

# HOW CAN VIDEOS HELP ACHIEVE EDUCATIONAL OBJECTIVES?

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## Abstract

The current study investigated which characteristics of educational videos influence the accomplishment of educational objectives. To evaluate educational applicability, four videos in high school biology were chosen based on specific criteria. Data were collected by focus group interviews among 25 high school students. The results of the study demonstrated that students can be categorized basically into two groups according to their learning styles: visual learners and auditory learners. Supportive titles on screen helped students memorize information. Quick motion of frames rather reduced memorizing but, at the same time, did not have a significant effect.

Keywords: educational video, improving classroom teaching, high school biology.

## 1 INTRODUCTION

In recent years, videos have played an important role in education. Educational videos help increase student engagement and facilitate deep learning [1]. On the other hand, creating educational videos is a demanding process. It requires selecting appropriate words and images, arranging them into coherent verbal and pictorial ways, and integrating the verbal and the pictorial representations with prior knowledge [2]. Although the technological development has been fast, still little is known on how educational videos work effectively in a classroom.

The manner in which individuals select or are inclined to approach a learning situation has an effect on performance and the achievement of learning outcomes [3]. There are a vast number of theoretical explanations, models, and measures about learning styles. For example, the dual coding theory states that there are two classes of phenomena that are handled cognitively in separate subsystems: one is specialized for dealing with objects, and the other, with language [4, 5]. The verbalizer-imager dimension of learning describes how people represent information during recall. Verbalizers are prone to remember information in words, and imagers, in pictorial form [6]. Therefore, relevant terms should be presented both in visual and in printed form so that the learners can choose the format that suits best with their learning preferences [7].

Learning preference is also connected to how people notice information. By “noticing” we mean what is important or noteworthy of educational videos for high school students: what catches students’ attention and what they miss after watching the videos [8].

Videos are an effective way to use the auditory and the visual channels of perception for learning. On the other hand, the information on screen is full of details, and there is a risk for cognitive overload. Human beings are able to process only a small amount of information at any one time [9]. Presenting too many elements at the same time may lead to overload and to some elements not being processed [10].

The overload of elements that need to be processed in watching an educational video can be interpreted on the basis of two theories: cognitive load theory [11] and cognitive theory of multimedia learning [12]. The theories state that our working memory is a limited resource and that learning is not effective if it exceeds human cognitive capacity. Therefore, in order to learn more effectively, the cognitive load should be optimal. Since people’s perception styles can be very different, the editorial decisions about the optimal amount of information in educational videos are even more difficult. In some cases, students’ cognitive overload is caused not by the amount of information but by the pace and the rhythms of the video clip.

In creating educational videos, how we present the information is important to ensure the optimal cognitive load of students and to allow information transfer through objects and language in order to support learning according to Paivio’s dual coding theory [5]. For example, if the auditory component of an educational video is too complex, it may overload working memory [9]. There are some techniques to reduce auditory cognitive load: remove extraneous sounds and words (coherence principle), use words as narration rather than as on-screen text (modality principle), and present the

narrative simultaneously with corresponding animation rather than continuously (temporal contiguity principle) [13]. Bishop et al. [14] found that sound and music hold a learner's attention, but they do not have effect on learning. A considerably great amount of information may lead to an opposite effect: students do not notice the necessary elements or remember the necessary information.

There are some other ways to reduce cognitive load. In order to avoid any load on working memory, information presented to learners should be structured [15, 16], and videos should be directly related to the concept [17]. On-screen text is an effective way to remember information. Adesope and Nesbit [18] found that on-screen text with key terms from narration is better for learning than on-screen text that is exactly the same as narration. At the same time, Yue et al. [19] suggest that for better learning, videos should have limited on-screen captions.

Special attention should be paid to novices: adding irrelevant material can be particularly damaging for individuals with low working memory capacity [20]. For example, redundant elements should be removed from the animation, but in order to direct learners' attention to specific parts, the appropriate on-screen texts or graphic devices should be added [21]. In this way, students remember the information better.

The current study investigates how the characteristics of audiovisual materials influence what students notice and remember from videos and how different videos can be used in the learning process.

We hypothesized that videos with titles on screen would help students memorize information and that animations work better for students to understand abstract processes in biology. The main reasons to decrease learning and understanding of the topic would be swapping the frames and lack of abridged and supportive texts.

## **2 METHODS**

In this study, a qualitative research approach was selected in order to analyze students' learning from videos in depth and to discover new ideas for the subsequent studies. Twenty-five voluntary high school students in four groups participated in the data collection. They were 17 to 18 years old and from five different high schools in Tartu area, Estonia.

