E-LEARNING OR BLENDED LEARNING – ENRICHING STATISTICS FOR BUSINESS STUDENTS

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ABSTRACT
There has been much interest within the scientific community to use the potential of new technologies for teaching since they have become widely available. We will deal with two questions: What has emerged out of e-learning endeavours? What are vital issues for their success? The specific situation for learners within an e-learning setting will be analysed in the light of two "events": First, the general discussion of the impact of technology on teaching at the ISI congress in Lisboa in 2007, and second, a series of papers on blended learning in the International Statistical Review published in the same year. Our long-term experience with a blended learning course on introductory statistics for business students will serve as background to respond to key questions for the success of e-learning. As an interactive exchange of feedback between students and staff has proved to be essential in the evaluation of our course, this paper gives support for blended learning enrichment of courses to assist the students in their learning process.

INTRODUCTION

As this is a *review* of different e-learning approaches we will freely use the jargon without defining the basic terms. E-learning has been promoted strongly by different initiatives:

- Virtual learning environments (like Moodle) were developed and spread.
- In several disciplines, large inter-university projects were financed.
- High awards (like the Medidaprix in German-speaking countries, see GMW, n.d.) were organized in order to steer development and highlight best practice.
- More recently, Massive Open Online Courses (MOOCs) are celebrated as offering a solution for reducing the outlay for education substantially.
- Academic teachers have supported their traditional courses with elements of e-learning such as electronically providing data, supplemental study material, etc.

The underlying rationale is to find synergies between universities, or to adapt to a flexible style of communication that students would be familiar with. The aim of this paper is to discuss *general* criteria of e-learning and give some reasons for our own approach. Of course, our approach is influenced by the circumstance that our business students have a limited interest and pre-knowledge in mathematics.

LARGE-SCALE E-LEARNING ENVIRONMENTS

Massive Open Online Courses (MOOCs)

MOOCs take advantage of the fact that a renowned person will teach the students, which can increase their motivation highly as it is not the same as when an "average" scientist or a world-known "researcher" tells you something. However, we have found that to continue to work in statistics, the students require regular feedback on their progress. During the learning phases, feedback about the steps already taken and still required is vital. We have to contrast the hype around MOOCs to their actual impact: "Registration [...] is around 50,000 [...] first lecture attendance is only 10%, finishers are only 1-2%." (Comment by *ilhan2000* at The Chronicle of Higher Education, n.d.; this is a widely recognised forum for current problems in education.) Thus, while MOOCs are a new supplement to regular courses, they are not sufficient to replace them.

Interuniversity e-learning environments

Large projects have to gather different competences under one roof to cover all skills required to produce e-learning material. EMILeA was one of the largest state-sponsored projects, which was intended to produce a statistics course at introductory level that could be used in all of Germany (nearly 3m € budget between 2001 and 2004). See Cramer, Kamps, & Zuckschwerdt (2004) for the aims of the project, or EMILeA (n.d.). The ambitious plan failed spectacularly in that the learning environment is used only by the original project partners nine years after its completion.

There are various reasons for this failure. First, criteria developed within statistics education would yield possibilities to improve the visual impact of the concepts represented. Second, the decision to use R – even if at first hand it may be avoided – precludes its use in teaching for non-mathematicians. Third, the learning environment lacks flexibility in all aspects. One reason for it is a genuine feature of large-scale systems: they require an artificial order of what can happen in them and how "cases" may be treated within such a system. And here we are at a crucial point: what does a learning environment have to fulfil so that it is suitable for wider use?

Vital issues for learning environments

For the success of electronic learning environments it is essential to complement the ordinary course and to know how high the hurdles to use it are. If the software used or the learning environment as a whole asks for *structural* knowledge or programming skills, it may hinder students in their progress as they would associate "mathematics" to it and almost immediately reduce their motivation. Commonly, the effort required to use any tool – especially online – is highly underestimated. With the availability of technological tools it has become popular to replace mathematical considerations by calculations in specific examples (e.g., use descriptive methods in a task instead of discussing the properties of the method used) or by simulation (e.g., simulate the consequences of using the confidence interval method instead of discussing its properties in mathematical terms). While there are good reasons to support mathematical reasoning by such tools, we might forget about the effort required to use the tools effectively.

