Resource and Profitability Assessment of Transition to Flipped Video-Based Lecturing

Iuliia Shnai, Lappeenranta University of Technology, Finland
Mariia Kozlova, Lappeenranta University of Technology, Finland

The European Conference on Technology in the Classroom 2016
Official Conference Proceedings

Abstract
In the current digital era, competitiveness of educational institutions is defined by the ability to satisfy the needs of smart video-learners. It explains active transition to video-based knowledge sharing, like substituting traditional lectures with 'flipped classroom' approach. However, creating video materials consumes huge amount of resources hindering adaptation of this practice by universities. This paper aims to estimate resources and profitability of flipped approach implementation. The assessment focuses on video-creation process for flipped classroom and is based on the experiments conducted in Lappeenranta University of Technology. Results of the research provide estimates of needed resources and expected payback period of adapting flipped classroom as well as reveal conditions under which it becomes more resource-efficient. Our conclusions suggest that despite initial resource consuming, flipped classroom realization leads towards lean and cost-effective lecturing.

Keywords: Flipped Classroom, Video Lecturing, Resource Assessment, Profitability Analysis.

iafor
The International Academic Forum
www.iafor.org

1. Introduction

Worldwide digitalization affects the way information is consumed, transforming the form of knowledge delivering. New era video learners study through blogs, social networks, online journals, open education websites, and unique social platforms like KHAN or TED. Universities as main institutions of educational system rearrange courses to satisfy the needs of millennials. For instance, the format of lectures switches to a short visualized reality with high level of attraction for students. Flipped classroom is one of the recently evolved concepts, which matches this format. According to it, a part of lecture material is substituted with video and is delivered before the class.

The growing body of research demonstrates effectiveness of the concept as an educational methodology (O'Flaherty, 2015). Mainly improvements of score, students' satisfaction, class activation, communication, engagement and personalization are revealed. Despite effectiveness of this blended learning approach, it consumes considerable amount of resources (Dharmadhikari, 2011). In addition, lack of economic assessment of this approach in the literature, alongside with teachers' reluctance to devote their time to its adaption constitute core obstacles in implementing flipped classroom.

This article reveals the economic benefits of flipped classroom video based approach from the university and/or professors' perspective. It specifically concentrates on the profitability analysis of transition from traditional lecturing to video with flipped delivering approach. Subsequently conditions for its implementation and pivotal to its development parameters are emphasized by means of break-even analysis. The input data is gathered and analyzed based on two experiments conducted in Lappeenranta University of Technology (LUT).

2. Background

The interest to Video Based Learning (VBL) increases with growing popularity of blended learning concepts, such as flipped classroom (Mohamed, 2014). New emerging tools and software provide opportunities for anyone to produce high quality videos. The diversity of video creation tools include but not limited to recording in studio with professional cameras and lightening, lecture captures systems like Echo 360 or Ponopto, and voice recording systems. For the distribution of material different open channels can be used like YouTube or ITunes. Universities apply different video creation tactics depending on available resources. In big universities video is produced in special studios with the help of a group of professionals. Consequently, this approach requires a lot of resources. Contrary, in small universities or in those making their first steps in the direction of video creation, the materials are developed by professors themselves by exploiting already available infrastructure. Generally, these professors-trailblazers are limited with resources and have no professional skills in video production. In both cases, video creation consumes a lot of time for its recording and development. Therefore, it is crucial for the developers to find an optimal video-approach, to make assessment of required resources and profitability beforehand.

Most of the articles consider flipped classroom or video production only from the students' perspective. Some of the authors describe their flipped classroom experience and report time of video development. Hollands and Tirthali (2014) state that approximately 40 minutes are needed for recording 1 minute voice over power point presentations. The flipped classroom practitioners from computer science department in LUT spent 20-25 minutes for creating 1 minute video without any practice (Herala, 2016). This time includes time for developing slides and voice recording on top of it. One professor from University of Trento declares that developing 1 minute video required him approximately 40 minutes (Fedrizzi, 2016). Overall, the reported time spent on video development ranges from 20 to 40 minutes per a minute of resulting video.

