BULB: Bright use of the Light Board (and getting ideas across)

1. 4TU.CEE 2019 proposal by Georg Prokert and Erik de Vink submitted with the support of the Department of Mathematics and Computer Science, Eindhoven University of Technology.

2. Background and justification

Doing mathematical proofs is to some an art, to others magic, but for engineers in Mathematics and in Computer Science an essential skill. Without proofs of mathematical statements no theorems, without formal verification of software no guarantees. The initiation of the student to proving is stretched over the whole of the curricula in Mathematics and in Computer Science. Central to the learning process is the continuous switching between the concrete level of the proof itself and the abstract level of why the proof constitutes a proof, the meta-level. Often, it is in close interaction that the learning takes place, often ofteacher and learner. Unfortunately, growing numbers of students in class and reduction of hours for practical classes enlarge the distance between teacher and student and hinder "the penny to drop". If only learning to do proofs could be offered outside of class, while still feedback and further directions are available.

Learning to do mathematical proofs requires examples of good practice as well as guidance to the learner in attempts to construct a proof independently. In written material the construction directions are either mingled with the proof itself or simply missing. In a video though these two threads can be kept separated. However, filming a person writing on the blackboard (or whiteboard for that matter) is a pain, not only because of lighting but also because of the uninviting position of the person writing on the board. Also writing on paper or a tablet makes the learner to feel distant from the teacher. The so-called light board, recently acquired in the web lecture studio of TU/e, is a viable alternative for filming a teacher writing on the blackboard. The light board avoids expensive post-processing of footage, but didactically speaking more importantly, allows to mimic the proximity of teacher and student in class.

Videos offered to students as on-line study material typically come with additional activities to help students to stay focused while watching and to increase the learning effect. Such activating add-ons are essential to the efficiency of learning process. A typical example is the feature to pause a video automatically while a question pops up that highlights the key point that just is raised. Watching can be continued after answering the question, making sure that note has been taken and feedback has been given when appropriate. Such additions can be made and updated after the video has been recorded. In the BULB project we seek to make better use of the light board facilities by combining the recordings with such activating techniques, as known e.g. from filmed material in MOOCs on the well-known Coursera platform.

The guiding vision of the project is the expectation that light board scenes augmented with questions will foster the symbiosis of explaining and understanding. On the one hand, proof and meta-proof are clearly distinguished. The proof-in-progress is on the light board, while the meta-proof is the narrative of the teacher. On the other hand, via auxiliary activities the student is asked to reflect on his/her own cognitive process. The overall setting is aimed at bringing these two levels of reasoning together.

3. Objectives and expected outcomes

In the context of the courses 2WA30 Analysis I in the Bachelor Applied Mathematics and 21T90 Automata, Formal Languages and Complexity in the Bachelor Computer Science & Engineering a number

of light board scenes will be recorded and subsequently decorated with guiding information and questions. Both courses are considered as difficult in the respective Bachelor programs. Raw material, i.e. exercises from the textbooks involved, are sufficiently available already. Focus in the project is on

1. experiments towards the development of a workflow and a scripting method for producing (augmented) light board videos in general,
2. the production of video material and the use of tools for augmentation,
3. the evaluation of the usefulness to students,
4. a manual on the practical/ technical aspects of the production, and
5. a report on didactical considerations regarding the resulting clips.

It goes without saying that the applicants are happy to share their findings with colleagues at TU/e and 4TU as well as in the broader context of beta education.

4. Project design and management

As first project activity within BULB, after a short investigation of scripting approaches and augmentation tools (like FeedBackFruits' Interactive Video and HSP), two light board scenes {LBS) will be scripted, trained, recorded and augmented, i.e. one for each of the two courses involved. An informal soundboard team will be assembled for each, and the results will be discussed with these teams. The next project activity comprises the making oftwo sets of three other LBSes where both the production as a whole and the overall set-up of the scene and decoration will be documented. Again the results are presented to the soundboard teams. The following project activity, two other sets of five to eight LBSes are made following the process documentation. The process and its documentation will be adapted when necessary. Results and findings are discussed with the soundboard team. Finally; the LBSes will be used and evaluated in the respective courses, and the manual and report will be written.

The BULB project will start in February, 2019 at the start of quartile 3. The aim is to use the results in quartile 1 and 2 of 2019/2020 for the courses 2IT90 and 2WA30, respectively. The first trial LBSes are to be written, filmed, augmented and discussed with the soundboard in March 2019, followed by the second batch in April 2019. Then also a first draft of manual and reported are to be written. The third and largest batch of LBSes is to be made, augmented and discussed in the period May to July 2019. In summer 2019 the manual will be completed. In the two quartiles following the material is to be used in education. Likely some adaptation to clips, manual and report will take place. During the academic year 2019/2020 dissemination activities will be executed. The project will finish before summer 2020.

The success of BULB is to be measured along two axes:

1. The usefulness of the LBSes in the concrete courses as experienced by students and assessed via interviews and the standard course evaluations (to which specific questions will be added).
2. The usability of the approach by teachers ofother courses, based on the manual, report, and experiences shared by the team with others at local and national level.

Major risk for the project is that students consider the resulting LBSes to have little added value on top of the material as regularly offered, because of the limited quantity or because of the format. Also, as

always, ifthe experiences gathered within BULB cannot be passed on to other courses the project by itself may be successful, but the educational innovation as such stops.

5. Dissemination and sustainability

Once a proper workflow and approach has been established it is essential that development, recording, and augmentation of new LBSes continue to take place. If considered useful and effective, the program directors of the Bachelor programs in Mathematics and Computer Science, as well as their counterparts in the other 4TU institutions, will be able to schedule and form succeeding LBS teams to anchor the approach solidly within faculty.