Abstract: Context-based teaching and learning has a long tradition in science, especially chemistry. Audiovisual media (movies and series) can be used to provide context, and it can help overcome many students’ negative attitudes toward real science. An example of audiovisual media in which a science context can be presented is science fiction (abbreviated Sci-Fi). The purpose of this study was to investigate how the Sci-Fi context influences pre-service teachers’ attitudes and perceptions regarding the use of Sci-Fi for teaching and learning science, with a focus on chemistry, as a result of a 15-week novel elective Sci-Fi course for pre-service teachers. The main instruments used were online questionnaires, a final exam, and a rubric-based presentation evaluation form. The results of our study show that the majority of pre-service teachers consider the Sci-Fi context to be a very interesting context for science education, especially chemistry, and a useful tool for promoting students’ interest in science. Students believe that it is important to incorporate the Sci-Fi context into chemistry instruction at all levels. Our results suggest that the Sci-Fi context is useful to students as an alternative learning method that can be used to improve student learning outcomes.

Keywords: chemistry; context learning; pre-service teacher; science; science fiction

1 Introduction

The contextual approach can be defined as a student-centered approach that uses the concepts and skills of students with different learning experiences in the teaching and learning process (Glynn & Koballa, 2005). In contextual teaching and learning, students are given the opportunity to build relationships in a context that is relevant and meaningful to them. Therefore, it is not surprising that contextual learning is often considered an effective teaching method to enhance students’ potential and spark their interest in learning science (Johnson, 2002). However, contextualized instruction has a long tradition in science, particularly in chemistry. The development of this approach was inspired by research showing that students do not learn chemistry because they do not find it relevant (Eilks et al., 2013). If chemistry is presented in a specific context to the learners, they are more likely to perceive it as more relevant and their interest in learning chemistry might increase. According to Kind (2007) and Bennett and Holman (2002), context-based chemistry education can be framed as follows: (1) the use of “everyday” or “real-life” applications for teaching chemistry, (2) active, student-centered teaching approaches that stimulate learning, and (3) the implementation of a “spiral” curriculum in which the specific chemical concept is presented in different settings (contexts).

When discussing the importance of context in chemistry teaching and learning, the 4C model of the relationship between concept and context can be used (Figure 1). The four Cs in this model stand for (i) Concept, (ii) Content, (iii) Curriculum, and (iv) Context. In this model, abstract chemical concepts are integrated into the basic framework of specific chemical content. This content is incorporated in the learning objectives that are specified...
in the national curriculum for chemistry. Context can be applied to the curriculum content to make the concepts relevant to learners; the basis of this context can be natural, societal, personal, contemporary, technological, historical, or other (Devetak & Ferk Savec, 2018).

The 4C model can be broadly implemented also into science courses that cover topics that are often challenging for students because some concepts are often abstract and therefore more difficult for students to understand. As a result, students often develop negative attitudes toward some courses, primarily because of the complexity and difficulty of these topics (Johnstone, 1991; Millar, 1991). One way to make science courses more attractive is to make strong connections between the subjects and everyday life. When students can relate the concepts they have learned to real-life situations, it means that they have inserted the context they have learned into actual situations and are implementing it as life experience (Harwell, 1999).

Contexts covered in science courses can be extended to those that students find interesting. Educational entertainment (edutainment), which is media designed to educate through entertainment, can be used to provide context (Rogers, 2007). Edutainment includes a variety of media ranging from magazine articles to novels to audiovisual media (e.g., documentaries, series, movies, computer games). Through the screening of an audiovisual media, not only content is conveyed, but experiences of all kinds: emotions, feelings, attitudes, actions, knowledge, etc., as cultural appropriation can provide individuals with symbolic systems of reality representation (Arroio, 2007). Audiovisual media create trends and have a broader influence on students than any other media. They are also capable of stimulating interest in scientific topics (Serra & Arroio, 2008). Another important aspect is that audiovisual media are a source of information that directly influences students’ perceptions and ideas. In this way, they help in the acquisition of information and contribute to the development of students’ critical thinking. Audiovisual media can help reverse many students’ negative attitudes toward real science by moving them from familiar experiences that they enjoy to unfamiliar experiences that they find boring and difficult, such as learning physics, biology, and chemistry (Dubec et al., 2004).