Flipped classroom changes the usage of classroom time moving the most of theoretical teaching out of the class and spending released time on interactive activities (Abeysekera, 2014). It means that flipped classroom frees time of the lecture (Mohamed, 2014). Notably, some of the authors draw a parallel between blended learning approaches and lean concepts, which mainly aim to eliminate wastes (Yip-Hoi & Welch, 2015). In this vein, flipped classroom concept can help in avoiding overburden in lecturing for the future.
Video based learning embedded into the flipped classroom concept empowers potential in resource savings despite its initial costs. Under certain conditions it becomes a sustainable and economically viable way of knowledge delivering, rather than being a pure investment of time and money.

3. Methodology

3.1. Experiment setup

We conducted two experiments of video elaboration in LUT. Both of video session experiments are applicable to the 'TRIZ[1] and Creative Problem Solving' course. First pilot experiment represents the low-cost option having low quality of video and low editing efforts, because of the small amount of resources involved. For the second experiment, the content and quality were significantly improved. Planning for the second session was more specific and accurate. The main preparation parts to be finalized were infrastructure, video design, and professor training of performance in front of the camera. A special studio in LUT, professional lightening, a generic camera and video editing program comprized the working process. With respect to the video delivering design it was decided to substitute the theoretical knowledge transfer part of the lecture that accounts for approximately 30% of the total lecture, leaving examples, discussions, and interactive activities for the class. Five main topics were distinguished in the course and for each of them the respective videos were developed. Duration of each video was from 10 to 15 minutes. According to the research of student perception (Wilson & Korn, 2007), it is the most effective and optimal duration. As far as after 5 minutes students normally become bored, the videos were segmented into parts.
The input data were gathered through the observations and interviews with the professor of the course. In the table below one can see the main parameters which were considered.

[1] TRIZ stands for Theory of inventive problem solving

Table 1. Specifications of input data

Parameters	Description
Professor's time	Meeting time + preparation time + discussion time + recording time
Assistant's time	Meeting time + preparation time + discussion time + recording time+ editing time
Video duration	Duration of the resulting video material
Compressibility rate	The rate of corresponding lecturing time to the time of the video material substituting it
Repetition Rate	The number of times the video material is used per year
Infrastructure cost	The costs of required supporting equipment and software
Professor's salary	Official registered salary of the participated professor
Assistant's salary	Official registered salary of the participated assistant

3.2. Valuation model and assumptions

To assess economic viability of flipping lectures with video materials we employ classical investment modeling, known also as capital budgeting analysis (Brealey, Myers, Allen, & Mohanty, 2012). Investment modeling involves estimating future cash flows generated by an investment and computing various profitability indicators. Among widely used are net present value (NPV) that reflects total project value in monetary terms; internal rate of return (IRR) that represents the threshold discount rate at which NPV would be zero; and discounted payback period (DPP) that shows a period of time after which the investment pays off (Graham & Harvey, 2001; Ryan & Ryan, 2002). Further, we complement investment modeling with the break-even analysis (Hussey, 1989) revealing critical values of input variables for investment profitability.

The investment modeling is applied for particular cases of the conducted experiments described above. The cash flows are defined based on the time resources spent/saved and their cost, in particular salary of the assistant and the professor. Thus, initial costs of video creation are calculated as the time spent by the professor and the assistant multiplied by their salaries plus some other so called infrastructure costs, whereas the revenue stream is defined as saved professor's time due to replacing lecturing with the video material multiplied by his salary. Here two important factors are involved, namely the repetition rate or how many times the video material is used per year and the compressibility that expresses how much longer the lecturing time substituted by the video in comparison to the duration of the corresponding video material. Though these values are course- and professor-specific, in our case they are equal to 4 and 2 correspondingly. The salary levels taken into calculation are 2400 euros for the assistant and 6000 euros for the professor. The effect of the replacing lectures with videos is calculated for 10 years and the cash flows are discounted at 1% rate to reflect the time value of money.

