background.

The study focussed around the module CS1022B Foundations in Computing, which is split into a first term that covers Logic and Set Theory and a second term that covers Statistics. In the academic year 2004-05 the cohort for CS1022B consisted out of 167 students, which includes students who take the module for the first time and repeating students. The first term is set up as a self paced learning course, supported by video material and online self-tests. The second term is taught in a more traditional manner. This difference in teaching approach allowed the study to make some comparison and see the effect the difference in teaching approach could have on the learning outcomes.

The module has been the subject of earlier research and publication (e.g. Rae, 1993) before the advent of web-based VLE and digital video. The self-paced learning approach seems to encourage students to adopt a deep learning approach (Hambleton, Foster and Richardson, 1998). Nevertheless, the results from the 2003-04 module survey also show a relationship between dislike of the learning material and the adoption of a surface approach to learning. This could indicate that the material and the learning approach in general encourage deep learning, but do not facilitate students that apply a surface learning approach. Still another interpretation is that the material and or learning approach was not accessible or engaging enough for all students, which might have de-motivated these students which leads to a surface learning approach. Therefore the project's overall aim was to establish a framework for setting up a VLE based around digital video material that encourages all students to apply a deep learning approach to learning.

The project started with analysing the usage of the VLE of the module in academic year 2003-04. Interviews were conducted that especially focussed on four groups of students: those who scored very low or very high in the module assessment, and those who were identified earlier on to have clearly adopted a surface approach or deep approach to their learning. This information was used to improve the VLE during the summer period. The usage of the VLE was also studied in an observation laboratory as part of a usability test. A small number of students, unfamiliar with the course subject, were invited to the lab to complete a number of learning tasks and were afterwards interviewed about their experience with the VLE.

The effectiveness of the improvements made to the VLE and the teaching approach was also analysed when the module was taught in the academic year of 2004-05. The analysis consisted again of several data gathering activities: online end of term surveys; automatically tracking student access and activities in the VLE; observing students in the lab sessions; and asking a group of students to keep a diary of their weekly learning.

The summaries of the results of all these evaluation activities are discussed in the following sections of this report. However, the following section first gives a brief overview of a teaching framework people can use when setting up a VLE based around digital material. The report finishes with the main conclusions that can be drawn from the findings.

Teaching Framework

According to the 3P model of teaching and learning (Biggs, Kember, and Leung, 2001) the two main factors that influence the learning process are the student and the teaching context. The learning process in its turn influences the learning outcomes. Therefore, the framework presented here focuses on the teaching context as it provides a way to improve students' learning. The aim of the framework is to move students away from a surface approach and to encourage a deep learning approach. Students that apply a deep approach are intrinsically interested in the subject matter and their strategy is to maximise meaning. On the other hand students with a high surface approach are more motivated by fear of failure and their strategy is too narrowly targeted often accompanied by rote learning.

The teaching approach in the first term of CS1022B is based on the Keller Plan also known as the Personalised System of Instruction (PSI) (Hambleton, Foster and Richardson, 1998). Although this approach was not developed with video support in mind, it provides a basic framework as it is a very effective self paced teaching approach. The key elements of the approach are:
- Student work on their own pace
- Student need to demonstrate mastery of enough of the material before proceeding to new material
- Teaching material and other communication between teacher and student is mainly text-based
- Instructors give student support and assess their achievement on individual components of the course
- Lectures are mainly intended to motivate the students

The ideas of PSI have been used in the development of the first term of CS1022B. This means that:
- Special written material is developed for the course, which is broken up into 4 modules, and each module again is broken up into 5 learning units.
- Special written diagnostic test are developed for each module, which instructors can use in seminars to assess together with the student their understanding of the material.
- Students receive a copy of a new module text only when they demonstrated in the diagnostic test that they mastered the previous material.
- Lectures mainly have a motivational purpose, intending to place the material in a practical context.

With the use of a video based VLE, PSI can be extended to give students more flexibility in their learning regarding time and place, and also to provide them with variation in the kind of information channels. The video based VLE implemented in WebCT consists of the following key components:
- *Online access to the special text-material*. However, access was only given to text material when students had taken the online self-test of previous learning units.
- *Online self-tests*. Each learning unit has its own online test which students can take to test their mastering of the material.

