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EDUCATIONAL SHORT VIDEOS TO UTILIZE IN THE BIOCHEMISTRY LABORATORY: OPINIONS OF UNIVERSITY STUDENTS

Melis Arzu Uyulgan,
Nalan Akkuzu

Abstract. *This research aimed to reveal the opinions of the university students who conducted original educational videos context for the experiments in the Biochemistry laboratory course. Participants were fourth year students (N=40) of the Mathematics and Science Education Department, in Chemistry Education Program. A case study was used and carried out during the Spring term of 2014 at the Faculty of Education of Dokuz Eylul University in Izmir, Turkey. The students designed and took participation in educational short videos. Besides, each group students prepared poster presentations of their video at the end of the 14-week implementation process. To collect data, semi-structured interviews were used. The interview results of the research showed that learning was more meaningful and valid through this laboratory course because the students attended the course with interest and favor and motivated positively. Eventually, the educational short videos can be a powerful convincing learning tool for students.*

Keywords: *active learning, educational short video, biochemistry laboratory, multimedia learning, science education.*

Melis Arzu Uyulgan, Nalan Akkuzu
Dokuz Eylul University, Turkey

Introduction

Utilizing of educational video, audio, overhead projectors, television and computer programs has reached the end of the 20th century and today's world, and the most important development that affects the quality and development of educational institutions is visual, audio, computer, internet and related technologies. The most important issue of the present century, education-integrated technological developments in general, has influenced education and has become an indispensable part of any educational innovation. Educational technologies and technological materials, which have now been in use for many years, serve many important purposes in the educational system (Alavi & Gallupe, 2003). These include facilitating individuals' learning, enhancing communication between individuals and providing extensive audiovisual input in the learning environment (Kaya, 2006). In addition to reading and writing, seeing and hearing play a significant role in learning as well. Using multiple senses in the learning environment allows for in-depth learning (Mayer & Moreno, 2002; Pekdag, 2010).

Multimedia learning promotes student understanding by mixing words and pictures. Learners construct meaningful internal representations through the multimedia learning which primes and guides active cognitive processing in learners. Jonassen, Peck, and Wilson (1999) assert that technologies such as video theater, cybermentoring, creating homepages, and hypermedia can support the construing of meaning by students, but this can happen only if students learn with technology, not from it. When active learning occurs, students can achieve meaningful learning. In this engaged process students pay attention to relevant incoming words and pictures, mentally integrate them with each other and with prior knowledge (Mayer, 2001; Wittrock, 1990).

Use of Educational Technology and Technological Materials in Learning Process

The integration of educational technology and technological materials, as well as the previous experiences of students, into the educational process facilitates the learning of abstract concepts (Eilks, Rauch, Ralle, & Hofstein, 2013). The use of technological materials (animation, video, film, power point presentations, etc.) containing audiovisual elements in the educational pro-

cess saves time and simultaneously allows for meaningful learning. It is possible to promote interaction between different aspects of the students' intelligence (Berk, 2009; Gardner, 2000; Veenema & Gardner, 1996). Students' interest and enthusiasm in the subject may also be increased by using visual materials (Bluma, Klincare, & Blums, 2010; Serra & Arroio, 2008). In addition, the use of such educational technology is useful in improving students' motivation and interest in the course and facilitating their learning (Weiss, Knowlton, & Morrison, 2002). Using this technology more often breaks the monotony of using board and book and offers students different ways to learn (Akbaş, Canoglu, & Ceylan, 2015; Ispir, Furkan, & Çitil, 2007). Nowadays, instead of the students who only understand by listening in the teaching activities, students who are actively participating in class at the university, asking questions, researching some topics with their own plans and techniques, systematizing and organizing what they find, comparing, observing, thinking and concluding and participating in the lesson are demanded. The use of materials in education plays an important role in achieving the success of the program, by making it easier for students to reach the foreseen goals by preparing an effective educational environment. For this reason, teaching should be based on the newest educational technology and appropriate tools and material at the forefront (Howe & Jones, 1998).

Educational Videos as Technological Materials in Education

Among the most interesting and intriguing materials which can be used in education are educational videos (Ioannidis, Garyfallidou, & Spiliotopoulou-Papantoniou, 2005). Educational videos are used as resources to provide students with new information (Duffy, 2009). Bruner (1999) describes them as educational learning tools which enrich the learning environment and serve as a guide to recognizing facts or ideas. The emergence of educational videos and their use in teaching dates back to 1950s in the rest of the world and in Turkey (Akbaş, 2011). Following the successful results obtained, the use of videos in education became increasingly widespread in the following years. But later, the use of educational videos gradually declined due to a lack of cooperation between teachers and video makers in the production of videos and teachers' inability to use them in classes in an efficient and effective manner (Cuban, 1986). Educational videos can be used to provide students with perceptual, classificatory, inquiry and problem-solving skills. In addition, educational videos are informative and lead students to think creatively. Arroio (2007) refers that by showing a video, not only the content is transmitted, but also experiences of all kinds, such as emotions, feelings, attitudes and knowledge. Berk (2009) states that the use of educational videos in the learning environment has several benefits, such as increasing students' interest in the course, enhancing existing knowledge, improving comprehension, exciting and motivating students, making learning fun and ensuring permanent learning. Bluma et al. (2010) investigated the effect of the use of educational videos in university physics on students' learning. They found that the educational videos were a good information source in teaching physical processes and theories and that they promoted active learning.

