NEVŞEHİR HACI BEKTAŞ VELİ ÜNİVERSİTESİ
Ara, bul.

Sosyal Bilimler Enstitüsü Dergisi
Cilt: 13 Sayı: 2 Haziran 2023
E-ISSN: 2149-3871

PRE-SERVICE SCIENCE TEACHERS' OPINIONS ABOUT THE PLANETARIUM

FEN BİLİMLERİ ÖĞRETMEN ADAYLARININ PLANETARYUM İLE İLGİLİ GÖRÜŞLERİ

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Geliş Tarihi:
27.03.2023

Kabul Tarihi:
23.05.2023

Yayın Tarihi:
30.06.2023

Anahtar Kelimeler
Astronomi
fen eğitimi
okul dışı öğrenme ortamı
planetaryum

Keywords
Astronomy
science education
out-of-school learning environment
planetarium

ABSTRACT

This study aims to determine the opinions of pre-service science teachers about the planetarium. Phenomenology design, one of the qualitative research methods, was used in the study. While determining the study group, criterion sampling, one of the purposeful samplings, was used. The study was carried out in the 2021-2022 academic year. The study criterion was determined as taking out-of-school learning environments courses by pre-service teachers, and 30 participants formed the study group. The study data were collected with the interview form prepared by the authors and analyzed with descriptive analysis. Pre-service teachers had the view that the planetarium was a fun, instructive, interesting, interesting and intriguing, useful, meaningful, and supportive environment for learning by experience and could be used in science lessons. Thus, they thought that it would contribute to students' meaningful and permanent learning and three-dimensional thinking. The authors recommend enriching pre-service and in-service teacher education with out-of-school learning environments such as the planetarium.

ÖZ

Bu araştırma, fen bilgisi öğretmen adaylarının planetaryuma ilişkin görüşlerini belirlemeyi amaçlamaktadır. Araştırmada nitel araştırma yöntemlerinden biri olan olgubilim deseni kullanılmıştır. Çalışma grubu belirlenirken amaçlı örnekleme yöntemlerinden ölçüt örnekleme kullanılmıştır. Çalışma 2021-2022 eğitim-öğretim yılında gerçekleştirilmiştir. Araştırmanın ölçütü, öğretmen adaylarının okul dışı öğrenme ortamları dersi almaları olarak belirlenmiş ve çalışma grubunu 30 katılımcı oluşturmuştur. Araştırma verileri, yazarlar tarafından hazırlanan görüşme formu ile toplanmış ve betimsel analiz ile çözümlenmiştir. Öğretmen adayları, planetaryumun eğlenceli, öğretici, ilgi çekici ve merak uyandırıcı, faydalı, anlamlı, yaşayarak öğrenmeyi destekleyici bir ortam olduğu ve fen derslerinde kullanılabileceği görüşündedirler. Böylece öğrencilerin anlamlı ve kalıcı öğrenmelerine ve üç boyutlu düşünmelerine katkı sağlayacağını düşünmüşlerdir. Yazarlar hizmet öncesi ve hizmet içi öğretmen eğitiminin planetaryum gibi okul dışı öğrenme ortamlarıyla zenginleştirilmesini önermektedir

DOI: https://doi.org/10.30783/nevsosbilen.1271718
Atıf/Cite as: Öner Armağan, F., Karaca, M., & Bektaş, O. (2023). Pre-service science teachers' opinions about the planetarium. *Nevşehir Hacı Bektaş Veli Üniversitesi SBE Dergisi, 13*(2), 1067-1083.

Introduction

Planetarium

It is nothing new for human beings to be fascinated by the stars and question the universe. Planetariums and devices aimed at reproducing the star-filled sky, Moon, Sun, planets, and their motions have existed since Archimedes (Allgayer & de Souza, 2021). A planetarium means a hall or building where an optical projector device is used that reflects stars, planets, the sun, the moon, and many astronomical events on a hemispherical screen (Ertaş Kılıç & Şen, 2014).

The first Planetarium was built by Archimedes. The planetarium is known to represent the movements of the planets, the Sun and the Moon, and solar and lunar eclipses. It is assumed that the entire system is placed inside a hollow sphere in which the stars are represented, swirling with water, and through an opening, one can see the inside. In the Middle Ages, the Arabs built Planetariums and observatories, the most beautiful of which is in Dresden (Barrio, 2002). In the Web of Science (WoS) database, 378 of the 63,983,680 records registered between 1975 and 2019 were related to planetariums. In his bibliographic evaluation, Bozdoğan (2020) reported that 58 (15.38%) of these records were in the education/educational research category. Therefore, it could be argued that a planetarium is a powerful tool that is frequently used by countries to achieve the goals of science and education over the years (Allgayer & de Souza, 2021). The number of planetariums that are increasing on Earth is now more than 3500 (WPD, 2021).

An important benefit of the planetarium is that it has rekindled interest in the scientific literature on popular astronomy "Zeiss Planetarium Insert, 1929". In addition, it provides a permanent education space that can be used for teacher training as well as awareness of students and the general public (Allgayer & de Souza, 2021). In addition to their known educational contributions, planetariums form planetary and cosmic thought. In other words, they lay the foundation for one's spatial awareness at the Earth and cosmos scale. Planetariums and observatories help the modern man to form the basis of his arête (full use of one's potential) by establishing the inseparable link between himself and space, by being conscious of his inner world and inner state. They extend one's worldview from the regional and even planetary scale to the perception of the self as a product of cosmic (related to the universe and its general order) processes, thus laying the foundation for the ontological orientation of individual self-actualization for future research (Zhukove & Bulgakova, 2019). In addition to being difficult to teach astronomy concepts that contain such versatile gains, they also have a structure that will pave the way for the formation of alternative concepts (Arıkurt et al., 2015; Bülbül et al., 2013). First of all, teachers and pre-service teachers should learn the concepts of astronomy meaningfully for students to learn these concepts meaningfully. One of the educational environments that will facilitate meaningful learning is the planetarium. Therefore, examination of pre-service teachers' views on the planetarium can positively affect their future students' meaningful learning about astronomy concepts.

