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PERCEPTIONS ON EDUCATIONAL FILMS CONTAINING BIOTECHNOLOGY APPLICATIONS PREPARED BY TEACHER CANDIDATES

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ABSTRACT

This study aims to examine the unique educational films prepared by science teacher candidates about biotechnology applications and getting their perceptions on the process/the educational films they have prepared. The phenomenology method was used. The study group consists of 30 sophomore teacher candidates. Teacher candidates prepared educational films. Then, the perceptions of the teacher candidates about this process were taken. According to the results of the study educational movies were prepared by teacher candidates by way of their writings about stem cells, genetically modified organisms, nanotechnology and cloning. The educational films focused on the positive and negative aspects of these biotechnology subjects, on the basis of daily life scenarios. Even though the short movies contained both negative and positive references, they mostly had a positive note.

Keywords: *cloning, educational films, genetically modified organisms, nanotechnology, stem cells*

INTRODUCTION

Educational films were first defined by Wayne Hodgins as a learning object in 1994. Learning object refers to contents that are stored and reused via computers in order to support learning (Polsani, 2003). Learning objects include concept maps, videos, simulations and movies in digital format (South & Monson, 2000). Educational films can be defined as teaching materials that deal with events that have occurred or are likely to occur and engage multiple senses of persons to create an impactful educational environment (Korkmaz, 2017). Mostly, educators approach learning environments and learning environment components from multiple perspectives (Oruç & Sarıbudak, 2015). Using educational films in educational environments, makes it easier to understand abstract and complex knowledge. Since educational films appeal to visual and auditory senses, more permanent learning takes place and learns acquire skills more easily (Birkök 2008). Educational films are also effective in instilling in students' positive sentiments for their country, because they reflect real life, popular culture and art (İşcan, 2011).

Researchers have emphasized the benefits of educational films in educational environments. For example, Gregg et al. (1995) stated that films contribute audibly and visually to a better understanding of difficult and abstract concepts. Again, a study by Michel et al. (2007), found that educational films used as teaching materials were effective in revealing and organizing preliminary information students bring to the classroom. Watts (2007) and Weinstein (2001) concluded that educational films were effective in increasing students' motivation for lessons. Barnett et al. (2006) stated that science fiction

films were effective in students' understanding of scientific concepts and the development of their mental skills. Güven Yıldırım et al. (2015) stated that educational films could be used to draw students' attention to the applications of science in daily life. Similarly, Whiteman (2009) stated that documentary films prepared for educational purposes could be used as a mass education tool, that large segments of society could be reached via films, and that these films could also affect individuals in many aspects. Also, according to Demircioğlu (2007), educational films are effective in clarifying phenomena, arouse students' sense of curiosity about the lesson and daily events in general, enable students to develop positive attitudes towards the lesson, and increase academic success. In addition to these benefits, educational films are widely preferred as teaching materials because they provide motivation, concretize abstract concepts and ensure permanent learning (Pekdağ & Le Marechal, 2007). A review of the studies reveals that the studies focus on nature and environmental education (Takmaz et al., 2017), social studies education (Karasu Avcı & Faiz, 2021; Kaya & Çengelci, 2011), biology education (Yılmaz, 2018) values education (Kaçmaz, 2020; Ünal, 2021), science education (Güven Yıldırım, 2015; Güven Yıldırım et al. , 2015; Köklükaya, 2014; Tatlı & Şahin, 2020; Topal et al., 2019) and foreign language education (Kaya, 2021). However, according to our knowledge, there is no study on educational films covering the field of biotechnology, which has rapidly developed over recent years and left its mark on the century we are in, with potential to play a major role in shaping our future.