As a result of the enhanced communication that comes with the increasing use of technology, individuals have become active producers and sharers of videos and films rather than mere consumers. It has become much easier than in the past to access these videos and films (Duffy, 2009). Kaya (2006) suggested that students could design audiovisual materials together with their teachers, and that these could be used in classes if there was an absence of appropriate educational videos, television programs or auditory materials. He also stated that being involved in this production process would benefit students. Akbaş (2011) found that the use of educational short videos prepared by prospective teachers was useful in that the activity was application-oriented; the videos were able to answer the question 'How?' and developed students' awareness about specific issues. In another research, Akbaş et al. (2015) highlighted that videos prepared by prospective teachers were useful with regard to many aspects, such as planning and implementing learning activities, and reflecting on and explaining experiences.

Studies have reported that educational videos support the printed materials used in teaching such as journals and books (Akbaş, 2011; Rackaway, 2012). Moreover, educational videos may be used to provide preliminary information (Michel, Roebers, & Schneider, 2007). Studies on the use of educational videos show that they have positive effects on learning. Furthermore, they are effective in allowing students to visualize and interpret scientific concepts (Barnett et al. 2006). Arroio (2011) refers that the use of audiovisual language in science education enables more effective communication and increases students' motivation and interest in the course. In his research, Koç (2011) had prospective teachers prepare educational videos in groups and analyzed these videos. From the result of his research, the prospective teachers improved their motivation, learning, empathy, and sense of professional identity. Akbaş et al. (2015) evaluated 47 videos from ten different universities taking part in the National Instruc-

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tional Short Video Contest. They found that the videos were effective in terms of the use of audiovisual elements, focusing on the target audience and the selection and presentation of content.

Research Focus

Educational videos are also among the technology educational tools preferred in chemistry education (Cruse, 2011; Goll & Woods, 1999; Harwood & McMahon, 1997; Pekdag & Le Maréchal, 2010). They are used at any point of the instructional process: support teaching, allow for a phenomenon, event or concept to be discussed, enable students to visually represent the subject better and ensure that meaningful learning takes place (Cruse, 2011). In their research, Pekdag and Le Maréchal (2010) found that the use of educational videos in chemistry education was effective in terms of ensuring a student-centred learning approach and providing students with an environment in which they could work together. Since most chemical concepts are abstract, using such technological tools facilitates teaching of new concepts. Moreover, presenting experimental operations visually allows for efficient use of time in chemistry teaching (Kennepohl, 2001). Bolte, Streller, and Hofstein (2013) noted, in their research carried out with high school students, that the students enjoyed watching videos related to the subject after carrying out experiments in the chemistry course. Erkoç et al. (2013) suggested that using audiovisual materials such as videos, slides, animations and virtual laboratory applications in the Biochemistry Laboratory was quite effective. Christensson and Sjöström (2014) examined videos containing an educational internet resource called *The Chemistry Calendar* in their research and found these videos to be original and useful for contextual learning in chemistry education.

In light of these studies, it can be understood that it is essential to utilize the technological educational activities such as videos and posters in order to promote meaningful learning and to plan instruction accordingly. So, it is possible to make a connection between theory and practice with the help of alternative ways of thinking. Additionally, they enable students to demonstrate their performances since they attempt to create a final product in this process. So, in this study the authors wish to foster an awareness of the role of the educational technological activities regarding biochemistry laboratory experiments. Developing such an awareness may be useful for educators in structuring their teaching more productively.

Aim and Research Questions

This research aimed to have university students prepare original technologic educational activities such as videos and posters related to experiments within the scope of the Biochemistry Laboratory course over the period of one semester and to reveal the students' opinions in the laboratory course taught through these activities. For this purpose, the research sought to answer the following questions:

1) What are the opinions of the students about the contributions of the activities which they carried out?
2) What are the opinions of the students about the difficulties which they experienced while carrying out these activities?
3) What are the opinions of the students about the learning biochemistry experiments carried out with these activities?
4) What are the opinions of the students about the activities which they engaged in?

Methodology of Research

Research Design

Taking the aim of the research and research questions into account, the qualitative interview study was performed in the Faculty of Education at the Dokuz Eylul University, a state university in Izmir, Turkey. In order to enable the exploration of details on how the students think about the active learning activities (educational short videos and posters) engaged in during the Biochemistry laboratory course, exploratory case study was preferred. This type of case study is used to examine situations where the intervention is not clear and does not contain a single set of results (Yin, 2009). The case analyzed in this research was the determination and

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evaluation of student opinions about the Biochemistry Laboratory course conducted using the active learning activities. The procedure was carried out in the Spring academic term because the students can only take the Biochemistry laboratory course at that term. The participations included all students who took this course during this time period and they designed and produced educational short videos and posters. Within the scope of the research, the students prepared a video and a poster for their experiments in groupwork. In addition, after an experiment was carried out in the laboratory, the video and the poster of this experiment were presented to the whole of the class. After a total of 5 experiments were completed in this way, face-to-face interviews were conducted with each participant student.