### **2.1 Procedure**

In a focus group, four to eight students watched two videos. Two groups watched the videos "Young People about Sexually Transmitted Diseases" (8 students) and "Respiration" (9 students), two other groups watched the videos "Psychologist about Eating Disorders" (16 students) and "Quality of Germ Cells" (16 students). Videos were presented on a wide screen or computer. After watching one video, students had five minutes to write down what they saw and heard. Then they participated in a group interview that was conducted by one of the authors of the article. The following questions were asked: (a) What did you see? (b) What did you hear? (c) What was the video about in general? (d) What was in titles of the video? (e) How did the video start and end? (f) What do you think about the video? (g) What did you like in the video? (h) Did you notice anything else in the video that we have not talked about yet? In an interview, pupils could express their opinions using, at the same time, notes on a paper. The interviewee tried to keep students on a theme, asked clarifying questions, and reflected back what the participants said. Focus group interviews lasted for 15–20 minutes. The interview was videotaped with camera for later analysis.

### **2.2 Videos**

The four videos used in the current study were selected from a set of 19 videos that support the national curriculum of high school biology (see Fig. 1). The set of videos that was developed by the workgroup also belongs to the authors of the article. In the process of production of the videos, it was concentrated on scientific content, and any element that might distract learners' attention (e.g., music) was avoided.



Fig. 1. Screenshots of videos. (a) “Young People about Sexually Transmitted Diseases” shown in two-shot. (b) “Respiration”—an expert speaking with an activity on the background. (c) “Psychologist about Eating Disorders”—synchronously with speech tags appearing on a screen. (d) “Quality of Germ Cells”—a screenshot of embryo containing visual effects.

Selected videos varied from each other by quality of sound and images, style of editing, and presence of animation and of keywords on titles that support the audiovisual text. The length of the videos ranges from four to seven minutes in order to keep students’ attention.

All the videos have similar “envelope”—in the beginning, a professor sets the problem, and in the end, the same professor makes a conclusion and suggests further learning actions.

The video “Young People about Sexually Transmitted Diseases” (length: 4:21) is based on a lecture given by two medical students. They are shown in two-shot and in individual close-up; no cut-away shots, titles on-screen keywords, intertitles or animations added. The synchronous sound is recorded with individual lapel microphones. The video has some audio problems in the end because the microphone used by one of the students felt off.

The video “Respiration” (length: 4:23) is a journalistic feature explaining the human respiratory system. The narrator is shown in long shot and medium long shot with some sportsmen on the background; some of the narrator’s texts are covered with cut-away shots of young athletes and an animation. The expert interview is partially shown in medium shot, partially covered with cutaway shots of different actions. The video is edited in dynamic style. No tags or intertitles are added.

The video “Psychologist about Eating Disorders” (length: 6:51) is a lecture given by a psychologist about bulimia and anorexia. Questions are represented in the form of intertitles on a black background. Synchronously with the psychologist’s speech, informative tags appeared on the screen. No cut-away shots or animations were used.

The video “Quality of Germ Cells” (length: 6:18) is a slow-pace journalistic feature with two interviews: one with an embryologist and another with a biologist who explained the main factors affecting germ cells. The video contains shots of embryos and sperms filmed under a microscope. Some intertitles and special visual effects are used to emphasize relevant information. One of the expert interviews is slightly underexposed.

## 2.3 Data Analysis

An inductive thematic content analysis was used to analyze the data [22]. All the focus group recordings were transcribed and read several times by two researchers who also had access to the students’ notes on paper. Comparing the texts written individually and the transcriptions of the focus groups we found that individual reflection on paper was more versatile and informative than oral communication in the focus group. At this point a decision was made to use written reflection as a primary source of information and treat the focus group interviews as a secondary source for

confirming the primary findings. After identifying emergent themes we proceeded to categorize them into clusters. Finally, a summary table of the structured themes was made.

We categorized the information on papers into three categories: (1) what did students see, (2) what did they hear and, (3) what opinions or judgments did they express. The analysis process was two-staged. First, the categorized information was read several times to mark concepts and key themes. Second, we specified individuals, objects and activities that students noticed for analysis.

### **3 RESULTS**

The aim of the current study was to investigate how the characteristics of audiovisual materials influence what students notice and remember from educational videos and how different videos can be used in the learning process. Therefore, we analyzed four different videos, paying attention to individuals, objects, and activities that students had noticed in the videos.

Most of the information was passed in an auditory way in the video clip “Young People about Sexually Transmitted Diseases.” As for the visual part, young people were shown in two-shot and in individual close-up. Although visual side and activities were monotonous as respondents marked in their spontaneous written reflection, it obviously did not impair receiving the information in the short-term memory. Information transmitted in the videos was remembered in the time of writing rather precisely, although the memorized information was, among eight respondents, to a certain extent different. It should be noted that the main resources talked in this video monotonously; it seemed as if they would read the text from a paper—two respondents marked the matter, and one of the respondents expressed an opinion that people only pretended that they read a text from a paper.