Biotechnology consists of the words "biology (life sciences)" and "technology (applied knowledge)" and means "applied life sciences" (Öcal, 2012). Biotechnology is an overarching concept subsuming fields of studies such as organ transplantation, genetically modified organisms, stem cells, nanotechnology, personalized medical applications, nuclear energy, genetic cloning, artificial intelligence and nuclear medicine. Research shows that students find biotechnology a particularly difficult field of study and this is usually attributed to the abstract and complex nature of biotechnology subjects, their constant updating and teachers improperly qualified to teach the subject (Kidman 2009; Turan & Koç 2012). Therefore, studies conducted with students, teachers or teacher candidates, show that the level of knowledge about biotechnology subjects is rather low. (Lamanauskas & Makarskaite-Petkevičienė, 2008; Prokop et al., 2007). For this reason, using different learning materials such as educational films in the teaching of subjects such as biotechnology that are difficult to learn, containing abstract concepts and consisting of a combination of many fields, can increase the quality of teaching. In addition, when the studies given above are examined, it is seen that studies are mostly carried out with educational films that already exist. However, it is also known that the videos and films prepared by teacher candidates also contribute to the acquisition of behaviours consistent with learning outcomes, such as students planning and executing their own learning activities, reflective thinking based on their own acquisitions, and making sense of the teaching process etc. (Akbaş et al., 2015). For this reason, it can be said that educational films prepared by individuals themselves have a significant contribution to the learning and development of individuals. In this context, unlike other studies in the literature, this study aims to examine the educational films prepared by science teacher candidates about biotechnology applications and getting their perceptions on the process/the films they have prepared.

METHODOLOGY

Research Design

Aiming at getting the ideas of teacher candidates about educational films prepared by science teacher candidates about biotechnology applications, this study employs phenomenology, a design component of qualitative research studies. Phenomenology aims to evaluate actual situations that have been experienced in real life (Baltacı, 2019; Jasper, 1994).

Participants

Participants were determined according to the purposive sampling method. In accordance with the purpose of the study, pre-service teachers who took courses on biotechnology subjects formed the study group. The study group consists of 30 sophomore teacher candidates (2 male, 28 female) studying at the Science Education Department of a state university in Ankara in the fall semester of the academic year 2019-2020.

Data Collection Tool

The semi-structured interview form, developed by the researchers, was the data collection tool for the study. There were four open-ended questions in the form about educational films which were on biotechnology applications. The four questions asked to teacher candidates about the films, written and shot by themselves, are as follows.

1. Which biotechnology application did you have in mind for your film?
2. How was your approach to biotechnology application in the film you shot? From what perspective did you approach it?
3. What is the idea behind the film?
4. Do you think the film has an impact on changing public awareness? If so, how?

The perceptions of two science faculty members were sought while examining the content of the questions. In line with the perceptions of the experts, some questions were divided into two, while others had changes to their verb stems. All data obtained from the interviews with the teacher candidates were recorded with a voice recorder to convert them into written text in a computer environment, after obtaining the consent of the participants. Since the teachers' own sentences are given directly in the results, each teacher candidate was given code names such as TC1, TC2, TC3.

Data Collection Process

The research was carried out with sophomore science teacher candidates. Data were collected within the scope of the Science and Technology Based Problems course in the second year of the science teaching undergraduate program. The course taught subjects related to biotechnology applications asking students to make a short educational movie about an application of their choosing. First of all, students were asked to form groups of 3. The groups were formed on a voluntary basis. The students, who formed a total of ten groups of three, were given a five-week deadline to make short educational films. Each week, during course hours, discussions were held on teachers' progress and any issues they might have encountered, where teachers were allowed to ask questions for guidance on their projects. Each group made its own movie, but the interviews were conducted with teachers separately. At the end of the process, interviews were conducted with the science teacher candidates and recorded with the permission of them. The interviews were conducted by the researchers. In addition, four questions were asked to the teacher candidates during the interview process. Detailed information about the implementation process given to the teacher candidates is given in Table 1.

