Video learning materials for better students' performance

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Abstract. *It has passed a decade when we prepared first video lectures and tested their didactics suitability* [1]. *During this time we tested different types of video learning materials and spent countless hours for their preparation. Learning materials of the huge project of preparing video lectures for SPSS* [2] *is still used by our students daily. During that time recording of lectures was not easy and extensive post processing was required. In the meantime new hardware simplified production of lectures and many institutions and individuals start recording their own video lectures. IJS (Institute Jožef Stefan) expanded their project to an internationally recognized brand – videolectures.net* [3]. *In the last year the Rector of University of Maribor announced initiative to produce contemporary learning materials, preferable video learning materials. A team of experts with the experiences in multimedia learning materials production were assigned to prepare guidelines and start the project that would eventually enable mass production of learning materials. Students are highly skilled learners and text based learning materials is most efficient for them. Addition of video for explanation proves to be success. Giving students a choice between different types of learning materials they favored text with multimedia elements - multimedia learning materials. Video lectures were initial success but proves to be cumbersome even if they were indexed and students need more time to study such materials in comparison to the text. Videos have much high value when skills are thought and not theory.*

Keywords. Learning materials, e-learning, instructional video, video lectures, design and development

1 Introduction

It was long known that video learning materials are very successful in the specific area of education – skill acquiring [4] [5]. During long process of experimenting with the video it proves to be too expensive for general education before the computer technology becomes powerful enough for video editing. Another thing that influenced the usability of video was sufficient bandwidth [6]. In the time of dial-up networking video learning materials were just a fantasy. Since then we evolve and today broadband with few mbps (megabits per second) is available to most of the students and we have abilities to prepare video learning materials. We could do this for quite some time but there were some technical glitches that make this process a bit awkward and frustrating. The initial small scale production proved the concept but a larger project was needed to acquire competences. Such project was expected to be so time and labor demanding that most involved have no desire to do it again [7]. Especially since required effort for design and development was not funded. In the mean time we could see the lectures on the web and unless there were presentations of Steve Jobs presenting new gadget people rarely watch the whole video. Popular web site TED that has extensive video library show that in the past few years their lecture shortened and most of the contemporary lectures are short – some even much less than recommended 18 minutes [8]. Should this tell us something about the average viewer or average student? In our humble opinion it should. Recordings of 90 minute lecture in the classroom are boring and unless students are really motivated they would not watch them. Therefore video needs to be post processed – shortened.

Multimedia learning materials are already successfully proven educational concept. The pedagogical point of view shows the advantages of using multimedia since communication takes place at several levels, integrating text, and picture and sound with the connection (or integration) of individual data [9]. The use of modern media in the learning process also means taking into account different learning styles and individual setting of the learning pace, learning level, and learner's individual control of the repetition of educational tasks, as well as increase the options for an extra-curricular education [10].

There are also some other considerations in the wider application of video learning materials. Some lecturers have impression that students would stop attending lectures and their performance would degrade. This is not without the reason since some research already proved this [11]. Another consideration is also that preparing learning material is time consuming and can cover more materials (educational goals) [12]. If these materials are used for blended learning they can show discrepancy between lectures and learning materials.

2   Video lectures

Videolectures.net has huge success and extensive library of eminent speakers [3]. From the perspective of a viewer it is a gold mine. But it is different experience watching speaker (live or in the classroom) or watching the recorded video. In general people takes a break at home and do not watch whole lecture in one piece. They may pause the recording and continue afterwards or not so rarely they stop watching and continue watching video next time. In the video lectures as in any online video it is generally not simple to find where you stop watching unless a time of break is recorded for later faster retrieval. On the other hand it is not easy to find topics that really interests viewer and skip the rest. If presenter uses the PowerPoint presentation then PowerPoint slides transitions can be used as timestamps (Figure 1) but if it is just a talk than viewers need to watch whole recording.