In the video “Respiration,” students identified people not by their names but by their roles and activities. Using experts did not impress the students. The students noticed activities pretty well. Three of nine respondents did not point out any visual information or describe any visual picture. The rest of the respondents wrote down at least some visual elements (e.g., an animation, people in different activities). For example, one replier (nr 6) marked out seven people and nine activities and described individuals and animation.

In answering the question “What did you hear?” students took into account the content, and the answer was not perception based. There was one exception where a replier pointed out that the speed of talking was too fast. The respondents did not distinguish the texts of a narrator, source, and background sound but wrote down what they remembered. The students used judgment several times. Some texts were named as “scientific”; for example, the text of a narrator was not scientific, but at the same time, the text of an expert was scientific.

It is hard to distinguish what kind of information is accepted by visual and auditory channel in the video “Psychologist about Eating Disorders.” Respondents pointed out concepts and rather exact definitions. Most of the keywords in the titles redounded in the detailed answers of the respondents.

In the video “Quality of Germ Cells,” 6 of 16 students marked that there were two people who were described as a man and a woman, embryologist and biologist. To compare this with other videos, in a research in spontaneous feedback, quality of picture was marked as unsatisfactory. Unsatisfying was also a matter that the oral speech of one source came across doubtful (female embryologist); the other (male biologist) seemed too peaceful and therefore did not excite interest. Video clips were watched one by one, and the counteraction appeared: students wanted to see the same keywords in the latter shots as they had seen in previous shots.

### **4 DISCUSSION**

In the current study, several characteristics were found describing effective and not effective educational videos. In the video about sexually transmitted diseases, the auditory element prevailed over the visual element. It revealed that students remembered the information rather well. The finding supports the dual coding theory: people process information either in a visual or in an auditory way [4].

Because the information is processed in different channels, it is possible to learn using both channels at the same time. Multimedia learning principle supports the last statement: learning is deeper from words and pictures than from words alone [2]. This last statement supports what we found in a video where a psychologist talked about eating disorders. At the same time, the psychologist’s speech abridged texts on a screen were noticed rather well: respondents brought out quite exact concepts

and definitions. Yue and Bjork [19] pointed out that students prefer on-screen texts because they are effective for learning. It is also useful to present the words both in printed and in spoken form so that students can choose the learning format that suits best with their learning style.

Students noticed the animation rather well and described the process they had seen and heard (video “Respiration”), synchronously with the speech words that appeared on a screen. It supports the statement of Betrancourt [21]: in order to focus students’ attention to the features, an animation should contain devices guiding students’ attention to them.

In the video “Respiration,” in which the visual part was prevailing over the auditory, three of nine students did not mention any visual information. These people probably use auditory channel for learning and therefore need more information presented in an auditory way. At the same time, students noticed the activities rather well. Although there were many shots in a video, still the answers were content based. It seemed that a variety of shots, activities, and people did not reduce the auditory reception importantly, but to compare with the video “Young People about Sexually Transmitted Diseases,” a slight difference was noticed.

In some cases, it is useful to show people in their roles and activities (e.g., in the videos “Respiration” and “Quality of Germ Cells”). In the current study, students noticed people and their roles rather well. It supports the author visibility principle: if students can see people personally involved in a video, learning is more successful [17].

## 5 CONCLUSIONS

To conclude, we can say that the way we present information in educational videos has a significant effect on what students remember and notice from videos.

Based on the analysis of the data, four recommendations can be done for creating effective educational videos: (1) The information should be presented both in a visual and in an auditory way because some students notice better visual, and the others auditory elements. (2) Titles on screen texts are an effective way to remember information because there are students who prefer information presented whether in a visual or in an auditory way. (3) Videos should have minimal number of elements in order to keep students’ attention and the aim to notice and remember relevant information. (4) Animations are an effective way to teach abstract processes. To make the animations more understandable, on-screen texts or necessary references should be included.

These recommendations should be still taken with some caution because of some limitations in the current study. First, how students’ content knowledge improved was not assessed. Second, in this study, only a short-term effect of memorizing information was measured. Third, this study was conducted as an explorative study on the small sample of voluntary students. Therefore, further investigations are necessary to test the effect of using educational videos.

## ACKNOWLEDGMENTS

This research was supported by the European Union through the European Regional Development Fund. It is financed in the project “Conceptual Framework for Increasing Society’s Commitment in ICT: Approaches in General and Higher Education for Motivating ICT-Related Career Choices and Improving Competences for Applying and Developing ICT” (<http://ict.ut.ee/>). The videos applied in this study were produced in the context of a project Biodigi (<http://www.biodigi.edu.ee/>), financed by the European Social Fund. We would like to thank the students who participated as respondents and the teachers who helped organize the focus group meetings.

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