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# Views of teacher candidates about slowmation: Biology units sample

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**Abstract**
The purpose of this study was to discover the views of teacher candidates on the use of Slowmation in education. Fifty-one students from the Primary School Teaching Program took part in the study. An explanatory approach to the combined method, which enables both quantitative and qualitative research, was used in the study. In order to collect the quantitative data, the teacher candidates were surveyed using the Slowmation Opinion Scale. For the collection of the qualitative data, six of the teacher candidates were asked semi-structured questions during a focus group interview. The teacher candidates prepared slowmations devoted to elementary 4th and 5th grade biology subjects. The prepared slowmations were presented and the survey was carried out. In light of the data obtained, a focus group interview was conducted and the data compiled from the scale was expanded. According to the data, the student teachers defined the slowmations as enjoyable, rewarding, educational, creative, informative and stimulating. According to the qualitative data, on the other hand, they remarked that slowmations should be used in accordance with course requirements and would be more effective when implemented on groups of younger learners. They also stated that preparing slowmations had been difficult initially, particularly in the designing of the subject to be presented.

**Keywords** Improving classroom teaching · Primary education · Simulations · Teaching/learning strategies

## 1 Introduction

The constant attempt to create is among the unique features of Mankind. By dint of this effort, human beings evaluate the knowledge they attain via their senses and endeavor to bring a product into being (Dündar 2013). With the rapid advancement of science,

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technological tools and products are also on the rise. By virtue of the widespread use of this expanding selection of technology, its employment in the field of education has also commenced. The developments in information and communication technology have become the most fundamental grounds for the transformation of an industrial society to an information society. Any view of education that turns its back on technological potentiality cannot fulfill today's social and individual expectations and requirements (Taşçı et al. 2010).

When integrating technology into education, a teacher needs field information, pedagogical information and technological information. Yet, the presence of these three types of information does not necessarily lead to successful integration by the teacher. All three informational dimensions need to be adapted to the lesson, the circumstances of the students and the school, and the lesson should be designed while keeping these circumstances in mind. The importance of information and communication technology to the educational environment can be illustrated by the following functions they present:

- Rendering students sensitive to informatics
- Easing the learning of scientific concepts
- Enhancing the cognitive skills of students
- Creating educational tools (Pekdağ 2005)

The use of technology in educational institutions was formerly limited to radios, TVs, videos and such devices, but we can see that, in today's technological world, the implementation areas of animation, simulation, web design, etc. are increasing incrementally as a result of computers (Bayram 2012). In Turkey, schools have been provided with computers since the 1980s, predominantly for administrative use. Gradually, with the increase in software devoted to learning, they have been included in the educational environment. Today, practically all schools are equipped with computer laboratories (Çepni et al. 2006).

The idea that the in-classroom use of computers by teachers and students enhances success has been put forth by a number of researchers (Ferguson and Chapmen 1993; Tjaden and Martin 1995; Yalçınalp et al. 1995; Coye and Stonebraker 1994; Siva and Tung 2001; Chang 2001; Tsai and Chou 2002; Powel et al. 2003). The use of teaching technologies for educational activities appeals to the multiple sense organs of the students and helps them in a more meaningful and effective way to learn the topics taught (Metin et al. 2013). Fleer (2017) stated that children's motives changed from play to learning; however, the research only examined the children's change of motive in free play settings using software tools such as slowmation.

Computer-Based Learning plays an important role in the teaching and learning of scientific concepts an in developing the learning skills of collecting, storing, reorganizing and analyzing data at the students' own pace (Chang 2001). As teachers employ educational technologies in the classroom, the diversity and quality of education will be improved. The lesson attracts the attention of the students, which motivates them and promotes success. Student creativity and productivity is advanced through participation in teaching-learning activities in the classroom (Cinkaya-Avşaroğlu 2011). Also Alvarenga et al. (2017) stated that the learning objects most mentioned by the teachers were: images, videos, and software.

Recent research reveals that some of the reasons teachers are unable to integrate technology into their lessons arise from factors such as a lack of information and training and from their failure to keep abreast of professional development (Genç and Genç 2013; Göktaş et al. 2009; Gülbahar 2008; İsman et al. 2008; Kiraz and Ozdemir 2006; Kocak-Usluel 2007). One can understand from this that the teacher factor is essential for the employment of technology in the field of education and that this employment should be aggressively structured. It is essential that teachers acquire pre-service training in the use of technological tools appropriate to the course, the students and the subject. Animations, PowerPoint presentations, films, documentaries, Internet-based course contents, educational games and similar technological products should be used in the lessons. Mayer (2005) points out that the incorporation of such state-of-the-art visualization techniques for educational purposes has to be justified, and more specifically, that it is important to understand how best to incorporate pictorial formats with verbal information.

