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PROSPECTİVE TEACHERS' OPINIONS ABOUT ANIMATIONS IN SCIENCE EDUCATION

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Abstract:
The purpose of the current research is to determine prospective teachers' opinions about animations. The current research employed case research design as a qualitative research method. The research group of the current research is comprised of 124 prospective primary teachers and 116 prospective science teachers. A structured form including 10 open-ended questions and a semi-structured interview form consisting of 8 questions were administered to the participants of the research. The findings of the research revealed that the opinions stated by the prospective teachers about the use of animations in science education could be gathered under the following themes: applications related to the objectives of the course, course energizers, individual differences, physical-technical capacity, student-teacher competencies, economic capacity, program capacity, learning gained with the help of others, type of music, behavioral-mental communication skills, empathy and science literacy. The data collected from the interviews showed that the prospective teachers see themselves as willing but incompetent in using animations, want to have training about the preparation of animation programs, want to use the animations they themselves develop but prefer to use the ones prepared by others and think that it is necessary to make use of animations in today's educational environments. In light of the findings of the current research, experimental activities in the form of student seminars and courses can be suggested for prospective teachers to enhance their information, skills and competencies about animations.

Keywords: prospective primary teachers; prospective science teachers; use of animation

1. Introduction

One of the effective methods for students to visualize the events constituted by micro-level abstract concepts in their minds, to accomplish meaningful learning and to cope

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with their misconceptions is computer-assisted instruction. For the implementation of computer-assisted instruction, science courses including many scientific concepts and principles are highly suitable in terms of content (Demircioğlu & Geban, 1996). For science education, computer animations and simulations have become important instruments of instruction. According to Akçay, Tüysüz and Feyzioğlu (2003) stating that animations and simulations enhance computer-assisted instruction, visualization through animations reifies abstract concepts and thus improves students' attention, perception and comprehension.

In recent years, as a result of considerable advancements in multi-media technologies, animations are being increasingly used in instruction. This can be clearly seen from the increase in the number of the users of 'youtube' or 'teachertube' (Snelson & Elison-Bowers, 2009). Computer animation is the generation of visual effects by using graphic instruments in the computer. Reflection of the developments in computer technologies onto the field of animation has facilitated animation applications in the computer. Particularly in the computer environment integrated with multi-media technologies, there are many instruments to combine real images, graphs, texts, actual voices and animations and this offers many opportunities in educational software development processes. In fact, animation is an effective and useful instructional instrument. Animations are original, enjoyable and interesting instruments facilitating teachers' task of provoking thoughts in a very short time. The research revealed that animations can effectively explain abstract and complex concepts (Barak, Ashkar & Dori, 2011; Ong & Mannan, 2004). It can deliver knowledge in both 2D and 3D visual and audio, and allows users to experience the simulation of a real-world scenario which may be difficult to explain without illustrations or actual practices. Furthermore, the use of animation can help students to develop their critical thinking, problem solving skills and their engagement to the subject content (Chan, 2012; Mayer & Moreno, 2002; cited in Chan, 2015).

Nowadays, students are grown within multi-media technologies such as video games, 3D animations, online videos and colorful graphics. As greater importance has been attached to technological visual skills, students are becoming primarily visual learners (Roberto, 2010). In this generation, students are generally called as digital natives. Digital learners prefer learning from pictures, sounds, video applications and multiple-media rather than learning form texts (Jukes, McCain & Crockett, 2010). On the contrary, traditional resources of learning and teaching disseminate information through static pictures and texts not catering to learning desires of digital natives. In this way, multi-media technologies provide an alternative way for teachers to facilitate learning and teaching for digital natives. The research pointed out that integration of digital resources into education increases students' motivation and eagerness to learn (Burke, Snyder, & Rager, 2009; Duffy, 2008).

Among the various types of multimedia resources, video is most commonly used as a pedagogical material. Cartoon animations, YouTube, virtual simulations and other digital devices and software that used to broadcast these videos, such as smart phones and tablet computers are all toys of the digital generation (cited in Chan, 2015).

Through the educational software using animation technique, the difficulties experienced by students in reifying and visualizing the abstract objects or concepts in the mind can be overcome. Thus, an enhanced learning environment can be created for students.

It is not possible to conduct some dangerous or expensive experiments or applications in a laboratory setting. By means of simulations that can be designed together with animations, such experiments can be easily demonstrated for students. That is, students can find opportunities to work on simulations and models adapted to the computer to carry out such experiments without risk so that they can easily internalize their information (Arıcı & Dalkılıç, 2006).

This section should comprise a description of the general framework, definitions and principles, primary issues and controversies, background information and contexts, etc.

2. Conceptual Framework

Animation is generally defined as caricature or 3D visual real simulation and in its 2D or 3D samples; it is defined as moving pictures produced by computer through the integration of various parts of media such as video, graphic, sound (Mayer & Anderson, 1992; Szabo & Poohkay, 1996). Many scholars contended that the use of animation in teaching is useful for learning of many students. In various studies, improvements can be seen in areas including abstract thinking, communication skills and problem-solving skills, thinking skills and learning engagement. It was also shown that animation can assist students to achieve the expected learning outcomes. As a learning instrument, animation was found to have remarkable positive effects on learning processes (Fralinger & Owens, 2009).

When the literature is reviewed, it is seen that many researchers agreed that animations used in science and mathematics classes visualize abstract concepts and are useful for learning of students (Lipeikiene & Lipeika, 2006). Scholars argue that creating visualising abstract concepts can be a challenging cognitive process for science learners (Ong & Mannan, 2004; Dalacosta, Kamariotaki-Paparrigopoulou, Palyvos & Spyrellis, 2009). In the past, students used to have difficulties in understanding complex and abstract concepts from static pictures and texts. However, the use of animations provides visual clues for students to enhance their cognitive processes through 3D visuals and real world simulations. In fact, animation strengthens the process of visualization as an effective cognitive strategy enhancing students' conceptual understandings (Marbach-Ad, Rotbain, & Stavy, 2008). Mayer and Moreno (2002) further elaborated that animations are effective as they are designed in ways that promote the human cognitive process – to have corresponding pictorial and verbal (narrations) representations in the human memory at the same time. Animation is the expression of thoughts simultaneously combining visual, audio and kinesthetic triple learning styles that can improve students' knowledge and comprehension (Barak et al., 2011).