Table 1. *Implementation process*

Time	Work Done
1. Week	Giving of short information about educational films and forming of groups
2. Week	Groups identify their chosen biotechnology application
3. Week	Writing of scenarios for educational films
4. Week	Making films out of scenarios
5. Week	Making films out of scenarios
6. Week	Watching and discussion of the films in the class

The educational film topics chosen by the teacher candidates were genetically modified organisms, stem cells, nanotechnology and genetic cloning. The duration of the short films made by teacher candidates varies between 4 and 10 minutes. Finally, the films were watched and discussed altogether in the class. Afterwards, semi-structured interviews were conducted with teacher candidates. Information about short educational movies made by teacher candidates is given in Table 2.

Table 2. *Information on educational movies*

Educational movies	Name of educational movies	Subject of educational movies	Duration of educational movies
1st Educational movie	Immortality	Stem cell	4 minutes 21 seconds
2nd Educational movie	Traditions	Stem cell	4 minutes 58 seconds

3rd Educational movie	Science with Billie	Genetic Cloning	7 minutes 11 seconds
4th Educational movie	Life with GMO	GMO	5 minutes 9 seconds
5th Educational movie	A nanochip	Nanotechnology	9 minutes 23 seconds
6th Educational movie	What do people say?	GMO	5 minutes 01 seconds
7th Educational movie	T-shirt that does not get wet	Nanotechnology	5 minutes 42 seconds
8th Educational movie	Technonews	Nanotechnology	6 minutes 39 seconds
9th Educational movie	Angel and devil	GMO	5 minutes 02 seconds
10th Educational movie	Symposium	Genetic Cloning	8 minutes 15 seconds

A brief summary of and excerpts from educational movies in the fields of stem cell, cloning, GMO and nanotechnology made by teacher candidates are given below.

Educational Movie 1: Immortality

This educational film about stem cell technology focuses on two university friends. Two friends start to discuss stem cell technology during their university years. One is an advocate of stem cell technology claiming it can reverse aging and bring people immortality, while the other makes a rebuttal emphasizing the unethical aspects of stem cells. Two friends meet again 40 years after graduating. Seeing his friend still looking young and fresh with no white hair, the once-staunch detractor of stem-cell technology, now looking gaunt and emaciated, regrets his perceptions.

Educational Movie 10: Symposium

This educational movie about genetic cloning technology focuses on an interview in a TV program. In the interview, there is a presenter, a scientist working on cloning and its benefits to society, a scientist opposing cloning because of its ethical and legal aspects, and a scientist representing the field of medicine. There is a heated discussion about what cloning is, its benefits, its long-term societal effects, and its health implications.

Educational Movie 5: Life with GMO
In this movie about the technology of genetically modified organisms, biotechnology expert Prof. Billie provides snippets of invaluable information about the subject. The GMO technology and the rationale behind it are explained at length by Prof. Billie.

Educational Movie 6: T-shirt that does not get wet
In this educational film about nanotechnology, a university student buys a t-shirt and realizes that it never gets wet. This arouses in him a curiosity for nanotechnology, which he starts to do research on.

Data Analysis
Content analysis, which is one of the qualitative analysis techniques, was used to analyze the data obtained from the short educational movies made by teacher candidates (Miles & Huberman, 1994). As Miles and Huberman (1994) stated, the consistency of the codes made by researchers independently was determined by the markings "Agreed" or "Disagreed". The consensus correlation coefficient between researchers was found .86.

Ethical Considerations
Informed consent was obtained and students participated voluntarily to the study. The data obtained from students was kept confidential.

FINDINGS

Under this research study, short educational movies about biotechnology applications were made by teacher candidates who, afterwards, were asked four open-ended questions about the films they made. The answers given by teacher candidates to the semi-structured interview questions are given in the tables below.

Teacher candidates were firstly asked, 'Which biotechnology application did you have in mind for your film? Why?' The answers given by teacher candidates regarding the biotechnology application of their choice were given in Table 3.