## 2 Literature review

Since the last quarter of the twentieth century, education has been one of the fields using computers and computer technology effectively (Linn 2003). Computer technology and the various tools which it offers have come to be integrated into education. Technology-aided education in itself is divided into subcategories including computer-aided learning, distance learning, electronic learning, Internet-aided learning, online learning and web-based learning (Anohina 2005).

It is mentioned that animations (Mayer and Moreno 2002), which is described as a simulated motion picture film depicting the motion of drawn objects, can serve different purposes such as attracting attention in education, providing motivation, providing extra information, and simplifying complex events (Weiss et al. 2002). For example, in a study by Barak et al. (2011), it was determined that the students in the animated group were more motivated towards learning science than the students in the group where only textbooks and still pictures were used. Similarly, it is stated that the motivated learning materials are more useful than the equivalent static learning materials (Spotts and Dwyer 1996; Taylor et al. 2007). Furthermore, it is known that dynamic processes are more likely to be presented with an animation than a static picture (Vermaat et al. 2003), that animation in the learning process is more effective than using static sequential pictures (O'Day 2006), and voiced and unvoiced animations (Lowe 2003; Mayer and Moreno 2002; Mayer and Anderson 1992; Sweller 1994). Similarly, there are many studies in the literature that show that animations can be used effectively in science education (Burke et al. 1998; Kelly and Jones 2007; Marbach-Ad et al. 2008; Williamson and Abraham 1995).

In their studies, Hoban et al. (2009) had students prepare slowmations and share them on the Web. Following the preparation, review and sharing of their slowmations, the students studied their learning of science topics. They concluded that creating slowmations and uploading them to the Internet was a new way for prospective teachers to learn science concepts.

Rutten et al. (2012), in a study investigating the effect of computer simulations on learning in science education, stated that the widespread use of computers, smart

boards, mobile devices and similar devices would lead to this equipment becoming an integral part of teaching programs. The use of such technological products, especially in making preparatory activities for laboratory work, was recommended. Kidman et al. (2013) stated that the preservice science teachers reported an enthusiasm for Slowmation Animation as a method for learning how to learn, as well as for highlighting what they thought they knew, but didn't really know.

It has been put forward that computer simulations enhance success in traditional education, especially in laboratory implementations (Rutten et al. 2012; Lin and Atkinson 2011). Ploetzner and Schlag (2013) have expressed that, according to the results of their study, animations lead to essential acquisitions for the students. Other research has revealed that because of the fact that teachers face problems in integrating technological products into their lessons, they need to be supported in this matter in their pr-vocational training (Angeli and Valanides 2009; Chai et al. 2011).

Teachers have reported that they rarely use informatics technology products and that those who do use them not for enabling the students to structure the knowledge, but for the transferring of knowledge (Chai et al. 2011; Ottenbreit-Leftwich et al. 2010; Sang et al. 2010). In today's world, the need is increasing rapidly for web-aided (on unit or topic bases) science materials that are in compliance with the syllabus and integrate the elements of field education and technology. Important tasks fall to those who are qualified in this respect (Haggas and Hantula 2002).

Animations help the students to develop creative thoughts. They accentuate possibilities and encourage attempts at various experiments in addition to helping students follow course topics thoroughly and understand them. Mayer and Moreno (2002) described animations as a simulated motion picture depicting the motion of drawn objects. Animations, by annihilating the dullness of the conventional classroom environment to a great extent, make learning activities enjoyable engagements (Cinkaya-Avşaroğlu 2011). Animation is conceptualized as the act, process, or result of imparting life. It relates to the art or process of preparing animated movies that involves the illusion of movement on a screen (Barak and Dori 2011). In today's world, the use of animations is common, while slowmations, considered important in terms of teacher-based preparation, are not widely recognized or used. Studies show that one of the successful ways for enhancing students' motivation to study science is via integrating visualizations and animations into their learning process (Barak et al. 2011; Barak and Dori 2005).

The slowmation process started with stop motions and later progressed to clay motions and slow-stream animations called "slowmations". Slowmation is a simplified way of defining a concept or telling a story to university students or students of any level. It is a learning-promotive method because students themselves coordinate the research and prepare an animation as an indicator of their learning (Ekici and Ekici 2011). Hoban and Nielsen (2014) defined slowmation as a simplified way of making animations to promote discussion resulting in scientific reasoning.

