Modified Flipped Classroom Model in Chalmers Professional Education

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Abstract— **This paper is the final report for the project in the course 'Blended Learning and Digital Media in Higher Education' given by Elisabeth Saalman and Thommy Eriksson. This paper proposes new implementation-ready concept of video education in the wind energy area for Chalmers Professional Education. Modified Flipped Classroom Model with video feedback is proposed in this paper as a new pedagogical concept. The model allows video education without skilled Instructor in the classroom and includes a number of components: 1) video lecture in wind energy, 2) quizzes, 3) discussions and 4) video summary of the discussions and 5) video feedback from skilled Instructor.**
Video Lecture 'Lesson on Wind Turbine Control' was developed within this project, recorded in Camtasia and supplied with the 'Guide' and 'Slides'.

I. Overview of the Paper

The paper starts with introduction and description of general perspectives of video education. Pedagogical perspectives and challenges in video education are discussed in Section III. Video education as a tool for improvement of learning outcomes is discussed in the next Section IV. Learning objectives of this project are formulated in Section V. Flipped classroom model and its modification proposed in this project are discussed in Section VI. Application of video education (with Camtasia video recording software) to Chalmers Professional Education (CPE) is presented in Section VII. Description of Video Lecture produced with Camtasia in this project for CPE is presented in Section VIII.

II. Introduction

Video lectures are the key part of MOOCs, flipped, blended and online courses, and will play even more important role in future eduction. There are many benefits to using video in education as shown in several decades of research, see for example [1], [2] and references therein. Video may impact on teaching and learning and encourage teachers to consider the flipped classroom model, where learners can digest the lecture content at their pace and explore content more deeply during class time. Video lectures also enable students to acquire a range of transferable skills such as critical thinking, problem solving, collaborative working, research and administrative skills.
Video lectures (if produced properly) can be as good as traditional lectures in terms of communicating knowledge and demonstrating procedures to assist in deeper learning where a student can view complicated functionality (such as mechanical procedures, electromagnetic interactions, control performance in the wind energy field and many others) as many times as they need to. Furthermore, advanced interactive features of modern web-based video players (such as screen adjustments, advanced navigation, streaming services, universal format support, smart phone applications and many others) can be used to promote active viewing approaches with students, [3].

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III. Challenges in Video Education: Pedagogical Perspective

Watching a video lecture does not imply learning something from the lecture, which creates new educational challenges. Video lecture is not for presenting visual information and knowledge only. Video lecture can be organized in different ways, which produce different outcomes. Learning outcomes together with the list of skills to be developed should be discussed in each video lecture to make it more efficient. Video lectures could be a valuable tool for improvement of learning outcomes provided that they are properly produced and integrated into the curriculum, as it is shown in the Section IV.

IV. Video Education as a Tool for Improvement of Learning Outcomes: Strategies for Development

The following methodology associated with active learning is developed for producing video lectures as a tool for improvement of learning outcomes, [1] - [3].
The methodology comprises of the following steps:

- Video lecture should be presented as a guided lesson. Active participation, associated with continuous attention is necessary for maximization of learning outcomes. The most important places should be emphasized and troublesome points should be recommended for re-watching.
  - Clear learning outcomes should be stated in the beginning of video lecture, that shows clear learning goals and expectations to the students.
  - Video lecture should be better outlined (for example with concise, descriptively labeled items) than a normal lecture, so that the students do not miss overall structure of the lecture and relations between the parts.
  - Video lecture is easier to connect to the previous knowledge of the students by simply recommending related video for watching before or after the lecture.

  - The students should be encouraged to think actively what they already know, do not know and what they want to know about the topic before the lecture.
  - Re-watching of video lecture or parts of the lecture should be encouraged, that would allow students to plan optimally their time, taking advantages of expected and unexpected opportunities (in transport, on weekends and so on, for example).
  - The assessment part, aligned with intended learning outcomes is desirable part of video lecture. The assessment (in the form of quizzes, multiple choice questions and others) can be embedded in the lecture or can be presented after the lecture. The assessment could be reported using video tools. Digital video reporting can inspire and engage students when incorporated into student-centered learning activities with increased motivation, enhanced team working and learning experience, development of administrative and video recording and editing skills.
- Video is considered as a starting point for in-depth discussion. This encourages students to relate the video content with their own existing knowledge. It also encourages student-to-student collaboration, which is a critical component of any successful online course. In-depth discussions can be started for example with the sticky notes posted on the discussion board, which contain brief answers to the following questions:
  - What was new on the lecture ?
  - What was the most interesting ?
  - What was confusing or maybe even erroneous and why ?
  - How the content relates to a previous class discussion or previous lecture (if any) ?