Another widely recognized benefit of animation is increasing students' learning motivation. Animation is an important instrument increasing students' academic interest in and attention to learning (Dalacosta et al., 2009; Wang & Reeves, 2006). Students who use animations to learn have higher motivation for categories of self-efficacy, enjoyment, connection to daily life and importance to their future compared to those who do not (Barak et al., 2011). Other studies indicated that animation can be an icebreaker to initiate class discussion and facilitate interesting, interactive and even entertaining lecture without putting in a huge amount of work and time spent on teaching preparation (Fralinger & Owens, 2009).

The benefits of animation are recognized positively to a great extent. However, whether the use of animations will be conducive to learning and teaching depends on how they are used. For the effective incorporation of animations into learning and teaching, teachers should be knowledgeable about applications, techniques and pedagogical dimensions of animations. The applied aspect of animations is related to the practicality of animations within the context of education. Thus, classroom environment and size of the classroom might be influential on the selection of animations. The technical aspect of animations requires the consideration of teachers' technical competencies, technical support and resources. The pedagogical aspect of animations might refer to academic merit of the anticipated learning outcomes and the content to which animation belongs.

In general, teachers cannot integrate animations into traditional teaching methods. On the other hand, they see them as an instrument of enhancing and supporting learning in classroom environment. For example, ambiguous static question forms that lead to erroneous reading and interpretations can be easily clarified through animations (Dancy & Beichner, 2006). Animations are useful learning instruments as reinforcers in traditional learning and teaching.

Dalton (2003) suggested animation for teaching of many abstract concepts in science education in such a way as to draw the interest of students and for comprehension of these concepts and stated that teaching via animations have more positive effects on students when compared to other methods of teaching.

Ausman, Kidwai, Munyofu, Swain and Dwyer (2004) investigated the effects of animation strategies. They conducted their research with the participation of voluntary students. The students were randomly divided into three groups. The first group was presented with visual animations, the second group was presented with audio and visual animations and the third group was presented with videos in addition to animations. On the basis of their findings, they reported that the use of visual and audio animations in education is a good strategy.

Barak & Dori (2011), in their research, integrated web-based animations into their science programs and then evaluated them. They examined the effect of animations on students' learning outcomes. The research was conducted by using experimental-control groups and collecting qualitative and quantitative data. In their experimental group, they found that animations supported different teaching strategies and learning methods promoting students' various thinking skills. They concluded that animations

increase scientific curiosity, enhance the acquisition of scientific language and develop scientific thinking.

Daşdemir (2013) attempted to demonstrate the effect of the use of animations in science and technology classes on sixth grade students by means of an empirical research. It was found that the use of animations for teaching of the unit of the granular structure of the matter had positive effects on students' academic achievement, permanent learning and scientific process skills.

Kapucu, Eren and Avcı (2014) explored the animation formation process of the prospective science teachers. Within the framework of this process, the students prepared animations by using Goanimation program. The students' opinions about this process were elicited. The students stated that animations are visual, interesting and might endear science to them. In addition to this, the prospective teachers stated that they had difficulties while preparing animations by using GoAnimate and it might be difficult to adapt animations into teaching of each subject.

Chan (2015) investigated how teachers perceive the use of animations and how they affect their professional development. Though the teachers have positive attitudes towards the use of animations, they do not have academic and technical competencies required for the effective implementation of animations in their classes.

2.1. Significance of the Research

Proportional to prospective teachers' competencies, animation are gradually increasing their contribution to the meaningful learning of students in class. Through animations, the content of science instruction programs has been enhanced with visual, audio and kinesthetic elements. In this regard, animations are increasingly becoming more important. Both teachers and students can prepare animations with the help of websites or on their own and thus, can improve the understanding of subjects. Animations help learners to retain learned information in their minds for a longer period of time. In the current research, the prospective teachers' opinions about the benefits of using animations and their contribution to their professional competencies were investigated.

2.2. Purpose of the Research

The purpose of the current research is to determine the opinions of prospective teachers (prospective primary teachers and prospective science teachers) about the use of animations in science education.

Problem of research; what are the opinions of prospective teachers about the use of animations in science education? The research is limited by the number of prospective teacher and the regions. It implicates the existing problems for the use of animation solutions were presented with this research. It is thought that the research literature offers local and international contributions.

3. Material and Methods

In the current research, as a qualitative research method, case research type was used. The main purpose of qualitative research is to present a detailed descriptive and realistic picture of the subject under investigation. In this regard, for the reliability and validity of the research findings, detailed and direct presentation of the data is of great importance (Creswell, 2013; Patton, 2014). In the current research, the participants' opinions are discussed in a detailed manner. According to Creswell (2013), case research is a qualitative research method in which one or a few time-restricted case(s) is/are subjected to in-depth analysis by using data collection instruments including the collection of data from multiple resources (observations, interviews, visual and auditory materials, documents and reports) and cases and case-related themes are defined. This is a research method aiming to elicit participants' viewpoints and the processes belonging to their viewpoints and collecting detailed data.

3.1. Research Group

The research group of the current research is comprised of 124 prospective primary teachers and 116 prospective science teachers. The ages of the participants vary between 20 and 22 years old. The sample size is believed to be sufficient for a qualitative study (Creswell, 20130). In the selection of the research group, prospective teachers' interest in using animations in their future classes and having taken courses related to animation in their undergraduate education were influential.

3.2. Data Collection Instruments

The data collection instruments include a structured form consisting of open-ended questions related to use of animations and interviews. Since it is stated that using different data collection instruments in the same research increases the consistency, intelligibility and actuality (Glesne & Peshkin, 1992; Poggenpoel & Myburgh, 2003; Roberts & Priest, 2006; Shenton, 2004; Patton, 2014). Use of different data collection instruments in qualitative research is an important factor increasing the reliability of the research.