In animations of this kind, the digital images obtained are loaded to a computer program in a way that they create an illusion. This program displays the photographs in order, thus giving the impression that the objects or living things in the image appear to be moving. The fact that the images follow one another makes the eye of the viewer perceive motion.

The preparation period for such animations involves information research done by the students, scenario writing and sketching, and the preparation of models and photographing them as they move. A specific computer program is used so that these photographs appear as animations (Ekici and Ekici 2011).

Slowmations are increasingly being used in education. The slowmations prepared by Hoban since 2005 are considered a new learning approach. After creating over 400 animations in the field of science (Hoban 2009), Hoban also investigated the effects of these slowmations on learning (Hoban et al. 2011). Nielsen and Hoban (2015) studied a group of three preservice elementary teachers creating a narrated stop-motion animation (Slowmation) from start to finish in 3 h to explain the challenging concept of "phases of the moon" to elementary school children. In their study Hoban and Nielsen (2013) propose a new way for preservice teachers to learn science by designing and making a narrated stop-motion animation as an instructional resource to explain a science concept.

For animations to be effective on learning, they should:

a) be understandable
b) be attention-grabbing
c) enable students to retain information
d) be experimental. (Cinkaya-Avşaroğlu 2011)

One point that should be kept in mind is that technology is not a goal, but a means. No technology developed until now can replace the teacher and the human element (Arıcı and Dalkılıç 2006).

Fleer and Hoban (2012) argue that Slowmation provides a mediating context where a system of interdependent concepts can be held constant, while the relations between a particular everyday concept and scientific concept can be interrogated through action and thought. The purpose of this study was to collect the views of teacher candidates on the use of slowmations in education. To this end, teacher candidates were asked to prepare slowmations and, following the implementation, their views were compiled. Within this framework, the answers to the following questions were sought:

- What are the opinions of teacher candidates about slowmations?
- What are the views of teacher candidates on the preparation of slowmations and their use in the classroom?

## 3 Materials and methods

This study was aimed at investigating the views of teacher candidates about slowmations. Mixed research involves collecting qualitative and quantitative data relating to basic facts within a single study or a series of studies, analyzing the data and interpreting it (Fraenkel et al. 2012; Leech and Onwuegbuzie 2009). An explanatory design was used in the study to flesh out the results. In this design, the researcher first carries out a quantitative method and then uses a qualitative method to follow up and refine the quantitative findings (Fraenkel et al. 2012). The quantitative data were collected using the Slowmation Opinion Scale (SOS). To collect

qualitative data, a focus group interview was conducted. A tape recorder was used to record the discussions.

### 3.1 Data collection tools

In order to collect the quantitative data for this study, the Slowmation Opinion Scale (SOS) was administered to the student teachers.. The scale is adapted from the scale prepared by Daşdemir (2006). This scale was used to determine their views about slowmations. In this scale, the questions, which were graded from 1 to 5, defined using slowmations as useful, instructive, enjoyable, informative and stimulating. For this sample, the Cronbach alpha coefficient was 0.824 This scale, which is applied to determine student opinions in the application of slowmations, consists of three categories. The first category consists of a question asking students how useful the slowmations are in their understanding of the lesson. The second category consists of graded questions about how the course is useful, instructive, enjoyable, creative, informative and stimulating. In the last category, there are open-ended questions to students about their opinions on slowmation.

### 3.2 Participants

The investigation study group was composed of 51 first-grade undergraduate student teachers in the Classroom Teaching Department of Düzce University's Faculty of Education. These students took the "General Biology" course in the fall term. These student teachers are being trained as primary school teachers. Participants in the focus group interview were determined randomly.

### 3.3 Study implementation

The student teachers were instructed how to make slowmations in the first weeks of the course; each weekly class lasted 2 h. The students were split into 17 groups of three.

The study program was as follows:

Weeks 1–2: Information about slowmations was given; sample studies were shown.
Weeks 3–4: Planning the slowmations
Weeks 4–5: Building the characters
Weeks 6–7: Designing the set
Weeks 7–8: Taking pictures
Weeks 8–9: Building the slowmations
Weeks 10–12: Slowmations were watched and evaluated

The student teachers chose topics, according to their own interests, from the biology topics taught in 4th and 5th grade science lessons. The topics and the distribution of the topics according to the class level are shown in Table 1.