Sample

The participants were fourth year students (N=40) attending the Chemistry Education Program in the Department of Mathematics and Science Education. 57.5% of the participants (N=23) were female and 42.5% (N=17) were male. Their ages range from 21 to 23. The application was carried out in the laboratory environment and the students participated in the application on a voluntary basis. For this reason, the students were informed from the start about the purpose and scope of the research and the process began when informed consent was obtained from all individual participants included in the research.

Procedure

Application Process of the Active Learning Activities

The research took a total of 14 weeks in the Spring academic term of 2014 including carrying out the experiments and the educational short videos. At the end of the 14-week process, each group prepared posters for their video to be presented during the course. Through the poster presentations in the research, it was aimed to deepen the knowledge related to the subjects in the experiments and reinforce the learning. The process of application was shown in detail in Table 1.

Table 1. The process of application of the active learning activities.

Duration	Process of application
1 week	• The students were informed about the scope and the purpose of the research and the educational short video activity. • The students were divided into 5 groups of 8. • Each group was given one experiment to be conducted during the semester.
2 weeks	• The groups were given two weeks to carry out research on the experiment. • The students created short video scenarios related to the experiment based on their research.
1 week	• The scenarios created by the students were reviewed and edited under the supervision of the researchers.
10 weeks	• The students conducted each experiment in the laboratory environment within two-week periods (5 experiments x 2 weeks). • In this period, all the students conducted the experiment during the first week and the group which was preparing the educational video related to the experiment presented their work to their classmates and the researchers in the following week.

Production Process of the Educational Short Videos

Each student in the group participated in the production process for their video. The process consisted of eight steps. The steps followed in the process were shown in Figure 1.

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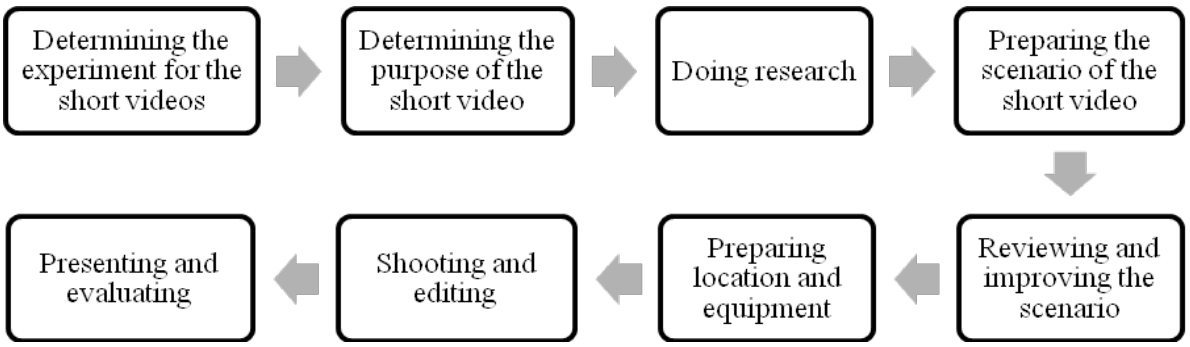

Figure 1: The production steps for the educational short videos.

For the experiments within the Biochemistry Laboratory course, the academic level of the students and their qualifications were taken into account. These experiments were as follows:

5) Separation of alkaloids by extraction: Obtaining nicotine from tobacco
6) Quantitative determination of sugars by the iodometric method
7) Extraction and saponification of milk lipids
8) Separation of plant pigments by column chromatography
9) Characterization of solid and liquid oils

The students' performance levels were determined according to the target behaviors of these experiments. The scenarios were edited in such a way that the concepts in the experiment would be relevant and interesting for the students. Under the guidance of the researchers, the students prepared scenarios covering the entire content of the experiment. The scenarios were reviewed and evaluated. The equipment, locations and actors necessary for the production of the short videos were provided entirely by the students. The students acted in their own short videos, which they also shot and edited. A total of five educational short videos were prepared related to the Biochemistry experiments included in the research. The videos were approximately 15-20 minutes long. They were produced under the guidance and in accordance with the opinions of two experts. In this way, the content validity of the educational short videos was ensured. In the videos, the students sometimes played characters, such as an anchorman, a housewife, a doctor, a farmer or a man in the street and sometimes played objects, such as a hydrogen atom, an organ (brain, stomach, etc.), a milk box or a plant pigment (chlorophyll, xanthophyll, etc.). The samples from the scenarios and screenshots of the videos prepared by the students are shown in the Appendix (see the Appendix).