3.3. Structured form including open-ended questions related to animation

This form consists of 10 open-ended questions. It was examined by two people expert in their own fields and two of the questions were excluded. Thus the structured form was reduced to 8 open-ended questions. In this form, the students were asked questions about the contribution of animations in science education, their use, availability, suitability for the subject, effect, content, contribution to communication skills and nature. Sample questions are; "*What do you think the contribution of animations to science education is?*", "*Do you follow the scientific research on animations? How?"* etc… This structured form was administered to the student classroom and science teachers. The prospective teachers were asked to answer these questions as well as they could and given 20 minutes.

3.4. Interviews about animations

The questions prepared for the interviews were constructed in a manner similar to the structured form. The interview questions were turned into a semi-structured interview form including 8 questions. These questions are similar to the ones in the structured form. But, there are two different questions in the semi-structured interview form. These are; "*Do you want to prepare animation programs in science teaching? Why?" and "Do you want to use ready-to-use animations or your own animations in your professional life? Why?"*. These interview questions were directed to 3 prospective primary teachers and 3 prospective science teachers randomly selected from among the prospective teachers who were administered the structured form. The interviews were conducted in a comfortable environment and in a face-to-face manner with the students. While conducting interviews, follow-up questions mostly including why and how questions were directed to the interviewees depending on their responses to the questions in the semi-structured interview form. The interviews with the students lasted for 10-15 minutes. The interviews were tape-recorded. Then they were transcribed.

3.5. Data Analysis

In order to be able to start data analysis, the response papers of the prospective primary teachers were enumerated from 1 to 124 and those of the prospective science teachers from 125 to 240. The data were analyzed according to content analysis method. The main purpose of content analysis is to reach concepts and relationships that can explain the data. For this purpose, it aims to gather the data exhibiting similarities around certain concepts and categories and to organize and interpret them in a manner understandable to the reader (Creswell, 2013). The data collected from the structured form were analyzed by using semantic relation technique (Patton, 2014). The statements having similar meanings were subsumed under certain themes constructed by the researchers. They were categorized by using the criterion of semantic relation. Within the context of the interview technique, transcribed tape-recordings were analyzed by using semantic relation criterion and thus the reliability of the research was increased. The interview data were supported with the data obtained from the structured form.

The participants' opinions about animation were gathered under certain categories, themes and codes and frequencies were given separately for the two groups of prospective teachers. Moreover, the participants' interesting remarks elicited by the structured form and the semi-structured interviews are given as direct quotations within the quotation marks " " by indicating the number of the participant (e.g. K105). Moreover, the participants' remarks stated during the interviews are also given within the text by indicating the participant's number such as SK1 (Prospective primary teacher) and FK6 (Prospective science teacher).

In order to establish the validity of the research findings, two important processes were conducted: (a) Coding of the data and data analysis process were explained in detail (Hruschka, Schwartz, St. John, Picone-Decaro, Jenkins and Carey, 2004) (b) For each of the constructed categories, the prospective teachers' excerpts assumed to be best representing each category are presented in the findings section

(Yıldırım and Şimşek, 2006). In order to establish the reliability of the research, two researchers' separate codes and code-related categories were compared to test whether the codes given under the conceptual categories obtained in the research represent these conceptual categories or not. After the research data were coded separately by a science expert and a computer expert, final form of the list of codes and categories was given in line with the researchers' opinions. The consistency of the codes used by the researchers independently was determined marking them as "Agreement" and "Disagreement". The cases where the researchers used the same code for the prospective teachers' statements was marked as "Agreement" and when they used a different code, then it was marked as "Disagreement". In cases where a researcher is not clear about coding, coding was performed by taking the opinion of the other researcher. The reliability of the data analysis conducted in this way was calculated by using the formula: [Agreement / (Agreement + Disagreement) x 100) (Miles and Huberman, 1994; cited in Kurt, 2013a,b). Inter-rater reliability was calculated to be 94%.

4. Results

The results of research obtained from the data collection instruments are presented below in tables. Under the tables, the excerpts taken from the prospective teachers' statements are given within "…." and then interpreted.

Table 1: Prospective teachers' opinions about the contribution of animations to science education

Category	Theme	Code	Prospective primary teachers frequency	Prospective science teachers frequency
Contribution of animations to science education	Applications to achieve the objectives of the course	Facilitating/enhancing comprehension/learning	41	30
		Increasing the permanency of information/ retaining in the memory for a long time	26	41
		Addressing sense organs	15	41
		Increasing interest/motivation in the course	14	12
		Making the lesson more enjoyable	17	5
		Reifying abstract concepts	11	12
		Drawing interest	12	9
		Promoting imagination	8	3
		Making effective learning possible	6	10

The prospective teachers stated some opinions about the theme of the applications to achieve the objectives of the course. In this regard, it was found that frequency of the prospective primary teachers stating that "*enhancing comprehension*" (41) and "*making the lesson more enjoyable*" (17) is higher than that of the prospective science teachers. On the other hand, frequency of the prospective science teachers stating that "*increasing the permanency of information/retaining in the memory for a long time*" (41), "*addressing sense organs*" (41) and "*making learning more effective*" (10) was found to be higher than that of

the prospective primary teachers. The reason for this difference might be because the prospective teachers are different in this category.

Excerpts of the prospective teachers taken from their responses to the structured form;

"It facilitates teaching." (K22)

"Visual learning is a more permanent way of learning. That is, it makes teaching more effective." (K143)

"…It addresses sense organs." (K200)

"We can present abstract concepts as concrete by means of animations." (K52)

"Lessons become more enjoyable…"(K4)

Excerpts from the prospective teachers' responses to the interview questions;

"Do you think that animations used in science classes are beneficial for you and students? Why? And from which aspects?"