The following statements support a critical attitude towards e-learning (Härdle, Klinke, & Ziegenhagen, 2007, p. 362): "We believe that e-learning is required in modern statistics education but we do not share a too optimistic view that it will also deepen the knowledge of students in statistics." Elsewhere Härdle, Klinke, & Ziegenhagen (2006, p. 12) conclude that "1. e-learning cannot replace the interaction of student, teacher and blackboard" and "2. e-learning tools can only be successful if they satisfy the need of all participants of the system." They continue to name requirements for excellent electronic media in education: "Robust and reliable technology, high-quality contents and the willingness to adjust the [...] behaviour from both, the students and the lecturers." A decision for a *complex* software can hardly be considered as appropriate for business students; this may even be doubtful for an *introductory* course for mathematics students.

THE DEBATE ON E-LEARNING IN THE INTERNATIONAL COMMUNITY

We refer to a session at the ISI congress in Lisboa (Gomes, Pinto Martins, & Silva, 2007) and one issue of the International Statistical Review in 2007 devoted to e-learning and computer-assisted learning environments. Both "events" independently illustrate the great endeavour.

Session on the impact of new technologies (ISI 2007, Lisboa)

New technologies require new forms of communication and teaching. The usual linear sequencing of information is quite ineffective for self-study, as explained below. To facilitate that learning becomes effective, e-learning requires a more sophisticated infrastructure than tutorial classes. To cope with these special challenges, Chaput (2007) presents details of an organizational memory, which provides a "neural network" of the notions. This embodiment may assist learners to find their own learning path through to find the concepts required for solving a specific problem as it reveals *a further structure* of relations between the concepts, which may enhance learning also in more traditional environments. If the study material is scattered online, the organizational memory works like a multi-dimensional index for searching for the appropriate concepts. The usual linear sequencing is replaced by *conceptual distance*.

The computer may change teaching even without the option of e-learning. Imagine a small group of students working together in front of their PCs. They would retrieve the information from a hypertext and work independently; but they could freely switch to tutoring phases and ask for advice. In such a setting, the teacher changes to the role of an *advisor* (Borovcnik, 2007b)

- organizing their work;
- consulting them what methods could be taken, or how to find the required information;
- introducing a classroom discussion by showing them traps of their approaches;
- using screenshots and audiotapes of their comments to follow-up students' work.

Computer-assisted learning environments (IS Review 2007)

The key for designing effective hypermedia for teaching is undoubtedly *structure* according to Schuyten and Thas (2007, p. 368). It is difficult to anticipate individual learning paths and an interactive adaption to individual (singular) difficulties is missing. "Structure can be easily given by the lecturer, but more careful thinking is needed [... in] an e-learning environment. Learning paths may be part of the solution, but nowadays they are often still too linear ..." (p. 369). Dynamic environments as offered by Nolan & Lang (2007) provide flexible documents, which can be enlarged by the users. However, the decisive step of embedding them into the structure of a statistics course requires much work, which has not yet been undertaken.

Making explicit the value of statistical methods for the students is an important step for any teaching in statistics as it is by no means obvious for many learners. Tamura (2007) comes to the conclusion that missing this requirement is a common failure of teaching. In constructing e-learning environments, the focus is shifted to solve many other – partially technical – problems so that insufficient effort is invested to implement context and feedback to underpin how statistics may help the learners to develop promising strategies for their own future careers.

One specific difficulty of learning environments is to anticipate individual learning paths. Another one is to provide guidance for the students. Wild (2007) names a further crucial point of any e-learning endeavour: With tutorial classes and the possibility for direct feedback, it is much easier to recognize when the (single) students *perceive* tasks or concepts differently from the *intention* and correct accordingly. Wild (2007, p. 329) states "Our experience with simple applets also gives transferable lessons for virtual environments. One lesson is that which seems to make something blindingly obvious to the initiated is often completely opaque to the novice." An e-learning environment has to *preview* such difficulties and design facilities to deal with such a break-down in communication. One element designed for that purpose is an organizational memory; others are to provide a clear structure, a distinct focus on the purpose of the content, or tasks for feedback to the student. Visualizations (and simulations) become much more easily available in a course with online elements than in a traditional course. However, that does not imply that they are used more effectively. With the "intention and perception" caveat of Wild in mind, a prevision of students' *remote* use of learning material enriched by visualization should help to channel students' perceptions after study.