Semi-structured Interviews

Semi-structured interviews were used in the research to collect data in order to reveal the opinions of the students about the active learning activities. The interview questions were prepared by the researchers in accordance with the purpose and the scope of the research. The questions were edited for language, wording and coherence by the instructor of Turkish language. The final semi-structured interview form included a total of four open-ended questions such as 'What do you think about the contributions of the activities which you have carried out?', 'What do you think about the difficulties which you have experienced while carrying out these activities?', 'What do you think about your learning with regard to Biochemistry experiments you have carried out with these activities?' and 'What do you think about the activities which you have engaged in?'. The layout of the form was followed sequentially during the interviews. Follow-up questions such as 'Why?' and 'How?' were asked during the interviews in addition to the questions on the form in order to obtain in-depth information about the students' opinions. The interviews were held individually with each student participating in the research and each interview took about 30-45 minutes. The interviews were recorded with a voice recorder after participants had given their verbal consent. The interviews were conducted in Turkish and the statements were translated into English by the authors. The interviews were then transcribed. Since the statements of the students were to be quoted directly in the findings section, the students were assigned codes, i.e. S_1, S_2, etc.

Data Analysis

The content analysis, which is a qualitative data analysis method, was used to analyze the data (Miles & Huberman, 1994). Among content analysis types, conceptual analysis was used in the research. The purpose of this type of content analysis is to identify the phenomenon in a conceptual form and to create a model of ideas. For analysis, the data were firstly transcribed into written documents. The interview documents were read several times in order to create and get a holistic understanding. An interview coding guide was developed by the researchers and main themes, categories and codes under these themes were determined. Considering the aim of the research, meaning units were identified from the statements of the students. After coding the meaning units, similar statements were re-ordered and collected under the relevant categories (Krippendorff, 2013; Patton, 2002). Table 2 shows examples of meaning units, codes, categories, and a theme.

Intercoder Reliability

The intercoder reliability was determined in order to analyze the reliability of the interview data. Two expert researchers coded the data independently to determine the intercoder reliability. The reliability calculation performed according to Miles and Huberman's agreement-disagreement formula showed that the intercoder reliability was 97.3%. This result indicates that the analysis performed in the research is reliable (Lombard, Snyder-Duch, & Bracken, 2002).

Table 2. Examples of meaning units, codes, categories, and a theme.

Theme	Contribution of activities			
Categories	Professional outcomes		Active learning	
Codes	Permanent learning	Technological material development	Intrinsic motivation	Creative thinking
Meaning units	Video work has improved ourselves and contributed a lot to us both in terms of learning the experiments and the concepts related to them and has been very useful in favor of permanence (S26-male)	I have never produced an educational video before, it was a first for me. I learned how to use setup programs on a computer (S24-female).	I was coming to lab reluctantly and without studying, however these activities completed my lack (S38-female).	The activities we did were the best works in the lab until this year. Those also greatly increased our creativity. We noticed the ores in ourselves (S4-female).

Results of Research

The interview analysis results were collected under one main theme as "Student opinions on using digital media in the biochemistry laboratory." This main theme was abstracted from four themes (Figure 2): "Contributions of the activities", "Difficulties of the activities", "The effects of the activities on learning", "Opinions on their own activities"

The Contributions of the Activities

The students mostly mentioned professional outcomes in relation to the short video activity and enhancing learning in relation to the poster activity. Permanent learning, technological material development and communication skills could also be given codes as they were topics also mentioned by the students under the professional outcomes. Some student statements related to these codes were as follows:

> In the short videos that we prepared in the Biochemistry Laboratory course, we learned about the properties of nicotine, metabolites and alkaloids in the video related to the nicotine, we learned about the properties and benefits of starch in the video related to starch, we learned about pigments in green-leaved plants and other plants giving color to plants in the video related to plant pigments and we learned about properties of saturated and unsaturated fatty acids and lipoproteins. We did this with animation while also having fun. [Permanent learning - S_{19}, female]

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> It's really difficult to make a short video. The most difficult part was to do it with lots of people. Of course, we received some help on the technical aspects of the task. But the fact that we produced everything was great. [Technological material development - S_{16}, female]
> We saw how talented our friends are. The laboratory course became more fun. I learned while having fun. We came to the laboratory wondering how the videos had turned out. Making a video was very challenging, but it was a nice activity. It allowed us to become closer to our friends and we were able to criticize each other, but with respect and care. [Communication skills - S_{18}, female]

It can be deduced from the students' statements that they both learned and had fun while preparing the videos and were able to share their experiences with their friends in an enjoyable way. This result shows that the educational short video activity may be useful in terms of constructivist learning. The students also stated that the activities fueled their curiosity, improved their motivation and increased their interest in the course.

