Internet Platforms for Education on Sustainability

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Abstract

Teaching in general and teaching sustainability aspects in various disciplines specifically can be facilitated by recording the lectures on video. The videos can then be shared not only with the own students but across universities, especially, if the accompanying teaching material like manuscript and PowerPoint presentation are shared simultaneously. The video recording actually leads to an increased quality of the lecture as a whole, including the lecture material. Especially for sustainability topics, such fully worked out and shared modules could augment existing curricula or lectures to the best possible educational outcome. A platform would be desirable for sharing these materials, based on standards, on which the contributors previously agreed.

1 Introduction

One challenge in teaching sustainability results from the expertise being distributed in various universities. At the same time, society would not require so many experts focused on sustainability that corresponding purely sustainability-oriented curricula should be offered in a majority of universities. Thus sustainability aspects have to be integrated into existing curricula e.g. in chemical engineering studies. To offer sufficiently high-level courses or teaching content, one way is to share modules dealing with sustainability aspects between different universities, developed and presented by the corresponding experts in the field.

The idea to share teaching capabilities on a national or international level is not new. One example is sustainicum (2016), where several Austrian universities share teaching material on an internet platform. For many of the available modules the authors just supply PowerPoint presentations or manuscripts. Unfortunately, the material is supplied mostly as PDF, which in turn means significant effort, if the module should be presented at another university. A certain limitation also results from German being the major language on that platform. Looking for teaching resources it also appears that the offered material has very different scope, some resources relating to entire courses, some to just an individual minimalistic aspect.

Consequently, a more systematic approach in view of building up a proper curriculum or a significant contribution to curricula would be desirable.

In order to facilitate delivering the corresponding module, the author has recorded videos of the presentations prepared, for which the PowerPoint slides as well as the manuscript have also been made available in the original format so that modifications are easily possible (Pfennig, 2013). The videos have been uploaded to YouTube to ease access.

Another example is BioEnergyTrain (2016), which corresponds to a European consortium including several universities and companies. The goal of BioEnergyTrain is to develop sustainability curricula as well as the corresponding teaching content, especially for Biorefinery Engineers and Bioresource

Value Chain Managers. Elements of generating the curriculum and module content are e.g. summer schools, think tanks, and labs performed in industry. Unfortunately, BioEnergyTrain does not deliver the results directly to the public, i.e. only site members have access.

While these approaches address the topic of sustainability with a relatively wide variety of facets, it is difficult to see, how a coherent picture can be obtained and transferred in education to students and the interested public.

2 Exemplary topic

While this is so, already regarding the most basic element of the versatile toolbox of chemical engineering, namely setting up and solving simple balances, leads to significant insights and especially a fundamental understanding on the basic interplay of at least some of the major drivers. These are – besides increasing world population, which is the main driver – the increasing energy consumption, the limited land area for food, biomaterials, and bioenergy production, the finite size even of the atmosphere leading to an increase in CO_2 concentration and climate change, to name just a few. All of these aspects refer to limited resources for which balances can be set up and solved. The balances have the advantage that they are so simple that everybody can assess their validity and the resulting implications. These insights are not just relevant for corresponding curricula but are also of social relevance as well as could contribute to more knowledge-based decision-making by politicians.

Based on the corresponding balances the major interacting factors have been related and corresponding teaching material worked out (Pfennig, 2013). As an example, the interplay between land-area use and food supply is shown in Figure 1, which is taken from the English version of that presentation. This diagram summarizes the results of corresponding balances, which are worked out in the presentation in such detail that also the non-engineer can follow in principle. This means directly that sufficient care has to be taken to introduce the corresponding concepts without requiring previous knowledge on the topic. In this presentation, also the conceptual basis for balances is developed and explained, starting from the simple example of a purse but also applying it to the radiation equilibrium between sun and earth determining earth's average temperature as an introduction to dealing with climate change. For this presentation, the comprehensibility has been ensured by testing the presentation at public schools as well as on the dies academicus, i.e. open university days for introducing interesting topics to the interested public and potential future students.

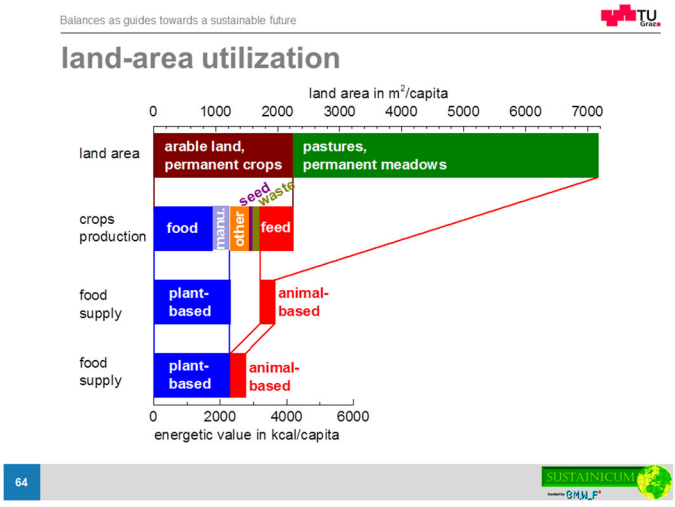

Figure 1: Relating land-area use and food supply.