A great example of audiovisual media in which a science context can be presented is science fiction (Sci-Fi) (Arroio, 2010; Brake & Thornton, 2003; Dubec et al., 1990; Karadeniz & Değirmençay, 2020; Vrasidas et al., 2015), although science fiction has rarely been used to teach science or change students’ attitudes toward science (Dubec et al., 1990). The Sci-Fi media combine science and pseudoscience for entertainment purposes and are often used to explore the relationship between science, technology, and society. It serves both as a source of inspiration for scientific development and as a means of popularizing and disseminating scientific ideas (Brake & Thornton, 2003), and also increase students’ curiosity about science and improve their creativity while providing them with a critical perspective (Karadeniz & Değirmençay, 2020). However, because Sci-Fi stories also involve the practice of science, they can influence students’ attitudes toward science and serve as a useful teaching tool to develop positive attitudes toward science among students (Karadeniz & Değirmençay, 2020). The positive effects of using Sci-Fi in science education in schools have been discussed in many studies (Arroio, 2010; Barnett et al., 2006; Bixler, 2007; Brake & Thornton, 2003; Cavanaugh & Cavanaugh, 1996; Dubec et al., 1990; Fraknoi, 2002; Karadeniz & Değirmençay, 2020; Laprise & Winrich, 2010; Liu et al., 2013; Liu, 2019; Ongel-
In summary, everyone agreed that the use of Sci-Fi in school science classes has many benefits, such as fostering scientific curiosity, promoting understanding of scientific content, fostering positive attitudes toward science and technology, improving science achievement, visualizing abstract topics, promoting scientific thinking, improving creativity, enabling scientific literacy, motivating students to acquire scientific knowledge, improving the relationship between scientific disciplines, encouraging students to explain scientific concepts, and providing an understanding of scientific and technological ethics during the scientific process. Dubeck et al. (1990) reported that the use of Sci-Fi contexts in physics, biology, chemistry, astronomy, physical science, earth science, and life science courses improved students’ attitudes toward science, their knowledge of science as a discovery process, and their cognitive development.

2 Purpose and research questions

The newly developed elective course aimed to provide pre-service teachers with the opportunity to learn about a context-based learning approach with an integrated Sci-Fi contexts (elements of edutainment) in the teaching of science at the lower and upper secondary science (chemistry) classroom. For this purpose, the course titled “Teaching Science in the Context of Science Fiction” was offered as an elective to undergraduate students (pre-service teachers) in the fall semester of the 2021/22 academic year. The use of edutainment in conjunction with Sci-Fi contexts can improve learning outcomes in science (chemistry) and make teaching science (chemistry) more interesting for students. This approach also promotes strong and inspired creative thinking, foundation to develop future thinking skills in science (especially chemistry) learning process, as chemical concepts are often abstract and complex for many students. For these reasons, it is important to understand how edutainment with Sci-Fi contexts influences pre-service teachers’ attitudes and perceptions about implementing this approach in science (chemistry) classrooms.

According to the research problem, we focused on the following research questions:

(1) How do pre-service teachers perceive the novel elective Sci-Fi course?
(2) What level of science knowledge do pre-service teachers develop by participating in the learning activities of the novel elective Sci-Fi course?

3 Methods

This is a mixed-method study with qualitative and quantitative approach. A descriptive method was used to examine how the application of learning activities in the 15-week novel elective Sci-Fi course for pre-service teachers affects their science (chemistry) knowledge.

3.1 Participants

Pre-service primary or lower secondary school teachers from the Faculty of Education at the University of Ljubljana participated in the study. 17 pre-service teachers (14 females, 3 males; 20–24 years old) enrolled in various undergraduate programmes at the Faculty of Education participated in this course. Descriptive data on participants’ type and year of study are presented in Table 1.

3.2 Instruments

Overall, three instruments were used in this study: the online questionnaires, the pre-service teachers’ achievement test and a rubric-based presentation evaluation form.