Another important heading derived from the content analysis was active learning. The students made statements indicating that they had benefited from the activity in that it allowed them to share knowledge, led them to further research and enhanced their creative-thinking and self-regulation skills. Some of the students' statements related to these codes were as follows:

> The activities taught us to work together. We shared ideas and I had the pleasure of working in a group. My friends thought up details that I couldn't and together we put together a finished product. [Sharing the knowledge - S_{17}, female]
> Preparing a short video was a unique experience for us. We found out what creative and fun people we are! I believe the visuals added a specific aesthetic value to the course. [Creative thinking - S_{9}, female]
> I believe that conducting in-depth research about the subject, turning results into a scenario and producing a video using this scenario allowed us to learn in a fun way that will last. [Leading to research - S_{22}, male]

These statements revealed that taking an active role in the activities affected the students positively. Thanks to these activities, the students practiced important skills (such as collaboration) through group work rather than just conveying information; students engaged in activities (e.g. discussion, debate) aimed to promote higher-order thinking (such as critical thinking, analysis etc.). By stepping out of the 'conduct the experiment-prepare a report' mentality, we believe that the students were provided with different experiences and a more effective education in the laboratory environment. The most frequently mentioned theme in relation to the poster activity was enhancing learning. A sample student statement related to the theme was as follows:

> Our poster was a summary of our video in a way. However, we put much more information in compared to the video. We took photos of the work we had done. We learned to prepare posters. I think the visual display made a positive contribution to our learning. It is an impressive way to create something memorable, fun and unique. [Enhancing learning - S_{30}, female]

As can be understood from this student's statement, the poster activity allowed the students to enhance the knowledge gained from the educational short video activity. Also, the students gained experience in relation to the presentation of work as a poster.

The Difficulties which the Students Experienced while Carrying out the Activities

The students most frequently referred difficulty in relation to the activities performed in the Biochemistry Laboratory course was the preparation of materials. This main theme contained the codes of technical problems, problems related to the venue, decorations and costumes, scenario preparation and acting in relation to the educational short video activity, and material layout in relation to the poster. Some of the students' statements related to the theme of preparing materials and its codes were as follows:

> Since we wanted the scenario to be informative, funny and creative, and since we had no prior acting experience, we had difficulties related to acting in and shooting the video. [Scenario preparation and acting - S_{14}, female]
> Since it was our first time preparing a short video, we had difficulty with editing. In addition, we did a lot of thinking to come up with different ideas since this task required creativity. We watched other short videos as examples. But editing and creating a whole video were the most difficult parts. [Scenario preparation and technical problems - S_{24}, female]

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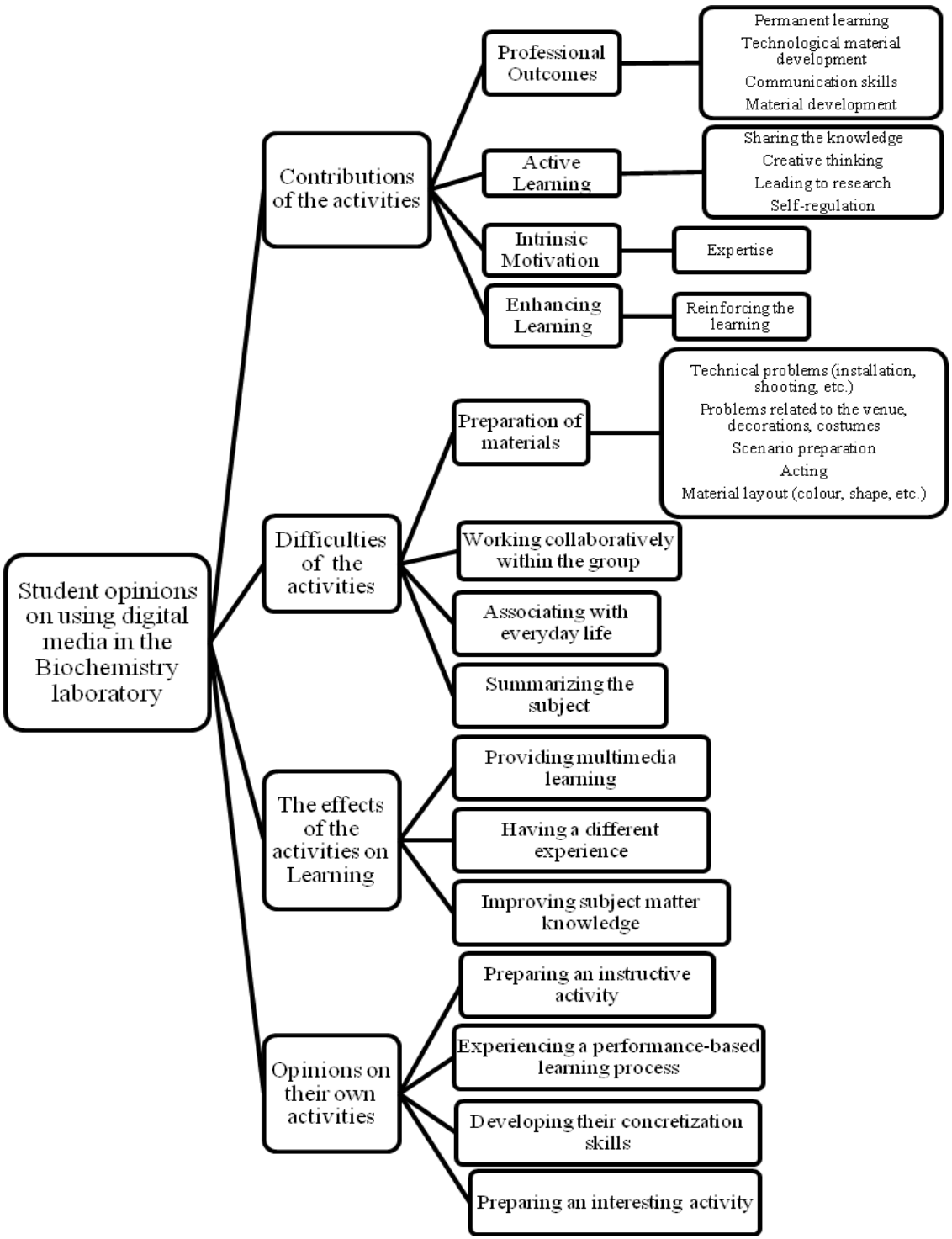

Figure 2: Overview of the results including the main theme, the themes, and the categories.