Planetarium in Science Curriculum

Our education system based on research and inquiry advises that students should take their responsibilities. Even though we try to give the features we aim to bring to the students with the education carried out in the school environment, this is not enough (Mertoğlu, 2019). In this case, out-of-school learning environments (informal education) come to the aid of educators. It has been proven by field studies that these environments contribute to the development of cognitive, affective, and psychomotor skills of students in terms of science, learning by discovery, increasing their sense of curiosity, and improving their academic success (Guisasola et al., 2005). Students gaining first-hand experience have the opportunity to develop their metacognitive skills by establishing a relationship between real life and the scientific knowledge they learned at school. Therefore, we can say that out-of-school learning environments support formal education in terms of gaining targeted behaviors and teaching subjects that are difficult to understand (Gerber et al., 2001; Ramey-Gassert, 1997).

Learning and teaching difficulties specific to astronomy education continue (Taylor et al., 2003). Astronomy education is a good way to understand the basic principles of scientific knowledge and the nature of science (Buaraphan, 2012). Astronomy offers students a philosophical approach with a broad perspective in gaining scientific literacy, which is the basis of many goals for the learning process (Tignanelli & Benétreau-Dupin, 2014). The need to include astronomy subjects, which provide students with versatile gains in the curriculum is

understood better with every passing day (Hansen et al., 2004). The International Astronomical Union made a statement regarding astronomy education: "Astronomy education should be included in the primary and secondary education curricula of all countries, whether it is a separate course or the content of another field" (Trumper, 2006).

In our country, astronomy topics are included in the "Earth and Universe" subject area in the 2018 Science Curriculum, at every grade level from the 3rd to the 8th grade. The fact that astronomy subjects, which are in the last chapter of the 2013 Science Curriculum, are included in the 1st chapter of the 2018 Science Curriculum, shows that the importance given to this subject has been increasing (Kalkan et al., 2021). This change is an important step long overdue for astronomy education. It could be argued that the only chapter directly related to astronomy in the 2016-2017 academic year was the 7th Grade "Solar System and Beyond: Space Riddle". On the other hand, this change brought along the problem of the lack of content knowledge among teachers (Koçak & Akkaya Oralhan, 2022). To solve this problem, astronomy courses were started to be given in education faculties. When the astronomy course content of teacher training institutions is considered, it is observed that this course is taught as a two-credit course in the 5th semester in the Science Teaching Departments of Education Faculties. The contents of this course prescribed by the Council of Higher Education are "Keppler's Laws and the Structure of the Solar System: Planets and their Properties, satellites" and "General Structure of the Universe: Galaxies, formation of Stars, red giants, neutron stars, white dwarfs, black holes" (Taşcan & Unal, 2015). It is of great importance that pre-service science teachers receive education in informal environments such as planetariums and experience this process to bring their education closer to the ideal (Storksdieck, 2001). However, Türkmen and Köseoğlu (2020) reported that all academics, regardless of titles, want to use informal environments in their teaching processes in education faculties, but they do not use them at the desired level. In the same study, the authors commented that academics hesitated to benefit from informal environments due to the difficulties they faced. To eliminate the problems encountered and to expand the use of planetariums, governments should allocate more funds for science education, be aware of the changing information and developments about astronomy, ensure that the information conveyed through the media is accurate and that centers such as planetariums, museum, and park are expanded (Percy, 1998b).

Literature Review

The literature has proven that planetarium learners learn astronomy concepts at a better level (Chastenay, 2015; Choi et al., 2019; Costa et al., 2019; Hobson et al., 2010; Koçak & Akkaya Oralhan, 2022; Plummer, 2009; Thornburgh, 2017; Yu et al., 2017). Yusof et al. (2022) stated that science could best be taught in the planetarium because of its capacity to accelerate learning and help explain unobservable phenomena. Soylu and Karamustafaoğlu (2020) found that science teachers mostly preferred planetariums, museums, and science centers to teach in out-of-school environments and that out-of-school learning environments provided socialization and prompted students to make research and inquiry. Costa et al. (2019) also determined that after the planetarium training, 95.65% of the participants stated that they would come again with their students. Thus, it was concluded that teacher-student communication would increase, facilitate teaching, contribute to meaningful and permanent learning, refresh the teacher's field knowledge and provide teaching opportunities by embodying it. According to Demir and Öner Armağan (2018a) after the planetarium trip, the teachers stated that the planetarium trip was effective in providing meaningful learning and that the planetariums were very interesting for those who visit for the first time. In the same study, it was seen that the teachers' opinion that planetariums were effective in concretely teaching astronomy subjects came to the fore. Plummer (2009) reported that both kinesthetic learning techniques and the rich visual environment of the planetarium were important for a better understanding of celestial movements involving abstract concepts. Solakcı and Bozdoğan (2022) concluded that secondary school students thought that planetariums offered a realistic environment and that they were more effective and entertaining spaces than the classroom environment. In the same study, students stated that they liked the planetariums because they created a feeling of wandering in space, and their interests and opinions on science and astronomy changed positively. Therefore, the literature has demonstrated that the planetarium was an effective way to teach astronomy topics. That being the case, the perceptions, views, and perspectives of the teachers and/or pre-service teachers who will actively use the planetarium in the education and training process become important. Therefore, determining the opinions of teachers and pre-service teachers on the planetarium is valuable in terms of using planetariums more effectively in the education

process. Moreover, it will provide valuable results for more efficient planning of pre-service and in-service teacher education (Crone et al., 2011). Based on all these reasons, this study aims to determine the views of pre-service science teachers about the planetarium.

Method

Research Design

This study was conducted based on the phenomenology design of the qualitative research method. Phenomenology is an approach that allows people to express their understanding, feelings, perspectives, and perceptions about a particular phenomenon or concept and is used to describe how they experience this phenomenon (Rose et al., 1995, p. 1124). The current study investigated the experiences of pre-service science teachers with the planetarium after their education.