The slowmations prepared by the participants were evaluated according to the following criteria, taking into account the characteristics expressed by Barak and Dori (2011).

**Table 1** Distribution of the topics according to class level

| Slowmations prepared by the students teachers | Grade |
|---|---|
| Structure and functions of the skeleton | 4th grade |
| Structure and functions of the muscles | 4th grade |
| The skeleton relationships of muscle in motion | 4th grade |
| Skeletal and muscular health | 4th grade |
| The respiratory organs and their structure | 4th grade |
| I'm breathing | 4th grade |
| Correct breathing and health of the respiratory organs | 4th grade |
| Circulation of the blood in the body | 4th grade |
| The pulse | 4th grade |
| The pulse and exercise | 4th grade |
| Breathing and exercise | 4th grade |
| Necessity nutrients | 5th grade |
| Carbohydrates | 5th grade |
| Proteins | 5th grade |
| Vitamins | 5th grade |
| What happens after we eat? | 5th grade |
| How does the urinary system work? | 5th grade |
| The eye and eye problems | 5th grade |
| The ear | 5th grade |

- Does it fit the curriculum?
- Is it related to students' daily life?
- Is there a narrator that provides verbal explanations?
- Are the text boxes that show correct wording and spelling used?
- Is there an emphasis on scientific thinking?
- Did all participants participate in the preparation?
- Are visual content appropriate?
- What is the general view of the followers?

## 4 Results

### 4.1 Quantitative analyses

Of the participats, 70.59% were female and 29.41% were male. All group members were first-grade classroom teaching students. In terms of gender, no meaningful difference was found in the students' views about slowmations ($p = 0.919$).

For the first question of the study, the student teachers were given an SOS on which they could express their views on slowmations. The percentage distribution of the answers given by the students to the questions of the scale is given in Table 2.

The scale average was calculated as $\overline{X} = 4.21$. In accordance with this result, it can be concluded that the general consensus of the student teachers about slowmations was

**Table 2** Students teachers' views about slowmation

| | Points (%) | | | | | | Mean score | |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | Sd | $\overline{X}$* | |
| Not enjoyable | 1.96 | 1.96 | 25.49 | 15.69 | 54,90 | 1,02 | 4.20 | Very enjoyable |
| Not stimulating | 3.92 | 11.76 | 17.65 | 19.61 | 47,06 | 1,22 | 4.18 | Very stimulating |
| Not informative | 0.00 | 3.92 | 7.84 | 43.14 | 45,10 | 0,78 | 4.18 | Very informative |
| Not useful | 1.96 | 1.96 | 3.92 | 31.37 | 60,78 | 0,83 | 4.17 | Very useful |
| Not instructive | 1.96 | 3.92 | 9.80 | 21.57 | 62,75 | 0,96 | 4.19 | Very instructive |
| Not creative | 3.92 | 1.96 | 3.92 | 31.37 | 58,82 | 0,96 | 4.26 | Very creative |
| Not good | 5.88 | 3.92 | 13.73 | 23.53 | 52,94 | 1,17 | 4.27 | Very good |
| | | | | | | | 4.21 | Overall average |

*Average out of five points out

positive. To determine their participation level in the scale statements, the average was divided into three degrees. The ratios of participation, as given in Table 3, were "low", "medium" and "high".

The positive rating of the views given by the student teachers that participating in the study was "high", with a percentage of 84.31. On the other hand, 13.73% of them stated a "medium" level of positive opinion (Table 3). It can be concluded from the answers given on the SOS that their opinions on slowmations were highly affirmative.

Based on this data, in order to receive more detailed opinions on slowmations from the teacher candidates, six of them took part in a focus group interview. The interview was recorded and the responses were analyzed.

### 4.2 Qualitative analyses

With the purpose of collecting qualitative data, the six student teachers – three males and three females – participated in a focus group interview. Semi-structured questions were asked in a way that enabled them to define their answers in a detailed manner. The frequencies of the codes in the templates created according to the findings obtained from the qualitative data were determined. The frequency distributions of the themes and codes expressing the views of teacher candidates about slowmation are given in Table 4.