- *Introduction videos*. Each learning unit has a short introduction video clip which explains the main topics of the unit and gives students a number of questions they have to keep in mind when studying the written material. If students use these questions when reading a text it will results in more elaborative processing which is a key factor for remembering material (Anderson, 1995).
- *Question and Answer videos*. A number of questions are presented in the written-text of each learning unit. A video clip in which the question is answered is provided for roughly 80% of these questions.
- *Summary videos*. Each learning unit has a 10 to sometimes 15 minutes video clip which summarizes the material of the learning unit. These videos are especially intended to be used as part of the revision strategy when preparing for exams.
- *Daily monitored online discussion board*. Students are actively encouraged to post their questions on an online discussion board. Questions directly emailed to the teacher will not be answered. Instead students are advised to post their questions on the discussion board. Although other students are asked to help answering the questions, students are promised that the teacher or instructors will answer the questions on a daily basis. This approach has both advantages for the students and the teacher. Students can read the questions and answers other students posted or received and the teacher has to answer each question only once. The discussion board was set to an anonymous mode, to reduce students fear for posting a message (fear for being regarded as dumb or the opposite, too eager, by other students or the teacher).
- *Online access to old exam papers and solutions*. This gives students a clear idea of what kind of questions they can expect in their assessment and allow them to practise their skills.

The video based VLE of CS1022B was implemented in a WebCT environment. The video clips were also made available on DVD, because currently video clips can only be streamed within the university network.

Evaluation

In depth interviews

In summer of 2004 Yogesh Kumar Dwivedi, a PhD student, interviewed nine CS1022B students who had taken the module in the academic year 2003-2004. The aim of the interview was to understand what factors encourage or discourage students to apply a deeper learning approach. Therefore, nine telephone interviews were conducted in order to obtain in-depth information from the experiences, views and opinions of former students of the Foundations of Computing module.

Although the interview was the main focus of this data gathering activity, it was conducted in the following two phases: (1) in the first phase a postal questionnaire was sent to all of the previous year's students of CS1022B. The questionnaire included all questions from the Revised Study Process questionnaire (R-SPQ-2F) (Biggs, Kember and Leung, 2001). The aim of this survey was to examine the students' learning approach (i.e. Deep approach or Surface approach). Following this survey Yogesh then conducted the interview over the phone. This interview examined the chain of events in learning, starting from: teacher's approach, students' characteristics, context characteristics; and linking them with the student's approach to learning which eventually determines the learning outcomes.

Findings suggest that students that apply a deep approach to learning regarded studying continuously across the year as more important. Students, who had a math background, were generally good with statistics and therefore they found attending lectures not very important. Videos were generally regarded as a very good facility but needed improvement in off-campus accessibility. Students suggested the following improvements:
- Self-tests should be more randomised and the number of questions should be increased. The initial test should be more difficult.
- For the purpose of seminars and the lab students, they should be split into two sections; lower and higher bands on the basis of their background and knowledge.
- Video quality is good, however problems of accessing online videos off campus should be resolved.
- There should be 5-10 minutes breaks in between one and a half hour long statistics lectures.
- More time should be devoted on the later part of statistics lectures and seminars e.g. regression, correlation and probability. It will be useful to have more working examples of regression analysis. Also there should be an extra statistics lecture on introducing or providing hints on excel or SPSS use.
- One more lecture in first semester would be helpful particularly on solving difficult problems. Just illustrate to students how to solve tricky questions by providing working example.
- At the beginning of the year students should be given a demo of WebCT. Students should be provided with demonstrations about what facilities are available on WebCT and how to access them.

Based on these findings the following actions were taking for 2004-05 regarding the first term:

- *General introduction video*. The video explains the set up of the course and also the teaching approach. Furthermore, it gives study instructions as students might not know how they study within this self-pace teaching approach.
- *Extending the number of questions in the self-tests.* Give students more opportunity to test themselves.
- *WebCT Demonstration*. A demonstration of the use and facilities of the modules VLE was provided in the first lecture.