Study Group

Purposive sampling was used in this study. Purposeful sampling help to explore and explain phenomena and events in many cases (Fraenkel & Wallen, 2006). In this study, the participants were determined by easily accessible case sampling, which is one of the purposive sampling types. In this sampling, the researcher prefers a situation that is close and easy to access (Fraenkel & Wallen, 2006). Thus, the participants were selected from third-year students studying at a state university in the 2021-2022 academic year. As a criterion, students taking the course of out-of-school learning environments were focused upon, and 30 students who met this criterion were selected.

Data Collection Tools

The study data were collected with an interview form. In this study, the document analysis form was preferred to reach people more easily. This form can be preferred when the observation and interview used in qualitative research cannot be done directly, to increase the validity of the research with other methods or to collect data alone. In this form, 13 open-ended questions were prepared to determine the opinions of pre-service science teachers about planetariums from out-of-school learning environments. While preparing the interview form, a literature review was conducted. The studies of Demir and Öner Armağan (2018a and b) were used. The questions formed were examined by three science educators who were experts in their fields and the questions were used in the study after necessary changes and corrections. Questions 1, 5, 6, and 7 in the final form were about the structure of the planetarium; while questions 8, 9, 10, 11, 12, and 13 determined the participant's experiences regarding the use of the planetarium in the science course. For example, the 5th question in the form was "Was the planetarium training adequate and useful?"; the 6th question in the form was "What kind of contribution does such an education make to students in terms of astronomy subjects in science lessons?".

Data Collection Process

Before the planetarium workshop at Kayseri Science Center, a 45-minute presentation on celestial bodies and planets was given to the participants and a question-answer activity was held. After the presentation, they participated in a workshop in the planetarium by the field experts. After this visual training, a question-answer activity was held again. After the planetarium trip, the planetarium interview form consisting of open-ended questions was shared with the pre-service teachers and they were asked to answer the questions. The participants were given 40 minutes as a response time. Participant opinions were collected through written forms for the participants to respond more easily. Before the application, it was explained to the participants that all their information would be kept confidential and that they would not receive any evaluation points from this application. Thus, pre-service teachers were encouraged by the authors to express their thoughts comfortably. It was also stated that the answers they gave to the questions would not be used for purposes other than the study.

Data Analysis

The data of the study were analyzed with descriptive analysis. In this approach, the aim is to organize and interpret the data obtained as a result of the interview. Data are classified, summarized, and interpreted according to predetermined themes (Karataş, 2015). The data were gathered under two themes: "Structure of the Planetarium" and "Integration to Science Lesson". None of the participants stated that they had no previous planetarium experience. Therefore, they did not answer questions 2, 3, and 4 and these questions were not included in the analysis. The data were analyzed separately by the authors and a consensus was reached. The themes were tried to be evaluated in a way that would cover all the data and answer the research question. As a result of the expert suggestions and the discussions between the authors, the answers given by the participants to questions 1, 5, 6, and 7 on the theme of Planetarium Structure and the answers to questions 8, 9, 10, 11, 12 and 13 in the theme of Integration to Science Lesson are presented in the findings.

Validity and Reliability

The authors analyzed the research data separately and reached a consensus as a result of repeated meetings. Thus, they aimed to ensure the consistency of research results and internal reliability. To ensure the internal validity of the research, the relevant findings were supported with direct quotations. To ensure external validity, the authors preferred purposive sampling. They also described in detail all the processes of the study. To ensure external reliability, the authors had the findings and conclusion/discussion parts checked by an expert and ensured that both parts were consistent.

Findings

The findings obtained as a result of the analyzes are presented under the titles of "*Planetarium Structure Theme*" and "*Integration to Science Lesson Theme*". The categories belonging to each theme were summarized in categories and code tables based on the questions in the interview form.

Planetarium Structure Theme

"*How would you describe the planetarium (Observatory) as an environment?*" in the interview form of the participants. The codes obtained in line with the answers given to the question are given in Table 1.

Table 1. *Codes of Media Category*

Code	Explanation	Participant
enjoyable	We learned while having fun.	K1, K10
instructive	Environments that help us recognize celestial bodies	K2, K10
	Enough educational and instructive environment	K12
inquisitive	interesting environment	K11
	arouses interest and curiosity in visitors	K12
useful	Very useful, needed everywhere	K9
	A useful application	K6, K7, K8
promotes meaningful learning	Very suitable for 3D thinking, and very useful for us to clearly understand space and planets	K3
	Useful beautiful places that contribute to teaching and provide a better understanding	K4
	Environments that help us better understand the topics covered in the lesson, thanks to visual effects and models in our minds	K5

Participants stated that the planetarium was a fun, instructive, interesting and intriguing, useful, meaningful, and supportive environment for learning by experience. K3 expressed: *"It is very suitable for 3D thinking, very useful for us to understand the space and planets clearly"*, and K5 stated: *"The environments that help us to understand the topics covered in the lesson better with visual effects and models in our minds"*.

In the interview form of the participants, "5. Did you find the training given during the planetarium trip today sufficient and useful?" The codes obtained in line with the answers given to the question are given in Table 2.

Table 2. *Codes of the Education Category Given*

Code	Explanation	Participant
Yes	It was sufficient and useful.	K1
	Sufficient and useful	K2
	Useful and sufficient	K3
	It was more enjoyable and more instructive	K4
	I found it sufficient and useful	K6
	It was very efficient	K7
	It was very useful I learned a lot of new information	K8
	It was small but very useful.	K9
	I found it useful.	K11
	I think it was enough and it helped a lot	K12

The participants stated that they found the planetarium education provided to be sufficient, useful, enjoyable, instructive, efficient, and concise. K8's statement *"It was very useful; I learned a lot of new information"* could be shown as evidence of this situation.

In the interview form of the participants, "6. How do you think an education in the Planetarium will contribute to the students in terms of astronomy subjects in the science course? The codes obtained in line with the answers to the question "Please explain" are given in Table 3.