SMALLER BLENDED LEARNING COURSES

Other projects pursued different goals by introducing electronic elements into traditional teaching.

Range and impact of blended learning

Blended learning covers a variety of approaches reaching from using a few technological add-ons to enriching hypertexts by applets to illustrate crucial notions. For paradigmatic examples implemented in Excel see Borovcnik (2011). Of course, some of the projects are oriented towards minimizing the required staff for mega classes (with more than 1,000 students). One way is to put the *video of the lessons* on the virtual learning environment; assess the solutions to weekly exercises *automatically*; restrict assistance of students in smaller groups to *student tutors*.

Interestingly, early analyses of the impact of blended courses by Ward (2004) found no differences in performance but lower feedback grades by students for the hybrid version of the course. They obviously preferred the interactive way of the face-to-face course to the electronic environment where they had to orientate themselves.

The blended learning course in introductory statistics at Klagenfurt

Our focus is on an introductory course for business students, which is quite usual with respect to a traditional pre-given curriculum and a split into different working forms (lectures and exercises, all in all 3 hours per week throughout the semester); the course is mandatory for the students in their second year. For content and pedagogy of the course, for applets (implemented in Excel), etc., see Borovcnik (2011), which is available online. We have more than 200 students in our yearly classes. The experience with growing e-learning elements in the course dates back more than 9 years. As it is comparably small, we can afford to get and investigate feedback from the stakeholders in various ways and use the data to improve the study material and the tasks:

- First, there is a general questionnaire at the end of the course.
- Second, during the course the students have the opportunity to answer a weekly questionnaire on the tasks and on the specimen solutions. The tasks are judged (on a 7-point Likert scale) according to the following criteria: difficulty of task; motivation of context and task; comprehensibility and usefulness of the solution for the individual learning progress. Their answers may be amended by comments; we ask for reasons why they find solutions still less convincing or not easy to understand (if this applies). The questionnaire is voluntary and linked to the student's name (about 30% of the students responded).
- Third, academic staff takes regular notes about students' difficulties in the exercises class.
- Fourth, student tutors regularly summarize their experiences in counselling a subgroup of students in a tutorial class.

A CATALOGUE OF ESSENTIAL ISSUES FOR STUDENTS' PROGRESS

From these sources we recognize the following issues as essential keys for students' progress. We will discuss some arguments for our decisions, which are based on feedback from our students and which influenced the current setting of the course. The decisions also have a severe impact on a traditional course. However, the larger the course or the more e-learning elements are built in, the less are the chances to recognize in time how the answers affect the students in their progress.

1. The decision about software

For calculations, especially for graphical displays and for amending mathematically complex notions by interactive animations and simulation, software has to be used: a crucial decision for the course and one with a huge impact on the setting and on the workload of the students.

We chose Excel as it is used in other courses, it is wide-spread in workplaces, and students have rudimentary skills in it before the course. As Excel cannot directly be used for some tasks that are standard also in an introductory course of statistics for business students, it has to be backed up. Instead of buying ready-made add-ons, we developed templates for specific demands and made them accessible to the students (for box plot, histogram, analysis of tabular data, e.g.). Of course, Excel is of limited use for higher-level courses. Mougeot (2007), e.g., uses R for postgraduate courses. Minitab is comparably easy to handle and the package opens the way to many statistical methods, which are used in practice. As the majority of the students will remain mere consumers of statistical results, the higher effort to learn new software does not reward in the end. There are arguments pro and con for any choice of software. The balance between effort to learn and ease to use may differ from group to group. Ease to use may not be the sole criterion as this may also hide details, which are essential for understanding the related concepts.

2. The development of suitable tasks for the students

To make statistics teaching more vivid, it should be data-driven, the calculations be performed within an accessible context to enhance the ongoing steps of calculation and the interpretation of the final results. What signifies challenging tasks?

The context can help to make also subtle concepts more plausible. However, context may also mislead the students. We try to get feedback from the students by the weekly evaluation of the tasks to modify the questions accordingly. Language often is a crucial issue; even the length of a text can have a severe impact on understanding. We have noted that difficulty of examination tasks (measured by the achievement rate) correlates simply to text length. Sometimes we are still surprised how a task is (mis)perceived by the students.

