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Consecutive Course Modules Developed with Simple Materials to Facilitate the Learning of Basic Concepts in Astronomy

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From the perspective of teaching, the huge natural laboratory that astronomy provides constitutes the most prominent connection between astronomy and other branches of science. The purpose of this research was to provide educators with activities of observation using simple materials that were developed to facilitate the teaching of basic concepts of astronomy, presenting these in the form of course modules that they could use in the classroom. Six modules were developed for teaching basic astronomy. The modules "What is Astronomy?", "The Solar System and Observing the Sun", "Astronomy Topics in the Elementary School Curriculum and Experimental Activities" and "Space Research and Life in Outer Space" were implemented in the day classes while the modules "The History of Astronomy and Sky Observation" and "Sky Observation with a Telescope" were implemented during evening classes. The modules developed are unique in that their content treats the basic concepts of astronomy with an integrated and consecutive approach to make the activities easier for teachers to implement in the classroom. The effectiveness of the activities that were designed was investigated by testing the modules on Pre-service Science Teachers (N=88), after which observation notes were recorded.

Keywords: hands-on astronomy activities, basic astronomy concepts, pre-service teachers, scientific observation

INTRODUCTION

Astronomy is one of the oldest branches of science that came to life when man began observing the skies. Phenomena in the sky have aroused the curiosity of man since time immemorial. Tombs with carvings depicting the Moon and its phases have been found in France and have been dated back to Cro-Magnon man, who is

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believed to have produced these 30,000 years ago. These structures, with their carvings of what can be interpreted to be lunar calendars, are accepted as being the world's oldest astronomical documents (Karttunen, Kröger, Oja, Poutanen, & Donner, 1996). It is unknown exactly how the science of astronomy first emerged. It is however asserted that its advent had to do more with man's desire to understand and control natural phenomena in order to live a safe and comfortable life rather than with wanting to comprehend the entire universe surrounding him. It was particularly the vital necessity prehistoric man felt to understand the phenomena of weather and sky movements that led people to make observations of the sky. People tried to determine the seasons by the positions of the stars in the sky. In those times, in which the tools needed for advanced observation had not as yet been invented, the method used to collect information about the sky was making observations with the naked eye.

The roots of classical astronomy go back to as far as the first ages of man, to the 6th century B.C. As far as it is known, the first people to systematically explore the movements of celestial objects with the help of observation and models were the ancient Greek philosophers. Despite the limitations of observing the sky with the naked eye, these philosophers used exceptionally successful deductive reasoning and mathematics (geometry) in their attempt to understand the World and in doing so, developed an entirely different perspective (Arny, 1994). For example, in the middle of the 4th century B.C., the Athenian philosopher Aristotle asserted in his treatise "On the Sky" that the Earth was not flat but round. He made this deduction by observing during a lunar eclipse that the Earth's shadow on the Moon formed a slanted line (Shu, 1982; Hawking & Mlodinow, 2006). Similarly, in the 3rd century B.C., Eratosthenes of Cyrene meticulously calculated the diameter of the Earth using simple observational and measurement techniques based on a basic knowledge of geometry (Kırbıyık, 2001). Thus Eratosthenes showed the connection between science and observation and deductive knowledge. In the light of the fundamental discoveries in astronomy in this period, in the almost two thousand years to follow, the exploration of astronomy began to concentrate on the movement of the planets (Arny, 1994). Starting from the ancient premise that all celestial bodies seemed to be moving around the Earth, the concept evolved that the Earth was the center of everything. This system based on the view of the Earth as the center of the Universe held its impact up until the 16th century. In 1543, Copernicus explained his theory of the universe in his work entitled "Movement of the Celestial Bodies," in which he asserted that it was the sun that was the center of the universe. His theory remained controversial until the end of the 17th century and was supported with observational data. In the same period, there were great developments in seafaring and with the journeys that began to be made for long distances over the seas, the biggest problem for navigators was finding their way. Finding a solution to this problem was the most important task taken on by the astronomers of the 17th and 18th centuries. With the help of observational tools such as the telescope and in the light of the information gathered in this way, the astronomers of the times--Kepler, Galileo and Newton--began to formulate scientific laws regarding the movement of the planets (Arny, 1994; Aslan, Aydın, Demircan, Derman, &Kırbıyık, 1996).

In recent years, technological advances and modern physics have added a very different dimension to astronomical exploration. Man's first landing on the Moon, the images captured of the Earth from outer space, the Hubble Space Telescope placed in orbit around the Earth and the exploration of the other planets are all examples of the extraordinary point to which astronomy has been carried.

Astronomy and the Scientific Method

Phenomena in the sky, the fundamental subject matter of astronomy, were treated by early civilizations as either miracles or a source of fear. People began to worship the natural phenomena that they feared or could not explain. It was for this reason that astronomy in the beginning was associated more with magic or religious ritual. Religious rites and prophecies for the future were based on the positions of the heavenly bodies in the sky (Karttunen, Kröger, Oja, Poutanen, & Donner, 1996). People believed that the objects visible in the sky had the power to make life and death decisions concerning their lives. The dawn of "astrology" was an offshoot of this belief and is still a discipline that modern man holds on to and finds hard to dismiss (Sagan, 2000).