  The students should be divided into small groups and discuss their answers to the questions above, that stimulates critical thinking.
- The skills of critical thinking may be associated with video lectures and developed using discussions. Video lecture may contain two or more different concepts and the discussion can be encouraged by posting the questions for example on the discussion board. The students are invited to identify, compare, and criticize the concepts presented in the video lecture. What are the similarities, differences and applications ?
- Video lecture can be used as a tool for development of research skills. This can be done in the following way:
  - The students get the research assignment after video lecture. This assignment may support, defend, criticize and develop the concepts presented on the lecture, using assigned literature and web resources.
  - The students are invited to produce the video report associated with this assignment.
  - Video materials produced by the students can be used as a starting point for classroom discussions. The students are asked to comment both videos and present their opinion on the discussion board.

V. Learning Objectives

Learning objectives and tasks for this project can be summarized and formulated as follows:

- to acquire skills of video recording for educational purposes
- to identify challenges in Video Education
- to produce video lecture on wind turbine control for CPE addressing these challenges
- to implement modified FCM (Flipped Classroom Model, see the next Section for details) in CPE (Chalmers Professional Education) via embedded assessment and class discussions
- describe the activities and contributions in the paper

VI. Flipped Classroom Model and its Modifications for Chalmers Professional Education

There is no universal definition of the term 'Flipped Classroom Model'. However, it appears that academics agree that a flipped classroom generally provides pre-recorded lectures (video or audio) followed by in-class activities. Students view the videos outside the classroom before or after coming to class where the freed time can be devoted to interactive modules such as Q & A sessions, discussions, exercises or other learning activities. Since FCM 'invert' activities inside the classroom with activities outside the classroom, they are sometimes also referred to as 'inverted' classrooms [4].
The teacher is typically in the central focus of a lesson and guides discussions, responds to questions and provides feedback.
This concept is modified in this project for CPE. The main idea is high quality education without skilled Instructor in the classroom with active learning (with enhanced student-to-student interaction) where the students (or student groups) provide feedback to each other and the discussion is guided by the Instructor (not skilled Instructor). In other words, the students watch video lecture in the classroom, perform exercises, and discuss the content of the lecture in small groups, providing feedback to each other. Representative from each student group records the video with summary of the discussion in each group and sends the video to skilled Instructor. The results of discussions are evaluated by skilled Instructor for providing final video feedback shortly after the lecture.
The advantages of this approach are the following:

- Teaching and learning activities can be performed without skilled Instructor in the classroom, which extends opportunities for CPE and reduces costs. The advantages and sources of savings can be summarized as follows:
  - Video lectures are recorded once only and may be used many times in different courses.
  - Skilled Instructor gets the summary of student discussions and does not follow intermediate steps,

which saves time in the classroom.
Notice that some of the students may have deeper knowledge in the wind energy area and many questions could be addressed in the class discussions, where the students help each other. Class discussion can be guided by the Instructor (skilled Instructor is not needed for general questions). Troublesome questions are addressed by skilled Instructor in video feedback.
  - Skilled Instructor is able to plan his/her time in a flexible way when producing video feedback for students.
  - CPE may offer video education for reduced price. In addition, the approach allows avoidance of financial losses for the cases where skilled Instructor is not available due to sickness, urgent traveling and other reasons.
  - The approach is especially efficient for organizing education at remotely located placed. Video lecture can be guided by a local Instructor, and skilled Instructor, which is located in other city provides video feedback for the summary of the discussions. This approach implies significant saving associated with travel costs.
- Peer-assessment or self-assessment model with video recording develops the skills of critical thinking, team working, potentially deeper learning as well as IT skills.
- The students may be encouraged to watch video lecture once again at home after watching video feedback from skilled Instructor, which enhances teaching and learning performance.
- Teaching and learning activities are well video documented facilitating evaluation and reflection, which in turn improves learning outcomes.