3. Feedback for the students

This feedback to the students should show them how they progress and help them to correct their preliminary ideas. One important issue: feedback has to be given with little delay so that they can continue their studies. Exemplary solutions to tasks are vital but how to decide what is good?

We have developed a style of specimen solution to exercises we share with the students. After initial feedback we separate side remarks, alternative solutions, further comments on context, and links to related concepts from the main body of the solution. To clearly signify the minimum requirements of a solution helps also to serve different learner groups and their needs. One special category of tasks was true-false tasks with *explicit justification*, which revealed much about the current status of students' perceptions.

Another source for feedback is regular quizzes; Esfandiari, et al (2010) argue for weekly tests, compulsory, delivered online, and assessed automatically. Such tests give the students the feeling of being monitored so that they feel the need to learn regularly, which is a vital element for student success. We opted for one test during the semester and one at the end. One crucial issue for success is regular learning during the semester so that the content is built up in smaller pieces and may be linked to newly introduced concepts. That is a decisive element whether the course is completely traditional or fully e-learning based. Accordingly, we are trying to establish feedback on a more regular basis. However, it is difficult if the answers are inspected by hand rather than being analysed automatically.

4. Orientation for the students

Every piece of information, which is put on a dynamic learning environment, is – per se – scattered. How to find it if you search for it? Search systems (supported by tagging with keywords), overviews, glossary with links, overview with links help. Normally the orientation is improved by hierarchical placement of information by enfolding more only on demand. That, however, may cause problems to get an overview. Once a student has a traditional book, the size is clear. Not so with a hypertext, scattered applets, or supplemental pieces of information. The content that is required for the exam has to be clear from online study material.

Feedback – if negative – referred to the extent of solutions and to missing search functions (areas of content, keywords, subject index etc.). For clearer orientation, we developed a companion manuscript, which illustrates and explains the details of the reference textbook (Duller, 2007), which was used as the central source for the lecture. This textbook is signified by a comprehensible, clear-cut, non-mathematical style without the extensive examples and explanations as are common to many US textbooks. Again text length may influence perceived difficulty.

5. Developing suitable applets

What are decisive criteria for applets? How to share ideas between the involved teachers? Any software used in the course has to be flexible enough to facilitate illustrating some (theoretical) property or effect on demand if a question arises and should be answered directly. Some examples of dynamic animations for enhancing properties of statistical concepts implemented in Excel are in Borovcnik (2007a, or 2011). "What is an effective visualization?" is an essential question for developing applets. But the following example from Gould (n.d.) shows that proper criteria for good visualization still have to be elaborated: in illustrating distributions, the scales are automatically adapted to changes of the parameters; this hinders – in the author's view – the comparison of the *shape* after some parameter has been changed to the shape before, which makes it difficult to judge the influence of the parameter and recognize its meaning.

6. Co-ordinating academic staff and tutors

Exchange of experience in class might help to anticipate students' difficulties with an approach or a technique. The *intention* of the set tasks is sometimes opaque and has to be clarified between the members of the staff so that they can support the students in their learning process.

To have academic staff for the exercises *and* additional student tutors gives a good chance to reach the students. A tutor is treated quite differently by the students; there is no formal barrier, no 'fear' that wrong questions will have a lasting effect, etc. As feedback from tutors is "more authentic", it establishes a valuable additional source for revising our learning material.

CONCLUSIONS

We have discussed the potential of widely different settings for e-learning. There has been a marked endeavour of the universities to build up such learning environments. We chose *one* project (EMILeA) as an exemplar to illustrate the problematic of large-scaled projects. Of course, this choice was influenced by the fact that EMILeA was greatly promoted by the publication in the *International Statistical Review*. The discussion about drawbacks of large-scale courses reveals that the reasons for its failure are *generic* and are embedded in its size.

If it can be realized (with regards to financial and staff resources), blended learning may have the advantage of more and direct feedback from students and obviously offers more incentives for interaction of teaching staff with the students. We have elaborated a list of essential questions, which are especially important for electronic learning environments but partially also apply for traditional face-to-face courses. The overall feedback from the students has been encouraging. They appreciated the variety of examples, the specimen solutions, the manuscript that is coordinated with the textbook, and the permanent help with Excel. More orientation and more links between the different sources of information are on top of the list of still open wishes of the students. Orientation for the students is a vital issue and it can be more easily granted in smaller courses. Communication about special problems of comprehension is also vital within the staff. Valuable ingredients are regular meetings discussing the design of tasks and the quality of solutions and special tutorial staff from among students who have a more direct access to the students.