3.2.1 Online questionnaire: The online questionnaires were used in this study titled “Course Evaluation Questionnaire (CEQ)”. The CEQ questionnaire consisted of 5 (at the beginning of the Sci-Fi course) and 15 (at the end of the Sci-Fi course) open-ended questions in
online format. The questionnaire at the beginning of the Sci-Fi course included an introductory section on participant demographic variables (e.g., gender, type of study, and year of study) and sections on pre-service teachers’ expectations of the Sci-Fi course and their instructors (four questions, e.g., What do you expect from the course?; What key skills would you like to acquire in this course?). The questions were an open-ended question type. The questionnaire at the end of the Sci-Fi course consisted of two parts and a total of 15 questions. The first part of the questionnaire included five questions about the amount of time pre-service teachers spend on this Sci-Fi course (e.g., How regularly did you attend lectures and seminars?; How much time did you spend on independent study in this course during the semester?) and 10 questions about the teaching–learning process in general, content delivery, professor/teaching assistant-student interaction, and course evaluation (e.g., Did you find the lectures with guest lecturers useful in achieving course competencies?; How interesting did you find the content covered in the course?) in the second part of the questionnaire. The survey questions consisted of open-ended, yes/no type of questions, while the other questions were based on a 5-point Likert scale (course evaluation questions). In order to allow pre-service teachers to state their actual views and feelings and to obtain reliable results, neither their names nor other personal information were requested when filling out the questionnaires. The prepared questions were designed to be clear and understandable to everyone.

3.2.2 Pre-service teachers’ achievement test: The achievement of the participants in the Sci-Fi course was measured by a final exam. The final exam included 15 multiple-choice questions and 10 open-ended questions (see examples in Table 2). All questions were discussed in lectures or/and seminars, and students had to work on the concepts during their individual work.

3.2.3 A rubric-based presentation evaluation form: The rubric-based evaluation form for the analysis of the students’ presentations included five main categories: a) fundamentals (proficiency and understanding, planning and organization of the activity, integration of important elements) (30 %); b) application and illustration of the presented activity (coherence with theory, clarification of the activity, and motivation of the audience) (30 %); c) visual aids (quality of slides, number, appropriateness, etc.) (10 %); d) communication skills in the presentation (10 %); and e) understanding of the material presented (20 %). Each category was subdivided to facilitate grading. A simple grading scale was located at the bottom of the page of the rubric-based presentation evaluation form. In addition, the form included scoring guidelines with an example of questions that could be asked during the presentation.

3.3 Research design

Online questionnaires via the online survey tool 1ka (https://www.1ka.si/), a final achievement test to assess student performance in the novel elective Sci-Fi course, and a rubric-based evaluation form were used to collect data.

A novel Sci-Fi course titled “Teaching Science in the Context of Science Fiction” (4 ECTS, 120 h of student work – 60 contact hours and 60 individual hours) was introduced as an elective in the fall semester of the 2021–2022 academic year. The Sci-Fi course was delivered over a single semester (15 weeks) in a lecture, seminar part and individual work, with a focus on science, particularly chemistry, and examples of Sci-Fi media, online via MS Teams, due to the COVID-19 situation. The weekly course time was divided into 90-min lectures (on topics related to the context of the Sci-Fi genre and its relevance to science education in schools) and 90-min seminars (active learning and elaboration of topics related to science using Sci-Fi context). In total, the Sci-Fi course consisted of 30 h of lectures, 30 h of seminars, and 60 h of individual student work.

Table 1: Descriptive data of Sci-Fi course participants (N = 17).

<table>
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</table>
The aim of this Sci-Fi course is to introduce the use of the Sci-Fi context in the science classroom, with an emphasis on chemistry, and to explain to pre-service teachers the basic concepts and approaches to science in Sci-Fi. Selected science topics, especially chemistry, covered in Sci-Fi media were introduced using real-life examples that illustrate the importance of science knowledge for today’s and tomorrow’s society. The lecture part of the Sci-Fi course considered the following topics: 1) Introduction, Teaching Science in Context – Focus on the context of the Sci-Fi genre in print and electronic media. The first topic serves to introduce the pre-service teachers to the Sci-Fi course so that they become accustomed to the Sci-Fi course material and the dynamics of the class, including the online platform. The activities are designed to motivate students to participate and complete the Sci-Fi course, 2) the importance of science in Sci-Fi for science education and science literacy development, 3) the history of visions related to science in Sci-Fi and their implementation in the real world, 4) science education and Sci-Fi, 5) ethics in science research and Sci-Fi.

