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Examining the Fringe Series in terms of science concepts and topics: A teaching material suggestion

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ABSTRACT

The Fringe series is a science fiction production with frequent references to scientific concepts and topics. This study aims to analyse the scientific concepts and topics in the Fringe series and examine them in terms of their appropriateness as a teaching material, particularly for science teacher candidates. This study is a qualitative study. In qualitative research studies, data is collected through observation, interviews, and documents. In this study, document analysis was carried out on the Fringe series as a data collection tool, and the results were discussed in terms of its appropriateness as a teaching material for science subjects. Each episode of the series was watched separately by two different researchers who are experts in their fields. The events and flow in all episodes of the series were examined in terms of sections and dialogues with exemplary references to concepts and subjects in physics, chemistry, and biology. The expert watchers determined the frequency with which the respective concepts and subjects were repeated. The results show that the scientific subjects and concepts covered in the series align with the subjects taught in the education faculties of universities. Therefore, the study proposes that the series can be used as a teaching material to support the learning of science courses, particularly for science teacher candidates. Future research can study other science fiction series and movies in terms of science subjects and concepts, to determine whether they are appropriate for use as teaching materials for science.

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1. INTRODUCTION

The universe and nature are big pictures that consist of several pieces and require a very versatile perspective (Taşdelen & Güven, 2021). Individuals need science to see this picture. Science is defined as the effort to question and explore the universe and to reveal its mysteries (Carin, 1993). The most important aim of science education is to make individuals gain science literacy and to provide them with basic information about physics, chemistry, biology, astronomy, earth and environmental sciences, and science and engineering applications (MEB, 2018). Teachers have the greatest responsibility for raising scientifically literate individuals. Therefore, it is extremely important that teacher candidates, particularly those who are to teach Physics, Chemistry, Biology and Science, are science literate. Education faculties of universities adopt certain policies/use specific

curricula to raise qualified teachers that match the profile of a competent/skilful teacher, and various teaching materials are used in order for them to gain basic knowledge in physics, chemistry, and biology and so become science literate. Educational films, one of the said teaching materials, have been considered for many years an important learning tool that should be included in the curriculum (Wenger, 1943). Some authors state that science fiction films are effective in students' understanding of scientific concepts and developing their mental skills (Barnett, Wagner, Gatling, Anderson, Houle, & Kafka, 2006).

Science fiction, based on positive science, explains what science will look like in the future using the medium of art and literature (Bayar, 2001). Science fiction movies, the most common science fiction tool, are based on scientific principles and provide the audience with experiences such as travelling through the universe and time; insights into the future state of the world; cloning; genetics; beings from other planets; war between colonies; apocalypse; life after civilization; miraculous inventions; robots, and so on (Karagöz, 2015). Science fiction movies, which deal with topics that other genres do not, contain both concrete and abstract concepts, making them an extremely effective teaching tool for science (Tatl & ahin, 2020). One science fiction production, which contains frequent references to scientific concepts and issues, is the Fringe series. J. J. Abrams, Alex Kurtzman, and Roberto Orci are the scriptwriters for the Fringe series, commissioned as 5 seasons and 100 episodes between August 19, 2008, and January 18, 2013. The 8.5 IMDB rating series was shot in a variety of locations including Toronto, Ontario, New York, and Vancouver, British Columbia, Canada (Fringe, 2021). Fringe has attracted and still attracts the attention of a large audience as a series that questions the universe, time, existence, and the effects of science and technology on society. The series is basically set in the city of Boston, focusing on a police department investigating crimes using unexplained high-level scientific methods. In the first episode of Fringe, Agent Olivia Dunham, who works in this department, explains Fringe science as astral travel, mind control, teleportation, invisibility, genetic mutation, unexplained or frightening events, and the relationships between these events. Fringe (neuroscience) employees, who work at an FBI-affiliated unit to solve these frightening events, find themselves up against dangerous challenges such as travelling between universes, invasions by extra-terrestrial beings who plan to take over the world, and the apocalypse. In an effort to cope with these dangerous situations, events take a dizzying turn with Agent Dunham deciding to seek help from Dr. Walter Bishop, a committed patient at an asylum, and Bishop being released from the hospital, and all the characters find themselves enmeshed in the midst of an unbelievable chain of events.