These statements disclosed that the students experienced certain problems when preparing their videos. They had difficulties especially in preparing an original, creative and fun scenario. In addition, the students encountered some difficulties during the making of the video as a whole.

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The statements also revealed themes such as relating the video to everyday life in the short video activity, summarizing the subject in relation to the poster activity and working in groups in relation to both activities.

> Relating the experiments to our everyday lives was extremely difficult and required a lot of effort. It needed talent to figure out which scenes to use to try to educate the audience, where to give information and how to give information related to the subject. We went through a very difficult process, but what stayed in our minds was the information, not those difficulties. [Associating with everyday life - S_3, male]
> It was very difficult to summarize the subject and show the basic concepts when preparing the poster because the poster had to reflect our entire work. [Summarizing the subject - S_2, female]
> We had difficulties working together as a group and making a product. If it had been a presentation instead of a video, each of us would have worked on our own section. But the fact that we had to work together to prepare the video and make an effort to do this made the final product more valuable. To choose one of the many different scenarios was also difficult. Editing was quite difficult too. [Working collaboratively within the group and scenario preparation - S_{15}, male]

The Opinions on Learning of the Students with regard to Biochemistry Experiments

The most frequently mentioned student opinions related to their learning about biochemistry experiments were providing multimedia learning and having a different experience. Some student opinions related to these codes were as follows:

> Lots of books on education say that visual intelligence is the most dominant in humans. So, we both had a lot of fun and learned easily while watching the videos. Even now, I can remember some lines and scenes. [Providing multimedia learning - S_{35}, female]
> We learned by doing and experiencing and laughing and having fun. We conducted experiments one week and watched the video the next, so we did not get bored in the laboratory courses. Looking forward to our friends' videos also meant looking forward to what we were supposed to learn in the course. [Having a different experience - S_{37}, female]

As can be understood from the students' statements, the educational short videos allowed students to have a new experience and thus ensured that they learned in an easier and more permanent manner. Also, the visual side of the educational short videos was dominant, the information was associated with familiar objects, and sound and light elements were used, which enabled multi-faceted learning.

The Opinions of the Students about Their Own Activities

From the expressions of the students about their own activities, the codes of preparing an instructive activity, experiencing a performance-based learning process, developing their concretization skills, and preparing an interesting activity were revealed. Some of the students' opinions related to these codes were as follows:

> Our short video was influenced by the TV series 'Love Bugs', which is very famous in our country. Our goal was to present starch's benefits and areas of use. We taught the concepts amylose, amylopectin and starch. [Preparing an instructive activity- S_{32}, male]
> We tried very hard and put a lot of time into it. We tried to do the best we could. Everyone demonstrated their various skills. I hope we managed to present the information that everybody needed to learn. I believe we exceeded expectations with our performance. [Experiencing a performance-based learning process - S_3, male]
> It helped us understand the contents of milk (e.g. the concepts of prebiotic and probiotic), we learned about the benefits of milk, we understood the importance of milk, we learned about the importance of proteins in human body by experimenting and watching. [Developing their concretization skills - S_5, male]

Discussion

Previous studies show that the use of educational videos – which are an important part of educational technology – in educational programs benefits the students in many ways (Allen & Smith, 2012; Griep & Mikasen, 2005; Hsin & Cigas, 2013; Ibrahim, Antonenko, Greenwood, & Wheeler, 2012; Kay, 2012; Rackaway, 2012). In this research,

it was aimed to determine and evaluate students' opinions with regard to conducting a Biochemistry Laboratory course using the educational short video and poster active learning activities. The activities were carried out in the Biochemistry Laboratory course over one semester. The students designed educational short videos specific to the experiment assigned to their group and presented these videos in the laboratory environment. In the educational short videos, the students played roles, for example, the video of Group 3 explained the contents of milk, such as fatty acids, amino acids and proteins, introduced carbohydrates and included the concepts of prebiotic and probiotic in a comprehensive manner. In addition, the students discussed the effects of milk within their scenario by playing the roles of some organs and diseases. Such roles can serve as models which allow abstract concepts to be made concrete. Hence, it can be said that the students developed their concretization skills through the role-playing they engaged in. Gregg, Hosley, Weng, and Montemayor (1995) note that complex and abstract concepts may be understood more easily if audiovisual images are presented to the mind through videos. Pekdag and Le Maréchal (2010) assert that the use of videos with scientific content facilitates learning and constructing concepts in the mind. Similarly, it was found in this research that the students were able to learn the concepts involved in their experiments thanks to the short videos they made and watched.