Astronomy as a branch of science and astrology, a tool that can produce prophecies for the future, are both concerned with the constellations and for this reason, get frequently confused in the minds of the uninformed. Modern astronomy, however, is not only concerned with the stars. Astronomy is a branch of science that investigates the movements, physical structures, and chemical composition of heavenly bodies (Arny, 1994). The term "astronomy" derives from the ancient Greek words astron (στρον) and nomos (νόμος), meaning the law of the stars. The word "astrology," however, originates in the Greek word for star, astron (στρον) combined with the word for knowledge, which is logos (λόγος), and thus means knowledge of the stars. Fundamentally, astrology is a system of thought that postulates that the position and movement of the stars and planets have an effect on human life. Despite the differing characteristics of astronomy and astrology, both have their origins in the same history (Shu, 1982). It can be said that astronomy and astrology began to be differentiated from each other at a not too distant date when in the 16th century, Nicholaus Copernicus succeeded in explaining that the planets moved around the sun (Shu, 1982). Later, the work of scientists who propounded the reliability of the scientific method, such as Galileo, Kepler and Isaac Newton, deepened the difference between astronomy and astrology.

Many societies, from the Babylonians to the Greeks, and scores of scientists from Galileo to Newton, took an interest in astronomy. As a result of these efforts, new branches of science emerged and the fundamental science of mathematics found room to grow and develop. At the same time, unknown truths in the universe and in life were discovered and thousands of new breakthroughs entered our lives thanks to astronomy.

Ensuring that human beings can make use of the scientific method and become individuals that are trustful of science is one of the basic goals of science education in the contemporary world. For this reason, a review of the development of astronomy easily reveals how much of an impact astronomy education has on this goal.

Astronomy and Science Education

In fact, the birth of astronomy and birth of science have the same meaning. Heavenly bodies were the first materials of science. By nature of the topics it encompasses, astronomy awakens a great deal of curiosity and awe. Astronomy shapes human's scientific comprehension from ancient times to modern ages. Therefore, it is put account for understand to science and scientific methods. For example, chance of our universe perception from geocentric universe to known universe demonstrates scientific knowledge is uncertain. Concordantly, astronomy can be used to interiorize the nature of science.

The continuous advance of science and technology and the increased significance given to space exploration in the world in general as well as the concerted efforts of

the developed nations to invest in scientific investigations in this field have made astronomy education more important than ever before.

The fact that astronomy has no national boundaries and all countries share the same skies is instrumental in creating an international cooperation among researchers, students and teachers (Aslan, 2010). In the "Astronomy for Development Strategic Plan for 2010-2020" of the International Astronomical Union, revised and published in 2012 for the purpose of developing the science of astronomy in all of its aspects through international cooperation, education in astronomy has been formulated for the various educational levels as follows:

The Elementary School Period (ages 4-10): The first years of growth and education are of the greatest importance in terms of creating an individual's system of values. Children at these ages are able to easily comprehend the beauty of celestial bodies and can be amused and entertained by objects in the sky. At this time as well, they can begin to form a perception of how big the universe is. The sky and the universe can be very exciting for young children and may provide the opportunity to stimulate their imagination. Acquiring an interest in inspiring subjects in astronomy may help students expand their ideas and develop their views of the world. Again, in this period of life, learning about astronomy provides an excellent and exciting start to using scientific and natural methods of reasoning.

The Secondary School Period (ages 9-18): Astronomy is an extraordinary tool to encourage secondary school students to develop an interest in science and technology. The universe and journeys into space are spellbinding subjects by themselves. These subjects can be integrated with lessons in physics, chemistry, biology and mathematics and a connection can be made between these topics and learning about technology and engineering. For this reason in recent years, telescopic educational networks have been developed to make it possible for students around the world to make astronomical observations using the Internet, making it possible for students to be introduced to exciting scientific research (IAU, 2012).

The stage of higher education and research training: The connection between astronomy and the sciences can be said to be one of the reasons university students frequently choose to work in this field. Studying astronomy provides excellent preparation for a career in technology or management. Astronomy's interest in the extreme states of matter, so abundant or so rare as to be impossible to reproduce on Earth, and its analysis of phenomena occurring under the extraordinarily challenging conditions in which astrophysical objects exist, are factors that develop an individual's problem-solving skills. At the same time, modern astronomical research carried out with internationally collaborative teams is also instrumental in developing an individual's management abilities and human resource skills.

As can thus be understood, individuals with an adequate education in astronomy are more able to grasp the importance of the sciences and how science is actually needed over the course of life. Being able to position oneself with reference to the universe helps the individual to better understand the world we live in and to comprehend that science is the most important key to shaping and facilitating life (Martin, Sexton, Franklin, & Gerlovich, 2005).