To determine the opinions, attitudes, expectations, and experiences of pre-service teachers related to the novel elective Sci-Fi course, a self-administered online CEQ questionnaire with closed-ended and open-ended questions was distributed to course participants at the beginning and end of the semester. It is assumed that all pre-service teachers participating in the study answered the questions truthfully and honestly.

Regarding rubrics for analyzing seminar presentations, two course instructors evaluated the quality of the pre-service teachers’ presentations using a rubric-based presentation evaluation form for each group of pre-service teachers. The final results of each group’s achievement by the Sci-Fi course instructors were then compiled for each category. The results of the professors’ and teaching assistants’ ratings of the presentations were then analyzed using a paired t-test to look for significant differences in the ratings of the two instructors for each group. All statistical analyzes were performed using the SPSS program (version 16 SPSS Inc., Chicago, IL).

At the end of the Sci-Fi course, teachers were given a final exam on the topics covered in the lecture on the science concepts learned in the Sci-Fi course. The results of the final exam were used as an indicator of the participants’ achievements. The timeline of the study is shown in Figure 2.
Selected scientific topics covered in Sci-Fi were presented with real-life examples of the importance of scientific knowledge to society today and in the future, e.g. space (phenomena in space; space travel; time travel; multiverse theory), radiation (ionizing and non-ionizing), matter particles (matter and antimatter), elements and the periodic table, carbon-based life on Earth and life on other planets, nucleic acids and cloning, origin of life and evolution, protection of the environment (atmosphere, water, soil), pharmaceuticals and medicine, biological, chemical and radiological weapons.

The teaching and learning method was dynamic and focused on pre-service teachers as the main actors in this learning process, with the aim of developing skills for science teaching in schools using the Sci-Fi context. The lecture part of the Sci-Fi course was based on a mixed method of active and collaborative techniques according to Arroio (2010). This included streaming short sequences of commercial Sci-Fi movies/series to look for ways to use them pedagogically. In this observation, the focus was on the audiovisual language to see if the film was able to communicate with the audience (pre-service teachers), especially young people. Then, the focus was on the scientific content presented in the scenes of the film, followed by the way the scientific knowledge is presented to check for possible errors and to consider how science can be contextualized in science education. The lectures also included guest lecturers from abroad who presented some aspects of using the Sci-Fi context in science education (e.g., The Science of Star Trek; The Secret Science of Superheroes; Exploring Science through Science Fiction; How to Use Sci-Fi in the Biochemistry Classroom; Writing Sci-Fi Stories).

In the seminar part of the Sci-Fi course, pre-service teachers in groups of two or three members analyzed various Sci-Fi series/movies of their choice from a science perspective, focusing on chemistry whenever possible, and prepared seminars focused on activities for specific educational levels in the context of the selected Sci-Fi series/movies.

The seminar part of the Sci-Fi course encouraged pre-service teachers to use Sci-Fi movies/series of their choice to organize classroom activities based on the Sci-Fi movies/series to contextualize the science content and engage the pre-service teachers in science learning (Arroio, 2010). In groups of two or three, the pre-service teachers designed and presented activities related to a Sci-Fi context that could be used in the school to develop students’ 21st century skills. The main goal of the seminar part of the Sci-Fi course was to integrate the Sci-Fi context into the design of activities that could be used in the school. Pre-service teachers formed groups of two or three members and gave a 20-min presentation of their activities online at the end of the semester via MS teams and PowerPoint.

The Sci-Fi course included additional optional exercises – homework assignments designed to improve pre-service teachers’ skills so that they would perform better on the final achievement test. The assignments consisted mainly of analyzing specific articles on the use of Sci-Fi in the classroom, analyzing a specific Sci-Fi episode or movie related to the lecture topic, or preparing questions for guest lecturers.