4. Results and discussion

A summary of inputs to investment modeling and its results for both cases is presented in the table below.

Table 2. Investment modeling assumptions and results

Case	I	II
Inputs		
Video duration, hours	0,67	1,07
Professor time (recording), hours	2	10
Assistant time (recording and editing), hours	28	86
Infrastructure costs, euro	50	250
Costs		
Assistant work related costs, euro	384	1 179
Professors work related costs, euro	69	343
Total investment (including infrastructure costs), euro	503	1 772
Revenues		
Saved lecture time, hours per year	5,33	8,53
Savings, euro per year	183	293
Results		
Development ratio	45	90
Net present value (NPV), euro	1 412	1 291
Internal rate of return (IRR)	57%	15%
Discounted payback period (DPP), years	2,8	6,2

A simple indicator of resources used in video creation is a proportion of the time spent for video recording to the video duration, here we refer to it as development ratio. It constitutes 45 and 90 minutes per a minute of video for two cases respectively. Indeed, in the second case the overall time spent for the video recording and editing is relatively higher due to higher requirements to its quality, heavier preparation and editing workload, as mentioned above in the experiment setup part. The higher the development ratio, the higher the associated costs for video recording and editing. Hence, the profitability indicators deteriorate with increasing development ratio ceteris paribus. Our results confirm this conclusion.

As can be observed from Table 1, video elaboration in both cases is profitable. NPV is above zero, IRR is substantially higher than the discount rate used (1%), and DPP varies from 3 to 6 years. All these signify economic viability of the projects. Mostly due to higher development ratio, the second case exhibits less attractive results in terms of profitability, but still remains financially attractive.

To highlight sensitivity of the results to different factors we run break-even analysis (Table 3). It indicates the minimum or maximum acceptable values of pivotal parameters, or in other words to what extent we can alter the parameters to keep the project profitable.

Table 3. Break-even analysis results

Case	I	II
Minimum repetition rate	1	3
Maximum development ratio	177	167
Minimum compressibility	0,52	1,16
Maximum assistant’s salary	11 226	5 028
Minimum professor’s salary	1410	3152

One of the most crucial parameters is the repetition rate that defines how often the video material is used. Nevertheless, the video creation project can sustain low repetition rates, such as once a year (in the first case), if the development rate is relatively efficient (45 minutes per a minute of video). With higher development ratio, e.g. for the second case it accounts for 90 minutes per a minute of video, the minimum repetition rate should be higher (at least 3 times a year) to maintain economic viability of the project.

The results demonstrate sound tolerance of project profitability to other factors, including the development ratio, compressibility of the video material, salary levels of the participating professor and assistant. Acceptable levels of the development ratio are far above experimentally gained values as well as achieved figures in practice of other universities. Tolerable compressibility is close to one for the second case and even lower for the first one, implying that even one to one correspondence of the lecture time to video duration is enough for keeping project profitable. Maximum acceptable assistant's salary is well above standard Ph.D. students' and postdocs' earnings in Finland, suggesting a possibility to hire professional staff. In contrast, professor's salary defines future savings, therefore the break-even analysis shows its minimum level, implying that recording lectures of even low-paid teaching fellows is reasonable.

In a nutshell, this profitability analysis justifies economic viability of flipping lectures with video material and demonstrates its tolerance to all influential factors suggesting notable flexibility in video elaboration.

5. Conclusion

In light of the modern digitalization trends in education, issues of effectiveness of flipped video-based learning implementation attract more and more attention in the academic community. One of the main obstacles in adaption flipped classroom is perceiving it by practitioners as resource-consuming. Furthermore, current literature lacks profitability assessment of this approach, hindering its wide implementation. Therefore, this paper presents an analysis of economic viability of transition from traditional to video-based lecturing.