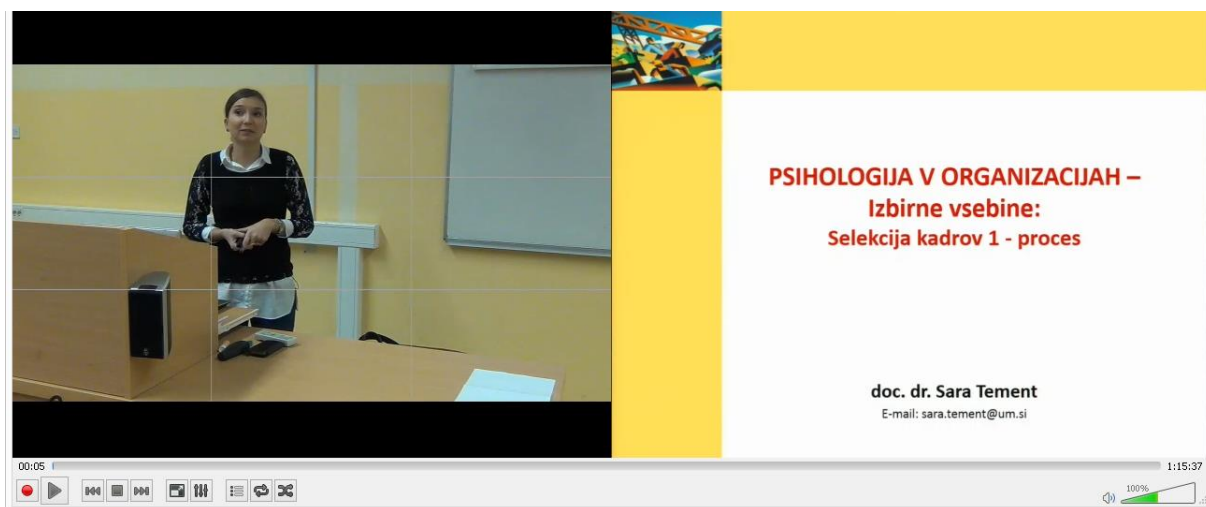Figure 1. Video lectures with the slides as table of content

Figure 2. Recorded lectures in the classroom without indexation

At the University of Maribor we made some recording with the equipment borrowed from IJS to test the abilities of equipment. Soon we discovered that there are two types of equipment. Simple and relatively cheap that does not have full features and does not make indexes from PowerPoint presentations and the other which we were not able to acquire.

Despite the fact that any camera with HDMI output can be used it is advisable not to use the cheapest. Wiring and preparing the classroom takes time and we need at least 45 minutes to prepare the system to be able to record the lectures. Later all those equipment needs to be packed and send to the IJS. In our tight schedule when we have just 5 minute pause between classes it is impossible to do it regularly. Equipment should be installed in one classroom where everyone who wants to be recorded would come; switch it on; record himself; and then switch it off. But we still need to have a skilled operator all the time for monitoring the sound and video inputs.

In the figure (Figure 2) we can see what might happen if operator is not paying extra attention to the input parameters. Camera was set to show the guidelines and the same are shown on the lecturer recordings. A few clicks prior to the recording would solve this minor imperfection

but this recording is not for public presentation as a best practice.

3   Hardware and client's device considerations

In the last five years computer hardware is powerful enough to play almost any kind of video without shuttering. Any low powered dual core processors in low budget laptops is sufficient and no restriction applies in the production of multimedia learning materials if students learn with the computers. But tablets and phones (phablets) are on the rise. Hardware considerations for such devices are still in place during the design and development process.

Hardware characteristics of the portable (mobile) devices are different. Processor computation power ranges from "snail like" low power single core processor that frustrates users even in the interface operations to "dream like" four cores processors. Some have small screen with low resolution while others don't. To use mobile devices in the education a special design and didactics was needed known under the term "m-learning" [13]. Developers have long been puzzled if it is possible to prepare learning materials suitable for most portable devices or should be designed differently according to the each individual device characteristics.

From the software libraries for portable devices that cover different portable operating systems we can see that design of software is different according to the end user devices. Games have different philosophy and should not be taken into this consideration.

Students use different hardware devices and not all of them are suitable for watching video lectures sized 1280x480. On laptop they look good; on tablets they are watchable; and on the smart phone they are rubbish. On the other hand even web browsers used on different devices behave differently. We have tested the video lectures on two phones capable to play the video (Samsung Galaxy Note and Nokia Lumia 520) with different resolution. The native resolution of the video lecture is 1280x480 and should fit nicely to the resolution of Samsung Android Phone but the texts on slides are unreadable (Figure 3).

Figure 3. Samsung Android Phone
1280x800 pixels screen (real width 11.4 cm)

4   Efficiency and effectiveness

Video learning materials need to "pay" for themselves. It is evident that if we produce learning materials in Slovene language we will never be able to get even a dime out of them. Therefore we need to evaluate their value in different currency. If learning materials is favored by students and attracts them this is one value. If students are able to learn from them faster that is another value and if they are simple to produce this is the third value. Therefore we need attractive, efficient and effective learning materials.