DESCRIPTION OF THE STUDY

The aim of the present study was to develop consecutive course modules with simple materials to facilitate the learning of basic concepts in astronomy compatible with the elementary school astronomy curriculum. The study conducted with pre-service Science Teachers (N=88) using the techniques of observation-based teaching. The goal was then to teach pre-service Science Teachers (N=88) topics

included in the elementary school astronomy curriculum using the techniques of observation-based teaching.

The objective was in particular to create awareness about the sky using observational activities and to encourage pre-service teachers to enhance their interest in natural phenomena, the foundation of all science. At the same time, the study also provided a means by which the pre-service teachers could explore the skies by themselves through a series of consecutive observational activities set up in the light of the scientific method. These activities increased the confidence the science teachers felt in the scientific method. Also, the observational activities provided an opportunity for the participants to develop their own observational tools (a telescope and a pinhole viewer), which made their observations much more meaningful.

The modules developed encompassed not only sky observations made with the naked eye or with a telescope, but also represented an integrated series of consecutive activities that featured simulations prepared for astronomy education programs open to the public, experimental activities, and general astronomy education, as well as video films and specially designed models in which sky phenomena are shown in animated form. Teaching materials and learning environments were thus diversified and the interactive participation of the pre-service teachers in the activities was achieved.

To summarize, the purpose of the research was to offer educators course modules for observational activities developed with simple materials to facilitate the teaching of basic concepts in astronomy.

Researcher Observation Notes

The researcher used observation notes as a tool in understanding the degree of effectiveness of the activities that had been developed. Researcher notes are notes that reflect the researcher's own observations and sometimes the researcher's reactions (Yıldırım & Şimşek, 2006). Two researchers one of them is instructor took observation notes. One of the observer who has a PhD on science education collected data as indirect observation throughout the implementation. Throughout the course of the study, the researchers collected observation notes around the following questions: "Which subjects and concepts were hard for the pre-service teachers to understand?" / "What alternative ideas did the pre-service teachers have about the topics in astronomy?" / "Were the pre-service teachers able to make a connection between the concepts they learned and everyday life?" - To increase the validity of the notes that were based on interpretation, care was taken to render the notes as descriptively as possible. After the observation process, researcher notes were analyzed independently by two researchers. Also worksheets put account for the data collection. Each researcher reviewed the observation notes, analyzed worksheets and categorized them according to above-mentioned questions. As an inter-mater agreement, Cohen's kappa coefficient was calculated .84. According to Landis and Koch (1977) the kappa values between .81 and 1 indicate almost perfect coherence between raters.

COURSE MODULES

Six modules were developed for teaching basic astronomy. The modules include basic astronomy topics (history of astronomy, shape, size, distance and movements of celestial bodies etc.) holistically and were developed on the basis of the history of astronomy. The modules displayed that the development of astronomy as a science. For instance, the first module handles the rising of astronomy and first sky observations while the last module deals with the searching extra-terrestrial life in

the known universe. Therefore, astronomy topics is taught incrementally and it makes easier learning to astronomy.

Some of the modules were appropriate for observations during the day, some were appropriate for the evening classes. The modules "What is Astronomy?", "The Solar System and Observing the Sun", "Astronomy Topics in the Elementary School Curriculum and Experimental Activities" and "Space Research and Life in Outer Space" were implemented in the day classes while the modules "The History of Astronomy and Sky Observation" and "Sky Observation with a Telescope" were implemented during evening classes. In the observations carried out with optical instruments, a Meade-Bresser (20 cm) LXD-75 mirror-lens telescope and Bresser-Corvette (10x50) binoculars were used. The modules were implemented as weekly. The objective of each module, the materials used, and the steps in the application are summarized below.

Module-1: What is Astronomy?

The objective of this module is to help pre-service teachers understand what astronomy means as a science, what the position of the Earth is as relates to the universe, and to raise their perceptions about concepts of magnitude in the universe. In addition, the module's goal is to teach pre-service teachers the working principles of the telescope, an instrument that plays a major role in astronomy, and also how to make a telescope making use of simple materials.

The module is divided into four sections: "Astronomy," "Our Place in the Universe," "Multiples of 10," and "Making a Simple Telescope." In order to allow for self-evaluation, the pre-service teachers were asked to fill out a worksheet both before and after the exercise (Attachment-1). A period of approximately 120 minutes was set aside for the implementation of the module.

During the implementation, the videos "Our Place in the Universe" (Symphony of Science, 2011) and "The Solar System" (Scientific and Technological Research Council of Turkey [TÜBİTAK], 2011), "Presentation of the Multiples of 10" (Conseil Européen pour la Recherche Nucléaire [CERN], 2011), "Celestia Astronomy Program for Public Education" and other animations and simulations on the working principles of the telescope were used. In addition, two thin-edged lens with different focal lengths (f=15 cm and f=5 cm), two 1-liter PET bottles, adhesive tape, glue, aluminum folio, candles, matches, a ruler and a craft knife were used for the activity "Making a Simple Telescope," which was presented as a demonstration experiment (Attachment-2).