**Table 3** Average distribution of the slowmation opinion scale

| Score range | f | % | Level |
|---|---|---|---|
| 1.00–2.33 | 1 | 1.96 | Low |
| 2.34–3.66 | 7 | 13.73 | Medium |
| 3.67–5.00 | 43 | 84.31 | High |
| Total | 51 | 100 | |

**Table 4** Frequency of the themes and codes determined according to the views of the candidate teachers

| Themes | Codes | Frequency |
|---|---|---|
| Difficulties | When first made | 4 |
| | To design | 4 |
| | Preparing for the student level | 3 |
| | To make it remarkable | 2 |
| | To combine pictures | 1 |
| | To set time | 1 |
| | To choose music | 1 |
| | To use the computer program | 1 |
| Usage areas | At the beginning of the course | 3 |
| | Teaching abstract concepts | 3 |
| | Small classes | 2 |
| | To draw attention to the course | 2 |
| | To repeat and reminder purposes | 2 |
| Benefits | Provides permanent learning | 4 |
| | Enjoyable | 3 |
| | Helps to attract attention | 3 |
| | Students become active | 2 |
| Losses | Not enough in teaching alone | 2 |
| | Harmful for eye health | 2 |
| | Can not set appropriate level | 1 |
| | May lead to wrong learning | 1 |

The main questions asked in this interview and some answers given by the students are given below:

**Question 1: At what points did you have difficulty preparing the slowmation?**

An examination of the answers given by the students to this question revealed that they had difficulties, particularly in design. The students stated that they had had long discussions with their group members about what to do, and that they moved on to the production after determining the important points. Several of the groups stated that they examined sample studies to solve the problems they encountered in the design process.

They also said that they had difficulty in ascertaining what materials to use, the level of the students, and the order in which they were to present the topic, as well as in choosing the music.

*S1: We had difficulty, particularly in the matter of design. Speaking for myself, this was the hardest part.*

***R: What was the most difficult for you while designing?***

*S1: First of all, it was really difficult to prepare it according to the level of the students. We did not know their readiness level. We considered what materials would attract their attention for an extended time. We saw using music as appropriate. Children today listen to fast music. For this reason, we chose rap music. The most crucial point, perhaps, was to design in accordance with the level of the students. We spent a long time on design, with the aim that it would be both suitable for their level and attention-grabbing.*

***R: How much time did you spend, exactly?***

***S1:*** *The designing process took about five weeks. Gathering the documents, studying the samples and deciding on which to use took a long time. Once the design was completed, implementing it was easier, I think. After procuring the materials, we performed several trials. The rest was enjoyable as it was easy.*

Another problem faced in the preparation of the slowmations was the glitches rooted in the program used for the merging of the images. Several of the students declared that they had difficulties since they had not used the Movie Maker program previously.

***S3:*** *I had not used Movie Maker before. Thus, it took us some time to figure out the program. In my opinion, we use technology only for personal purposes. As we had not used it for other purposes, we had problems. In this project, we learned to make positive use of technology by creating something new for a designated purpose as well. We should carry out more work devoted to using technological products for education.*

***R: Did you get support from anyone in using the program?***

***S3:*** *We received some basic help from our friends who have used it before. Yet, because of the fact that each group was using different materials, the production styles were different. Consequently, we figured out the program through trial and error and then prepared the assignment. Almost all of the groups learned how to use the program, which they had never used before, in the same way.*

**Question 2: In which sections of a lesson can slowmations be employed?**

In the focus group interview, for this question, the students expressed both opinions supporting the use of slowmations at the beginning and supporting the use of them at the end of the lessons. Those of the opinion that it was appropriate to use slowmations at the beginning of the lesson gave the reason that it would attract interest, as visual stimulation. Those who said it should come at the end of the lesson were of the opinion that it could serve as a brief revision.

***S6:*** *Since it was difficult to prepare the slowmations professionally, our preparations were at a pretty low level. For this reason, it would be better to use them at the beginning of the lesson to attract attention. If students think that they are*

*going to watch cartoon films, they will concentrate on the topic better. As it is a good introduction, it will then be easier to continue the lesson. The visuality is important and can certainly aid learning retention.*

***R: Does it matter in which stage of the lesson they are employed?***

***S6:*** *For me, it does not. Because no matter which age group you implement it on, it will be interest-grabbing and leave a lasting impression because it turns the abstract into the concrete. We cannot use them to teach the core of the topic. It is already too difficult to prepare anything extensively. For this reason, using them at the beginning of the lesson to attract attention is sufficient.*

Another view suggests that they should be used at the end of the lesson as reinforcement.