Teachers are didactics experts and are able to prepare efficient learning materials. With the right equipment we are able to lower the cost and effort therefore we can produce effective learning materials. To produce attractive learning materials we need someone who has talent [14]. Not everyone can be used for this task.

Our students' population is a grateful audience since they are used to learn from extremely boring learning materials. But their endless patience is limited to the classroom and who knows how they would react to the recorded (boring) lecture?

We do not know about the rest of the world but our students really lack some basic computer skills. They all "know" how to use Word, Excel and PowerPoint but when they prepare their final theses, where strict formatting is required, they often need help. Since the Bologna reform of the curriculums we have huge number of students that need to prepare their work in the short time and upload their work to the university electronic library. Therefore it is huge demand for those skills that cannot be met in short time period. We decide to prepare video guides for those tasks that are frequently used and mainly unknown to our students (Figure 4). None of video guides exceeds 3 minutes even if it presents the use of caption and cross-references in the document.
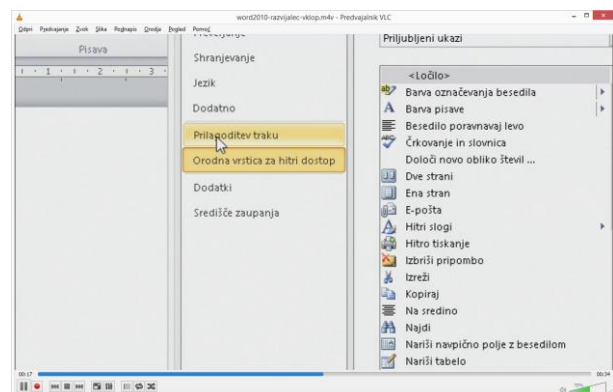

Figure 4. Video guide for Word 2010
How to enable developer mode.

5   Past and present experiences

Natural scientists are able to define strict measurement systems in their work. For social sciences this is not entirely true therefore social scientists often extensively use statistics. Course "Introducing to the statistical methods and SPSS (Statistical Package for Social Sciences)" prepare the students' for statistical researches but statistical methodology is subjected to the process of forgetting because it is used only in few occasions during the study. Statistical methodology support is therefore almost always required. Since all our statistical experts are

overloaded with their work the multimedia learning material was developed [2]. The multimedia learning materials combine: sample data; instructional video; brief textual explanations of the selected methods; and printouts in PDF and SPSS (Figure 5). Such combination of elements is necessary to explain particular statistical method or procedure. The essential elements in the learning materials are instructional videos (Figure 6) [15]. The instructional videos included in the e-learning material are real-time screen captures with the teacher spoken explanation of statistical method and the way to get the analysis results in SPSS.

Implementing the instructional video was a very practical solution with some setbacks in distribution capabilities. At the early stage of the production the distribution of video was very demanding matter due to limited bandwidth of intended users – students. But in the meantime the situation improves and almost anyone has the ability to see those instructional videos. The multimedia learning material was initially distributed on CD media. Soon after the LCMS become capable to provide video contents the complete multimedia material was transformed to the SCORM packages. Since these learning materials predate HTML5 video clips were converted to video streams and streamed from the Windows Media Server. Despite the old technology used for the production of these learning materials students still use them for preparation of their seminar works and graduation thesis. Those materials are available on the LMS and statistics show that even students at the master and doctoral studies use them.
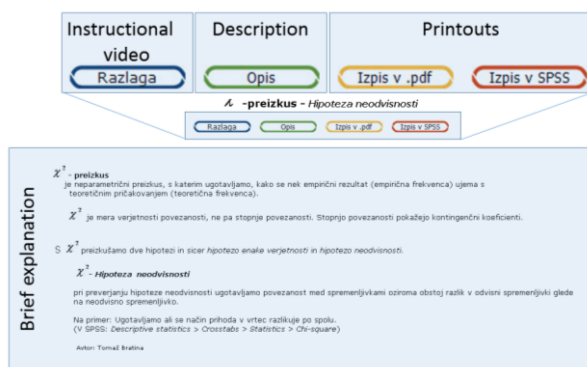

Figure 5. Multimedia learning material for SPSS
(*with highlighted "transparent light blue" areas for description*)

The primary goal of the implementation of these learning materials was achieved. Instructional videos and additional materials enable the student to recall forgotten knowledge they gained during their study course. Methodological experts are freed from basic support and can focus on more intelligent students' problems.