Laboratory observation

An early version of the video based VLE was used in the academic year of 2003-04. However during the year some concern was raised about its usability. For example, the student survey of 2003-04 indicated that students with a more surface learning approach rated the usefulness of example questions, written material, feedback of assessments, and lab session lower than students that tend towards a deep or strategic learning approach. Furthermore, students that tend towards a strategic approach rated the usability of the video based VLE environment higher than other students. This could suggest that the early version of the VLE was not accessible or usable for all students. Therefore in the summer of 2004, Fang Liu, a PhD student, was asked to conduct a usability test to identify potential elements for improvement. The testing contained eight user cases which focused on examining the usability issues of learning materials, the module-related contents and the design of the WebCT environment for CS1022B. The main learning materials and items investigated in these tests were the study guide, the lecture slides, the course videos, the learning instructions for module 1 learning unit 1, the online self-tests, the progress overview, the online discussion board, and old exam papers facility etc. The testing results were collected from three sources: the tasks performed by the eight participants, the interviews and questionnaires.

According to the findings, the overall impression of the WebCT learning environment of CS1022B was a rather easy and flexible to use environment, especially the course videos are useful and supportive for validating the exercise solutions and help the students understand the concepts, theories and reinforce learning. The self-tests were also relative easy to use and the automatic feedback of the test was considered handy and convenient. However, the participants experienced many difficulties, which caused huge frustration in learning, when using a number of online facilities such as unclear presentation of the learning instructions and visibility problems, the inconsistent design of the course materials and site design, lack of constructive and progressive structure of the navigation tools and unclear status of the functions in course videos etc.

Based on these finding the following alterations were made to the VLE:
- *Consistent navigation structure*. Both the structure supported by the navigation panel as the hyperlinks in the various pages were made identical.
- *Navigation panel to represent site structure*. Using indents to show the hierarchic structure of the site.
- *Video clips and self-tests for units 5.* Unit 5 of each module is the application unit, which did previously not have VLE support.

Surveys

As in the previous year students were asked to fill out an online survey on WebCT at the end of each term. Examining the results of the online surveys shows that the students perceived the quality of the module between fair (2) and good (3). However, compared with results from last year the difference in perceived quality between the first and the second term has increased which suggests that the improvement made to the VLE had a significant impact on the students' perception. The overall perceived quality of the module by students in the previous year was on average 2.88 for the first term and 2.63 for the second term. This year students responded to the same question "All things considered, how would your rate the quality of the first/second term of this module" with a 3.12 for the first term and 2.45 for the second term, on a four points rating scale ranging from Poor(1)/fair(2)/good(3)/very good(4). The difference in perceived quality between the first and second term, was also found back in the comments made by students in the survey of the second term.

The first term survey also included a self-consciousness test (Trapnell and Campbell, 1999). Analysis of the survey data however did not find a significant correlation between self-consciousness scales (self-rumination, self-reflection) and the self-reported use or perceived usefulness of online self-tests. Students in the same survey were also asked to complete the Revised two-factor Study Process Questionnaire (R-SPQ-2F) (Biggs, Kember and Leung, 2001). Analysis of the results showed a positive correlation between the deep learning approach and teaching context elements such as the perceived usefulness of introduction videos, online discussion board, written course material, but also with the usability of the WebCT environment. On the other hand, the analysis also showed a positive correlation between the surface learning approach and teaching context elements such as perceived usefulness of introduction videos and the discussion board. These results might suggest that video based VLE facilitates different needs for students, for students who apply a deep learning approach it might provide a way to increase and test their understanding; for students who apply a surface learning approach, it might provide an extra kind of security as it provided them with an extra information channel outside the normal teaching session.

However, comparison of the first term results of this year and of the previous year did not reveal a significant change in the applied learning strategy by students in the first term. Furthermore, analysis of the results of 2004-05 first and second term data did also not reveal a change in the students learning approaches between the two terms. This is unfortunate, as the results of the survey showed a positive correlation between the deep learning approach and the coursework grades and also a negative correlation between the surface learning approach and coursework grades.