The simplicity of these balances and the clarity of consequences resulting from regarding probable scenarios of future development are intriguing. It is believed that being aware of these balances and the orders of magnitude of the various contributions may lead to significantly more relevant social and political discussions. If e.g. the orders of magnitude of the material basis of human life are regarded as shown in Figure 2, it becomes obvious that discussing about avoiding plastic bags or the secondary energetic use of spent motor oil are referring only to marginal aspects, i.e. actually other contributions could lead to significantly more impact for minimizing the use of fossil resources. On the other hand, it also becomes obvious that the major driver, namely the increasing world population as the actual problem to be solved is rarely properly addressed, in influential publications even fundamentally denied (§50 of Francis, 2015). If society were more aware of the basic balances, such fallacies could be avoided.

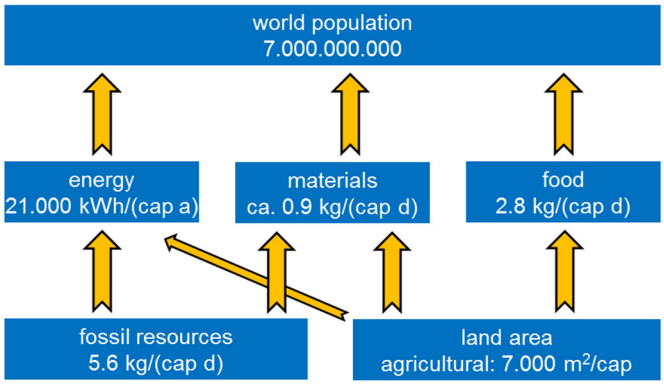

Figure 2: Interaction of some major drivers (Pfennig, 2016).

3 Video Recording

Along a different line of personal development, first own lectures have been recorded by the author since of the order of 10 years. These videos were originally recorded during the ordinary lectures with little effort hardly edited and supplied to the students on corresponding intra-university teaching portals. The videos were intended to support the students in their studies, e.g. allowing them to watch the lecture again shortly before the exam e.g. on specific topics they realize as problematic in the exam preparation. The media used during lectures at that time were the blackboard for developing all theoretical aspects of the lecture and PowerPoint slides for any accurate graphical representation or photographs shown. Consequently, the videos were good for the intended goal but had little reach beyond this.

Regarding the effort to be put even into this simple recording and the parallel development of the videos of the sustainicum presentations mentioned above, the decision was then obvious that in the future the lecture content should be recorded only once in sufficiently good quality. During the first attempts with video recording different set-ups were tested and lectures available on the internet evaluated. Some colleagues e.g. present all material on a tablet laptop, the screen of which is recorded together with the voice of the lecturer. While this is easily realized, this setup minimizes the personal interaction between the lecturer and the observer, because the lecturer is not visible. It appears especially difficult to deliver any enthusiasm for a topic, if face and gesture are not recorded. Then it was tested, if the setup using a blackboard together with PowerPoints could be optimized, which failed, because proper illumination of all elements was not possible simultaneously. The same problem arose, when the presentation was delivered on a tablet laptop being projected with a beamer. In that setup the lecturer can be recorded together with the projection, but either the lecturer appears too dark or the

projection is overexposed. The media experts then proposed to use green-screen technology, sometimes used on TV, because then each individual element can be optimally illuminated. Since this requires significant practice, this suggestion was not followed further. With the support of the media experts at TU Graz the final setup was then realized, which allows good results. Later a similar setup was realized at the University of Liège in the studio of the Institut de Formation et de Recherche en enseignement supérieur (IFRES).