In total, pre-service teachers were given 11 such assignments during the semester. Finally, pre-service teachers could receive 10 % of their final grade based on their participation in the homework assignments given during the Sci-Fi course. For this, at least 9 of the 11 assignments had to be successfully submitted on time.

As an indicator of the participants’ performance, pre-service teachers were given a final achievement test (exam) on the topics covered in the lecture on the science concepts learned in the Sci-Fi course. The final achievement test (Week 15) was the same and administered at the same time via MS teams to all pre-service teachers independently. The final achievement test covered the content of the lectures and seminar part of the Sci-Fi course from week 1–15. The time for the achievement test was limited to 45 min.

The final grade for the Sci-Fi course was calculated based on the following assessment elements: (1) final project presentation (seminar part) (30 %); (2) final achievement test (lecture part) (70 %); and (3) additional participation – optional exercises, homework (10 %).
4 Results

4.1 Pre-service teachers’ opinion about the Sci-Fi course (CEQ questionnaire)

4.1.1 At the beginning of the Sci-Fi course

A total of 17 pre-service teachers, participants in the Sci-Fi course, completed the CEQ questionnaire at the beginning of the Sci-Fi course. After the first few hours of the Sci-Fi course, the pre-service teachers were asked to give their opinions on the lectures and seminars of the Sci-Fi course. Regarding the lectures, they highlighted the good concept of the Sci-Fi course with many invited guests from the field of Sci-Fi. Regarding the seminar part of the Sci-Fi course, they pointed out the independence of each individual regarding their Sci-Fi topic in the seminar part. As for the question of expectations for this Sci-Fi course, the majority were positively surprised and their expectations were mostly met.

4.1.2 At the end of the Sci-Fi course

A total of 17 pre-service teachers, participants in the Sci-Fi course, completed the CEQ questionnaire at the end of the Sci-Fi course. Analysis of the collected material revealed that the majority (80 %) were present at most lectures and seminars of the Sci-Fi course (75–100 % attendance). The majority (53 %) devoted a portion of their time per week during the semester to individual study, while 27 % spent 4–10 h and 20 % spent 1 h or less. The pre-service teachers had mixed opinions about regular homework assignments during the Sci-Fi course. However, the majority of the pre-service teachers (60 %) felt that the homework was good, while others felt the opposite.

At the end of the course, the pre-service teachers were asked to indicate their experience with the lecture and seminar part of the Sci-Fi course on a Likert scale of 1–5 ("5" representing "strongly agree" and "1" representing "strongly disagree"). The statements were related to the content of the lectures and seminars, the knowledge acquired in the lectures and seminars, the relationship between professor/teaching assistant and pre-service teachers, the quality of the work of the professors/teaching assistants, the encouragement of inquiry-based learning, clear evaluation criteria, etc. The average scores of these experiences were 3.1 and above on a five-point scale. Pre-service teachers also provided an explanation for all responses.

Pre-service teachers also rated the difficulty of lectures and seminars in the Sci-Fi course on a Likert scale of 1–5 ("1" represented “too difficult” and a “5” represented “underwhelming”). Participants rated the difficulty of the Sci-Fi course lectures and seminars as 2.5 out of 5 (SD ± 0.5) and 2.7 out of 5 (SD ± 0.5), respectively. This indicates that pre-service teachers did not strongly believe that lectures and seminars of the Sci-Fi course lectures and seminars were too cognitively demanding.

Participants found the interest in the invited guests’ lectures and the importance of these lectures in gaining competence in using contexts in science education and incorporating the Sci-Fi context in science education very interesting/useful. Participants rated this as 1.1 (SD ± 0.3) and 1.4 (SD ± 0.7), respectively. On a Likert scale of 1–5 ("1" representing “very interesting/useful” and a score of “5” representing “not interesting/useful”), the results show that pre-service teachers considered the invited guests’ presentations to be very interesting and useful for using contexts in science education and incorporating the Sci-Fi context into science education.