The plot unfolds with Dr. Walter Bishop, the main protagonist of the series, having Peter transported from another universe to his own by opening an inter-universe wormhole to reunite with his dead son. Due to this wormhole, both universes are slowly being turned upside down, intertwined, and the question of which is the real world arises. As the narrative continues, the characters lose their perception of reality, caught between the two worlds, with the audience sharing in the warped perception of two twin worlds. For this reason, the series uses colour to separate the two worlds from each other. The Blue Verse denomination, a reference to the colour of the universe, is used for episodes taking place in the real world, while the alternative universe is called the Red Verse, referring to the colour of danger (Daley, 2014; Yegen & Ulusoy, 2020). In the following episodes, it turns out that agent Olivia Dunham, one of the main characters of the series, was used as a subject in Dr. Walter Bishop's experiments as a child, leading her to gain super powers because of the drugs she took in the process (Wilcox, 2014). Another protagonist, Peter, is actually the son of Walternative, a copy of Dr. Bishop serving as Secretary of Defence in the other universe. However, Dr. Bishop brings Peter, the copy of his son in the other universe, to this world with the wormhole he opened after the loss of his own son, which he could not prevent in this world. And this situation causes many unexplained, unusual, and complex events to occur. For this reason, Peter undertakes the role of saviour in many episodes/scenes in the series and dedicates himself to solving problems for the future of the world in the triangle of science-technology-humanity (Yegen & Ulusoy, 2020). In addition to all these, "Watchers" appear in the series, who travel through time and interfere with the course of history and historical events, and these time travellers try to shape the world and the alternative world in order to create a future under their own control. The Watchers, who have the ability to read people's thoughts, are present at all times in the series and bend/manipulate events and therefore reality as they wish (Yegen & Ulusoy, 2020; Zinder, 2014). Also, in the later parts of the series, Bishop's former partner, William Bell, and his technology company in the other universe, Massive Dynamic, come into play. The company is the scene of scientific and technological experiments that do not exist in the real world yet are carried out by using Bishop's scientific data. Fringe, which provides a window of perspective into the future, tries to answer the question of what awaits us in the future and sheds light on the effects of advanced science and technology on humanity and what it can be instrumental in achieving,

Throughout the story, the audience is shown the positive or negative outcomes of Dr. Walter Bishop's experiments and the technologies. The main plot of the series is based on the disruption of social order, which is the unique characteristic of science fiction, as Sobchack (2001) states. The series shows how Bishop, who makes tough choices between the progressive power of science and the requirements of scientific ethics, shapes science and technology, and thus human life, through trial and error, despite all the dilemmas. In fact, all these scientific dilemmas arise as a result of the conflict between genius, professional ambitions, and scientific and technological opportunities and developments. Deadly consequences occur when basic emotions such as jealousy, love, rivalry, and filial love are added to the survival instinct and the desire to know the secrets of the universe comes into play (Sturgis, 2011). The Bishop, who caused all this destruction, gets a chance to make up for his mistakes when he gets discharged from the mental hospital. Dr. Bishop, who believes in positive science and disregards some ethical values and does away with the laws of physics, uses experimental procedures and fictional technologies that do not really exist towards the end of the series more effectively and intervenes in the events of the world. Wending his way through a maze of intricacies, he gets in touch with his son Peter and his partner Olivia to find the "pieces and fringes" of humanity and science, and eventually ensures that both universes can exist (Sturgis, 2011; Yegen & Ulusoy, 2020).