***S4:*** *I believe that it would be useless for a student to watch these without having any knowledge of the topic. We would provide more opportunity for retention and reinforcement of learning if we used slowmations once the topic has been taught. I also agree that it would be suitable to use them for the comprehension of abstract concepts. If the students do the other activities related to the topic and watch the relevant slowmation afterwards, it would be quite appropriate. This way, we can remove any of their misunderstandings.*

***R: Does it matter at which stage of the lesson they are used for different age groups?***

***S4:*** *In my opinion, they can be used for children's groups. Older students would prefer more professional visuals. Most of them today are used to seeing better visuals. Thus, more specialized materials should be prepared for them in their education as well. For younger children, however, even the slowmations that we prepared would be sufficient.*

Besides these views, there were also opinions that slowmations could be used during the course of the lesson. Additionally, there were recommendations for using slowmations for the preparation of physical activities and exercises, as the prepared slowmations give the impression of motion. Another point of view suggested that slowmations might well be used for all grades so long as the level of the age group has been determined and the slowmations have been prepared accordingly.

**Question 3: In your opinion, what are the benefits of slowmations?**

In the answers the students gave to this question, they expressed their views on the effects of slowmations on the teaching of the topic and on the learning of the students. Besides the view that slowmations rendered the lessons more attractive, enjoyable and flowing, there were views that learning would be facilitated and retention of learning would be enhanced.

***S5:*** *I think that learning would be easier as visuals are extensively used. In my view, children, particularly in their "concrete" stage, would delight in learning a topic in this way.*

***R: Are they more effective for the learning or for the teaching of the topic?***

***S5:*** *I think both. The structure of this implementation requires creativity and leads the children to be more active in the lesson. For this reason, it would have a positive effect on students and they would enjoy lessons in which this implementation is used. In other words, it would have a positive effect on attitude as well.*

Parallel to this view, there were opinions that it was also a good implementation for teacher candidates.

***S2:*** *It is also important that teachers be able to learn a variety of similar implementations. There should be different activities during a lesson to arouse the interest of students, motive them and lead them to develop a positive attitude. By this means, the intrinsic talents of the children may be brought to light. If you teach using the conventional methods, you can estrange even a student who shows interest in and likes the course. We have to lure each student into active learning and let the students provide their own learning experience.*

***R: Are slowmations more effective for learning or for teaching?***

***S2:*** *It seems to me that they are more effective for students. I even think that making the students create slowmations themselves would be more effective. True, they would find it very difficult at first, but later on, they would have a lot of fun. Moreover, they could even learn the subject as they prepare the slowmations. I realized that I learned the subject while we were preparing for our topic. While doing research on the topic, studying which piece of information was essential and factual, deciding which one should be used, you learn the topic. It is a mind-exercising implementation.*

The striking point in the answers was that the operations, particularly in the preparation stage, had a positive influence on the scientific process skills of the individual teacher candidates as well. Similarly, researchers also perform activities that are rewarding for their scientific process skills such as observation, classification, data recording, and modeling.

**Question 4: Do you think slowmations have disadvantageous aspects? If they do, what are they?**

The common opinion of the teacher candidates in their answers to this question was that slowmations did not have disadvantageous aspects.

***S1:*** *I am of the opinion that they would be advantageous as long as we do not give particularly false information. Maybe they might cause eye strain due to*

*computer use. I think that they would not have drawbacks of any other kind. In the event that the slowmation was long, the students' eyes might get strained and they might get distracted.*

***R: What can be done to reduce the disadvantages?***

***S1:*** *I think they should be brief and succinct. Using them at the beginning of the lesson to arouse attention would not be disadvantageous at all. The preparer of the slowmations should definitely master his/her subject and the slowmations should be checked by a specialist.*

Another student stated:

***S6:*** *I do not believe that there would be any disadvantages as long as they are appropriately prepared for the educational program. That they are suitable to the level of the students is essential. There would be no problems if, through looking at the program, the factor of the ages of the students is taken into consideration.*

***R: What can be done to reduce the disadvantages?***

***S6:*** *At this point, it falls to the teacher's lot. The teacher should examine the program closely and, at the same time, prepare the slowmations according to his/her students' prior knowledge and capacities because alone they might not be sufficient for education. They should be prepared with supplementary activities in mind. Therefore, the teacher should continually improve himself/herself by keeping up with the latest innovations in the field.*

When the answers are analyzed, it is seen that the answers are categorized on the difficulty of the application, where it should be used, the benefits and the possible risks. Below are some screenshots of some of the slowmations that the participants have prepared (Figs. 1, 2, and 3).