The instructional video production process revealed many technical problem and difficulties. Those videos were made in standard resolution which does not provide sufficient space for good quality video (Figure 6). To meet the requirements of good visibility and readability we have to set screen resolution to 800x600 pixels. To add the sound to the recorded screen additional post processing

was needed and many artefacts appear. Therefore an installation of two computers was needed where one was used for presentation and the second computer encodes video without interference with to the processing power of the first computer. Simultaneously the spoken explanations were recorded and it has to be perfectly from the beginning to the end. But the available technology (cheap enough) at that time distorts sound in the live recording therefore the speaker voice is distorted but still understandable. Another problem was speakers' errors and unwanted pauses etc. Any recoding process would significantly lower the quality of video therefore we have to resolve such faults during online video editing. All of the mentioned steps were time consuming and some inevitable influenced the quality of outcomes.

Instructional video can be prepared using different technologies. Recording the screen proves to be most natural since anyone can see user's actions in the real time. But as we have said before there are problems of degrading quality during the post processing. Screen recorders also present some problems because software used for screen recording alters the behavior of the computer interface. In general recording with the Windows Media Encoder overrides the double click. Therefore all actions need to be orchestrated and rehearsed in somehow unnatural way. Screen recording usually do not need very high frame rate. In general 10 fps could be sufficient for presenting the users action and encoding can be loss less. Recoding the video streams lose significantly degrade of quality but is still good since the input is almost flawless.
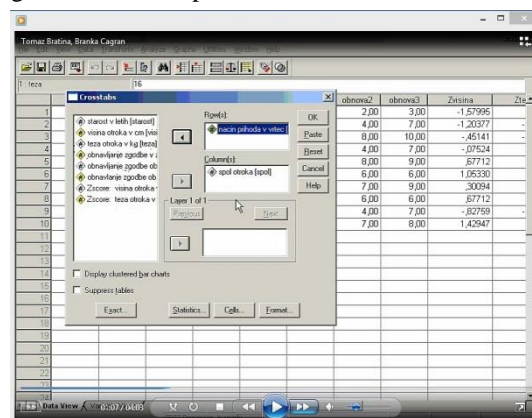

Figure 6. Video tutorial for SPSS

In some cases only images are used in video and they are narrated with the voice. Production of such video clips can be a bit less demanding but still requires a lot of attention. The instructional video in next example (Figure 7) was prepared to help the students citing different forms of sources in their works according to the APA standard. This topic in the text processing is also proven to be highly prone to forget by the students. A bit less problems in this topic is seen in recent years because Microsoft Word since its version 2007 support literature citation but most of our students forgot what they were thought at the beginning of the study. This video was prepared with less motion, higher image quality and additional emphasis on sound narration (Figure 7).
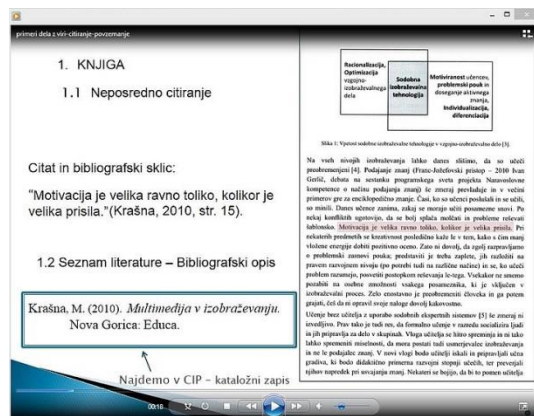
Figure 7. Video guide for APA style citation

The video learning material was produced from PowerPoint slides and the image quality was much better than screen capture. PowerPoint can be synchronized with the transitions, sound and images and exported as high quality video. Because this video is not screen capture and does not have a lot of dynamic changes video codecs can produce high quality output and relatively small file size. Produced video require sufficiently low bitrate and can be streamed even on relatively slow networks. Students are able to watch instruction online as much as they want and learn or refresh their knowledge about correct citing of different bibliographical sources and literature.