Table 3. *Codes of Contribution to the Student Category*

Code	Explanation	Participant
meaningful and permanent learning	Provides memorable information	K1
	Helps them better understand the subject	K2
	Elements such as size, rotation, and shape are more clearly understood	K3
	With more active teaching, it can increase learning	K4
	It enables them to comprehend better and learn without memorizing.	K5
	Realizes permanent learning	K7
ability to think in three dimensions	Allows students to recognize planets and different materials	K6
	It is very useful visually and in terms of permanence.	K9, K10
learning with fun and experience	allows them to learn in a fun way	K5
	The information is permanent, as the lessons are told by experiencing the events instead of learning in a monotonous and boring way.	K8
	Increases students' interest in the subject by attracting attention	K11
remarkable, intriguing	Students are more interested in the lesson…	K4
	It increases students' curiosity. It enables them to be more successful in the lesson.	K12

Participants stated that a science course to be held at a planetarium would contribute to the students having meaningful and permanent learning, three-dimensional thinking, and learning by having fun and experiencing so that the course would become remarkable and intriguing. K8 said: *"In the lessons, instead of learning in a monotonous and boring way, the information is permanent because the events are taught by experience"*; K11 mentioned: *"It increases the interest of the students by attracting their attention"*.

In the interview form of the participants, "7. What are the positive and negative aspects of planetariums? The codes obtained in line with the answers given to the question are given in Table 4.

Table 4. *Codes of the Positive and Negative Aspects Category*

Code	Explanation	Participant
Positive	Allows you to understand the positive aspects more quickly	K2
	Positive aspects of 3-dimensional thinking	K3
	Increases the student's interest in the lesson	K4
	All features are positive	K5
	Visual representation of planets with different instruments	K6
	I think it is very useful I do not think it has a negative feature	K7
	It was all so good	K8
	Learning by seeing and doing	K9
	Appeals to visual memory	K10
	The positive aspect is that it provides students with a different learning environment, there is no negative aspect	K11
	Being very educational is a positive feature	K12
Negative	It brings sleep	K1
	It may be time and financial loss.	K4
	But it's bad that it's always unreachable	K9

Participants thought that the planetarium facilitated understanding, developed three-dimensional thinking, that visual material support was important, and that it contributed to learning by doing and experiencing. On the other hand, some participants also stated that the planetarium had negative features such as being boring, a waste of time and money, and being hard to reach. For example, K1 thought: *"Brings sleep",* P4 said: *"While increasing the student's interest in the lesson, it may waste time and money"*, and K9 expressed: *"It teaches by seeing and applying, but it is bad that it is not always accessible"*.

Integration of Planetarium into Science Lesson

All of the participants stated that they wanted to use the planetarium in the science course. Participants evaluated their willingness to use the planetarium in their lessons in terms of students (Table 5), teachers' pedagogical content knowledge (Table 6), time (Table 7), science achievements (Table 8), and learning environment (Table 9).

Table 5. *Codes of the student category*

Code	Explanation	Participant
beneficial	Useful for students	K1
	It would be amazing	K3
	Definitely very useful for students.	K8
ability to think in three dimensions	To make the celestial bodies come to life better in the eyes of the students	K2
	It contributes to the students visually and enables them to recognize the tools and materials they have not seen.	K6
	It facilitates learning as it appeals to visual memory	K10
interesting, intriguing	To attract students' attention	K4
	good for attraction	K9
	Arouses students' curiosity	K11
enjoyable	I use it to teach better and more fun.	K5
	Making the lesson fun	K7
	Becomes a fun lesson outside of the classroom environment	K10
permanent and meaningful learning	Explaining the subject better to students	K4
	teach the subject better	K7
	I think that the information provides permanent learning	K8
	more permanent	K9

efficiency enhancer	I think it will make my lecture easier.	K11
	I think that the lesson with students who are more interested and who like to observe and ask questions will be more productive.	K12

Participants thought that this would be beneficial for students, developing three-dimensional thinking skills, interesting, arousing, entertaining, permanent, and effective, facilitating meaningful learning. For example, K12 expressed: *"I think it will make my lecture easier. I think the lesson with students who are more interested and who like to observe and ask questions will be more productive"*.

Table 6. *Codes of the category of Pedagogical Content Knowledge*

Code	Explanation	Participant
communication enhancer	It enhances communication.	K1
	Increases interaction between teacher and student	K2
facilitator in teaching	Increasing students' interest	K4
	As it facilitates learning	K5
	It provides benefits	K6
	I think it fits the curriculum.	K10
facilitating meaningful and permanent learning	I think it will be very effective in realizing meaningful and permanent learning.	K7
	Narration should be fluent and not boring	K9
refresher of teacher's field knowledge	Repetition of information for teachers	K8
	Teachers who are competent and knowledgeable in the pedagogical field know that they should use such educational environments and use them as much as possible.	K12
teaching by concretization	More convenient and understandable for children	K3
	Transfers pedagogical content knowledge to students in a more concrete environment	K11

Participants stated that teachers with sufficient pedagogical content knowledge would already use these environments. They stated that teacher-student communication would increase, would facilitate teaching, contribute to meaningful and permanent learning, the teacher's field knowledge would be refreshed and teaching would be provided by embodying it. In this context, while K7 said: *"I think it will be very effective in terms of realizing meaningful and permanent learning"*, K11 said: *"It transfers pedagogical content knowledge to students in a more concrete environment"*.

Table 7. *Codes of the time category*

Code	Explanation	Participant
sufficient	Pretty standard and enough	K3
should be longer	There can be a more efficient course flow in more time	K4
	It should always be done	K8
	It may take a while	K11
should be shorter	1 hour is enough	K1
	3 hours is enough.	K5
	1 lesson is enough	K7
	I think 2 lesson hours is enough	K10
other	Provides faster understanding	K2
	Time was used efficiently	K6
	It may take a lot of time, but this is negligible in the face of permanence	K9
	They used their time very effectively	K12

There was no common consensus among the participants evaluating a lesson in the planetarium in terms of time. While some thought that the training time was quite accurate, some stated that it should be shorter or longer. For example, K1 stated: *"1 hour is enough"*, P4 specified: *"There can be a more efficient course flow in more time"*, and K9 expressed: *"It may take a lot of time, but this can be ignored in the face of permanence"*.