Module-2: The Solar System and Observation the Sun

In this module, the objective was to teach the pre-service teachers something about the history of astronomy, to inform them about the life of Galileo Galilei, who occupies a very important place in the development of astronomy and the scientific method, and to show them how to make observations of the sky with the naked eye.

The Modulewas divided into two sections: "A general overview of the history of Astronomy" and "Observing the Sky with the Naked Eye." A period of approximately 120 minutes was set aside for the implementation of the module.

The materials used in the implementation of the activities were the presentations prepared by the researchers on "The History of Astronomy" and "Observing the Sky," the documentary on "The Life of Galileo" and the Stellarium public education program on astronomy. In the activity on "observing the sky with the naked eye," the materials used were a flashlight, a map of the sky, a sky atlas, a green laser and a compass.

Module-3: Sky Observation with a Telescope

The objective of this module was to allow the pre-service teachers to observe objects in the sky using different optical instruments and to help them understand the importance of these optical instruments in astronomy.

The module was divided into two sections: "Observing the Sky" and "Observing the Planets." A period of approximately 120 minutes was set aside for the implementation of the module.An observation sheet was used during the implementation of the activities (Attachment-3). In making their hand-made telescopes during the activities, the pre-service teachers used the Meade-Bresser LXD-75 telescope and Bresser Corvette binoculars (Figure 1).



Figure1. Jupiter Observation with a telescope

Module-4: The Solar System and Observing the Sun

This module targeted getting the pre-service teachers acquainted with the Solar System, understanding the history behind it, using simple methods of observation to making observations of the sun.

The module is made up of two sections: "The Solar System" and "Observing the Sun." An observation sheet was used during the implementation of the activities (Attachment-4). A period of approximately 100 minutes was set aside for the implementation of the module.

The materials used during the activity were a presentation on the formation of the sun, the elements of the solar system and the planets, black carton to use in making a pinhole viewer, a needle, tracing paper, glue, scissors, a craft knife and a box covered with aluminum foil (Attachment-5), and binoculars, a tripod, a screen, a plastic ball and adhesive tape for the solar observation (Figure 2).



Figure 2. Solar observations via binoculars

Module-5: Topics in Astronomy in the Elementary School Curriculum and Experimental Activities

The objective of this module is to help pre-service teachers learn about which topics are taught in the elementary school curriculum and understand that they can conduct observation-based activities in the classroom with models, computers, simulations and animations. In addition, the aim is to use this experiential activity to teach pre-service teachers some basic astronomy concepts and sky phenomena.

The module consists of two sections: "Astronomy topics in the elementary school curriculum" and "Experimental Activities to teach basic topics of astronomy." The first part of the module covers the topics of astronomy taught in the elementary school science curriculum. In the second part, main elementary school topics such as the occurrence of day and night, the phases of the Moon, eclipses of the Sun and the Moon, the seasons, and why the same face of the Moon is always seen from Earth are explained briefly with a single setup that has been developed for classroom activities (Okulu & Oğuz-Ünver, 2012). The question of "Is Outer Space light or dark?" is similarly explained through an experiential activity (Oğuz, Sever, &Yürümezoğlu, 2008). The worksheets were used before and after the implementation of the module (Attachment-6). The module took approximately 100 minutes to complete.

The presentation of elementary school astronomy topics, videos, animations, simulations, the Stellarium program and a Sun-Earth-Moon model (Figure 3), a screen, a candle and a piece of wood were used as materials during the activities.

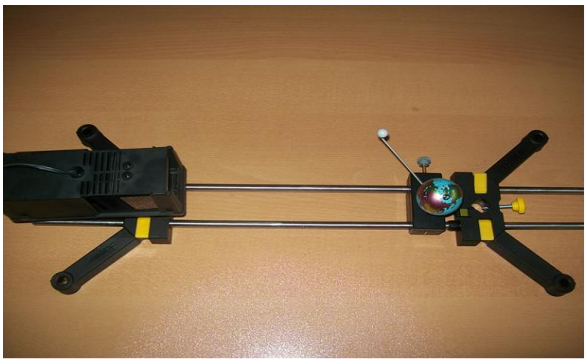


Figure 3. Sun-Earth-Moon model

Module-6: Space Research and Life in Outer Space

In this module, the goal was to raise the awareness of pre-service teachers about the conditions needed to sustain life in outer space, to inform them about space research and encourage them to make their own deductions about the research in this field that may be carried out in the future.

The module comprised two sections: "space research" and "life in outer space." The module took approximately 80 minutes to complete.

The technique of free discussion was used in the activities, which concentrated on four basic topics. These can be summarized as The Space Age, Smart life outside of the Earth, Impact of the Zodiac on our life, and Doomsday scenarios. During the discussions, an attempt was made to guide the participants and provide a scientific framework for any non-scientific thoughts they may have. The summarize of the modules can be seen Table 1.