6   Efficiency assessment

The combination of multimedia elements was considered as very efficient in achieving better understanding and learning results [16] [17]. The efficiency of this particular multimedia learning material was tested with encouraging results. Testing the efficiency was performed with evaluating results of two groups of students. First group acquired the required knowledge about the statistical methods and procedures within SPSS using the multimedia learning material. The second group of student attended frontal lectures presenting the same statistical methods and procedures. After certain period of time the students of both groups were invited to session where they have to solve some statistical problems by using SPSS. In the next session the new test was presented to the students of both groups. In this case the students worked without any teachers support. The test includes different, formerly presented (in multimedia learning material or by lectures), statistical methods and procedures within SPSS. The results show that students achieved better results if they use multimedia learning material. The difference is statistically significant at sig.:= 0.017 by the level of lower or equal than 0.05 [7].

Latter the multimedia learning material was tested to its influence in the processes of problem solving or reasoning strategies. The reasoning strategies in problem solving are cognitive steps in the processing and the application of acquired information toward finding one or more solutions. Results have shown that using of multimedia learning material have certain influence in stimulating more efficient problem solving by more successful application of reasoning strategies. Student

using multimedia learning material were more successful in application in 3 out of 4 reasoning strategies than students without these materials [18].

7   New design approach

Armed with the past experiences and encouraged with the initiative of the Rector of University of Maribor we prepare learning materials for entire course for student at the Faculty of Arts. Students from the special didactics disciplines can choose this elective course in the first year of postgraduate studies (2nd Bologna degree studies). Course is worth 3 ECTS which is 15 hr. lectures and 15 hr. laboratory work. The materials were also presented to other students:

- Students of general pedagogy used these learning materials as the design consideration for the creation of e-learning materials and evaluate their didactical values.
- Students of educational computer science from the Faculty of Natural Sciences and Mathematics used these learning materials from the two perspectives: (1) technical considerations, and (2) didactical consideration.

Learning materials were prepared with different consideration in mind. From the learning styles theory we have three learning modalities [19] [20]: visual, auditory, and tactile (kinesthetic). On the other hand VAK/VARK model expand previous categories and add reading-writing preference learners [21]. Therefore we tried to prepare learning materials explicitly in favor of each of these learning modalities. Visuals were covered with the text and video, auditory were covered with the audio and video narrated presentations, and tactile were covered with the full spectrum of multimedia learning objects and laboratory work. It is hard to prepare learning materials that would suit tactile learning modalities because everything exists in the virtual world therefore laboratory work is required and needed.

Preparing learning materials for students to check their preferences took three months during the summer time. At that time we were able to prepare the 6 lectures that used to take 90 minutes in the classroom and e-tests to see students' performance. Students who participate in this experiment attended the lectures in the classroom and then they got learning materials for the same lecture. Since they are used to get slides at all courses we changed this routine and prepare learning materials to include the additional elements around the slides. They got (1) text narrated slides (Figure 8), (2) audio narrated slides (Figure 9), (3) video narrated slides (Figure 10), and (4) multimedia learning materials (Figure 11). Each week they need to make a report about the learning materials. They need to specify the amount of time they need to study the materials and their impression about the learning materials.

7.1   Text narrated learning materials

Students' comments about the text narrated learning materials were in general very favorable and previously unknown. Time ranged for studying the material ranged

between 40 and 60 minutes (average 42 minutes). It would suggest that student were faster about one third it they study from this materials in comparison with the lecture in the classroom. In general students did not make any distinction between web site or PDF learning materials. Though web text narrated materials were completely new for them the PDF with PowerPoint slides were old. The text narrated slides in PDF were pleasant surprise and shows huge potential for the advancement of learning materials quality since they require no additional training and they are simple for production.

Figure 8. Text narrated slides

7.2   Audio narrated learning materials

Audio narrated learning materials take students more time to review (between 60 and 90 minutes). That is natural since they are limited with the speed of the speaker. Despite they were not used to have such learning materials they expressed mixed feelings. One student argued that speaker should speak faster. Another one argued that watching only few points and listen to the speaker for 5 minutes is easily distracted (carefully reading between the line suggest that learning materials are boring). On the other hand other students did not express any discontent with the learning materials and the experience for them was new and refreshing.

Figure 9. Audio narrated slides

7.3   Video narrated learning materials

Since we review video lectures and see the potential problems with the size of video we decide to put video onto the slides. Students have ability to minimize the video (hide it completely) on demand. Interestingly students did not use this function and one even argued that video covers the part of the slide. Latter in the discussion he admits that he misses the button "hide" completely.

