Analysis of learning by doing in the creation of instructional video in teaching optics

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Abstract – It is well known that videos in education have some advantages in specific areas. We have made the experiment to see the effect of video in physics education. Our goal was to see if short video clips can improve understanding of physics – optics. In our experiment we wanted to test the principle “learning by doing” with the specific emphasis on creativity. Students were divided into two separate groups with the same assignment. First group was to prepare a video without any additional instruction from lecturer but they were not limited by any other means. The second group was further divided into two teams. Both teams got the same instruction how to create educational video clips. The difference between these two teams was that one team was given the detailed analysis of previously created bad educational video on the same topic while the other did not. Since creativity cannot be though and has to come from the individuals own inspiration we wanted to know if too many instructions actually influence the outcome of the students’ performance.

I. INTRODUCTION

Instructional video is relatively new in education although it was first used in World War II. In distance education we have years of experience with the e-learning materials production. Only in the last few years recordings of lectures on the web becomes feasible [1]. Never the less e-materials are undoubtedly on the raise, enhancing many of their advantages and minimizing disadvantages (like burdening the eyes). But there is still an open problem of reliability of information if they are not reviewed [2]. Furthermore e-learning materials are useful addition to the educational process. If used appropriately they can help improve students’ understanding of the basic concepts of natural sciences [3].

At the Faculty of Natural Sciences and Mathematics all students of special didactics study programs have ICT course. This course prepares them for the various applicapion of ICT in education.

In the past research it was shown that the use of instructional video brings only minor improvements in students’ knowledge but its other value is tremendous [1][4]. They proved that the instructional video is very good for skill training [1]. But making of the instructional video is very time consuming. If there are no evaluation of the additional workload, teachers will not prepare any additional instructional videos [5]. This fact is neglected in our educational institutions and is actually quite a shame because e-learning materials are interesting addition to the learning process, in particular for natural sciences [6].

We have to emphasise that instructional videos cannot substitute lectures and should only be used as a secondary source of knowledge. Not only instructional videos but all e-learning materials have some drawbacks. If they are (too) good they lower the classroom attendance [5]. Anyway, the student population is not entirely uniform and it is shown many times that older the students are less they are familiar with the technology and more they are conservative in their preferences [7]. But new generations are more ICT literate and they will demand more, high quality instructional videos and e-learning materials in general.

II. INSTRUCTIONS FOR MAKING A INSTRUCTIONAL VIDEO

With optical set from a seller nT-BROG students were to prepare instructional videos that will help understand optics. Video is not meant to substitute the experiment, but should be consider as its supplement. Video is meant to help learners to refresh their knowledge gained somewhere else (in the school at physics lessons or physic courses – summer schools, etc.)

Though instructional video looks simple on the design paper its actual production requires many skills. Light consideration is the one that cannot be dismissed in video recording for good visibility and reflection issues. Viewers of the experiment need to get good impression of the surroundings of the experiment and scale. To prevent video shaking a tripod should be used. These are only technical consideration in the video recording. The other considerations are also highly important – aesthetic aspect. No matter what kind of learning materials is prepared it needs to be aesthetically pleased and didactically suitable. [1] [2]. To be didactically suitable the physics experiment must be easy to understand with the clear intention for the viewer. Focus of the video is experiment and not the preparation of the experiment even if it may be considered highly important for teachers who want to prepare the same experiment. Though sound is not important in the video of the experiment it is not uncommon to prepare suitable sound background or audio narration if this is feasible. For the real universal video learning materials (hearing impaired people too) all elements should be visual. Textual of image explanations are therefore necessary in such educational video. If video is further processes it is possible to include subtitles. From the users perspective subtitles can be turned on and off and even
switched between different languages. This would enable to produce multilingual learning materials. Any text, schemas and images used in video should be verified by the experts who know the experiments thoroughly.

Students get the following assignments for the video production:

- Concave mirror,
- Convex mirror,
- Mirror 1,
- Lens 1,
- Lens 2,
- Lens 3,
- Lens 5,
- Lens 6,
- Lens 7,
- Lens 8,
- Refraction of light,
- Reflection of light,
- Model of a healthy eye,
- Model of short-sighted eye (+correction),
- Model of far-sighted eye (+correction).