"I think that they have some contributions ...both visually and auditory, as the number of sense organs addressed increases, the learning is enhanced…They can result in effective and permanent learning…"(SK1)

"Yes, I think …they draw the attention of students…prepare them for learning…"(FK4)

"…visuals are always important in education. To show something concrete…they facilitate teaching…" (FK5).

Table 2: Prospective teachers' opinions about animations' frequency of use

Category	Theme	Code	Prospective primary teachers frequency	Prospective science teachers frequency
Animations' frequency of use	Planning course content	In teaching of topics /in each lesson/related to each topic	37	28
		When necessary/at certain intervals/in specific topics	28	24
		According to topic difficulty/according to topic/for topics students have difficulties to understand	24	17
		They must be used frequently/always	11	21
		They should not be used too frequently/should not be continuous/sometimes/rarely	17	10
		They must be used in abstract topics	2	10
		They are used at the beginning and end of the topic	-	7
		At the beginning and end of a unit	4	4
		For introduction or conclusion to the lesson	5	2
		At some specific points of a lesson	3	2
		1 or 2 animations should be used for each topic	1	1
	Class energizer	Attention can be distorted/lack of motivation	8	-
		They can be used for reinforcing	4	6
		Short-time use to increase motivation/to draw attention to the lesson	3	1
		To draw attention	2	2

	Individual differences	To enhance learning	3	1
		According to academic achievement	2	1
		According to student profile	2	-

The prospective teachers stated the most opinions about the planning of the course content. They, on the other hand, expressed fewer opinions about individual differences. In relation to the use of animations, the frequency of the prospective primary teachers' stating that *"in teaching of topics/in each lesson/related to each topic"* (37), *"According to topic difficulty/according to topic/for topics students have difficulties to understand"* (24), *"They should not be used too frequently/should not be continuous/sometimes/rarely"* (17) and *" For introduction and conclusion to the lesson"* (5) is higher than that of the prospective science teachers. On the other hand, the frequency of the prospective science teachers stating that *"They must be used frequently /always" (21), "They must be used for abstract topics"* (10) was found to be higher than that of the prospective primary teachers. Moreover, some of the prospective primary teachers stated that *"They are used at the beginning of the end of a topic"* (7), none of the prospective primary teachers stated this opinion. On the other hand, while some of the prospective primary teachers stated that *"Attention can be distorted/lack of motivation" (*8) and *"according to student profile"* (2), none of the prospective primary teachers stated these opinions. The reason for this might be because interaction with animations and use of animations vary from individual to individual.

Excerpts of the prospective teachers taken from their responses to the structured form;

"*They must be continuous because they can distort the attention."* (K5)

"I teach lesson, according to the suitability of the topic" (K16)

"They should be used more while teaching abstract concepts" (K74)

"It depends on the learning status of the class." (K122)

"There must be at least one for each subject." (K128)

"At the beginning of the topic or when necessary, they can be used to draw the attention and to raise curiosity." (K131)

Excerpts from the prospective teachers' responses to the interview questions;

"Do you consider using animations in science teaching in your professional career? If yes, how frequent do you use?

"Yes, I hope…I think I use in compliance with the units." (SK1)

"…I do not use them continuously because students may get bored … once in a two-week period is good." (FK4)

"Of course….I use them to reify abstract topics ….. it might change depending on the difficulty level of the topic."(SK2)

"…I think that they would be useful…depending on the state of the lesson…if it is necessary, I try to use them continuously" (FK5)

"…if conditions are suitable I use them.. I use them as long as I need…" (SK3)

"I would use them because they have some effects on students. Therefore, I would use every type of animation for students to learn…once in a week or depending on the importance of the topic. " (FK6)

Researcher asked the question *"Particularly for the teaching of which topics?"*. Participant *"For the teaching of topics which can be understood by students with the help of visual presentation"*.

Table 3: Prospective teachers' opinions about the relevant use of animations

Category	Theme	Code	Prospective primary teachers frequency	Prospective science teachers frequency
Relevant use of animations	Applications in line with the objectives of the course	They are not used	50	50
		They are not used very much/ they are not used properly enough	48	29
		Traditional methods are used/teachers are lecturing	9	14
		Relevant use	11	10
		Lack of animations/technological shortages	13	6
		Teachers' not using technology/teacher incompetency	11	8
		They are relevantly used	8	11
		I have no information/idea/blank	8	7
		They are not relevantly	6	8
		Making more meaningful and permanent/facilitating learning	5	2
		They must be suitable for the level of students/their information level	2	3
		It changes depending on the teacher	-	3
		They are used to spend time	2	-

The prospective teachers stated how much they view animations relevant to the objectives of the course. In this regard, the frequency of the prospective primary teachers stating that *"They are not used very much/not used properly enough"* (48), *"Lack of animation/technological shortages"* (13) and *"Making more meaningful and permanent /facilitating learning"* (5) is higher than that of the prospective science teachers. The frequency of the prospective science teachers stating that *"Traditional methods are used /teachers are lecturing"* (14) is higher than that of the student primary teachers. Moreover, while some of the prospective science teachers stated that *"It changes depending on the teacher"* (3), none of the student primary teachers stated this opinion. On the other hand, while some student primary teachers stated that *"They are used to spend time"* (2), none of the prospective science teachers stated this opinion. The reason for this might be because the student primary teachers' opinions about the relevant use of animations are more meaningful than those of the prospective science teachers.