Diary study

To understand how students engaged with the module throughout the year Yogesh Kumar Dwivedi was asked to conduct a diary study for the year 2004-05. A total of 15 students initially replied at the start of the year to an email invitation to participate in the diary study. Of these 15 students, 10 completed and returned the diary for first week. The remaining 5 participants did not complete the first week diary, even after

sending a reminder three times. Detail about how many respondents completed how many dairies is provided in Figure 1.
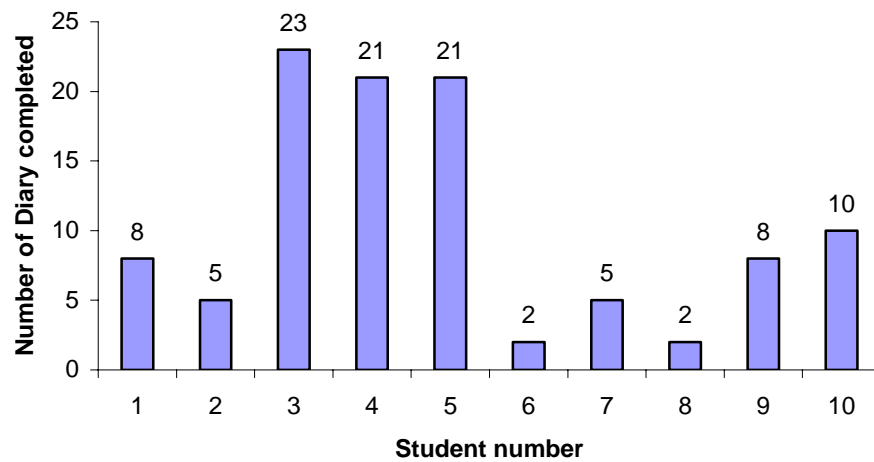

Figure 1: diary reports received

Table 1 represents a summary of the self-reported hours obtained from the diary study that the students spent on lectures, seminar, lab, self-study, and total time spent per week. The data illustrated in the self-study column varies between 1 hour (student 5) and 16.1 hours (student 3). Total weekly time spent on studying this module varies between 1.6 hours (student 5) and 19.5 hours (student 3).

Table 1: Number of hours study time spend on average in a week

Student	Lecture	Seminar	Lab	Self study	Total time
1	1.9	1.0	0.8	4.2	8.1
2	1.0	0.5	0.7	1.7	3.8
3	1.7	0.8	0.8	16.1	19.5
4	1.5	0.9	1.0	4.7	8.0
5	0.2	0.2	0.1	1.0	1.6
6	2.0	1.5	1.0	4.0	8.5
7	3.3	2.3	2.1	3.8	11.8
8	1.7	0.7	0.3	6.3	9.0
9	1.5	1.5	4.5	3.5	11.5
10	1.8	1.0	1.2	7.0	11.0
Median	1.7	0.95	0.9	4.1	8.75

A number of issues emerged from the experiences recorded in the diaries. Although WebCT and videos generally are regarded as an important means of help by a number of participants for first semester study, participants also emphasised that lectures, seminars and workshop support is essential as some of the problems and difficulties of understanding the module can not be overcome just by using WebCT. Participants highlighted the importance of the online discussion board,

which is helpful in a situation where students cannot obtain direct help from the lecturer or seminar leaders. In such a situation they have at least the option to post their queries to the discussion board. One participant mentioned that the interface of Tarski was confusing and suggested that a built-in tutorial with improved layout will help students more. The participant also suggested that a booklet of information related with Mathletic test (second term) should be provided to help the student. One participant suggested that 'there should be some self-test on WebCT for the material covered in the second term'. Lecture slides available on WebCT are considered useful, in situations where some concepts were complicated and the pace of the lecture too fast. Although the WebCT was regarded as a very helpful tool, a student raised concerns over its quality. Student commented that "some of the clips are so blurred streamed or on DVD that you cannot see what the guy is writing".

Other issues that emerge from diaries include errors in lab notes, the time for completing coursework, and the need for more workshops. A number of participants mentioned that in few instances information provided and communicated to them appeared complex but when they discussed that with their friends they found that that was quite easy to understand.

Field observations

During the year 2004-05 Yogesh Kumar Dwivedi was asked to visit each week one of the lab sessions and to record his observations. In the first term, students were expected to work on the coursework assignment and work through the written material, completing the exercises, watching the videos and taking the online self-tests. In the second term students were expected to work through specially developed text and exercised on using SPSS and Excel, taking the Mathletics self-tests and assessments, and Stat Report coursework. If students had problems they were supposed to ask one of the attending GTAs for help.