Pre-service teachers suggested some improvements for the Sci-Fi course such as: Literature available for study, PowerPoint materials provided in advance to take notes during lectures, more focus on homework reports during lectures, fewer Sci-Fi series/movies to be viewed as homework – which is time consuming (suggestion: show relevant parts of episodes/movies and discuss during lectures – and give information about the episode so that participants can view it later), more open discussions such as “what if …”, more specific instructions on how to apply this approach in the classroom, etc.
4.2 Approaches into teaching by using Sci-Fi (seminar part of the Sci-Fi course)

4.2.1 Examples of chemistry contents from Sci-Fi media

The seminar topics selected by the pre-service teachers focused on activities for specific educational levels within STEAM framework with an emphasis on chemistry related to selected audiovisual Sci-Fi media. Pre-service teachers selected a total of eight Sci-Fi films or series such as: Arrival, Interstellar, Jurassic Park, Star Trek Prodigy, The Core, The Martian, X-files, and Dune. In connection with the selected Sci-Fi movie or series, they developed STEAM activities for primary and lower secondary school students.

The pre-service teachers prepared a total of eight STEAM activities related to selected Sci-Fi movie or series for implementation in primary and lower secondary school activities. The pre-service teachers named each activity and assigned it to the appropriate educational level according to the national curriculum of the respective STEAM subject, also based on the complexity of the activity. The activities were designed either as part of a science day, a technical day, as part of regular classes, etc.

The activities were designed for implementation in 4th grade (three activities; Journey to Prodigy – Replicator, Animal Evolution, Wrap Drive and Protostar Vessel; Become a Young Scientist, Engineer, Technician, Artist, and Mathematician; Journey to the Center of the Earth), 5th grade (two activities; Become a young scientist, engineer, technician, artist and mathematician; Journey to the Center of the Earth), 8th grade (four activities; A journey into the world of extraterrestrial creatures – heptapods; Young forensic scientist – fingerprints; Young nephrologist – An insight into kidney function; Travel into space) and 9th grade (three activities; Life in the biosphere – Build Your Own Mini-Biosphere; Young Forensic Scientist – Fingerprints; Journey to Space). A single activity may be conducted in more than one grade level. The presentation of each seminar topic was followed by a discussion part, in which each student made suggestions for improving the activities.

Examples of chemistry contents from Sci-Fi media were also presented and integrated into the lectures and seminars, e.g. periodic system – new elements (The Avatar, Star Trek Voyager), inorganic life (Star Trek The Next Generation), noble gasses (Star Trek Strange New Worlds) (Figure 2), peptides (Star Trek Strange New Worlds), communication with hydrocarbons (Star Trek Discovery), pH (The Andromeda Strain), DNA and RNA (The Andromeda Strain, Gattaca, Back Issue, Jurassic Park), polymers (Spiderman), respiratory fluid fluorinert (The Abyss), ionic and covalent bonding, differences between aggregate states of matter (Avatar: The Last Airbender), hazardous properties of substances, labeling (Catwoman), etc.

Pre-service teachers developed various activities by their own for the purposes of applying them into elementary school science education, using different Sci-Fi movies or series to present and explain a range of chemistry contents: 1) using the Sci-Fi movie “Interstellar” to explain processes important to the self-preservation of the biosphere, plants with photosynthesis obtain nutrients while producing oxygen (chemical change, reactants, products, consumption or binding of energy), 2) using the Sci-Fi movies/series “Arrival”, “Star Trek Prodigy”, “Jurassic Park,” “The Core,” and “The Martian” to explain the periodic table of elements and their properties, 3) using the Sci-Fi series “X-Files” to learn about the structure and composition of ice where a new organism was found, the molecular structure of ice (water), the states of matter, and the motion of their particles. Students learn that a magnifying glass and microscope can be used to see things that are invisible to the naked eye; learn about substances used in forensics, 4) use the Sci-Fi movie “Dune” to explain the chemical process of kidney function and learn about the main functions of laxatives such as filtration, reabsorption, and excretion, and 5) use the Sci-Fi series “Avatar: The Last Airbender” – scenes with fireworks could be related to flame reactions to explain how alkali and alkaline earth elements color flames. In the classroom, students could conduct flame reaction experiments and observe flames of different colors specific to a particular element. The students’ task would be to draw and write down the color of the flames and compare their drawings to the colors of various fireworks in the series, and then determine which chemical elements were involved in the flame reactions of the fireworks (Figure 3).
4.3 The effect of Sci-Fi course on pre-service teachers’ science knowledge

4.3.1 Rubric to analyze the seminar presentations

The average achievement (%) for the seminar presentations of the professor and teaching assistant evaluations was 88 % (SD ± 6 %) and 90 % (SD ± 5 %), respectively. The average final score for seminar presentations was 89 % (SD ± 7 %). Some discrepancies were noted between the ratings of the two course instructors, but these were minimal and did not show statistical significance when analyzed with a paired t-test.