Table 8. *Codes of the Science Achievements category*

Code	Explanation	Participant
effective and harmonious	Effective and compliant	K7
	The names of the planets and the concepts of their properties are compatible with the acquisitions.	K10
	It included most of the scientific achievements	K11
	science achievements were sufficient.	K12
useful	Nice and useful	K1
	Provides benefits in terms of scientific achievements	K6
	Visual, psychomotor, and auditory are very useful	K9
love the lesson	Positive feedback is received after the trip	K5
	to arouse interest in science	K8
meaningful learning in a short time	Allows you to grasp the gains more quickly	K2
	Events such as celestial bodies, seasons, night, and day are understood.	K3
other	May give more or less of your gains	K4

Participants thought that a science course that would take place in the planetarium was compatible with the acquisitions in the curriculum, an effective and useful lesson could be taught, and meaningful learning could be achieved in a shorter time. While K2 uttered this idea as *"It allows to grasp the achievements more quickly"*, K11 expressed it as *"It included most of the scientific achievements"*.

Table 9. *Codes of the Learning Environment category*

Code	Explanation	Participant
enough	Quite enough	K1
interactive	Provides a more interactive learning environment	K2
	interactive	K7
out-of-school learning environment	It is very suitable for science courses in terms of out-of-school learning environments	K3
	I think it is an environment that every student should see.	K12
active learning	A more active learning environment	K4
diversity is out of focus	There is a lot of variety, which is good for interest, no distractions	K9
funny	I think it will be productive and fun since it will be outside the classroom environment	K10
	Provides a fun learning environment	K11
productive	It is the ideal learning environment as it is visual and auditory.	K5
	Students learn faster because they see visually.	K6
	Provides lasting learning	K8
	I think it will be productive and fun since it will be outside the classroom environment	K10

Participants defined the planetarium as an efficient, interactive, active learning environment that facilitated active learning, provided diversity without shifting the focus, and was an efficient out-of-school learning environment. Some participant statements were as follows: K3, *"It is very suitable for science lessons in terms of out-of-school learning environments"*, K9, *"There is a lot of variety, this is good for interest, there will be no distraction"*, K12, *"I think it is an environment that every student should see"*.

Conclusion and Discussion

The authors concluded that pre-service science teachers had a positive opinion about their first planetarium experience. Similarly, Gürsoy (2018) revealed that pre-service teachers had a positive view of out-of-school learning environments and that these environments contributed to students' cognitive and sensory skills. The Science Curriculum recommended teaching the lessons in learning environments that are student-centered and benefit from informal learning environments (MoNE, 2018). Metin and Bozdoğan (2020) also found that if out-of-school learning is carried out in a planned way, it achieves its purpose, and according to the current learning process, learning with a planetarium trip significantly increases student success, students' interest in science subjects and the level of motivation for science learning. They have seen that students who had no idea about the planetarium at first learned about this environment and found it fun and instructive.

Pre-service teachers had the view that the planetarium was a fun, instructive, interesting, interesting and intriguing, useful, meaningful, and supportive environment for learning by experience. Başoğlu Dümenci and Yıldız Bıçakçı (2019) expressed the opinions of the participants about the planetarium with informative, impressive, intriguing, and entertaining codes. Oktay et al. (2020) reported that the students were generally satisfied with the activity, enjoyed the activity, were excited, and found it extremely entertaining after the planetarium trip with a disadvantaged group of secondary school students. Therefore, it could be argued that when planetariums were used in a planned and effective way, they provided meaningful and permanent learning, especially in teaching abstract concepts. Thus, the dissemination of training for pre-service and in-service teachers to use the planetarium effectively in education would make it easier to reach the aims of education. Therefore, how can these planetariums contribute to education other than the dignity of student clubs and spatial richness in events? Planetariums were included in STEAM programs or used in different social activities, from yoga sessions to drama events, from painting competitions to poetry recitals in planetariums abroad. The frequency of use of these spaces and the spread of planetarium projects could be ensured by harmonizing planetariums with class and student levels and achievements. It is possible to design presentations for the academic achievements of each course in planetariums. It is possible to address astronaut diseases and biology course outcomes, or foreign language course outcomes by examining a mythological reading piece with constellations. In an institution, it would be a more accurate assessment to look at whether there was a planetarium in education planning, whether that planetarium was used efficiently, and whether the program implementers had the necessary and sufficient equipment (URL).

Pre-service teachers are considering using the planetarium in science lessons. Özcan and Yılmaz (2018) also reported the opinions of pre-service teachers that they would use in their science and astronomy lessons after the trip to the planetarium. On the other hand, Dönel Akgül and Arabacı (2020) stated that among the teachers who participated in their research, there was a substantial number who did not use the out-of-school learning environment throughout their professional life. In this study, pre-service science teachers stated that science education in this environment was compatible with the acquisitions in the curriculum, sufficient, useful, enjoyable, instructive, efficient, facilitating active learning, and increasing interaction. Pre-service teachers thought that such an education would contribute to the students with meaningful and permanent learning, three-dimensional thinking, and learning by having fun and experiencing so that they can make the lesson interesting. It was observed that field studies obtained similar results (Costa et al., 2019; Funderburk, 2016; Lee, 2019; Mora Mayo, 2019). For example, Elmas et al. (2021) concluded that pre-service teachers had the opinion that informal learning activities such as excursions would solve the problems of having the course abstract, forgetting information quickly, incomplete learning, and forming misconceptions. Eighth-grade students, who were the participants of the study by Sontay et al. (2016), stated that the planetarium trip was suitable for learning science, that the information became more permanent, and that such out-of-school learning environments should be done because they were fun and effective. Choi et al. (2019) found that planetarium education was effective in improving the astronomical thinking skills of high school students. In particular, this program was effective in improving the ability to model the observed astronomical phenomenon by reconstructing it from the point of view of the universe according to the spatial idea in the field of astronomy and improving the ability to organize the system by comprehending the relationship between the elements that make up the astronomical system. Demir and Öner Armağan (2018b) concluded that the students thought that the planetarium trip was very effective in increasing their interest, desire, and curiosity toward the science lesson. On the other hand, students