Sever, Yurumezoglu, and Oguz-Unver (2010) videotaped some experimental activities designed by them in their research and had 148 prospective teachers watch these videos. They introduced the experiments both by demonstration and also in video form and investigated the differences between these. As a result of their research, they found no difference between actual demonstration and videos. They suggested that videos could be used as an alternative learning method to laboratory experiments. It can be said that making Biochemistry experiments into short videos and watching these videos in addition to conducting experiments in the laboratory is an alternative learning tool for learning about these experiments. Similarly to this result, Frey, Mikasen, and Griep (2012) noted that the use of films and videos by chemistry teachers aroused the interest of students and allowed for meaningful learning. The students stated in interviews that these activities enabled permanent learning. In line with this result, Ardaç and Unal (2008) maintained that the use of audiovisual educational technology allows permanent learning to occur. In similar studies in the field of chemistry teaching, videos were shown alongside carrying out the experiment, since the use of certain chemicals may be hazardous for students. It was found in these studies that showing videos contributed to students' success in terms of subject matter knowledge (Jones, 2013; Kelly & Jones, 2007).

In this research, the students stated that the educational short videos provided multimedia learning. Multimedia learning makes use of tools such as video, radio, television and other media for sharing knowledge and ideas. Learning environments utilizing multimedia engage multiple senses through their audiovisual elements and support permanent learning (Neo & Neo, 2001). Studies in the literature emphasize that multimedia learning is used to improve learning performance (Taşçı & Soran, 2008; Tsoua, Wang, & Tzeng, 2006). The results of this research are consistent with the results of these studies in the literature. The students also declared that the educational short videos were a new experience for them. The students produced an educational video as prospective teachers for the first time in their university life. They created a scenario as a group to produce these videos, thought about their scenarios, researched the concepts to be presented in the videos and used them in the scenario. Also, they felt and experienced the events happening in these videos by acting in them. Novak (2010) notes that cognitive learning (thinking), active learning (feeling) and psychomotor learning (taking a role) must occur together so that learning can take place. In this sense, it can be asserted that the use of educational short videos allowed the students to experience all these learning types. Galloway and Bretz (2016) recorded the university students while conducting chemistry experiments, had them watch these recordings and sought to reveal their opinions, feelings and what they had gained during these experiments. They found that the students had a new experience; some students were able to conduct laboratory experiments as they were supposed to, whereas others still had difficulties. With educational short videos and posters, the students improved their skills in developing materials by designing a product and creating an original educational tool. It can be said that these activities provide a step towards them developing their own materials for students in their future teaching careers. Akbaş (2011) reported that elementary school students found educational short videos produced by prospective teachers to be quite useful.

The results also revealed that educational short videos were active learning tools. The findings show that the activities performed by the students allowed for the sharing of knowledge, promoted creative thinking, led the students to further research and enhanced their self-regulation skills. The studies in the literature highlight that the use of information and communication technology in learning environments allows students to transit from a passive position to an active position (Koç, 2011; Own & Wong, 2000). The students build up their skills and knowledge related to creative thinking and problem-solving by taking an active role in their learning.

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The students stated that the activities were interesting and instructive. Turkoguz (2012) developed a scale that examined the use of visual media in the chemistry laboratory. The students evaluated experiments which they had recorded on social media. His research results showed that the use of videos in the laboratory environment had a positive effect and improved the students' attitudes and interests towards the laboratory course. Similarly to this research, many studies in the literature have shown that visual materials such as films and videos were interesting and improved students' motivation by capturing their attention (Cook, 2006; Kumar, 1991; Pekdag, 2010). Weinstein (2001) stated that the use of videos in teaching improves students' motivation related to the subject. Motivation has a great impact on students' success and how they structure their knowledge (Lee, Luchini, Michael, Norris, & Soloway, 2004; Uyulgan & Akkuzu, 2014). For this reason, students with a high intrinsic motivation are expected to have a greater academic success. At the end of the research, the students stated that the educational video learning activities positively affected their intrinsic motivation. In addition, the students mentioned that they experienced the joy of creating something. By preparing educational videos related to their own experiments, the students created their own unique works. This is consistent with the need for success which is one of the dimensions of intrinsic motivation (Uyulgan & Akkuzu, 2014). Also, the students experienced social acceptance, which is closely related to intrinsic motivation, by showing their video to their friends and the researchers. Another theme which emerged in the students' opinions was that the educational videos improved student's communication skills. The students enhanced their communication with each other by exchanging knowledge and discussing various ideas while preparing the scenario and making the video. This result is consistent with those of studies reporting that the use of educational technology improves communication and social interaction between students (Jowallah, 2008; Laroche, Wulfsberg, & Young, 2003; Sutherland, 2004).