Table 3. Selected biotechnology applications

Biotechnology application	f (group)
Genetically modified organisms (GMO)	3
Cloning	2
Nanotechnology	3
Stem cell	2

When Table 3 is examined, three of the teacher candidates chose genetically modified organisms, two chose cloning, three chose nanotechnology, and the two groups chose stem cell technology.

The perceptions of teacher candidates on the reasons for their choices are given in Table 4.

Table 4. Teacher candidates' reasons for their choices

Biotechnology application	Reason for choosing	f
GMO	Related to health	7
	Command of the topic	3
	Interesting topic	2
Cloning	Surprising topic	4
	Popular topic	3
	Self-motivated research	2
	Fantastic topic	1
Nanotechnology	A topic with links to real life	6
	Interesting topic	4
	The need to raise public awareness	2
Stem cell	Related to health	4
	Relevancy of the topic	2
	Drawing attention to donations	2

When Table 4 is examined, teacher candidates chose GMO because it is related to health (f=7), because they have a good command of the subject (f=3) and because they find it interesting (f=2). While teacher candidates chose cloning because it is surprising (f=4), because it is popular (f=3), because of the need to do their own research (f=2) and because they find it fantastic (f=1). Thirdly, teacher candidates chose nanotechnology because it has links to real life (f=6), because they find it interesting (f=4) and because the public needs more direction (f=2). Finally, teacher candidates chose stem cells as it is related to health (f=4), it is a relevant topic (f=2) and more needs doing to draw attention to donations (f=2). Direct quotations from the teachers' responses to the question are given below:

TC3: …I find the topic of genetically modified organisms very interesting. That's why I chose it because it caught my interest. My friends in the group thought the same, so we made a joint decision.
TC10: I think cloning is a very popular topic… I also find it very fantastic.
TC7: I chose nanotechnology because I think society is not really aware of it. As far as I can judge from people around me, I thought that at least… the public should have more awareness on such a relevant topic.
TC20: Stem cell is one of the subjects that has a great impact on human health. This was the most influential reason behind my choice. I also find stem cell donation very important. So, I wanted to draw attention to this issue.

Teacher candidates were asked, 'How was your approach to biotechnology application in the film you shot? From what perspective did you approach it?' The answers given by teacher candidates regarding their approaches to biotechnology application in their movies and their perspectives on the subject were given in Table 5.

Table 5. Teacher candidates' approaches to biotechnology applications in their movies

Theme	Code	f
Works positively	Related to health	12
	Good for the public	10
	Related to daily life	2
	New technology	1
	Enjoyable	1
Works negatively	Bad for the environment	9
	Prone to abuse	2

	Ethically concerning aspects	2
	Long-term effects unknown/risky	1

When Table 5 is examined, teacher candidates approached these technologies from the following perspectives; related to health (f=12), good for society (f=10), related to daily life (f=2), new technology (f=1) and entertaining (f) causing them to embrace a positive attitude. While teacher candidates approaching the subject from a negative perspective dwelt on the following aspects; bad for the environment (f=9), prone to abuse (f=2), contains ethical violations (f=2) and unknown long-term results (f=1). Direct quotations from the teachers' responses to the question are given below:

TC9: Our film is about health… Technologies that deliver important outcomes regarding health should feature more prominently in our lives.
TC13: Today, technology has its benefits, while also being bad for the environment. We even use technology to solve problems created by technology itself. Moreover, we do not have definitive data on whether these technologies are beneficial or not. That was our perspective.

Thirdly, teacher candidates were asked, 'What is the idea behind the movie?' The answers given by teacher candidates regarding the idea behind their movie are given in Table 6.