The final setup shown in Figure 3 uses a convertible laptop for delivering the lecture, where the slides are shown as PowerPoint presentation. The text e.g. for derivations are presented as Windows Journal file, where prior to the lecture an empty document with a sufficient number of pages should be created because this eases scrolling. Care should be taken that the tablet is equipped with a directly accessible key that allows either switching between open applications or that opens the task bar to maneuver between the PowerPoint and the Journal file. In addition, a digital pen should be used that allows easy erasing, preferably with the rear end of the pen. The screen is then displayed on a large TV screen of e.g. 70 inch diagonal. The screen should also not be of excessive size to allow easily pointing at the different locations on the screen. The lecturer can then present the diagrams and photos on the screen, actively interacting with the content. The derivations and other text are written on the tablet screen, which the author places on a Curver box turned sideways (see Figure 4), which is also used to transport the required material to the lecture room. A lectern would be preferable, but in many lecture rooms, the box placed on a table is a good solution. The lecturer is illuminated by one or two spotlights, e.g. 50W LED spotlights found in ordinary hardware stores with appropriate stand. Alternatively, comparable professional spotlights can of course be used as seen in Figure 3, where actually only the right ones are used in video recording, because the left one causes reflections on the TV screen.

Figure 3: The chosen recording environment, where the Curver box underneath the convertible is omitted (photo reproduced with permission: © Olivier Borsu, IFRES - ULg, 2016).

The video is recorded with any suitable camcorder of at least HD quality, for the sound recording a clip-on microphone and a 24-bit wave/mp3-recorder is used, e.g. Roland R-09. The reason for recording the audio track separately with 24 bit resolution is that selecting the proper recording level without loss of signal-to-noise ratio is greatly facilitated. The audio track is then optimized with level

adjustment, slight compression and conversion to a 16 bit mono track with the open-source software Audacity, available at http://www.audacityteam.org/. Joining video and sound track as well as final cut can then be realized with any suitable software. At the University of Liège Pinnacle Studio is available, which has been used for the latest videos. Synchronization is facilitated by a hand clapping at the beginning of the recording. If cuts are to be made, hand clapping is also a good way to mark the positions, because their position is later easily seen in the audio track. The final video has a resolution of 1920 x 1080 pixel with 24 frames/s, the audio is mono with 16 bit, 128 kBit/s. The overall bitrate is 2000 kBit/s with mp4v-codec.

Figure 4: Screenshot of a final video.

An example picture from a video is shown in Figure 4. Care is taken that the individual videos are of proper length, i.e. mostly between 20 and 30 minutes. Only in exceptional cases, up to 45 minutes are recorded, where individual derivations require this.

After recording, the video is uploaded to YouTube, but alternatives like Vimeo are possible as well. These platforms allow various additional features like using sub-chapters, adding the content of the slides as searchable text, or active interaction with the community. The author currently does not use these additional features, because of the additional work effort.

Since the lecture is recorded, significantly more care is required for working out the individual chapters. E.g. consequently including slides with the chapter headlines, slides with take-home messages at the end of each chapter, using most appropriate and up-to-date pictures for visualization, and including sufficient and appropriate color in the diagrams are some aspects to be accounted for. Also the manuscript should exactly match the content of the lecture and sufficient care needs to be taken to really transfer the exact logical structure, i.e. arguments mentioned need to be exact and complete, where in usual lectures hand-waving or plausible arguments sometimes might have been sufficient. This of course also greatly supports the quality of the live lectures as well. A difficulty to be mentioned is that for the videos to be made available to the public, the copyright issues need to be clarified before using any diagram of photo. Experience shows that a lot of material can be found on Wikipedia with sufficient quality and sufficiently flexible copyright rules. Other material, like e.g. YouTube videos or diagrams from other web pages need individual consideration, but also here experience shows that while being tedious, generally the right to publish is granted by the copyright holder after a simple e-mail briefly explaining the project.

The quality of the final videos is such that the videos can be used in teaching directly. The author in the past actually applied this in some exceptional cases of urgent absences. Proper care should be taken that in such cases questions occurring to the students can be asked and answered e.g. by a

teaching assistant present or during the next live lecture. Daring to view into the future, it can of course be envisaged that the students are required to view the videos at home – since they are recorded at the best educational level – and only Q&A sessions are offered occasionally. This is a picture slightly reminding the author of a situation in the movie "Real Genius" of 1985, where the students successively left their recording device in the lecture room until after some lectures no live student was left, so that the next time the lecturer also was replaced by a magnetic tape.

4 Conclusions

As a general conclusion, it is found that recording the lectures in a studio enhances the quality of lecture material and thus the lecturing as an important side effect. The videos together with the matching manuscript and the PowerPoint presentation allow easy transfer of the material. For sustainability topics, a corresponding platform, possibly as YouTube channel with links to the lecture material, or a dedicated platform would be desirable. As a result from evaluating some existing similar platforms, a general agreement on the quality and scope of the contributions would be required, which is then defined as standard, which is checked. With such a platform, a variety of high-level sustainability teaching modules could be collected to be used in teaching at various universities with minimal local effort. Such a platform would allow sharing educational means worked out by the experts in the field on the highest possible level fitting to a variety of curricula, where sustainability could otherwise not be taught appropriately or only with significant additional effort.

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