Although the students stated that the videos had many benefits, they encountered certain obstacles when preparing them. These included editing the video, finding decorations and costumes, acting a role, relating the events and concepts in the video to everyday life and working collaboratively within the group. The students mostly preferred to use video cameras to make their videos. In some cases, the students shot basic scenes with smartphones. It can be asserted that the reason which the students had such difficulties is that they were using advanced technological materials in this way for the first time in their lives. Kılıç and Çelik (2014) got students to design digital videos in their research. Similarly to our research, they reported that students had difficulties in relation to the financial aspects and sourcing cameras, computers and equipment.

Conclusions

Considering the research results, it can be said that thanks to the educational short videos produced in this research, students can understand and concretize the concepts they learned by experimenting in the laboratory. The university students expressed more meaningful learning by internalizing the information about the concepts while characterizing them. In view of these expressions it can be inferred that such activities can be used as learning tools in the laboratory courses. It was also determined that in the results of the research there may be some drawbacks especially while preparing the material and working collaboratively besides the positive feedbacks of the activities. So, in the further research, the benefits and disadvantages of the activities can be discussed deeply.

Preparing and developing video and poster activities also gave the students the experience of producing a technological learning material. Thus, a new learning practice has been gained to students in their learning experiences. Through the active participation included in cognitive and constructivist theories it can also be indicated that the students' higher-order life and thinking skills such as creativity, motivation, communication, social acknowledgment etc. were enhanced thanks to these experiences. The university students must be able to create content for multimedia learning and have necessary skills to develop such media in accordance with the requirements of the 21st century. In this research, university students were able to acquire these skills by creating educational short videos specific to the laboratory experiments. Evaluating the results of the research, it can be asserted that the laboratory course carried out using these activities enabled more meaningful and permanent learning, allowed students to participate in the course with more enjoyment and interest and improved their motivation.

Implications

The findings of this research were limited to the students' statements. Therefore, studies of a similar nature and experimental or special case studies could be conducted in order to investigate the effects of such educational

technology tools on students' achievements, attitudes, motivations and self-regulations. The educational short videos produced in this research could be used as advance organizers in the teaching certain concepts (saponification, prebiotic, alkaloid, pigment, etc.) related to Chemistry and Biochemistry. Educational short videos could be designed for different laboratory applications and be disseminated in order to increase the achievement level and effectiveness of laboratory courses. The educational short videos produced in the research could be used with students at different academic levels to investigate their effects on them. The material development skills of prospective teachers may be increased by having them design similar active learning applications. In addition, the educational short videos developed by the students in this research may serve as powerful educational tools.

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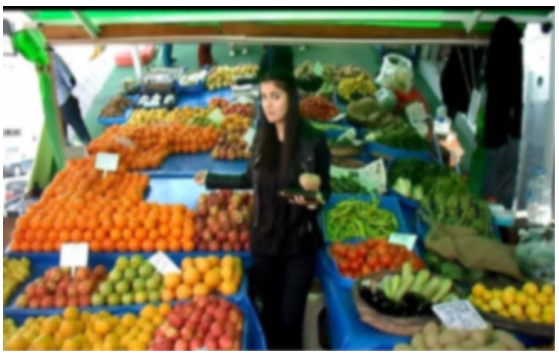
APPENDIX. Samples from the scenarios and the screenshots of the educational short videos

Experiment 1: Separation of alkaloids by extraction: Obtaining nicotine from tobacco

This video involves a television discussion show called "No dırdır, Yes gırgır". This television show features a tobacco farmer, an artist and a doctor. The guests discuss *whether nicotine is found only in tobacco or if it is found in food as well*. The student playing the doctor gives information about chemical properties of nicotine and explains its areas of use. She also mentions nicotine-induced diseases and the place of nicotine in nutrition. An advert aired during the commercial break gives a social message about quitting smoking using "171 Smoking Cessation Hotline". Another commercial shows how an ex-smoker's life has changed after quitting smoking. Later on in the show, a reporter interviews people in the street about *how to obtain nicotine*. The video ends with a blooper reel.



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Experiment 3: Extraction and saponification of milk lipids

This video covers events experienced by a student at home. A female student sits in the living room and watches TV while eating dinner. Her glass of milk suddenly comes to life while the student is eating her dinner. The student playing the milk starts a conversation with another student playing the stomach about the effect of milk on the stomach, prebiotics and probiotics. Then the female student changes the TV channel to a sports show and starts exercising. The student says, "*My bones hurt!*" and a student playing a bone appears on the screen. This time, the bone starts a conversation with the milk about the benefits of milk for bone development. The benefits of milk are explained in detail throughout the video with various dialogues between the milk and students playing the brain, cancer, cholesterol and a microbe. Finally, the video ends with the milk and the student saying they are good friends.

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Melis Arzu Uyulgan PhD, Assistant Professor, Department of Mathematics and Science Education, Dokuz Eylul University, Faculty of Education, Izmir, Turkey.
E-mail: melisarzucekci@gmail.com
Website: http://debis.deu.edu.tr/akademik/index.php?cat=3&akod=20060910

Nalan Akkuzu PhD, Associate Professor, Department of Mathematics and Science Education, Dokuz Eylul University, Faculty of Education, Izmir, Turkey.
E-mail: nalan.akkuzu@gmail.com
Website: http://debis.deu.edu.tr/akademik/index.php?cat=3&akod=20060908