As it can be understood from the summarised plot of the series, the concepts, subjects, and applications of science are included in almost every episode. Considering that learning is structured and configured by the individual himself (Vural, 2005) and the subjects of science fiction films are mostly scientific (Balba, Yenilmez, & Turut, 2012), using science fiction movies for teaching science affects individuals' knowledge acquisition and configuration processes, contributing positively to academic success. In addition, in the world we live in, information, science, and technology are developing unpredictably day by day, and this situation heavily affects individuals' perceptions of understanding and interpreting the world (Yegen & Ulusoy, 2020). In this context, it is thought that science fiction works are very important in terms of following rapidly changing developments, trying to predict, understanding and interpreting them. In this study, Fringe, which is a science fiction classic, was examined in terms of being a teaching material. Various studies report that science fiction films are effective in teaching scientific concepts (Cavanaugh & Cavanaugh, 1996; Fraknoi, 2003; Freudenrich, 2000; Gess, 2017; Kzlck, Daml, & Ünsal, 2014; Kzlck, 2021; Liberko, 2004; Shaw & Dybdah, 2000), and in the questioning of scientific theories (Derjani Bayeh & Olivera Fuentes, 2011), by drawing attention to scientific concepts in different fields of science. However, when the literature is scanned, there are no studies on the use of the relevant directory as a teaching material in learning environments. Therefore, it is thought that the study is original in this aspect and will contribute to the field. In this respect, this study aims to analyse the scientific concepts and topics in the Fringe series and examine them in terms of their appropriateness as a teaching material, particularly for science teacher candidates.

2. METHOD

This is a qualitative study of the television series Fringe in terms of scientific concepts and topics. Observation, interviews, and documents are utilised to obtain data in qualitative research investigations (Berg & Lune, 2015; Merriam, 2009). In this study, document analysis, one of the qualitative research approaches, was utilized. Document analysis entails the examination of materials that provide information about the topic under investigation in a research project. In document analysis, not just written but also visual elements such as images, videos, and films are used (Goodson & Walker, 1988; Yıldırım & Şimşek, 2016). When evaluating documents, they are initially subjected to a cursory examination, followed by a thorough analysis and interpretation of the results (Bowen, 2009). In this study, a document analysis was conducted on the Fringe series as a means of data gathering, and the results were analysed in terms of its suitability as a teaching tool for science courses. At this time, it appears impossible for the researcher to create a code that is devoid of individual impact. Different encoders must be used to encode the same data set in order to deal with this circumstance. As a general rule, it is advised to compute the similarity ratio of the data set coded by multiple coders (Fidan & Öztürk, 2015). Because this similarity rate is also a determinant of the reliability of qualitative research (Baltacı, 2017, Patton, 2014). In this respect, during the study, first of all, each episode of the series was watched separately by two different researchers who were experts in the field of science education and who had done educational film analysis before. The events and flow in all parts of the series have been examined in terms of sections and dialogues that can set an example for the concepts and subjects of physics, chemistry, and biology. The expert watchers determined the frequency with which the respective concepts and subjects were repeated. In addition, all episodes were watched by the two researchers, and after the codes for the associated concepts and subjects were retrieved, the researchers assessed the compatibility and consistency of these codes. As Miles and Huberman (1994) stated, the consistency of the codes made by researchers

independently was determined by the markings 'agreed' or 'disagree'. The consensus correlation coefficient between researchers was found to be 0.85. The fact that the percentage of coding agreement between two different researchers for the collected data is 70% or higher indicates that the coding is reliable (Yıldırım & Şimşek, 2016).

3. RESULTS

The purpose of this study was to assess the suitability of the Fringe series as a teaching tool by analysing the scientific concepts and topics featured in the show. In order to accomplish this, the Fringe series was studied, and the results and commentary, including episode references, are provided below. Table 1 presents the frequency distribution of physics-related concepts and topics in the Fringe Series.