## 5 Discussion and conclusion

It is recognized that new ways of presenting scientific concepts to students and teacher candidates are needed (Bennett 2001; Davis et al. 2006; Lee et al. 2009; Tytler 2008). The integration of technological products within education is especially important as one of the recommended new ways to improve the learning process. Technological products such as animations have been extensively used in education, particularly for enhancing the comprehension of complicated processes and abstract concepts (Ploetzner and Schlag 2013). In this study as well, the teacher candidates were asked to use different techniques and perspectives in creating slowmations to augment their teaching of science topics. In the first stage of the study, they were given a scale on which their opinions of slowmations were recorded. According to the data obtained from the scale, slowmations were defined as enjoyable, beneficial, educatory, informative and stimulating. Studies have shown that computer-aided techniques such as


**Fig. 1** Series of screenshots from one of the slowmations

simulations, slowmations and animations have a positive influence on learning. Daşdemir (2013) used animations in his study. As a result of the study, it was found that the use of animation in the basic education 6th grade science and technology course in the unit of particle structure of matter had positive effects on the academic achievements of the students, retention of this achievement, and the development of scientific process skills. Moreover, it was determined that the students in the experiment group expressed positive views about the use of animations. Similarly in their study, Önal and Söndür (2017) investigated the views of middle school students towards their attitudes towards technology and their use of animations as a technology application in science. They stated that the participants' Animation Opinion Scale perceptions are positive and satisfactorily high. Genç (2013) investigated teacher candidates' views about using animation on learning the subjects of biology. Result of this study reveals that use of animation in lessons was useful, enjoyable and effectively to learning subjects. For example, Boyle et al. (2014) found that games, animations and simulations had a positive effect on the teaching of research methods and statistics. Shepherd et al. (2013) investigated the potential of using a new but simplified form of stop-motion animation called slowmation to support 4 primary school students with mild intellectual disabilities in co-constructing an animated social narrative about their own social skills. They stated that each student was able to use a range of stop-motion skills with varying levels of support. As a consequence of their co-construction, the students' understanding of their own social skills increased.

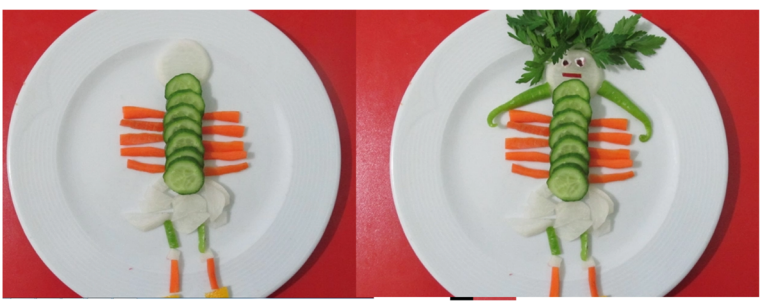

**Fig. 2** Series of screenshots from one of the slowmations

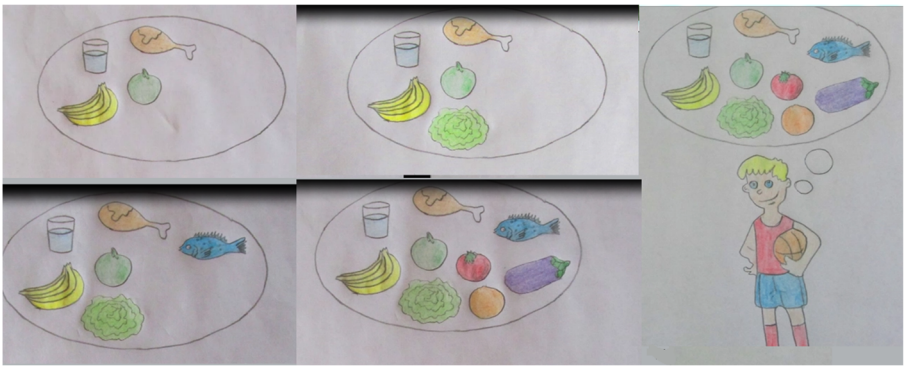

**Fig. 3** Series of screenshots from one of the slowmations

Furthermore, Özmen (2011) stated that the combined use of animations and conceptual-change texts was an effective way of enhancing the comprehension of basic science and chemistry concepts for 6th grade students. Similarly, Kervin (2007) has used slowmations in different areas of teaching. In his study, he used slowmations as a teaching strategy to help 4-year-old students understand fractions. King (1999) investigated the use of technology, via motion pictures, as an educational means in achieving the goal of scientific literacy. Other studies have shown that students learn complicated scientific concepts and thoughts more easily in computer-aided science teaching programs which use simulations effectively (Gorsky and Finegold 1992; Huppert et al. 2002; Podell et al. 1993). Fleer and Hoban (2012) stated that slowmation is an innovative way of realizing intentional teaching in early childhood settings as young children co-construct digital animations about science concepts. In parallel with these studies, there are studies stating that computer simulations are effective in eliminating misconceptions (Lee et al. 2004; Olde and Jong 2004).