The following list presents the main findings of the observations and suggestions made by the observer to overcome problems identified.
- Preparation of computers for lab work was observed as a problem in both first and second term, which affects learning in lab.
- Printed notes for first term need to be re-evaluated before giving them again to students as some parts are not understandable to students.
- First lab should be dedicated to explain students what and how they are expected to work in the lab and showing them how to login to WebCT as in the first three labs students were still facing problems with login in.
- No students ever brought ear phones in order to listen to the videos. Instead they all tried to read text in video. Hence, they could not have exploited the full potential of the videos. Therefore, students must be encouraged to bring ear phones or these should be provided to them.
- Students tend to work only before they had coursework due, in normal lab they ignore the lab or they do not make any effort to complete the learning exercises. This should be changed to enhance learning process.
- Students from other courses and levels distract students of this module; therefore, it is required not to allow other students in lab period.
- Internet was observed as a major cause of distraction and less productive in terms of learning. It might be useful to not to have internet explorer on lab computers.

- In the second term the number of students attending labs reduced substantially. The reason could be that they think that it is easy and could be learned any time. Furthermore even if students came to the lab they were doing something different. This ignorance might have affected their performance in second term.

WebCT usage

Four weeks into the course a recording mechanism was implemented in WebCT to monitor the traffic. Figure 2 shows the weekly number of hits various web pages received. The use of video, but particular use of self-tests is apparent especially before the midterm test, and again after the Easter break in the revision period running up till the exam. The number of hits on the old exam paper web page also has a steep increase in the run up to the exam. A similar pattern can be seen for web pages related to coursework in the weeks of their deadline. Therefore, it seems that WebCT access was heavily depended on assessments events, which is clearly illustrated by the peaks in the line representing the number of hits received by the home page. Students accessed the site throughout the week, with significant drop in the weekend. Still, there is a small increase in number of hits for Tuesday, the day when the labs were scheduled between 3 and 5 pm. Access during the days seems to follow a cycle with a high point around 2 and 4 pm and low point around 5 and 6 am.
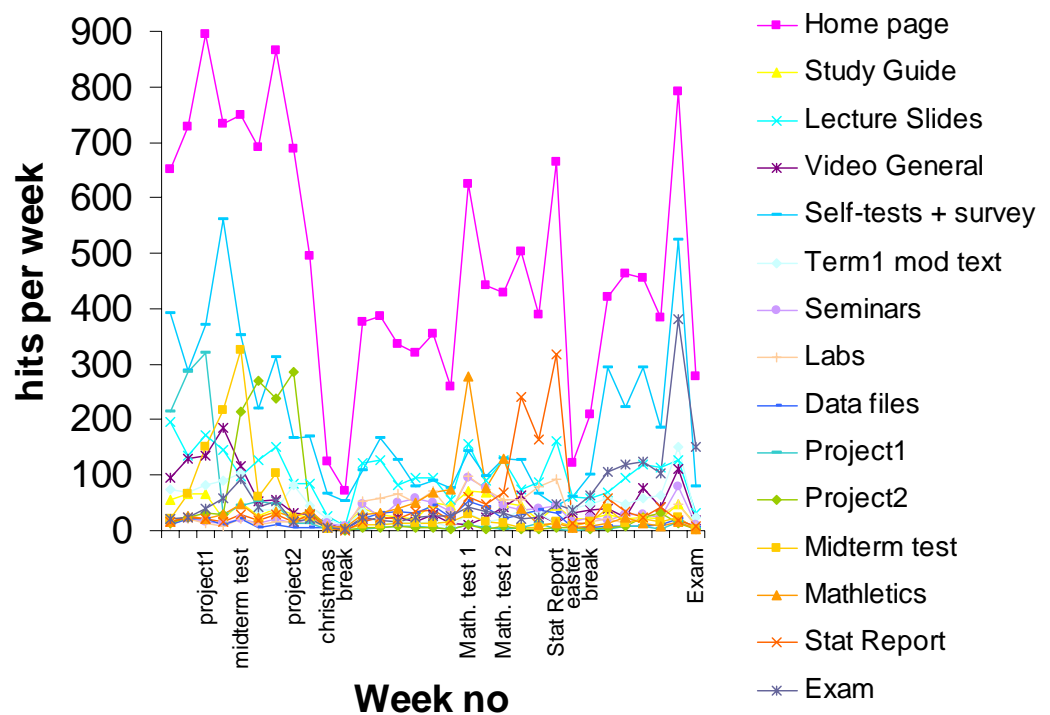

Figure 2: WebCT usage of CS1022B between week 4 and 34 with the assessment events.