4.3.2 Pre-service teachers’ achievement at the Sci-Fi course

The average final exam achievement was 69 % (SD ± 9.4 %). The overall course achievement, including a) final project presentation (seminar part) (30 %), b) final exam (lecture part) (70 %) and c) additional participation – optional exercise, homework (10 %), was 81 % (SD ± 11 %).

5 Discussion

This study investigates the opinions and experiences of pre-service teachers regarding the context learning, specifically the science fiction (Sci-Fi) context in the science classroom used during the elective Sci-Fi course titled “Teaching Science in the Context of Science Fiction”.

The results of our study show that the majority of pre-service teachers consider Sci-Fi context as a very interesting context for science education and a useful tool to stimulate pre-service teachers’ interest in science content. One student pointed out “The course was very interesting, there was a lot of emphasis on the chemical content present in various Sci-Fi media. So, we got an insight into real and fictional facts in Sci-Fi media related to chemical content”. Another student wrote “I found the course very interesting because we discussed scientific topics from Sci-Fi media. Based on this, we distinguished between real and fictional facts in Sci-Fi media, which often carries the danger of not distinguishing between reality and fiction”. They also liked seminar part of the course, and some of them wrote “I particularly enjoyed the seminar part of the course, where we had to choose our own Sci-Fi media and present real and fictional facts from the field of science, with an emphasis on chemistry. This gave us the opportunity to think critically, creative and gave us also an opportunity to judge what is actually real and what is fictional in chosen Sci-Fi media”. Sci-Fi media can increase students’ curiosity about science, enhance their

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<tr>
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<td>f) Barium chloride, BaCl₂</td>
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Figure 3: Screenshot of a scene with fireworks in the series “Avatar: The Last Airbender” (left) and an activity for students related to flame reactions and determining the elements responsible for the specific color of the flame (right).
Creativity, and provide them with a critical perspective (Arroio, 2010; Brake & Thornton, 2003; Dubeck et al., 1990; Karadeniz & Değirmençay, 2020; Liu, 2019; Orcan & İnçeç, 2016; Özütürk, 2017; Rose, 2003; Vrasidas et al., 2015). It can be used as a tool for science education, because Sci-Fi stories also involve the practice of science (Karadeniz & Değirmençay, 2020) and students need to discuss many scientific facts. Vrasidas et al. (2015) reported that the implementation of Sci-Fi cross-curricular learning modules was successful in motivating students and supporting their science learning and related skills development.

In our study, the pre-service teachers pointed out some ideas on how the Sci-Fi context can be used to teach science subjects, e.g., to attract students’ attention, c) to bring the subject topic closer to the students so that they can better memorize the material, d) to find connections between facts in Sci-Fi media and real life, e) to make science lessons more varied, etc. Arroio (2010) suggested that appropriate supporting materials and science teacher training are important for using the Sci-Fi context in science education. Dubeck, Boss, and Mosher (2004) also noted that audiovisuals can help reverse the negative attitudes that many students have toward real science by moving them from familiar experiences they enjoy to unfamiliar physical, biological, and chemical concepts they assume are boring and difficult to learn. Many other studies report the benefits of using Sci-Fi in teaching science classrooms (Brake & Thornton, 2003; Dubeck et al., 1990; Karadeniz & Değirmençay, 2020; Laprise & Winrich, 2010; Lin et al., 2013; Liu, 2019; Orcan & İnçeç, 2016; Özütürk, 2017; Rose, 2003; Surmeli, 2012; Vrasidas et al., 2015). Since Sci-Fi involves the practice of science, it can influence students’ attitudes toward science and serve as a useful teaching tool to develop positive attitudes toward science among students (Karadeniz & Değirmençay, 2020; Liu, 2019; Rose, 2003; Vrasidas et al., 2015).