Table 1. The summarize of the modules used in the study

Module Name	Objectives	Parts of Module	Teaching aids
What is Astronomy?	-To ensure perceptions of the participants' about the concept of the size and the position of the Earth in the universe - To fabricate a telescope with simple and cheap materials	-Celestial science -Our place in the Universe -Multiple of 10 -Make a simple telescope	Celestia 1.7 and Stellarium 0.12.4 astronomy simulation software
History of Astronomy and Sky Observation	- To inform the history of astronomy - To teach how to do sky observation with the naked eye	-An overview of the history of astronomy -Sky observation with naked eye	Stellarium 0.12.4 software and presentations
Sky Observation with a Telescope	-To observe celestial objects using different optical instruments	-Moon observation -Planet observation	A Meade-Bresser (20 cm) LXD-75 mirror-lens telescope and simple telescopes fabricated by participants.
The Solar System and Observing the Sun	-To identify the solar system -To observe sun with simple materials	-Solar system -Sun observation	Celestia 1.7, Universe Sandbox 2.0 software and animations, a Meade-Bresser (20 cm) LXD-75 mirror-lens telescope and pinhole cameras fabricated by participants.
Astronomy Topics in the Elementary School Curriculum and Experimental Activities	-To scan astronomy topics in the Turkish elementary school curriculum -To plan an observation-based lesson with using models, computers, simulations and	-Astronomy topics in the elementary school curriculum -Experimental activities for the teaching of basic astronomical topics	A special Sun-Earth-Moon model and animations.

	animations		
Space Research and Life in Outer Space	-To inform about the current space researches	-Space research -Life in outer space	Animations and simulations

FINDINGS IN THE RESEARCHER OBSERVATION NOTES

The data obtained from the researcher observation notes were examined under three themes for each module: "the topics and concepts that pre-service teachers had difficulty understanding," "the alternative thoughts they had about topics in astronomy," and "the level of their ability to make a connection between the concepts they learned and everyday life." The findings from the observation notes are presented below in order of the implementation of the modules.

Findings obtained from the observation notes about the What is Astronomy? module are presented Table 2.

Table 2. Findings of What is Astronomy? module in terms of the participants' difficulties, alternative thoughts and connections astronomy with everyday life

Module	Difficulties	Alternative thoughts	Connection with everyday life
What is Astronomy?	-Reference point -Sizes of the celestial objects - Four fundamental forces -Our place in the universe - Wavelengths of light and energy	-The Sun is center of universe	-Changing constellations relevant with seasons

Working with the first module, "What is Astronomy?" showed that the pre-service teachers were not completely able to understand the concept of "reference point" before the implementation and that for this reason; they had difficulty comparing the sizes of the celestial objects in the solar system with each other. Another finding was that the participants were also unable to differentiate between the four fundamental forces that shaped the universe. Moreover, it was observed that the pre-service teachers had considerable difficulty defining their place in the universe but that using the animations which has journey from the Earth to known universe was effective in overcoming this problem. In the activities conducted in the module to explain the nature of light, the pre-service teachers were seen to have difficulty with associating wavelengths in particular with energy concepts. In addition, a large part of the pre-service teachers expressed their belief that the Sun was the center of the universe. However, when one student posed the question, "*If we can't know what the boundaries of the universe are, how can we say that the Sun is the center of the universe?*" it was seen that the pre-service teachers were affected by this and started to exhibit a different pattern of reasoning about the subject. Furthermore, it was found that when the time measurement systems based on sky phenomena are explained to the pre-service teachers during the activities, the students can be led to associate the concept of the year with the changes of season, thereby learning to apply topics in astronomy to everyday life. According to finding

obtained from the worksheets most of the students placed Earth or Sun in the center of Universe, but after the implementation, They mostly expressed center of the universe cannot be known. Nevertheless, a few participants insisted to place Earth in center of Universe.

Findings obtained from the observation notes about the History of Astronomy and Sky Observation module are presented Table 3.

Table 3. Findings of Astronomy and Sky Observation module about the participants' difficulties, alternative thoughts and connections astronomy with everyday life

Module	Difficulties	Alternative thoughts	Connection with everyday life
History of Astronomy and Sky Observation	- Place on Earth -Inadequacy physic knowledge	-Planets can be seen only with a telescope -The stars and the Moon are very close each other -The brightest star in the sky is the North Star	-Lunar phases relevant with month -Sky is a time measurement tool

The second module, "The history of Astronomy and Sky Observation," presented difficulties for the pre-service teachers in that they were not able to define their place on Earth as they evaluated their own thoughts about the universe and had difficulty comparing different models of the universe in their attempt to make daily sky observations. The virtual observation of the other planets in our solar system using the Stellarium program was particularly effective in overcoming these difficulties. Apart from this, in the process of teaching basic skills in sky observation, the inadequacy of the pre-service teachers' knowledge about fundamental topics in physics led to their confusing various concepts with each other. One of the participants however expressed the notion that "*Knowing astronomy means knowing physics*." Furthermore, it was observed that the documentary shown in the module on the "Life of Galileo" was effective in helping the pre-service teachers to make the connection between astronomy and the scientific method. During the activity of observing the sky with the naked eye, it was seen that some of the pre-service teachers were able to use the sky map, making practical use of their theoretical knowledge and thus internalizing the subject matter more effectively. This occurred even though at the beginning of the activity, the students said that the planets could not be spotted with the naked eye. One of the students remarked, "*We can only see the planets with a telescope."* During the activity, however, the participants were actually able to differentiate the planets from the stars in the sky, as well as understand the positions of the celestial bodies through their practical experience of observing time-related changes and the flickering of the stars. In addition, it was found that some of the pre-service teachers commented on the depth and directional concepts of space by expressing their thoughts in this way: "*The stars*