stated that a lesson held in the planetarium helped them understand the subjects better, and they learned by having fun. Efe (2019) also stated in his study that planetariums were places where students had the most fun; Aksu and Umdu Topsakal (2017) stated that planetariums positively affected students' attitudes towards science and students enjoyed the planetarium trip; Özcan and Yılmaz (2018) stated that as a result of the planetarium trip of science teacher candidates, there were positive changes in astronomy concepts; Bozdoğan and Ustaoğlu (2016) concluded that the pre-service teachers provided permanent and meaningful learning to embody the abstract science concepts of the planetarium. Bozdoğan and Ustaoğlu (2016) also organized a trip to Samsun Ondokuz Mayıs University Planetarium in the 2014-2015 academic year with 31 science teachers and investigated their thoughts on planetariums. As a result of the research, it was stated that planetariums transformed interesting, instructive, entertaining, abstract concepts into effective and meaningful learning in a short time. Planetariums enable children to experience areas that they cannot see or experience in person, in a virtual environment, and enable them to make sense of abstract concepts more easily (Bishop, 2003). The field studies that were presented as examples bring to mind the mastery learning model. The Bloom Mastery Learning Model aims to increase the learning power of students and advocates creating opportunities for them to learn faster (Bloom, 1988). The quality of learning service is an important factor for a desired change in the learning level. In the mastery learning model, it is known that some behaviors increase the speed of learning and make it simpler (Bloom, 1995). Various studies such as making use of materials, performing arithmetic operations, making regular repetitions, and commenting increase the learning rate and ensure that the information obtained is more permanent. Planetariums will contribute to full learning as they contain most of these gains.

To popularize the use of planetariums, which have such contributions to education and training, by teachers in the field, first of all, their perceptions and opinions would need to be improved, and they would need to have the necessary and sufficient information. Pre-service teachers participating in this study thought that teachers with sufficient pedagogical content knowledge would use planetariums anyway. Kutlu Abu (2019) attributed the teachers' insufficient use of informal learning environments in education and training to the fact that teachers did not have sufficient knowledge about curriculum differentiation and alternative assessment methods for gifted students and that they did not give a course about differentiated education practices and out-of-school learning in undergraduate programs apart from special education courses. Bostan Sarıoğlu and Küçüközer (2017) also reported that pre-service teachers did not have the necessary and sufficient knowledge and skills about out-of-school learning environments. Atmaca (2012) stated that pre-service teachers took the subjects more seriously with a professional point of view after they received the out-of-school science course, and they became able to design new applications in the field by completing their theoretical and practical inadequacies. Therefore, the training that pre-service teachers received at the planetarium was important in terms of improving their pedagogical content knowledge in teaching astronomy.

Three of the pre-service teachers (K1, K4, and K9) had the opinion that the negative aspects of the planetarium such as boredom, waste of time and money, and transportation difficulties would negatively affect this training. Mertoğlu (2019) also evaluated the transportation problem of some of the pre-service teachers and the expensive entrance fees of some out-of-school learning environments as negative factors in the trips. Similarly, Karademir (2013) and Bozdoğan (2007) also mentioned transportation and financial difficulties as negative aspects of out-of-school trips. In this study, it was concluded that there were different views, especially in terms of time. While some of the pre-service teachers thought that the training period was very accurate, some of them stated that it should be shorter or longer. The possible reason for this may be due to the different experiences of the participants, their field knowledge, and the student profiles they actively take part in. Therefore, individual differences in time came to the fore. Soylu and Karamustafaoğlu (2020) stated that science teachers thought that the high number of students on trips to out-of-school environments may hinder activities, and there may be difficulties in meeting costs and providing transportation. Planetarium software could be preferred to address these concerns. For example, Hobson et al. (2010) investigated young children's understanding of observable Moon phase shapes, predictable Moon shapes, and the cause of Moon phases, targeted Moon shapes, including when to observe the Moon, with Starry Night planetarium software. According to the results of the study, they achieved a positive change in children's conceptual understanding of all the targeted concepts, including the cause of the Moon phases, which was remarkable considering the complexity and abstraction of the subject. They also concluded that computer simulations reduced the burden on children's cognitive capacities and could

help them learn complex scientific concepts that they could not learn on their own. Başçı (2019) reported that students stated that the physical structure of the planetarium made them feel like they were in space as if they were looking at the sky and seeing the stars that way because of its dome shape. Başçı also stated that the students found the planetarium realistic and enjoyed it. Some students stated that the physical conditions (image and sound) of fixed planetariums were better than the mobile application. Therefore, it could be recommended that teachers/pre-service teachers prefer the fixed planetarium if possible.

Based on all of this, this study is in line with the literature in proposing a fun and flexible planetarium. The current study is very important as it asks teachers to use the planetarium to develop their students' affective qualities and support their meaningful learning.

Recommendations

•This study, which was based on the qualitative research method, could be conducted using a larger sample. Thus, the generalizability of the results of this study could be checked.

•Teachers and pre-service teachers could be supported with training in this direction for planetariums to be used effectively in science lessons.

•The usability and effectiveness of planetariums could be investigated not only in astronomy but also in other science disciplines.