Excerpts of the prospective teachers taken from their responses to the structured form;

> *"No because they are viewed to be time-consuming and it might be difficult to use animations for teaching of many subjects." (K109)*
>
> *"No, I do not think that they are used adequately. This is because teachers do not want to spend time." (K99)*

"Yes, they are used because learning becomes more permanent for children seeing visuals." (K54)
"No because teachers usually prefer to teach by means of presentation or discovery." (K133)
"Yes, certainly; particularly in the course of anatomy." (K162)
"As the physical conditions of each school are not suitable. Not every class has a smart board or a projector." (K240)

Table 4: Prospective teachers' opinions about the availability of animations

Category	Theme	Code	Prospective primary teachers frequency	Prospective science teachers frequency
Availability of animations	Physical-technical capacity	Finding easily (in the internet environment / they are in a close interaction with the daily life	48	72
		There are not many /it is not easy to find them	49	28
		I have no idea/blank	16	3
		There are not adequate efforts to develop them/there is no one developing them	10	3
		It is difficult to find resources (web) in Turkish	1	5
		It is difficult to find/to understand in foreign sites	-	2
		It changes depending on the level of the student	2	1
		It depends on teachers	2	-
	Program capacity	It changes depending on the subject	10	15
	Economic capacity	It depends on capacities	5	1
		Not available as they are expensive	3	1

The prospective teachers associated the availability of animations mostly with physical and technical capacities. They did not find economic capacity closely associated with the availability of animations. In relation of the availability of animations, frequency of the student primary teachers stating that "*There are not many/it is not easy to find them"* (49), "*There are not adequate efforts to develop them/there is no one developing them"* (10), "*I have no idea/blank"* (16) and *"It depends on capacities"* (5) is higher than that of the pr-service science teachers. On the other hand, the frequency of the prospective science teachers stating that *"Finding easily (in the internet environment)/they are in a close interaction with daily life"* (72), "*It is difficult to find resources (web) in Turkish"* (5) and *"It changes depending on the subject"* (15) than that of the student primary teachers. The reason for this might be because the student primary teachers learned something about animations in their undergraduate courses but they are not competent enough in the application and obtaining of animations. Moreover, while few of the prospective science teachers stated that *"It is difficult to find/to understand in foreign sites"* (2), none of the student primary teachers stated this opinion. It is seen that prospective science teachers have difficulties in findings animations due to lack of language competence. While few of the student primary teachers stated that *"It depends on teachers"* (2), none of the prospective science teachers stated this opinion.

Excerpts of the prospective teachers taken from their responses to the structured form;

"It changes depending on the distribution of the topics." (K3)

"If the conditions are suitable, then they can be found." (K13)

"No, because there are not many animations that can be used in science courses." (K48)

"They can be found through the internet." (K126)

"There are no animations in Turkish." (K208)

"It is not easy to find them because in our country not enough animations are produced. Foreign countries are more concentrated on this issue. It is difficult to find and understand animations in English." (K143)

The prospective teachers were asked "*Are there animations produced for each subject*?" and both the student primary teachers and the prospective science teachers responded that traditional methods are used.

Table 5: Prospective teachers' opinions about the effects of animations left on individuals

Category	Theme	Code	Prospective primary teachers frequency	Prospective science teachers frequency
Effects of animations on individuals	There are individual effects		5	5
	No effect; reasons	Their lives and perceptions are different	62	38
		Their knowledge and intelligence levels are different	28	43
		Their kinesthetic, physical and verbal skills are different	20	12
		Their learning strategies are different	10	15

The prospective teachers stated different reasons to explain that animations do not leave the same effect on each student. In relation to the effects of animations on students; five of the student primary teachers and five of the prospective science teachers; thus, a total of ten prospective teachers stated that animations leave the same effect on students. In the contrary, the other prospective teachers stated that animations do not leave the effect on every student. For this, they proposed the following reasons "*their knowledge and intelligence levels are different*" (43) and "*their learning strategies are different*" (15) and the number of the student primary teachers is higher than that of the prospective science teachers. On the other hand, the number of the student primary teachers proposing the following reasons "*their lives and perceptions are different*" (62), "*their kinesthetic, physical and verbal skills are different*" (20) is higher than that of the prospective science teachers. The student primary teachers and the prospective science teachers used similar statements with different reasons.

Excerpts of the prospective teachers taken from their responses to the structured form;

"They do not leave because students have kinesthetic, physical and verbal skills. Some students learn by hearing and some others by seeing." (K1)
"It is not possible because each student has different learning strategies." (K80)
"Of course, they do not leave the same effect. Each student's perception and comprehension skill is different." (K111)
"No they do not because each student has a different intelligence level." (K126)
"It can be almost the same." (K132)

Excerpts from the prospective teachers' responses to the interview questions;

"Do you think that animations used in science education leave the same effect on each student? Why?"
"No, as their thinking and intelligence levels are different ….. some of them learn by reading and in this case, they cannot be good for such students…" (SK1)
"No, they do not… as some students' visual intelligence is better, they might not leave the same effect." (FK4)
"They do not leave the same effect because not all the students in a class have the same affective and psychomotor skills… "(SK2)
"…students' attention levels are different…if I myself prepare the animation, then I will do it in such a way as to draw the attention of all the students but even so, they can perceive differently." (SK3)
"They might not leave the same effect because students' learning manners are different, some learn from what has been told and some others learn from visual animations…" (FK6)

Table 6: Prospective teachers' opinions about the effect of sounds and music in animations

Category	Theme	Code	Prospective primary teachers frequency	Prospective science teachers frequency
The effects of sounds and music in animation	Learning attained with the help of others	They have positive effects/they address sense organs	40	32
		They arouse interest/draw attention	17	23
		They contribute to permanent learning/help to retain the information longer	13	21
		They distract the attention (negative)	11	12
		Sounds and music related to the topic have more positive effects	12	7
		They do not affect	4	8
		They draw attention	5	4
	Type of music	It changes depending on the type of music	18	15
	Individual differences	It changes depending on the student/changes depending on the type of intelligence (multiple-intelligence)	12	10
		They spiritually affect/increase affective retention	3	3

While explaining the effect of sounds and music in animations, the prospective teachers mostly focused on learning with the help of others. Both groups of prospective teachers do not pay much attention to individual differences. In relation to effect of sounds and music in animations, the frequency of the student primary teachers stating that *"They affect positively/they address sense organs"* (40), "*Sounds and music related to the topic have more positive effects*" (12) and "*It might change depending of the type of music"* (18) is higher than that of the prospective science teachers. The frequency of the science teachers stating that *"They arouse curiosity/draw attention"* (23), *"They contribute to permanent learning and retention in the mind" (*21) and *"They do not affect"* (8) is higher than that of the student primary teachers. The reason for this might be because the prospective teachers' perceptions of music can be different.