The paper reviewed e-learning approaches for the target group of business students. We illustrated the specific challenges of this framework by a theoretical discussion of technical learning environments. Against this background, we developed our key questions so that the online materials offered to students could enrich their learning. While these questions may be answered differently, they all support smaller-scaled blended approaches. As a side effect, the considerations on the key questions may also contribute to improve traditional courses.

REFERENCES

Borovcnik, M. (2007a). The influence of software support on stochastics courses. In M.I. Gomes, J.A. Pinto Martins, & J.A. Silva (Eds.), *Bull. 56. Sess. of the ISI*. Voorburg: ISI, 4602-4605.

Borovcnik, M. (2007b). New technologies revolutionize the applications of statistics and its teaching. In M.I. Gomes, J.A. Pinto Martins, & J.A. Silva (Eds.), *Bull. 56. Sess. of the ISI*. Voorburg: ISI, 823-826.

Borovcnik, M. (2011). Key properties and central theorems in probability and statistics – corroborated by simulations and animations. *Selçuk J. of Applied Mathematics. Special Issue of Statistics*, 3-19.

Chaput, B. (2007). An organizational memory as support of learning in applied mathematics. In M.I. Gomes, J.A. Pinto Martins, & J.A. Silva (Eds.), *Bull. 56. Sess. of the ISI*. Voorburg: ISI, 808-812.

Cramer, K., Kamps, U., & Zuckschwerdt, C. (2004). st·apps and EMILeA-stat: Interactive visualizations in descriptive statistics. In: J. Antoch (Ed.), *Proceedings in Computational Statistics* (pp. 101-112). Heidelberg: Physica.

Duller, C. (2007). *Einführung in die Statistik mit Excel und SPSS*. Heidelberg: Physica.

EMILeA (n.d.). *Eine multimediale, internetbasierte, interaktive Lehr- und Lernumgebung in der angewandten Statistik*. Online: www.emilea.de/.

Esfandiari, M., et al (2010). Enhancing statistical literacy through short open-ended questions that involve context, data, and upper level thinking. In: C. Reading (Ed.), *Data and Context in Statistical Education: Towards an Evidence-based Society*. Voorburg: ISI (4pp.).

GMW (n.d.). *Gesellschaft für Medien in der Wissenschaft. Medidaprix*.

Gomes, M.I., Pinto Martins, J.A., & Silva, J.A. (Eds.) (2007). *Bulletin 56. Sess. of the ISI*. Voorburg: ISI.

Gould, R. (n.d.). *Statistics Online Computational Resource (SOCR)*. Visualisation of the normal distribution. Online: socr.stat.ucla.edu/htmls/SOCR_Distributions.html.

Härdle, W. Klinke, S., & Ziegenhagen, U. (2007). On the utility of e-learning in statistics. *International Statistical Review*, 75 (3), 355–364.

Härdle, W. Klinke, S., & Ziegenhagen, U. (2006). e-learning statistics – A selective review. *SFB 649 Discussion Paper 2006-024*. Berlin: Humboldt University.

Mougeot, M. (2007). Impact of new technologies for teaching statistics. In M.I. Gomes, J.A. Pinto Martins, & J.A. Silva (Eds.), *Bull. 56. Sess. of the ISI*. Voorburg: ISI, 813-816.

Nolan, D., & Temple Lang, D. (2007). Dynamic, interactive documents for teaching statistical practice. *International Statistical Review*, 75 (3), 295–321.

Schuyten, G., & Thas, O. (2007). Statistical thinking in computer-based learning environments. *International Statistical Review*, 75 (3), 365–371.

Tamura, H. (2007). Foundational value of statistics education for management curriculum. *International Statistical Review*, 75 (3), 397–405.

The Chronicle of Higher Education (n.d.). *The minds behind the MOOCs*. chronicle.com/article/The-Professors-Behind-the-MOOC/137905/?cid=at&utm_source=at&utm_medium=en#id=overview.

Ward, B. (2004). The best of both worlds: A hybrid statistics course. *J. Statistics Education*, 12(3), 74–79.

Wild, C. (2007). Virtual environments and the acceleration of experiential learning. *International Statistical Review*, 75 (3), 322–335.