According to the qualitative data of the current study, designing slowmations was a compelling activity for the teacher candidates. Similarly, DeCoursey (2012) investigated the attitudes of teachers towards making animations. Forty-four teachers stated that making animations was valuable, meaningful, and essential, yet difficult and time-consuming and that it required a high level of communicative skills. According to the quantitative data, on the other hand, animations as tools of education were recommended. In a similar vein, Youssef and Bizzocchi (2008) specifically recommend using new-generation post-production products in the making of slowmations.

The data in the current study reveal that teacher candidates are in need of support, particularly in preparing materials suitable for the levels of their students. For this reason, it is advisable that designs be made within the learner-teacher-system triangle (Wood et al. 1999). Because an increasing number of studies suggest that students' learning is enhanced when they create digital artefacts, such as representations of science concepts (Fridberg and Redfors 2018;101).

The student teachers stated that slowmations were supportive of long-term learning. However, they also remarked that slowmations alone would not be adequate and that the lessons should be reinforced with similar activities. Similarity Wishart (2017) stated that the student science teachers reported that making animations themselves supported them in thinking through the process of how, as teachers, they would need to

communicate the underpinning science to others. Likewise, Lin et al. (2013) specified that simulation systems with enhanced mobile collaboration offer better learning environments than conventional 2D animations. Hyun (2005) emphasized that employing technological products in the lessons is beneficial, particularly when utilized by cooperative groups. Teachers have given such recommendations as well. In addition, several studies have shown that a positive effect was achieved by the use of animations enriched with conceptual change texts that enabled students to understand simple chemical concepts (Özmen 2011; Özmen et al. 2009). Since the transfer of knowledge to the brain is easier when given to students via multimedia (Bagui 1998), developing countries are preparing web-based science materials as an alternative to conventional teaching materials (Tsai and Tsai 2003). The Internet is capable of instantly providing multimedia facilities such as texts, pictures, graphics, animations, audio, and the like.

In this study, slowmations were used to aid the teacher candidates as they endeavored to integrate technology into education in an appropriate manner. It is important that prospective teachers live up to these requirements of the era in keeping with the requirements of the students, the lessons and the learning environment. It is advisable to give pre-vocational training with the goal of enabling teacher candidates to perform parallel studies that they can implement in their professional lives. Nielsen and Hoban (2015) stated that (i) creating a slowmation enabled the preservice teachers to develop more elements to contribute to their understanding of moon phases; (ii) the design of the slowmation was based on breaking the concept into a sequence of sub-concepts that were represented digitally.

Slowmation is a simplified way of making an animation, it is the preservice teachers who design and make the animation as an instructional resource to explain a science concept (Hoban and Nielsen 2012).

Hoban et al. (2011) suggest that when preservice teachers create a slowmation, they design and make a sequence of five representations, each being a semiotic system with particular affordances that link as a semiotic progression: (i) research notes; (ii) storyboard; (iii) models; and (iv) digital photographs, which culminate in (v) a narrated animation. Also, Loughran et al. (2012) stated that as a consequence of teaching Slowmation that these student teachers came to recognize and respond to students' alternative conceptions. Data of Hoban and Nielsen's study (2013) illustrate how the preservice teachers' science learning was related to their prior knowledge and how they iteratively revisited the content through the construction of five representations as a cumulative semiotic progression: (i) research notes; (ii) storyboard; (iii) models; (iv) digital photographs; culminating in (v) the narrated animation. This progression enabled the preservice teachers to revisit the content in each representation and make decisions about which modes to use and promoted social interaction. Creating a slowmation facilitated the preservice teachers' learning about the life cycle of a ladybird beetle and revised their alternative conceptions.

The studies (Hoban and Nielsen 2010, 2012; McKnight et al. 2011) suggest that slowmation has the potential for widespread use, because the creation process is relatively simple and uses accessible technology. Preservice teachers or other learners use their own digital still camera or mobile phone camera, everyday materials in constructing their models and have access to free movie-making software on their personal computers.

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