and the Moon are very close to one another" and "*The brightest star in the sky is the North Star.*" The participants were then led into clearing this up in their minds during the sky observation with the naked eye by being asked to make comparisons between the different brilliances of the celestial bodies. Also some participant express that "Phases of moon show us to month cycle." and "The Moon and constellation can use as a calendar."

Findings obtained from the observation notes about the Sky Observation with a Telescope module are presented Table 4.

Table 4. Findings of Sky Observation with a Telescope module about the participants' difficulties, alternative thoughts and connections astronomy with everyday life

Module	Difficulties	Alternative thoughts	Connection with everyday life
Sky Observation with a Telescope	-Orbit of planets - Differences of planets and stars in night sky	-The Moon can be seen only during the night -The Moon rises at night and sets in the day - The Moon rises as the Sun sets	- The Sun must orbit on an elliptical plane

In the third module of "Sky Observation with a Telescope," the pre-service teachers were seen to have difficulty with understanding how the planets orbited on an elliptical plane. Some of the pre-service teachers were unable to differentiate the planets from the stars during the observation. Observation with the telescope, however, made the differentiation much easier. In addition, these observations stimulated the pre-service teachers' interest and curiosity about the sky. One of the candidate teachers in fact said, "*I will always watch the sky from now on*," and "*It would have been wonderful if I could have seen Saturn's rings.*" During the observation of the Moon, the students were noted as saying, "*We can only see the Moon during the night,*" "*The Moon rises at night and sets in the day,*" and "*The Moon rises as the Sun sets.*" At the end of the activity, some of the participants made remarks such as, "*I can easily differentiate between the stars and the planets,*" "*If Jupiter and the Moon are orbiting on an elliptical plane, the Sun must be, too.*" These were examples that indicated that the students were associating the concepts with daily life experiences. In addition, the fact that the pre-service teachers wanted to make more observations with the telescope showed that their interest in the sky had increased significantly.

Findings obtained from the observation notes about The Solar System and Solar Observation module are presented Table 5.

Table 5. Findings of The Solar System and Solar Observation module about the participants' difficulties, alternative thoughts and connections astronomy with everyday life

Module	Difficulties	Alternative thoughts	Connection with everyday life

The Solar System and Solar Observation	- The effect of gravitational force - Distances of the planets to the Sun	- Big Bang and the formation of the solar system occur at the same time -The Sun doesn't move -The Sun is at a fixed point within the universe.	-The Sun stayed in the sky for different periods of time in the summer and in the winter

In the fourth module, "The Solar System and Solar Observation," it was observed that the pre-service teachers had difficulty with understanding the concept of the effect of gravitational force on the formation of the solar system. It was also seen that the participants had trouble in expressing the distances of the planets to the Sun within the solar system. During the activity, however, it was observed that the animations and the simulations made the information more concrete to the pre-service teachers and helped them to internalize this knowledge. On the other hand, it was found that the idea was widespread among them that the Big Bang and the formation of the solar system took place in the same space of time. Apart from this, during the activities, it was seen that the following notions were also expressed: "*The Sun doesn't move*," "*The Sun is at a fixed point within the universe.*" During the solar observation activity, however, some of the pre-service teachers explained the relative movement of the Sun as being due to the Earth's revolving around the Sun. However, the questions such as the following that were asked of the pre-service teachers during the observations, "*Where would you place yourself in the solar system*?" or "*What are the movements of the Earth within the solar system and what are the results of these movements?"* proved to be considerably effective in overcoming their uncertainties. In addition, during the observations, the pre-service teachers made the statement that the Sun stayed in the sky for different periods of time in the summer and in the winter, which indicated that they had been able to make a connection between their observations and occurrences of everyday life.

Findings obtained from the observation notes about Topics of astronomy in the elementary school curriculum and activities with experiments module are presented Table 6.