Table 6. Ideas behind teacher candidates' movies

Theme	Code	f
Positive outcome	Good for the health	15
	Raises public awareness	12
	Investment in the future	5
	Makes life easier	3
	Gives hope	3
Negative outcome	Pollutes the environment	10
	Bad for the health	8
	Throwing away technology	4
	Causes addiction	2

When Table 6 is examined, the answers given by teacher candidates regarding the conclusions to be drawn from their movies are grouped under two themes, positive and negative. The conclusions to be drawn from movies that are described as positive are; it is good for health (f=15), it raises public awareness (f=12), it is an investment in the future (f=5), it makes life easier (f=3) and it gives hope (f=3). As for negative conclusions to be drawn from the movies, teacher candidates dwelt on; it pollutes the environment (f=10), it is bad for health (f=8), we should throw away technology (f=4) and it causes addiction (f=2). Direct quotations from the teachers' responses to the question are given below:

TC30: The conclusion to be drawn from our movie is that these technologies will be a major part of our lives in the future, and many health problems will be solved in this way.
TC23: We shouldn't get too caught up in these technologies. That is what we tried to show. Because these are technologies that have harmful effects on the environment. The nature rings its alarm bells.

Finally, teacher candidates were asked, 'Do you think the film has an impact on changing public awareness, if so how?' The answers given by teacher candidates regarding the potential of their movies to create public awareness are given in Table 7.

Table 7. The movie's impact on changing public awareness

Situation	Reason	f
Effective	Awareness was raised	11
	Environmentally wrong practices emphasized	9
	Problems related to daily life emphasized	9
	Backing it up with a scenario accentuated the impact	8

	Its health impacts emphasized	7
	Its positive impacts for the future emphasized	3
Not effective	Imaginary technologies	2
	Scenario fell short of getting across the message	1

According to Table 7 is examined, most of the teacher candidates stated that the film they made was effective in changing public perceptions. The reasons why teacher candidates stated that the movies were effective in changing public perceptions were; public awareness was raised (f=11), environmentally wrong practices emphasized (f=9), problems related to daily life emphasized (f=9), backing it up with a scenario accentuated the impact (f=8), its health impacts emphasized (f=7), its positive impacts for the future emphasized (f=3). Teacher candidates stating that their films were not effective in changing public perceptions cited the following reasons; they are imaginary technologies (f=2) and the scenarios fell short of getting across the message (f=1). Direct quotations from the teachers' responses to the question are given below:

TC19: I think the film we made can change awareness. Because we discussed the problems we face in our daily lives. We solved those problems with these technologies. I think this is one of the most effective ways to change awareness.
TC1: These are imaginary technologies, which we are way off harnessing and putting to good use. It is not possible to raise awareness right now.

DISCUSSION

For purposes of this study, in which educational movies made by science teacher candidates about biotechnology applications were examined, data were collected via interviews with teacher candidates. First of all, teacher candidates were asked to choose a current application of biotechnology in line with their wishes to make an educational movie. The educational film topics chosen by the teacher candidates were stem cells, genetically modified organisms, nanotechnology and genetic cloning. When one looks at the reasons behind their choices, they are gathered around common reasons such as being related to health, being popular, finding it fantastic, being relevant, and finding it interesting. Teacher candidates' choices are related to the field of biology. Because the biology field is more closely related to issues that directly affect the society, such as health and environmental issues (Ratcliffe & Grace, 2003), compared to other fields. This explains the reason why teacher candidates emphasized that their choices were mostly about health.