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GENİŞLETİLMİŞ ÖZET

Arşimet'ten bu yana var olan planetaryumlar, gezegenlerin hareketlerini, Güneş ve Ay'ı, güneş ve ay tutulmalarını somutlaştırarak görselleştirmektedirler. Özellikle son yıllarda yapılan eğitim araştırmalarında planetarium konulu çalışmaların sayısının arttığını görmekteyiz. Planetaryumlar, öğretmen yetiştirmenin yanı sıra öğrencilerin ve genel kamuoyunun farkındalığı için kullanılabilecek kalıcı bir eğitim alanı sağlar (Allgayer & de Souza, 2021). Bilinen eğitim katkılarına ek olarak, planetaryumlar gezegensel ve kozmik düşünceyi oluşturur. Bu kadar çok yönlü kazanımlar içeren astronomi kavramlarını öğretmek zor olmakla birlikte alternatif kavramların oluşmasına da zemin hazırlayacak bir yapıya sahiptirler (Arıkurt vd., 2015; Bülbül vd., 2013). Astronomi eğitimine özgü öğrenme ve öğretme güçlükleri halen günümüzde devam etmektedir (Taylor ve diğerleri, 2003). Öğrencilerin astronomi kavramlarını anlamlı bir şekilde öğrenmeleri için öncelikle öğretmenlerin ve öğretmen adaylarının astronomi kavramlarını anlamlı bir şekilde öğrenmeleri gerekmektedir. Öğrencilere kazandırmayı hedeflediğimiz özellikleri temelde okul ortamında gerçekleştirilen eğitimle vermeye çalışsak da bu yeterli değildir (Mertoğlu, 2019). Bu durumda okul dışı öğrenme ortamları (informal eğitim) eğitimcilerin imdadına yetişmektedir. Anlamlı öğrenmeyi kolaylaştıracak eğitim ortamlarından biri de planetaryumdur. Bu nedenle öğretmen adaylarının planetaryuma ilişkin görüşlerinin incelenmesi, onların gelecekteki öğrencilerinin astronomi kavramlarını anlamlı bir şekilde öğrenmelerini olumlu yönde etkileyebilir.

Ülkemizde 3. sınıftan 8. sınıfa kadar her sınıf düzeyinde astronomi konuları 2018 Fen Bilimleri Öğretim Programında "Dünya ve Evren" konu alanında yer almaktadır. 2013 Fen Bilimleri Öğretim Programının son bölümünde yer alan astronomi konularının 2018 Fen Bilimleri Öğretim Programının 1. bölümünde yer alması bu konuya verilen önemin giderek arttığını göstermektedir (Kalkan vd., 2021). Bu değişiklik, astronomi eğitimi için çoktan gecikmiş önemli bir adımdır. 2016-2017 akademik yılında astronomi ile doğrudan ilgili olan tek bölümün 7. Sınıf "Güneş Sistemi ve Ötesi: Uzay Bilmecesi" olduğu söylenebilir. Öte yandan bu değişim öğretmenlerde alan bilgisi eksikliği sorununu da beraberinde getirmiştir (Koçak ve Akkaya Oralhan, 2022). Bu sorunu çözmek için eğitim fakültelerinde astronomi dersleri verilmeye başlanmıştır. Öğretmen yetiştiren kurumların astronomi ders içeriklerine bakıldığında bu dersin Eğitim Fakültelerinin Fen Bilgisi Öğretmenliği bölümlerinde 5. yarıyılda iki kredilik ders olarak okutulduğu görülmektedir. YÖK tarafından öngörülen bu dersin içerikleri "Keppler Kanunları ve Güneş Sisteminin yapısı: Gezegenler ve özellikleri, uydular" ve "Evrenin Genel Yapısı: Galaksiler, yıldızların oluşumu, kırmızı devler, nötron yıldızları, beyaz cüceler, kara delikler" şeklindedir (Taşcan ve Ünal, 2015). Fen bilgisi öğretmen adaylarının planetaryum gibi informal ortamlarda eğitim almaları ve bu süreci yaşamaları eğitimlerini ideale yaklaştırabilmeleri için büyük önem taşımaktadır (Storksdieck, 2001). Ancak Türkmen ve Köseoğlu (2020) unvanları ne olursa olsun tüm akademisyenlerin eğitim fakültelerindeki öğretim süreçlerinde informal ortamları kullanmak istediklerini ancak istenilen düzeyde kullanmadıklarını bildirmiştir. Aynı çalışmada yazarlar, akademisyenlerin karşılaştıkları güçlükler nedeniyle informal ortamlardan yararlanma konusunda çekindiklerini belirtmişlerdir. Karşılaşılan sorunları ortadan kaldırmak ve planetaryumların kullanımını yaygınlaştırmak için hükümetler bilim eğitimine daha fazla kaynak ayırmalı, astronomi ile ilgili değişen bilgi ve gelişmelerden haberdar olmalı, medya aracılığıyla aktarılan bilgilerin doğru olmasını sağlamalı ve planetarium, müze ve park gibi merkezleri yaygınlaştırmalıdır (Percy, 1998b).

Literatür, planetaryumun astronomi konularını öğrencilere öğretmek için etkili bir yol olduğunu göstermiştir. Bu durumda, eğitim-öğretim sürecinde planetaryumu aktif olarak kullanacak öğretmenlerin ve/veya öğretmen adaylarının algıları, görüşleri ve bakış açıları da önem kazanmaktadır. Bu nedenle öğretmen ve öğretmen adaylarının planetaryuma ilişkin görüşlerinin belirlenmesi, planetaryumların eğitim sürecinde daha etkin kullanılması açısından değerlidir. Ayrıca hizmet öncesi ve hizmet içi öğretmen eğitiminin daha verimli planlanması için değerli sonuçlar sağlayacaktır (Crone vd., 2011). Tüm bu nedenlerden hareketle bu çalışma, fen bilgisi öğretmen adaylarının planetaryuma ilişkin görüşlerini belirlemeyi amaçlamaktadır.