Table 6. Findings of Topics of astronomy in the elementary school curriculum and activities with experiments module about the participants' difficulties, alternative thoughts and connections astronomy with everyday life

Module	Difficulties	Alternative thoughts	Connection with everyday life
Topics of Astronomy in The Elementary School Curriculum and Activities With Experiments	-Formation of seasons - The visible side of the Moon - Relative movements of The sun, Earth and Moon	- The changes of the seasons can be explain with the distance of the Earth to the Sun	- The participants were able to associate the phases of the Moon with their sky observations

In the fifth module titled, "Topics of astronomy in the elementary school curriculum and activities with experiments," it was seen that the pre-service teachers had the most difficult time with understanding the occurrences of the seasons. At the same time, the pre-service teachers were challenged when they had to explain why the same side of the Moon always appeared to Earth. It was also observed that the pre-service teachers were unable to clearly comprehend the movements of the Sun, Earth and Moon, relative to each other. It was found that

using Sun, Earth and Moon models, supported with simulations and animations, was considerably advantageous in overcoming these problems. One of the pre-service teachers made the statement, "*I really understand the phases of the Moon and eclipses now. I will create a model like this too and explain the topic to my students with the model."* It was determined that in the activity in which a model was used to explain the changing of the seasons, the pre-service teachers were most likely to explain the changes of the seasons by associating this with the distance of the Earth to the Sun. The use of simulations and animations during the activities made the sky phenomena more visual for the students and therefore easier to understand. That the participants were able to associate the phases of the Moon with their sky observations indicated that they could make a connection between the topic and everyday life. According to finding obtained from the worksheets, almost all of the students could not draw formation of seasonsliterally. Before implementation, they mostly associate seasons with the distance between the Earth and the Sun and they did not pay attention the axial tilt of the Earth. After implementation, vast majority of participants draw formation of seasons correctly.

Findings obtained from the observation notes about Space research and life in outer space module are presented Table 7.

Table 7. Findings of Space research and life in outer space module about the participants' difficulties, alternative thoughts and connections astronomy with everyday life

Module	Difficulties	Alternative thoughts	Connection with everyday life
Space Research and Life in Outer Space	-Conditions of life in space	-Astrology is a branch of science like astronomy - Doomsday scenarios are real	- The participants explained the topics using examples from popular science news stories

In the sixth module titled, "Space research and life in outer space," the pre-service teachers had difficulty in explaining which conditions were needed for life anywhere in space beyond the Earth. Asking them to describe the criteria required for life at this point made the discussion livelier. It was also interesting to note that the participants claimed that astrology too, like astronomy, was based on science. One of the pre-service teachers, for example, said, "*Astrology is scientific because astrologists are all scientists*." At the same time, it was observed that when the pre-service teachers began to interpret doomsday scenarios, they made their assessments without using any scientific criteria.

At the end of the discussions, it was seen that more of the explanations given by the participants was based on scientific fact. Additionally, it was also noticed that the pre-service teachers explained the topics using examples from popular science news stories, which showed that they were making the connection between the topics and everyday life.

CONCLUSION

From the perspective of teaching, the huge natural laboratory that astronomy provides constitutes the most prominent connection between astronomy and other branches of science. Because astronomy is a branch of science that effectively teaches individuals to think correctly and logically, it is used in many countries as the key to making students to like and appreciate science (Tunca, 2002). Moreover, the combination of its scientific aspects and technological and inspirational

dimensions assign astronomy a unique role in all levels of education in the effort to create awareness about science in society (International Astronomical Union [IAU], 2012). By stimulating inquiry into the fundamental and practical applications of astronomy, this branch of science not only makes learning easier but also enables the retention of the knowledge learned (Göğüş, 2010). The fact that astronomy has led the way to the emergence of many branches of science and is directly related to "observation," one of the most important skills used in the scientific process, is a significant indicator of how astronomy can be used effectively in teaching science (Koçer, 2002; Ergin, Şahin-Pekmez, &Öngel-Erdal, 2005).

In the light of this, through its presentation to educators of course modules containing observational activities using simple materials that were developed to make the teaching of basic concepts in astronomy easier, the present study arrived at the following conclusions:

- *The modules developed are unique in that their content treats the basic concepts of astronomy with an integrated and consecutive approach to make the activities easier for teachers to implement in the classroom.*
- *The activities developed encourage the use of the scientific method and scientific observation. Thus, the interest of the participants was stimulated and awareness was created about the sky. This awareness triggers feelings of curiosity and it can accordingly be expected that curiosity will in its turn develop into scientific inquiry.*
- *Developing the activities using simple materials, creating observation instruments with simple supplies (e.g., making a simple telescope, a pinhole viewer, etc.) and making observations with the naked eye destroyed the participants' preconceived notions that "activities in astronomy and sky observations can only be carried out with expensive instruments."*
- *The variety of activities and the enriched teaching environment, especially observations of the sky at night and during the daytime, computer simulations and animations, models, documentaries and group work, created an awareness in the educators that there are many methods that can be used in teaching astronomy.*
- *The activities developed not only support theoretical material but also hands-on astronomy education.*
- *Activities in the modules such as "Sun-Earth-Moon" not only facilitate the understanding of concepts such as the occurrence of night and day, the phases of the Moon, the changes of the seasons, lunar and solar eclipses, but they also shorten teaching time.*
- *The activities encourage students to make a connection between concepts in astronomy and everyday life.*
- *The activities help to dissipate misconceptions about basic astronomy.*

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ATTACHMENTS

Attachment-1. Where are we in the universe?



1- How would you describe your place (position) in the universe to your friend? Make your description in the space below in writing and with a drawing.

2- Approximately how many stars (suns) and how many planets are there in the Milky Way, the galaxy in which we exist?