Student also receive additional instructions that video should be interesting for the learners and that all exposed parts of the body that are recorded on the video should have not jewellery or tattoos. Audio background should match the scene of the video, be neutral to the viewer, and obey the copyright restrictions.

III. METODOLOGY

In our case we prepare single case study. We analysed videos that were made by the students of previously described groups. In the analysis we exposed the good and the bad issues in the instructional videos. But to make things more interesting we compare our result with the instructional video made from the interdisciplinary group of students from physics and computer science who have different instruction but the same outcome. Their goal was to make instructional video for students competition and that was all they were instructed. The topics, approach and implementation was entirely up to them.

IV. INSTRUCTIONAL VIDEO

First group that had no instructions how to make a video generally made bad instructional videos. Their videos were shaky, experiment was not in centre of video, and hand that moved the lenses and mirrors is considered the nuisance (fig. 1 and 2). Though students today have sufficient ICT knowledge and are considered highly innovative their video were dull and provide no viewers appealing.

The second group got more instructions how to prepare instructional video. But for this experiment we divide them into two subgroups. First subgroup did not see videos (from other groups) and receive analytical view what is considered good and bad instructional video, while the second subgroup does. As expected the subgroup that has instruction and sees video from other groups made the best instructional video. Room in which they filmed videos was darker than room from the first subgroup. Darker room exposed the contrast between laser and white blackboard in the background but the scale is still visible. They used a scale and showed the point where the rays meet (focus) but they did not show that the lens is at the base of a scale (fig. 3). Unfortunately the reflection of cameraman is seen on the video (fig. 4).

Fig. 1: Example of a bad instructional video.

Fig. 2: Blurry image due to quick movement of a camera.

Fig. 3: Scale was used. Images tend to be black and white. Room is darker but you can still see the scale – that way contrast between background and laser is better. Sadly it was not shown that lens is at the base of a scale. From this image you cannot identify the focal length of a lens.
The best videos made the team from the second group that saw bad videos from the first group. They got the chance to see and correct all the mistakes of the first group. It turn out that they took their chance to improve flaws of the first group. They also made better videos then the other team of the second group. For example they showed that the centre of a lens was at the base of the scale and enable viewer to determine focal length of a lens. Table 1 shows us bad and good activity in instructional video production.

<table>
<thead>
<tr>
<th>BAD</th>
<th>GOOD</th>
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<tbody>
<tr>
<td>shaky videos</td>
<td>use a tripod</td>
</tr>
<tr>
<td>recording room in which you are making videos</td>
<td>experiment in centre of a video</td>
</tr>
<tr>
<td>kitschy transitions</td>
<td>neutral music</td>
</tr>
<tr>
<td>to dark or to bright videos</td>
<td>there should be just enough light that scale is visible but not too much so that there is a good contrast between laser and background</td>
</tr>
<tr>
<td>video substituting the experiment</td>
<td>appealing videos so that students are motivated to watch it at home – that way they refresh their acquired knowledge</td>
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V. INTERDISCIPLINARY TEAM

We also analysed one older video which was made by five students. Two of them were physicists, the other three were computer science teachers. They made very good instructional video on optics. Not only did they use video but they included animations (fig 5). Animations are unrealistic but they are very pure and minimalistic. In real world video it is often very difficult to expose everything but animations can be prepared in sterile environment and easily achieve that. In video they included nice neutral music. The transitions between inscriptions, animations and experiments are not too aggressive; and experiments were all in the centre of the video.

Fig. 4: Entry angle and reflective angle are nicely visible but there should be no shadow of camera operator.

Though they were not given any instructions for their work they prepare good instruction video. This may contradicts our findings that students will make better instructional video if they are given instructions. But we must not forget few vital things they had. They knew that their product is going to be for the competition, and they were highly motivated because they know the prize they can achieve in the competition. In general such high motivation is hard to achieve between students and it is also true that students know they can get different grades for their work. Some of them see no need to score the highest grade. This does not contradict with the findings that not all students are suitable to participate in different projects.

VI. CONCLUSION

In this article we presented the results of research made between students of physics. Now it is evident that instructions do not kill the inventiveness. We showed that student would make better instructional videos when they are provided with good and extensive instructions. But there are some experiences that come only with time and practice. One who has more of them will make better instructional videos. And at the end we would really like to emphasize the effect of motivation on the quality of the product.

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