Secondly, it was examined from which angle teacher candidates approached the biotechnology topic they chose while making a short film script, and it was found that most of the teacher candidates approached the scenario from a positive perspective because of being related to health, being useful to society, being related to daily life, incorporating new technologies and being enjoyable. On the other hand, some teacher candidates approached the subject negatively because they thought it was harmful to the environment, it was prone to, it contained ethical violations and its long-term effects were not yet known. This shows that teacher candidates do not look at the subject from a single perspective. Because biotechnology issues are discussed within the scope of socio-scientific issues. Socio-scientific issues, on the other hand, are related to science in conceptual, procedural or technological terms but socially contradictory (Kolstø, 2001; Sadler & Zeidler, 2004). For this reason, individuals are expected to have sufficient knowledge, scientific thinking / decision-making skills on these issues (Ministry of Education, 2018). In line with their knowledge and skills, individuals have perceptions about whether these practices are positive or negative. In parallel with the results of this study, Sürmeli (2008) stated that students think that studies in the field of biotechnology and genetic engineering are beneficial. Similarly, Çelik (2009) concluded in his study that students believed that biotechnology subjects would be useful in their daily lives. In this study, besides the positive perceptions, the subject of biotechnology is also handled negatively in short educational movies made by teacher candidates. The reason for this situation may be due to the low level of knowledge of teacher candidates on the subject. As such Sönmez and Pektaş (2017) stated in their research that students who had negative views on the

application areas of biotechnology had poor knowledge of the possible benefits and harmful effects of these applications. Similarly, Demirci (2008) found that the majority of teachers were opposed to genetic cloning and genetically modified organisms. Similarly, in parallel with the results of this study, Sürmeli (2008) stated that students had negative perceptions about these two applications due to the risk of genetic cloning and genetically modified organisms.

Afterwards, the perceptions of teacher candidates regarding the conclusions that should be drawn from their short movies were examined and it was found that a large number of teacher candidates designed movies with positive outcomes, such as being good for health, raising awareness in the society, investing in the future, making life easier and giving hope. However, some teacher candidates focused on drawing negative conclusions from the movies, such as polluting the environment, being bad for health, the necessity of removing technology from our lives and creating addiction. Considering these results, teacher candidates focused on drawing both positive and negative conclusions while making their biotech movies. This might be related to the fact that the topic is rooted in conceptual, procedural or technological aspects but socially contradictory (Kolstø, 2001; Sadler & Zeidler, 2004). The applications chosen by teacher candidates are complex, open-ended, mostly controversial and have no definite answers (Sadler, 2004; Topçu, 2010). In this case, teacher candidates' field knowledge, scientific process skills and scientific literacy levels affect their decision-making with regards to these issues (Sadler, 2004).

Finally, the views of teacher candidates on whether their movies are effective in changing public perceptions were examined and a great majority of teachers stated that they had an effect indeed on public awareness. Among the reasons for its effectiveness were; raising awareness, emphasizing environmentally wrong practices, emphasizing problems associated with daily life, creation of more impact with scenario, emphasizing of the effects on health and emphasizing of positive effects for the future. A few teacher candidates stated that the film they made was ineffective in raising public awareness. To justify their standpoint, they emphasized that these technologies were imaginary. They also stated that their scenarios fell short of getting across their message. The reason for this result may be that examples of biotechnology applications, which are considered controversial and contradictory, with both positive and negative aspects, are given via educational movies. Because educational movies are tools that indirectly make individuals gain experience (Bruner, 2008). People's life spans are not long enough to experience many situations. At this point, films can compensate for the limited lifespan of people by providing them with different experiences (Blasco, Moreto, Blasco, Levites & Janaudis, 2015). And that can help raise awareness on many topics. As a matter of fact, Önen Öztürk (2017) states in his study that educational movies create awareness about the subject discussed.

CONCLUSION

In this study, it's seen that the short movies focused on the positive and negative aspects of these biotechnology subjects, on the basis of daily life scenarios. Even though the short movies contained both negative and positive references, they mostly had a positive note. Each teacher candidate gained a unique perspective on the subject, with the short movies watched and discussed by teacher candidates altogether. For this reason, it is assumed that educational movies can be effective in changing individuals' views, perceptions and learning, involving a preparation and viewing processes. In this context, educational movies on other controversial aspects of biotechnology can be made in future studies. These educational movies can be useful in helping individuals to gain extra awareness about the subject they are learning.

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Conflict of Interest

On behalf of all authors, the corresponding author states that there is no conflict of interest.

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