Excerpts of the prospective teachers taken from their responses to the structured form;

"*They do, characteristics of the music such as it being lively, interesting, confusing etc. are as effective as animations."* (K9)

"*They do not. The more senses are involved, the more effective learning becomes."* (K71)

"*They might affect. Music can be used as positive reinforcer because if the music is turned up to indicate the most important points of the topic, then more attention will be drawn*" (K95)

"*They have positive effect in terms of motivation. As long as music does not become more prominent than the topic of instruction, it can be used to draw more attention*." (K143)

"*They do, by making more enjoyable, they facilitate learning*." (K217)

"*If the background music is not too laud, then it does not affect. But if the music is too laud, then learning of each student may change depending on the characteristics of the student."* (K230)

Excerpts from the prospective teachers' responses to the interview questions;

"Do you think that the background sounds and music in the animation affect students' learning? Why?"

"In my opinion, they can affect both positively and negatively. They might affect positively when a student is engaged in off-task activities, the music may direct his/her attention to the task. But, at the same time, they might affect negatively while the teacher is teaching a subject. The student may continuously become focused on the music." (The participants stated that music may distract students' attention; on the other hand, might focus their attention on a specific point. For teachers, sounds and music can have negative effects and distort their attention.) (FK4)

"…animations accompanied by music might be retained better in the child's mind. It might increase the retention."(SK2)

"…as a result of laud and confusing sounds, students might get bored and feel disturbed after a while." (FK5)

"If the music is enjoyable, students may become more prone to listen. But, if the music is slow and moving, then they might be reluctant to listen. Rhythm of the music is very important…" (SK3)

"…music may distance students from the target outcomes. As it might distract students' attention, learning can be weakened… students might get overtly concentrated on the music and ignore learning objectives…" (FK6)

The prospective teachers were asked "*whether the use of animations in science education motivates students or not"*. Both the student primary teachers and the prospective science teachers stated that animations would motivate students and they would use them.

Table 7: Prospective teachers' opinions about the contribution of animations to communication skills

Category	Theme	Code	Prospective primary teachers frequency	Prospective science teachers frequency
Contribution of animations to communication skills	Behavioral-cognitive	Yes, they contribute	56	54
		No, they do not contribute	22	11
		Undecided/no idea	12	21
		They improve thinking and imagination/sentence construction/vocabulary/linguistic skills	12	4
		They visualize communication	4	9
		Socialization (children interact with each other)	5	3
		They facilitate learning/comprehension	-	8
		They develop questioning /interpretation and perception skills	1	4
		They impart different viewpoints/widen the horizon	3	-
		Quality of animation	2	-
		Application in daily life	2	-
	Empathy	They deteriorate teacher-student communication	2	3

The prospective teachers stated that animations contribute to communication skills. In this regard, most of the teachers expressed opinions about how they contribute. They mostly stated that they make contributions at behavioral-cognitive dimension. In terms of communication skills, the frequency of the student primary teachers stating that "*They do not contribute"* (22) and "*They improve thinking and imagination/sentence construction/vocabulary/linguistic skills"* (12) is higher than that of the prospective science teachers. On the other hand, the frequency of the prospective science teachers stating that "*I am undecided/I have no idea"* (21), "*They visualize communication"* (9) and "*They develop questioning/interpretation/perception skills"* (4) is higher than that of the student primary teachers. While the student primary teachers focus on speaking skills, the prospective science teachers focus on facilitating comprehension. Moreover, while some of the prospective science teachers stated that "*They facilitate learning/comprehension"* (8), none of the student primary teachers stated this opinion. On the other hand, while some of the student primary teachers stated that "*They impart different viewpoints/widen the*

horizon" (3), "*Quality of animation is important"* (2) and "*They must be referred to daily life"* (2), none of the prospective science teachers stated these opinions.

Excerpts of the prospective teachers taken from their responses to the structured form;

"*They might contribute somehow as they develop thinking and imagination*." (K5)
"*They do not contribute. I think that communication usually develops by speaking*" (K65)
"*I do not think. They weaken teacher-student interactions.*" (K113)
"*Yes, the sentences and speeches used there have positive effect on it.*" (K136)
"*Yes, they have positive effects. Visual perception may have positive effects on the development of communication skill.*"(K144)
"*No, because I think animations are not related to communication skill.*" (K177)

Table 8: Prospective teachers' opinions about the scientific research/nature of science related to animations

Category	Theme	Code	Prospective primary teachers frequency	Prospective science teachers frequency
Research and nature of science related to animations	Science literacy	No/I have no time/I do not recognize/I do not need/It does not interest me/I have no information/to prepare for the exam/KPSS	88	66
		Partially	9	29
		Yes	19	13
		For students/for effective learning/for learning	4	3
		Facilitates teaching of a subject	1	3
		Increases the retention of information	-	3
		Interesting/useful	3	-
		Following ready-to-use animations	2	-
		Improving oneself	1	1

The prospective teachers expressed opinions related to the content of science literacy. More than 50% of the prospective teachers giving the response of "no" stated that they would follow developments in the research related to animations in the future. The frequency of the student primary teachers stating that "*No/I have no time/I do not recognize/ I do not need/It does not interest me/I have no information/preparation for the exam/KPSS"* (88) and "*Yes" (*19) is higher than that of the prospective science teachers. The frequency of the prospective teachers stating that "*partially*" (29) is higher than that of the student primary teachers. This might be because the student science literacy levels related to nature of science are not high. Moreover, while few of the prospective science teachers stated that "*Increasing the retention of information*" (3), none of the student primary teachers stated this opinion. On the other hand, while student primary teachers stated that "*Interesting/useful"* (3) and "*Following ready-to-use animations"* (2), none of the prospective science teachers stated these opinions.