Table 1. Frequency distribution of physics-related concepts and topics in the Fringe Series

Topic/Concept	Frequency (f)	Reference to the series		
		Season	Episode	Minute
Modern Physics	193	2	18	12
Mechanics	67	4	12	5
Electricity and Magnetism	48	1	1	42
Vibration and Waves	37	3	6	7
Light and Optics	19	5	8	12
Sound	13	1	19	34
Heat and Temperature	11	1	19	38
States of Matter	11	4	20	1

Source: complied by authors

Table 1 contains physics-related concepts and topics covered in the series, and example references to seasons and episodes where these concepts and subjects are mentioned. When the data is examined, the subject with the highest frequency, that is the subject most frequently mentioned among the Physics-related concepts and subjects in the series, is modern physics (f=193). This is quite understandable, as teleportation and parallel universes are mentioned throughout the series. However, the series also contains frequent references to the subjects of mechanics (f=67), electricity and magnetism (f=48), vibration and waves (f=37). On the other hand, the series also touches upon the subjects of light and optics (f=19), sound (f=13), heat and temperature (f=11), states of matter (f=11), though with less frequency. The following are short excerpts from sample seasons and episodes that contain references to related concepts and subjects:

Concerning the issues of modern physics, at the 12th minute of season 2, episode 18, Walter Bishop mentions in passing while trying to resolve a case, how Peck took Einstein's theory of relativity and bent it into different shapes and forms. In addition, there is talk about teleportation, parallel universes and the passage between these universes in almost all episodes. Although the scope of mechanics is very wide, references within the series to certain phenomena such as the operation of machinery were not included within this scope with more specific examples counted as frequencies. From this point of view, the movement and fall of the plane at the 5th minute of season 4, episode 12, were chosen as an example of issues of mechanics dealt with in the series. Similarly, the series contains many references to issues of electricity and magnetism. At the 42nd minute of season 1, episode 1, Walter explains to Olivia that the human brain produces an electric field. Agent Broyles, while briefing the team at the 7th minute of season 3, episode 6 about vibration and waves, says that 15 people had lost their memory collectively and that all of these people had been using short radio waves. Stepping in, Bishop explains that the brains of individuals suffering memory loss had been melted down by a magnetism generated by the solar storm. The series also contains frequent references to the subjects of light and optics. For example, at the 12th minute of season 5, episode 8, the image of Olivia Dunham is taken with the help of a camera and projected onto a table in 3D by means of optical tools. Another topic, sound, is dealt with at the 34th minute of season 1, episode 19. In the episode, it is explained how the sound is produced in a phonograph, with references to a new technology that can create a sound by transferring the digital trace to the computer by passing through the grooves on the recording with the help of an electron microscope. In the same episode at the 38th minute, there is another reference to the subject of heat and temperature, where Nancy's body

temperature is within normal range, and in the following scenes, the audience sees changing values on Harris' screen due to Nancy's rising body temperature. The states of matter, which is another topic, is handled by Walter in terms of the effects that may occur as a result of the overlapping of two universes at the 1st minute of season 4, episode 20. Walter mentions that in such a situation, an enormous mass of power will be generated, where matter and energy will be compressed at one point, causing the specific mass to be extremely large, leading to a big explosion. The distribution of chemistry-related concepts and topics throughout the Fringe Series is presented in Table 2.

Table 2. Frequency distribution of chemistry-related concepts and topics in the Fringe Series

Topic/Concept	Frequency (f)	Reference to the series		
		Season	Episode	Minute
Medications /Vaccines	177	2	7	23
Chemical Reactions	78	1	13	1
Chemical Compounds	43	1	3	28
Mixtures and Solutions	34	4	13	41
Acids and Bases	19	2	19	18
Gases	13	4	9	15
Organic Molecules	7	3	7	3
Radioactivity	3	1	6	6

Source: complied by authors

Table 2 lists the chemistry-related concepts and topics covered in the series, as well as their respective references. Examining the data reveals that, among the chemistry-related concepts and topics in the series, drugs/vaccines (f=177) have the highest frequency, i.e., they are discussed the most frequently. Since a substance administered to young children as part of an experiment is discussed in every season of the series, the frequency value associated with the topic appears to be significant. In addition, the series frequently mentions chemical reactions (f=78), chemical compounds (f=43), mixtures and solutions (f=34), and acids and bases (f=19). There are also less frequent references to gases (f=13), organic molecules (f=7), and radioactivity (f=3). The following are brief snippets from sample seasons and episodes containing references to relevant concepts and subjects:

One of the main themes of the series is structured around giving a drug called Cortexiphan, developed by William Bell, to a group of children, including Olivia Dunham. Medications come up in so many episodes; to give a more specific example, at the 23rd minute of season 2, episode 7, a pilot is given a drug to strengthen his brain waves and enable the electrodes on his helmet to read the waves more easily. Similarly, Tyler, Dr. Carson's child, uses the medication to alleviate his pain. While one instance where chemical reactions are mentioned is at the 1st minute of season 1, episode 13. The scene shows a passenger on a plane bleeding through the nose, who puts the swab sample taken from the tongue epithelium into the substance in a test tube. A chemical reaction takes place, resulting in a colour change. The subject of chemical compounds is mentioned at the 28th minute of season 1, episode 3 as Walter describes the injection of an iridium-based compound into a subject's brain. Increased rates of this chemical compound in the blood of the subject make him a kind of receiver for radio broadcasts and the subject overhears all conversations on a network. At the 41st minute of season 4, episode 13, the subject of mixtures and solutions is discussed: Walter comes to a pharmaceutical company and drinks one of the mixtures in the bottles shown to him, saying that it is not Cortexiphan, but rather a died potassium iodide mixture. Regarding acids and bases, the man who comes to see Mr. McCallister at the 18th minute of season 2, episode 19, drops an acid on the floor causing it to be perforated. There is a reference to gases at the 15th minute of episode 9, season 4. In the episode, a doctor releases poisonous gas to the hospital, causing the death of all patients. At the 3rd minute of season 3, episode 7, in reference to organic molecules, someone breaking into the house stuns the young child with ether, an organic molecule. Finally, at the 6th minute of season 1, episode 6, high levels of radiation are measured at a scene, and the following events in the episode are tied up with the subject of radioactivity.

The frequency distribution of the biology-related concepts and topics in the Fringe Series is given in Table 3.

Table 3. Frequency distribution of biology-related concepts and topics in the Fringe Series

Topic/Concept	Frequency (f)	Reference to the series		
		Season	Episode	Minute
Disease (Hereditary/Epidemic)	57	2	2	31
DN /Gene / Chromosome	39	2	2	30
GMO and Transgenic Creatures	27	1	16	1
Organ/Artificial Organ	21	5	6	6
Cell	15	2	17	9
Tissue and Tissue Transplantation	13	2	2	30
Systems	12	3	8	8
Mitosis and Meiosis	7	1	2	9
Hormones	5	3	7	17
Viruses/ Bacteria	5	4	16	12
Biomolecules	3	4	19	25

Source: complied by authors

Table 3 contains the biology-related concepts and topics dealt with in the series as well as references to these. When the data is examined, the subject with the highest frequency, that is the most frequently mentioned, among the biology-related concepts and topics in the series is diseases (f=57). The chain of events in the series begins when Walter Bishop loses his son Peter due to an illness that he cannot cure, and has his son's copy teleported from another universe through a wormhole. Therefore, there are frequent references throughout the series to Peter and his illness, the reason for the high frequency of the subject of diseases. Also, there are frequent references to DNA/gene/chromosome (f=39), GMO and transgenic organisms (f=27), organ/artificial organ (f=21), cell (f=15), tissue and tissue transplantation (f=13) and systems (f=12) throughout the series. In addition, the subjects of mitosis and meiosis (f=7), hormones (f=5), viruses and bacteria (f=5), biomolecules (f=3) are also covered in the series. The following are short excerpts from sample seasons and episodes that contain references to related concepts and subjects:

As stated before, disease features prominently in the series with a cure constantly sought. To cite a specific example, at the 31st minute of season 2, episode 2, there is mention of lupus and the changing of a baby's DNA in the mother's womb to prevent it. There is similarly another reference to changing genes at the 30th minute of the same episode. Emphasis is placed on the assumption that the baby's genes were replaced by a scorpion or a blind mouse. One of the most frequently encountered topics in the series is transgenic creatures. Starting from the 1st minute of season 1, episode 16, the entire episode contains references to transgenic creatures. Regarding the subject of organ/artificial organ, Walter enters a building at the 6th minute of season 5 and episode 6th, where he encounters a woman with an artificial eye. As for the subject of cells, the uncontrolled division of cells and the subject of cancer that can be transmitted by touch are discussed, starting from the 9th minute in season 2, episode 17. In many episodes, the subject of tissues is handled through the removal and re-transplantation of Walter's brain tissue. Also, at the 30th minute of season 2, episode 2, there is a reference to the tissue composition of a baby. To cite an example for the way the subject of systems is covered, Peter injects himself with a drug to save Olivia, which affects his movement system and creates a paralysis effect for a few hours, at the 8th minute of season 3, episode 8. At the 9th minute of season 1, episode 2, Broyles explains to Walter that a baby born at dawn grew old abnormally fast and died within half an hour. Walter explains this is a mitosis division (celermitosis) anomaly and accounts for the anomaly through cell cycle inhibitors becoming unusable. Concerning the topic of hormones that comes up at the 17th minute of season 3, episode 7, there is speculation about how Sugar Man can look both young and old with Dunham saying that the part responsible for aging is the pituitary gland. He says he gets hormones from a man's pituitary gland. After Dunham's explanations, his friend goes on to explain that in theory this hormone would be used for healing and even rejuvenation, but that this would cause side effects such as anemia, tremor, and hypoglycemia. In season 4, episode 16, viruses and a viral infection are discussed. At the 12th minute, Peter is said to have injected undercover cop Marshall Bowman with a virus that alters his DNA, turning him into a kind of giant porcupine. In the following scenes, this virus also infects Agent Lee, but the agent is treated by Walter. Another scientific topic covered in the series is bio-molecules. For example, at the 25th minute of season 4, episode 19, Simon

injects Walter with synthetic neurotrophin (enhanced protein), aiming for Walter's brain to complete the missing tissue in a short time.

4. DISCUSSION AND CONCLUSION

With the intent of determining the suitability of the Fringe series as a teaching resource by analysing the scientific concepts and themes addressed in each episode, this study assessed all episodes of the series in terms of the scientific concepts covered.

The study firstly examined the series in terms of the physical concepts and themes it contains, revealing these concepts and themes along with their frequency of repetition. The data showed that the most frequently mentioned subject of science in the series was modern physics. In addition, the series also covers the subjects of mechanics, electricity and magnetism, vibration and waves, light and optics, sound, states of matter, heat and temperature. The subjects and concepts of Physics covered in the series are almost the same as the subjects covered by Physics I and Physics II courses taught in education faculties of universities. In fact, topics of modern physics are frequently mentioned in the series, containing information/references that fully align with the Physics III course. Looking at some of the Physics books used as teaching material in the education faculties of universities (Ayvacı, 2019; Bueche & Jerde, 2010; 2015; Halliday, Resnick, & Walker, 2014; Serway & Beichner, 2011; 2015a; 2015b), the topics that emerged from the analysis of this series and the content of the books match almost exactly. This also applies to chemistry-related subjects and concepts. When the series was analyzed in terms of Chemistry-related concepts and topics, it was seen that the most frequently mentioned Chemistry topic in the series was medications/vaccines. In addition, the series also covers chemical reactions, chemical compounds, mixtures and solutions, acids and bases, gases, organic molecules and radioactivity. Looking at the Chemistry I, Chemistry II, Chemistry III books used as teaching material in the education faculties of universities (Mortimer, 2004; Petrucci, Herring, Madura, & Bissonnette, 2012; 2015; Skoog, West & Holler, 2007) the topics that emerged from the analysis of this series, in terms of chemistry related concepts, and the content of the books match almost exactly. The matching of the subject titles in the books was possible as a result of the analysis of the series in terms of chemistry-related topics and concepts. The same applies to biology-related topics and concepts. When the biology-related subjects and concepts covered in the series were examined, it was seen that the most talked about subject was the subject of diseases. DNA/gene/chromosome, GMO and transgenic organisms, organ/artificial organ, cell, tissue and tissue transplantation, systems, mitosis and meiosis, hormones, viruses and bacteria, biomolecules are also covered in the series. Similarly, the content of some of the reference books (Campbell, 2017; Klug & Cummings, 2011) used in the teaching of Biology I, Biology II and Biology III courses at education faculties, and the concepts and topics derived from the series overlap. The results show that the scientific subjects and concepts covered in the series align with the subjects taught in the education faculties of universities. For this reason, this study makes the proposition that the series can be used as a teaching material to support learning in science teaching.