Bu çalışma, nitel araştırma yöntemlerinden fenomenoloji desenine dayalı olarak yapılmıştır. Bu çalışmada amaçlı örnekleme kullanılmıştır. Bu çalışmada katılımcılar, amaçlı örnekleme türlerinden biri olan kolay ulaşılabilir durum örneklemesi ile belirlenmiştir. Böylece katılımcılar 2021-2022 eğitim-öğretim yılında bir devlet üniversitesinde öğrenim gören üçüncü sınıf öğrencileri arasından seçilmiştir. Ölçüt olarak okul dışı öğrenme ortamlarında ders alan öğrenciler üzerinde durulmuş ve bu ölçütü karşılayan 30 öğrenci seçilmiştir. Araştırma verileri görüşme formu ile toplanmıştır. Bu çalışmada insanlara daha kolay ulaşabilmek için doküman inceleme

formu tercih edilmiştir. Bu formda fen bilgisi öğretmen adaylarının okul dışı öğrenme ortamlarından planetaryumlara ilişkin görüşlerini belirlemeye yönelik 13 adet açık uçlu soru hazırlanmıştır. Doküman inceleme formu hazırlanırken literatür taraması yapılmış, Demir ve Öner Armağan'ın (2018a ve b) çalışmalarından yararlanılmıştır. Oluşturulan sorular alanında uzman üç fen bilimleri eğitimcisi tarafından incelenmiş ve gerekli değişiklik ve düzeltmeler yapıldıktan sonra sorular çalışmada kullanılmıştır. Planetaryum gezisinin ardından açık uçlu sorulardan oluşan planetaryum görüşme formu öğretmen adaylarıyla paylaşılmış ve soruları cevaplamaları istenmiştir. Araştırmanın verileri betimsel analiz ile analiz edilmiştir. Temalar tüm verileri kapsayacak ve araştırma sorusuna cevap verecek şekilde değerlendirilmeye çalışılmıştır. Uzman önerileri ve yazarlar arasındaki tartışmalar sonucunda katılımcıların 1, 5, 6 ve 7. sorulara verdikleri cevapların "Planetaryum Yapısı" temasını; 8, 9, 10, 11, 12 ve 13. sorulara verdikleri cevapların ise "Fen Dersine Entegrasyon" temasını oluşturmasına karar verilmiştir.

Yazarlar, fen bilimleri öğretmeni adaylarının ilk planetaryum deneyimleri hakkında olumlu bir görüşe sahip oldukları sonucuna varmışlardır. Öğretmen adayları, planetaryumu eğlenceli, öğretici, ilgi çekici, ilgi çekici ve merak uyandırıcı, faydalı, anlamlı ve yaşayarak öğrenmeyi destekleyici bir ortam olarak görmüşlerdir. Dolayısıyla planetaryumların planlı ve etkili bir şekilde kullanıldığında özellikle soyut kavramların öğretiminde anlamlı ve kalıcı öğrenme sağladığı söylenebilir. Bu nedenle, planetaryumu eğitimde etkin bir şekilde kullanmaya yönelik öğretmen adayları ve hizmet içi eğitimlerin yaygınlaştırılması, eğitimin amaçlarına ulaşmayı kolaylaştıracaktır. O halde bu planetaryumlar, öğrenci kulüplerinin saygınlığı ve etkinliklerdeki mekansal zenginlik dışında eğitime nasıl katkı sağlayabilir? Planetaryumlar STEAM programlarına dahil edildi veya yurt dışındaki planetaryumlarda yoga seanslarından drama etkinliklerine, resim yarışmalarından şiir dinletilerine kadar farklı sosyal aktivitelerde kullanıldı. Bu alanların kullanım sıklığı ve planetaryum projelerinin yaygınlaştırılması, planetaryumların sınıf ve öğrenci seviyelerine ve kazanımlarına uyumlu hale getirilmesiyle sağlanabilir. Planetaryumlarda her dersin akademik kazanımlarına yönelik sunumlar tasarlamak mümkündür. Astronot hastalıkları ve biyoloji dersi çıktılarına ya da yabancı dil dersi çıktılarına takımyıldızlı mitolojik bir okuma parçasını inceleyerek değinmek mümkündür. Bir kurumda eğitim planlamasında planetaryum olup olmadığına, o planetaryumun verimli kullanılıp kullanılmadığına, program uygulayıcılarının gerekli ve yeterli donanıma (URL) sahip olup olmadığına bakmak daha doğru bir değerlendirme olacaktır. Öğretmen adayları, gökevini fen derslerinde kullanmayı düşünmektedir. Öğretmen adayları böyle bir eğitimin öğrencilerin anlamlı ve kalıcı öğrenmelerine, üç boyutlu düşünmelerine, eğlenerek ve yaşayarak öğrenmelerine katkı sağlayarak dersi ilgi çekici kılacaklarını düşünmüşlerdir. Eğitim ve öğretime bu tür katkıları olan planetaryumların alan öğretmenlerince kullanımının yaygınlaştırılması için öncelikle onların algılarının ve görüşlerinin geliştirilmesi, gerekli ve yeterli bilgiye sahip olmaları gerekmektedir. Bu araştırmaya katılan öğretmen adayları, yeterli pedagojik alan bilgisine sahip öğretmenlerin planetaryumları zaten kullanacaklarını düşünmüşlerdir. Öğretmen adaylarından üçü (K1, K4 ve K9) planetaryumun can sıkıntısı, zaman ve para kaybı, ulaşım zorluğu gibi olumsuz yönlerinin bu eğitimi olumsuz etkileyeceği görüşündedir. Öğretmen adaylarının bir kısmı eğitim süresinin çok doğru olduğunu düşünürken bir kısmı da daha kısa veya daha uzun olması gerektiğini belirtmişlerdir. Tüm bunlara dayanarak, bu çalışma planetaryumun eğlenceli olması ve formal eğitim ortamlarına göre esneklik sağlaması açısından alanyazınla uyumludur. Mevcut çalışma, öğretmenlerden öğrencilerinin duyuşsal niteliklerini geliştirmek ve anlamlı öğrenmelerini desteklemek için planetaryumu kullanmalarını istediği için çok önemlidir.