Excerpts of the prospective teachers taken from their responses to the structured form;

"No, not much, sometimes scientific research can be boring." (K3)

"Rather than scientific research I follow ready-to-use animations." (K6)

"Yes I do because thus I believe that I can develop professionally for my future career." (K62)

"I do not follow; there is no opportunity." (K128)

"Generally because it interests me." (K136)

"No, because I spend all my time to prepare for KPSS." (K232)

Excerpts from the prospective teachers' responses to the interview questions;

"Would you like to follow scientific research related to animations in science teaching? Why?"

"…We used to research on texts therefore I would like to follow such nice developments so that I can use them in the future." (SK1)

"…they always interest me. I would like to follow because we, as prospective teachers, will have to teach something to our students…" (FK4)

"…a teacher should renew himself/herself." (SK2)

"As I am thinking of generating animations, I follow them because I think that they will have some contributions to me" (FK5)

"I do not follow but I am somehow interested in this topic.. but such journals are a bit expensive as far as I know therefore I cannot follow them…" (SK3)

"…It does not interest me … I find topics boring." (FK6)

The analyses for the prospective teachers' responses to the question "*Do you want to prepare animations in science education? Why?* are given below.

"I do not want. I might not be creative in this regard because I find using animations in science teaching a bit strange. If I get the required training, then I would like to try." (SK6)

The participant does not see himself/herself adequate in terms of preparing animations. On the other hand, he/she is willing to undergo training.

"I want to prepare but I do not know whether I have the required talent. I want to get training." (FK4)

Participant feels himself/herself responsible for preparing animations but does not know whether he/she has the talent. But he/she wants to get training about the preparation of animation programs.

"Do you use ready-to-use animations or the animations that you have developed in your professional life? Why?"

This question was asked to the prospective teachers. Some of their opinions are;

"If I learn how to prepare animations and continuously follow the developments in the field of animations; then of course I can be sure that my animations will be liked. I want to use my own animations but if I do not know to develop animations or if I am not interested … then I do not think that animations will be useful and thus I can prefer ready-to-use animations." (SK3)

Here the participant expressed some opinions about his/her preparing animations. He/she stated that if he/she knows how to prepare animations then he/she will develop them, otherwise, he/she will use ready-to-use animations.

"I prefer the animations I myself prepare because if I myself prepare then they are original. If you prefer to capitalize on ready-to-use animations then you do not give your own information to students. Therefore, I can use the animations I myself develop." (FK6)

It is seen that the participant prefers to use the animations he/she develops. The participants were also asked whether they would like to tell anything else about animations. Only two prospective teachers expressed some extra opinions.

"Today's children are already growing up among animations. They learn animations before learning to eat, walk etc. They become quite interested in animations. In class, when animations are used to teach something that would be difficult to teach otherwise, students become more interested and they can understand the topic well." (SK3)

Here, the participant states that today's children are highly accustomed to animations; therefore, using animations in education may draw students' attention and interest. Thus, he/she emphasized the importance of using them in education.

"They should be used by every teacher in teaching of every subject because animations leave some effects on students. "(FK6)

The participant thinks that any animation has some influence therefore they should be used in education.

5. Discussion

The purpose of the current research was to determine the prospective teachers' opinions about the use of animations in science education. To this end, data were collected through a structured form and semi-structured interviews. The results of research showed that there are some differences between the student primary teachers and the prospective science teachers' opinions about animations' contribution to science education, frequency of use of animations, relevant use of animations, availability of animations, effects of animations on individuals, sounds and music used in animations, communication skills, and scientific research and nature of science.

In the current research, in relation to the contribution of animations to science education, it was found that the frequency of the prospective science teachers stating that *"they enhance the retention of information"* and *"they address sense organs"* than that of the student primary teachers. On the other hand, the frequency of the student primary teachers stating that "*they facilitate and enhance learning"* and *"they make lessons more enjoyable"* is higher than that of the prospective science teachers. The frequencies of the prospective science teachers and the student primary teachers stating that "*they increase motivation", "they reify abstract concepts", "they draw interest", "they promote imagination"* are quite similar to each other (Table 1). When the relevant literature is examined, it is seen that there are studies reporting similar findings such as the use of animations in education is useful (Mayer &Anderson, 1992; Szabo & Poohkay, 1996), animations can enhance students' conceptual understanding and strengthen their visualization processes (Marbach-Ad, Rotbain & Stavy, 2008). The use of animations in science and mathematics instruction is believed to be useful in visualizing abstract concepts

(Dalton, 2003), thus, useful for students' learning (Lipeikiene & Lipeika, 2006; Ong & Mannan, 2004; Dalacosta et al., 2009). Moreover, they increase the learning motivation of students (Dalacosta et al., 2009; Wang & Reeves, 2006) and they are useful instruments to increase students' academic interests and attention (Fralinger & Owens, 2009; Barak et al., 2011).

In the category of the frequency of the use of animations, in relation to the theme of planning the content of the course, both groups of the prospective teachers mostly stated that *"they are related to every subject"*, *"for certain periods"*, *"to teach subjects difficult to teach"* (Table 2). But, prospective teachers stated that they experience difficulties in preparing animations by using Goanimate and it might be difficult to adapt the prepared animations to the teaching of every subject (Kapucu et al., 2014). In relation to the theme of class energizers, the participants stated opinions such as *"they might distract the attention"*, *"they can be used as reinforcers"*. Similarly, Dancy & Beichner (2006) reported that animations are useful instruments to reinforce what is done through traditional methods. The researchers stated that ambiguous and static question forms leading to erroneous reading and interpretations can be easily explained through animations. In relation to the theme of individual differences, the participants stated that "*they improve learning"*, *"they change according to academic achievement" and "they change according to student profile*. In different studies, it has been reported that animations are useful instruments to increase students' academic interests and attention (Wang & Reeves, 2006; Dalacosta et al., 2009) and use of animations makes positive contributions to students' academic achievement, retention of the learned information and scientific process skills (Daşdemir, 2013).