Based on the conducted pilot projects in Lappeenranta University of Technology we demonstrate that video elaboration is profitable, because, its initial resource intensity, it saves considerable time in future lecturing. We show that one of the crucial to economic viability factors is the number of times per year particular video material is used to flip the lecture. However, with the development ratio equal to or less than 45 minutes per a minute of video that well corresponds to the observed rates in practice of other universities (20-40 minutes), employing video once a year is enough to pay off initial costs within less than a decade. In turn, more often use of video material allows even greater development ratio, indicating a possibility to spend more time on video elaboration keeping the project financially reasonable. Indeed, our experiments show that the development ratio can easily rise due to a number of factors, including quality of equipment and sophistication of software, amount of additional content to be visualized in the video material, experience of an assistant in recording and editing videos, professor's recording performance and even mood of participants. However,

with growing experience of participants, efficiency in video elaboration essentially improves.

Along with already proved educational advantages of flipped classroom, revealed by this work economic viability of flipping traditional lectures with video material is expected to convince broader public in its benefits and trigger further diffusion of this approach.

Acknowledgment

We would like to acknowledge the contribution of Prof. Leonid Chechurin, who inspired us for this project and actively participated in its implementation; LUT administration that kindly procured us with the professional studio; Antti Herala and Mario Fedrizzi for consultations on their experience in adapting flipped classroom in their practice. We also would like to acknowledge the financial support received by M. Kozlova from Fortum Foundation.

References

Abeysekera, L., & Dawson, P. (2014). Motivation and cognitive load in the flipped classroom: definition, rationale and a call for research. *Higher Education Research & Development*, 34(1), 1–14.

Brealey, R. A., Myers, S. C., Allen, F., & Mohanty, P. (2012). Principles of corporate finance. *Tata McGraw-Hill Education*.

Dharmadhikari, V. (2011). Creating educational lecture videos compatible with streaming server using low cost resources. *Proceedings - IEEE International Conference on Technology for Education*, T4E.

Fedrizzi, M., *personal communication*, April 2016

Graham, J. R., & Harvey, C. R. (2001). The theory and practice of corporate finance: Evidence from the field. *Journal of Financial Economics*, 60(2–3), 187-243.

Herala, A., personal communication, June 13, 2016

Hollands, F., Tirthali, D. (2014). Resource requirements and costs of developing and delivering MOOCs, *International Review of Research in Open and Distance Learning*

Hussey, R. (1989). Break-even analysis. *Cost and management accounting* (pp. 139-151) Springer.

Karen Wilson and James H. Korn (2007) Attention During Lectures: Beyond Ten Minutes, *Teaching of Psychology*, Saint Louis University, http://www.informaworld.com/smpp/title~content=t77565.

Mohamed, A., Yousef, F., Chatti, M., Schroeder, U., (2014). Video-Based Learning: A Critical Analysis of The Research Published in 2003-2013 and Future Visions eLmL. *The Sixth International Conference on Mobile, Hybrid, and On-line Learning*

O'Flaherty, J., & Phillips, C. (2015). The use of flipped classrooms in higher education: A scoping review. *The Internet and Higher Education*, 25, 85–95.

Ryan, P. A., & Ryan, G. P. (2002). Capital budgeting practices of the fortune 1000: How have things changed. *Journal of Business and Management*, 8(4), 355-364.

Yip-Hoi, D. M., & Welch, J. G. (2015). Enhancing a Blended Learning Approach to CAD Instruction Using Lean Manufacturing Principles. *In ASEE Annual Conference and Exposition, Conference Proceedings* (Vol. 122nd ASEE). American Society for Engineering Education. Retrieved from http://www.scopus.com/inward/record.url?eid=2-s2.0-84.

Contact email: iuliia.shnai@lut.fi