When the literature is examined, it is noteworthy that there are many studies on the effect of science fiction series and movies on science teaching. For example, Tatlı & Şahin's (2020) study examined the effect of science fiction films on learning scientific concepts with the study presented as a practical guide for teacher training. The object of the study was to investigate the impact of science fiction films on science teacher candidates' learning of some scientific concepts, and the study concluded that science teacher candidates learned enough scientific concepts with the help of science fiction movies while updating/revising their existing knowledge. Vrasidas, Avraamidou, Theodoridou, Themistokleous, & Panaou (2015) shared the results from their EU-funded project 'Science Fiction in Education'. The aim of the project was to incorporate science fiction into science lessons in order to improve teachers' teaching skills, make science more attractive to students and help learners associate it with real-life issues such as the environment. At the end of the project, the researchers concluded that using science fiction materials in science education had many positive contributions. Nevil (2012)'s research found that movies could be utilized to support teachers' professional development. In support of this finding, Barnett and Kafka's (2006) study "Using Science Fiction Movie Scenes to Support Critical Analysis of Science" discusses the pedagogical benefits and challenges of using science fiction movies for primary school teachers teaching introductory science courses. The study concluded that science fiction had a positive effect on the learning of scientific concepts. Another study conducted by Çemrek et al. (2005) found that science fiction movies reflected positively on the success of teacher candidates in science lessons. The same was also emphasized by Liberko (2004) who argued that science fiction facilitated the concretization of scientific theories and concepts in the minds of students; and that students can better comprehend and retain in their memories basic concepts of many physics and chemistry subjects with the help of science fiction movies. Similarly, Shaw and Dybdah (2000) argued that science fiction attracted viewers' attention to interdisciplinary

scientific concepts for different fields of science (physics, chemistry, biology, earth science, astronomy) encouraging students to learn basic scientific concepts. Similarly, many researchers argued that science fiction helped visualization of abstract scientific concepts through embedded special effects, offering an important opportunity in terms of teaching scientific concepts. (Barnett & Kafka, 2007; Bixler, 2007; Derjani Bayeh & Olivera Fuentes, 2011; Dubeck, Moshier, & Boss, 2003; Kirby, 2003; Rose, 2003). Many other studies have emphasized that science fiction movies have a positive effect on the teaching of Physics, Chemistry and Biology, from primary school to university (Cavanaugh & Cavanaugh, 1996; 2004; Czerneda, 2006; Dark, 2005; Firooznia, 2006; Liberko, 2004; Rose, 2003, Yazıcı & Altıparmak, 2010).

Today, developments in communication technology affect educational processes as well as in all areas of social life (Say, Gökmen & Özel, 2019). Many students acquire an interest in scientific subjects after exposure to works of science fiction, which later turns into an interest in science itself (Cornea, Bowater, James, & Bowater, 2012). Science fiction movies brought to the classroom environment are seen as a tool that students enjoy, via which they learn scientific concepts in a concrete and permanent (Idier, 2000) manner. This finding coupled with results reported by other studies on the subject reveal that works of science fiction are an important material for science teaching. The findings reported by this current study also show that the Fringe series conveys/delivers to the audience a lot of knowledge in terms of science subjects and concepts. Therefore, the study proposes that the series can be used as a teaching material to support the learning of science courses, particularly for science teacher candidates. Future research can study other science fiction series and movies in terms of science subjects and concepts, to determine whether they are appropriate for use as teaching materials for science. Works of science fiction can also be studied to see if they can be utilized for teaching courses other than science.

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Notes

Ethical Statement

No human participants were used in the study. In this respect, the research meets ethical guidelines and complies with the legal requirements of the country of study.

Disclosure of conflicts of interest

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