Another category in the current research is the relevant use of animations and in this category, in relation to the use of animations in compliance with the objectives of the course, the participants stated that "*they are not used"*, *"they are not adequately used"*, *"traditional methods are used"*, *"technological shortages"*, *"teacher's lack of technological competency"* and *"animations are used to spend time"* (Table 3). In a similar research conducted on animations (Barak & Dori, 2011), web-based animations were integrated into elementary school science curriculum. They found that animations promote various thinking skills, enhance different learning strategies and learning methods. In another research, it was found that teachers need to use animations and be aware of their technical and pedagogical aspects. Moreover, teachers' competencies, technical support and resources should be considered for animations to be technically viable (Chan, 2015). In the current research, the student primary teachers' statements were found to be more appropriate and meaningful and this might be because of the student primary teachers' undergraduate course content and their seeing more animation applications in their courses.

In the current research, in the category of animations' being available, in relation to the theme of physical and technical capacities, the participants have some conflicting opinions such as *"easily available in internet environment/they are in close interaction with daily life"*, *"there are not many of them"*, *"it is difficult to find them in Turkish resources"* and *"it is difficult to find and understand them in foreign sites"*. In relation to the theme of

teacher-student competency in the same category, the participants expressed opinions such as "*there is nobody preparing them*", "*it changes depending on the student's level*", "*it depends on teachers*". In relation to the theme of economic capacity, the participants expressed opinions such as "*it depends on capacities*" and "*not available as they are expensive*". In relation to the theme of capacities of the program, they expressed the opinion "*it changes depending on the topic*" (Table 4). In the literature, it has been stated that animations can be integrated into course programs by considering the teacher's competency, technical support and resources (Chan, 2015), the use of animations in education is useful for students to learn (Mayer & Anderson, 1992; Szabo & Poohkay, 1996).

In the current research, in the category of personal effects of animations, some of the participants stated that they would leave some effects and some others stated they would not (Table 5). The reasons given by the participants for animations not to have effects are; "*their interest, intellectual levels are different*", "*their lives and perceptions are different*", "*their kinesthetic, physical and verbal skills are different*" and "*their learning strategies are different*". In their research conducted on animations (Fralinger & Owens, 2009), it was reported that animations have considerable positive effects on learning processes, support different teaching strategies and learning methods (Barak & Dori, 2011), use of educational and visual animations is a good strategy (Ausman et al., 2004) and perceptions of the use of animations is positive (Chan, 2015).

In the category of sounds and music used in animations, the themes of learning attained with the help of others, according to the type of music and according to individual differences emerged. In relation to the theme of effects of sounds and music in animations, the participants expressed opinions such as "*they positively affect*", "*they arouse curiosity/draw attention*", "*they make permanent learning possible*", "*they do not affect*" and some contrary opinions such as "*they distract the attention*". In relation to the theme of the type of music, the participants stated that "*it changes according to the type of music*". In relation to the last theme, individual differences, the participants expressed opinions such as "*it changes according to the type of intelligence*" and "*it spiritually affects/increases affective retention*" (Table 6). Crowter, McFadden, Fleming and Davis (2016), in their research conducted on high school students, found that video teaching with music is more useful than video teaching without music and makes more contribution to teaching.

In the category of communication skills, high majority of the participants stated that animations make positive contributions to communication skills and few of the participants stated that they do not make any contributions. The participants expressed the following opinions about the contribution of animations to communication skills "*they develop thinking and imagination/sentence construction/vocabulary/linguistic skills*", "*they facilitate learning/comprehension*", "*they enhance questioning skills*", "*they impart different viewpoints to students*", "*they promote socialization*", "*they visualize communication*". On the contrary, few participants expressed this opinion "*they weaken teacher-student communication*" (Table 7). According to Daşdemir (2013), the use of

animations makes positive contributions to the retention of the learned information and scientific process skills.

In the category of scientific research/nature of science, in relation to the theme of science literacy, most of the participants stated that "*they do not follow scientific research/they do not find them interesting/they do not have information about them/they are worried about exams"*, few of them stated that they partially follow scientific research (Table 8). It was seen that the participants' opinions about the nature of science are inadequate. But, they emphasized that animations are very useful in terms of acquiring scientific language and developing scientific thinking (Barak & Dori, 2011).

Apart from the questions included in the structured form and semi-structured interview form, two extra questions were directed to the participants. First of these questions is "*Would you like to develop animation programs in science education? Why?* and from the participants' responses to this question, it became clear that they are willing to prepare but do not rely on their competencies. The participants were found to be willing in preparing animation programs. In a similar research, it was reported that technical aspect of animations requires the consideration of teachers' technical competencies, technical support and resources (Chan, 2015). During the interviews, the participants were asked *"Would you like to use ready-to-use animations in your professional life or use your own animations? Why?"*. In this regard, the participants want to use their own animations but they might also prefer to use ready-to-use animations. In a research by Chan (2015) conducted to determine how teachers perceive the use of animations and how they affect their professional development, it was found that though the teachers have positive attitudes towards the use of animations in education, they think that they do not have the technical competencies required for the application of animations. This finding is parallel to the findings of the current research.

6. Recommendations

In light of the findings of the current research, these suggestions can be made. Research questions similar to and different from the ones used in the current research can be directed to teachers and students from different levels of schooling to elicit their opinions about animations. Activities in the form of in-service training programs and courses can be organized to increase teachers' information, skills and competencies about animations. In this way, teachers' technological qualifications can also be developed.

7. Conclusion

In conclusion, the results of the current research that support each other were obtained in this research in which prospective teachers' opinions about animations were determined through using different data collection instruments. The collected data showed that there are some differences between the student primary teachers and the prospective science teachers' opinions about animations' contribution to science

education, frequency of use of animations, relevant use of animations, availability of animations, effects of animations on individuals, sounds and music used in animations, communication skills, and scientific research and nature of science. The research is believed to contribute significantly to national and international literature. In addition to the research that the opinions of teachers, the use of animation for science education is important to reflect the science curriculum. In order to make use of animation in science teaching seminars and undergraduate courses should be given to prospective teachers and teachers in practice the animation program.

About the Author(s)

The researchers work in the fields of educational sciences, teacher training and science education.

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