This concept can be implemented in two steps. In the first step video education can be used as a back-up solution for the cases where skilled Instructor is not available. Video lecture can be given without skilled Instructor in the classroom in the second step, if the first step is successfully tested.

VII. Video Lectures in Chalmers Professional Education

A. Chalmers Professional Education

Chalmers Professional Education (CPE) is Chalmers University of Technology's organization for specially tailored education of professionals in industry, where the programs are designed in accordance with industry's needs and requirements. The aim is to provide industry with world-leading knowledge in technology-related knowledge areas. The educational programs are aligned with Chalmers areas of advance: Energy, Information and Communication Technology, Life Sciences, Material Science, Nanoscience and Nanotechnology, Production, Built Environment, and Transport.

B. Video Lectures Perpectives

The author participated in the CPE initiative via contributing to the course on 'Wind Power Technology' (Area of Advance: Energy) by giving the Lecture 'Lesson on Wind Turbine Control' in 2012. The comments from 'Course Evaluations' and suggestions of the students has been taken into account in the Video Lecture.
The Lecture (after several draft recordings) was recorded in Camtasia and final version with improved quality will be used in the next Session of CPE initiative. Benefits of using video in education were discussed in the previous Sections. Notice that Camtasia[1] is the software produced by TechSmith, for creating video tutorials and presentations directly via screencast, or via a direct recording plug-in to Microsoft PowerPoint. The screen area to be recorded can be chosen freely, and audio or other multimedia recordings may be recorded at the same time or added separately from any other source and integrated in the Camtasia Studio component of the product.
The results of this development project will be implemented in the next course on 'Wind Power Technology' by giving the Video Lecture 'Lesson on Wind Turbine Control' to the students and by organizing classroom discussions on wind turbine control. The students will watch Video Lecture in the classroom (which is the most effective way to use video) and will get classroom assignments embedded in the Video Lecture. Learning will be performed without skilled Instructor in the wind turbine control area, which permits flexibility and reduces the cost of education.
The project was initiated by the discussion with the Head of the Department of Electric Power Engineering (who is also responsible for the CPE course on 'Wind Power Technology') and was approved for implementation.

VIII. Overview of the Video Lecture: 'Lesson on Wind Turbine Control'

Wind energy is currently the fastest-growing energy source in the world, with a concurrent growth in demand for the expertise of engineers in the wind energy field in Sweden. In this lecture we first review the basic structure of wind turbines and then describe wind turbine control systems and control loops. Of great interest are the generator torque and blade pitch control systems, where significant performance improvements are achievable with more advanced systems and control research. We describe recent developments in advanced controllers for wind turbines within SWPTC (Swedish Wind Power Technology Center), and we also outline challenges in the areas of modeling and control of wind turbines. The lecture consists of the following parts:

- The first part describes hardware settings for drivetrain, pitch control and yaw control, see Slides 6 - 19 .
- The second part is devoted to control hardware and supervisory control system architecture, see Slides 22 - 26 .

[1] $https://en.wikipedia.org/wiki/Camtasia_studio$

- The third part is devoted to control oriented turbine modeling, see Slides 29 - 45 .
- The fourth part introduces $K\omega^2$ controller, see Slide 46.
- The last part is devoted to control activity within SWPTC, see Slides 48 - 51 .

The literature [5] - [16] recommended to this lecture is presented in the Section 'References'.
Complete 'Guide' to this lecture and the 'Slides' are provided in separate files.

IX. Conclusion

Video Lecture 'Lesson on Wind Turbine Control' was developed within the project in the course 'Blended Learning and Digital Media in Higher Education'. The lecture was recorded in Camtasia and is supplied with the 'Guide' and 'Slides'. New pedagogical concept of modified FCM was developed that allows to run the course in the Wind Energy area without skilled Instructor in the classroom, which implies significant savings. The concept is implementation-ready and can be tested first as a back-up solution for the case, when skilled Instructor is not available.

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