Pre-service teachers also pointed out that discussing real and fictional facts in Sci-Fi media is important so that students do not make conceptual errors. With the activities they prepared during the seminar part, they had to highlight the real and fictional facts in selected Sci-Fi media (e.g., a) fictional fact: 1) Sci-Fi movie “Jurassic Park”: scientists extract DNA from a mosquito in the lab and combine it with amphibian DNA to develop different species of dinosaurs; 2) Sci-Fi movie “The Martian”: manipulation of radioactive plutonium without proper protection; 3) Sci-Fi movie “Avatar”: discovery of a new element unobtanium on Pandora planet; b) real fact: 1) Sci-Fi movie “Jurassic Park”: geologists find well-protected animals encased in amber; 2) Sci-Fi movie “The Martian”: radioactive decay of an element causes heat release; 3) Sci-Fi movie “Avatar”: organisms on Pandora planet are chemiluminescent). This gave them a clear insight into the difference between real and fictional facts in selected Sci-Fi media. Similar issues were also discussed by Karadeniz and Değirmençay (2020) who conducted a study on the effect of science fiction books on arousing students’ curiosity about science. When using Sci-Fi media for science education, students might develop misconceptions due to the influence of pseudoscience that can be portrayed in Sci-Fi. It should be remembered that Sci-Fi is not science, but combines science and pseudoscience for entertainment. It provides students with knowledge while giving them the opportunity to experience entertaining fictions (Arroio, 2010).

Sci-Fi media can impact science learning by a) directly illustrating abstract science principles—movies make the abstract understandable; b) discussion of a film enhances understanding of science as a rational and discovery process—important in helping students distinguish between scientific and pseudoscientific approaches; c) making science relevant by relating it to social issues; and d) science is usually presented as an interdisciplinary approach to solving problems (Dubeck et al., 1990).

This study provided pre-service teachers with the opportunity to 1) use a context-based learning approach as part of the course with an integrated Sci-Fi context and implement project-based learning by developing their own activities within STEAM framework for primary and secondary school students (Matilainen et al., 2021). Content integration was used in the seminar part of the elective Sci-Fi course, where students prepared STEAM activities. These activities required integrating content from different disciplines to show that they were all necessary to address a particular topic. In designing the activities, they also integrated their content knowledge, science, math, engineering, technology, and art. Moore et al. (2014) reported that when implementing integrated STEAM instruction to learn disciplinary content, it is possible to focus on all content areas or emphasize one and use the others as context. Consequently, STEAM integration can be implemented as content integration or context integration (Moore et al., 2020; Roehrig et al., 2012). An (2020) reported that pre-service teachers often enter teacher education programs with less confidence and interest in integrating STEAM. For this reason, our study
aimed to ensure that pre-service teachers have the opportunity to gain earlier and more interdisciplinary teaching experiences so that they can acquire STEAM knowledge and skills for integration STEAM and develop their own STEAM tasks.

6 Conclusions

Based on this study, it can be concluded that the Sci-Fi context is very interesting for pre-service teachers participating in the course and can be an effective tool to make students show or describe alternative conceptions of science phenomena and to understand the science concepts of pre-service teachers’, especially in chemistry. Therefore, the contextual approach seemed to be very useful to the pre-service teachers because it can be used as an alternative learning method to improve students’ learning outcomes. The pre-service teachers believe that it is important to include the Sci-Fi context in science education, especially in chemistry education, at all levels.

There are many topics that can be taught using the Sci-Fi context. Teachers can be advised on how to implement such pedagogical approaches in their practice to foster students’ interest and engagement in science, especially chemistry. Another outcome of integrating STEAM through the Sci-Fi course into the pre-service teacher education in this study is that the pre-service teachers recognized several opportunities to design STEAM activities in the Sci-Fi context as part of the elective Sci-Fi course and found that it could be easily integrated into the curriculum. They also recognized that STEAM is a fun and engaging way for pre-service teachers to collaborate creatively and critically while learning science.

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