3-If we accept that the size of the Earth is 1 unit, how many units would the size of the Sun be?

Attachment-2. Experiment sheet for "making a simple telescope"

Purpose of the Activity: To review the working principles of telescopes by making a telescope with a lens.

Materials needed:

—Two thin-edged lenses (f=15 cm and f= 5 cm) of 2 magnifying glasses with different focal lengths
—2 one-liter PET bottles
—Adhesive tape
—Glue
—Aluminum foil
—Candle
—Matches
—Ruler
—Craft knife

Steps to the Experiment:

1- A candle is lit first and the rays of light given off are reflected on the thin-edged lens. The rays coming from the lens are reflected on the screen. The thin-edged lens is moved back and forth to find the point that gives the clearest image. The distance between this point and the thin-edged lens is measured with a ruler. The same procedure is then repeated for the other lens.

2- The longer focal length is determined as the objective, and the shorter one as the eye of the lens. The focal lengths of the two lenses are calculated to find the magnifying power.

3- The top and bottom of the PET bottles are cut with a craft knife to make two tubes. These tubes are then covered with aluminum foil to make sure light does not penetrate inside. A tube system is set up so that one of the bottles can move inside the other. The lenses are then taped and glued into the mouths of the tube. Clear resolution is adjusted by moving the tube back and forth.

4- Students are reminded that telescopes can be made with different tube systems.

Attachment-3. Nighttime sky observation



1- How can you differentiate between the planets and the stars when you look up at the sky?

2- How does the surface of the Moon look? Draw it in the space below.

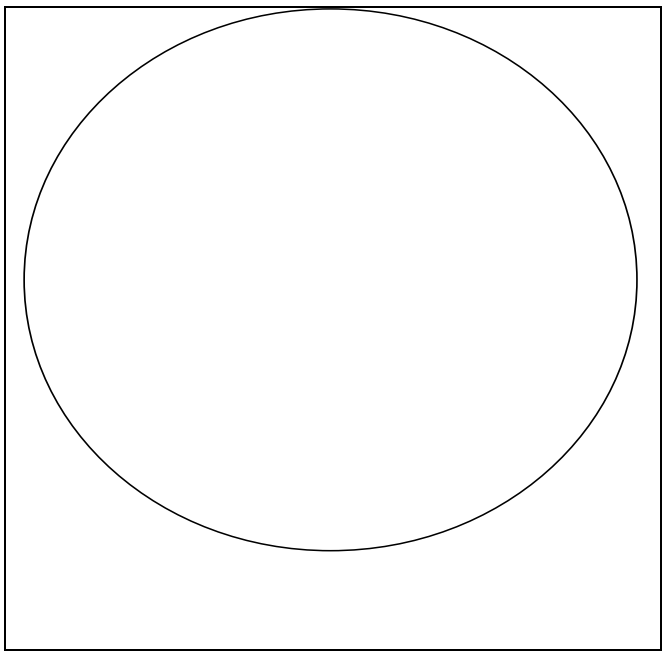
3- Draw yourobservations of Jupiter in thespacebelow.

Attachment-4. Observing the Sun



1- How can we observe the Sun?

2- Draw your observations of the Sun in the space below.



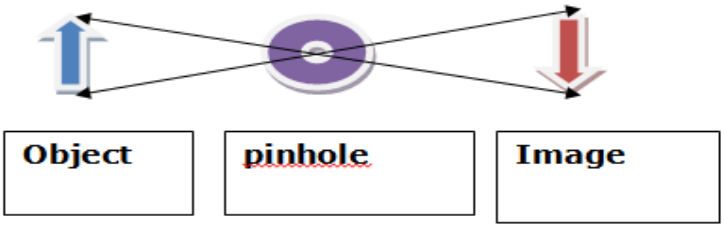
Attachment-5. Experiment sheet for "making a pinhole viewer"

Purpose of the Activity: To make a pinhole viewer that can be used for making solar observations.

Materials needed:
—An empty potato chips cylindrical box made of aluminum foil which light cannot penetrate
—A needle
—Adhesive tape
—Glue
—Craft knife
—Black carton paper
—Half-transparent tracing paper

Steps to the Experiment:
1- It is explained that when the light rays reflected from an object pass through a pinhole, the image of the object is reflected upside-down on the other side. It is then

explained that this property of the pinhole can be used to make a simple observation tool for observing the sun.



2- A hole is poked into the center of the bottom of the light-resistant potato chips box with the help of a needle.

3- The black carton paper is rolled up so that it can move inside the cylindrical box. A piece of tracing paper is cut and glued to one end of the box, covering it up completely.

4- The part of the roll with the tracing paper glued onto it is placed inside the cylindrical box, near the pinhole.

5- It is explained that different sizes of pinholes offer different observationaloptions.

Attachment-6. The Sun- The Earth- The Moon



1- Describe the phases of the Moon by making a drawing in the space below.

2- How do the seasons come about? Describe this by making a drawing in the space below.

3- Make a drawing of the phenomena of Solar and Lunar eclipses.

4- Why do we always see the same side of the Moon?