Figure 3 shows that a large percentage of the students completed the self-tests of the module 1 and 2, but fewer completed the self-tests of module 3 and 4. The General test, especially created for the revision period as it included questions from all units, again saw a little increase in the number of students completing it. In the academic year of 2004-05 a total of 767 messages were posted on the discussion board. Of the 610 not anonymously posted messages, 322 were posted by students, of

which 124 by one single student. In a survey conducted by Aamina Daroge as part of her final year project, students mentioned that they often only read messages posted by other students instead of posting messages themselves. However, this reading behaviour could not be recorded.
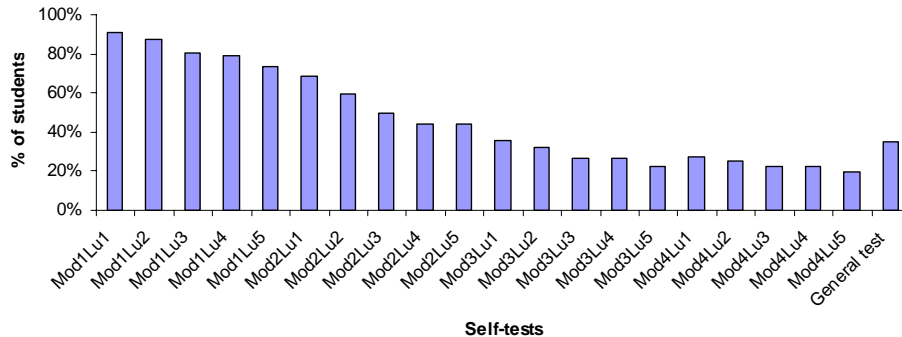

Figure 3: percentage of students that attempted a particular self-test

Learning Assessments

Analysis of the exam marks for term 1 in 2003-04 and 2004-05 did not show a significant change in score of the questions related to learning units for which new video clips were developed in the summer of 2004. On the other hand the analysis shows a significant difference in the scores obtained in term 1 (supported by video and online self-tests) and term 2 (taught in a more traditional manner), and also a two-way interaction effect between year and term on the exam score. Where the average exam score for questions related to term 1 remained stable over the two year, the average exam score of term 2 drops from a difference of 14 points in 2003-04 to 20 points below term 1 score in 2004-05 exam. This could either be attributed to the difference in the teaching approach, such as video clips and online self-tests, or to a change of the teacher in the second term of 2005, or combination of these factors.

Conclusions

The following main conclusions can be drawn from the evaluation data gathered in this project.

- The teaching framework, which is based around the use of video-based VLE, seems to be more effective in stimulating learning than more traditional teaching approaches when it comes to teaching CS1022B. This effect is found in the exam marks but also in students' perception of the quality of the module.
- The video-based VLE appears to facilitate students with different learning strategies in different ways. A possible explanation could be that students that apply a more deep learning approach seems to appreciate this teaching environment because it help them to increase and test their understanding of the subject mater, while students that apply a more surface oriented approach appreciate the environment because of its flexibility to provide information outside the normal contact hours.
- No data was found to suggest that the video-based VLE could move students away from surface to a more deep learning approach.
- Students seem reluctant to bring headphones to the lab, which means that they only look at video clips without having access to the voice that explains the solutions in the labs.
- Learning and assessment activities should be aligned as much as possible as students are often motivated by assessment activities, and they have the tendency of ignoring learning activities if they do not perceived them as directly related to assessment of the module.
- Because the teaching approach differs from the teaching approaches applied in other modules, it is necessary to provide students with a good introduction about the teaching approach at the start of the course, e.g. an introduction video, study guide, or demonstration of the video-based learning environment in the first lecture.
- A number of students voiced their desire to have the streamed video clips made available out side the campus network.
- As the teaching approach is heavily depended on IT, it is important to make sure, well in advance, that IT infrastructure is functioning properly.

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