Students use from 45 to 90 minutes with the peak in 75 minutes. That suggests that they did not watch the whole video for each slide. This does not contradict with our previous findings where student do not watch video lectures unless highly motivated. In general there are no ways to motivate students enough to watch whole videos.

Figure 10. Video narrated slides

7.4   Multimedia learning material

Equally to other learning materials types even multimedia learning material was produced with HTML5 technology. During the design process we want these materials to be good enough to be read even on 800x480 resolutions. It proved to be good enough for use on mobile devices. We could not influence the behavior of Internet Explorer on windows mobile devices which always plays video full screen. Therefore video narrated slides are not suitable for IE on mobile devices but it works flawlessly on Android.

Student use from 30 to 120 minutes for study these materials and on average 70 minutes. These time difference proves that students have different motivation in the study of learning materials. Some just read the text while other even watch educational videos and open URL addressed in the materials.
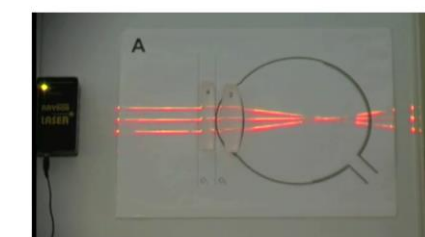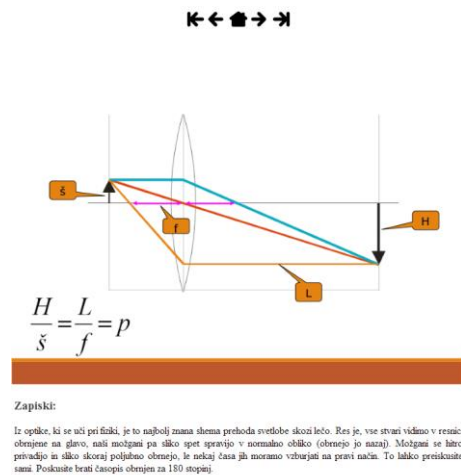

Figure 11. Multimedia learning materials

8   Analysis of students' response

When students were subjected to all types of the learning materials we have analytical discussion about those learning materials. After a debate they all agree that text narrated learning materials are more suitable for their way of studying and enables them the fastest study. Multimedia learning materials with included links and video (not lecturer recording) was the best for them. Video lectures and video narrated learning materials were most time consuming and less deviations were observed in their study requirements. Since students in this experiments were in the second degree study of special didactics disciplines they admit that watching the video lectures even highly structured proved to be difficult since they often find themselves in the state of daydreaming. The same thing happens in the classroom too but lecturer can detect students' fatigue and has the ability to make a necessary break with the distraction elements that wakes them up.

They use materials on the computer and dimensions (viewport) of learning material was appropriate and even when they have ability to check how material behave on mobile devices they were satisfied.

What should this tell us about video in the learning process? It is appropriate in some occasions but not always. From the perspective of the teachers video lectures do not necessarily make their work somehow easier. If they prepare slides probably the same amount of time may be used to make text narratives or recording and processing video lectures. Students in general prefer text and other types should be just accompanying materials.

The effect of high quality learning materials is also less attendance of students in the classroom. When students find out that almost all the required knowledge is available to them online they start skip lectures and eventually start skipping their regular study of the materials too. This inevitable lowers the students' performance since they are unable to study through all materials before the exam. Their sense of time and their discipline is not yet developed to the extent that they would be able to start study on time. They would always need few more days to get better grades.

9   Conclusion

We know how to prepare learning materials but it cannot be done in our free time. It is much too time consuming to do it. As long as there are not satisfactory evaluation of the additional workload (*lecturers workload is assessed only by the time they spend in the classroom*) no additional learning materials will be prepared. Lecturers who prepare such learning materials will not be subjected to additional tradeoffs since they are no longer needed in the classroom and should do some additional work. Video lectures are the alternatives for the students that miss the lectures. Even teachers who have required skills to prepare such e-learning materials are aware that e-learning materials cannot substitute reality and should be used as alternative (secondary) source for knowledge acquisition [22]. But

has also drawback since good learning materials inevitable lowers the classroom attendance. Students who attend the lectures will be much better with the multimedia learning materials prepared in blended learning paradigm. Seeing into the near future we advise designers to prepare learning materials for mobile devices. Such materials would look good on computers anyway but will suits two different worlds that coexist today. For the success of the study only high quality learning materials are not enough. A strict schedule of study must be enforced otherwise students would lost themselves in their inability of enforcing their own study discipline.

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