CHAPTER IV

METHODOLOGY

4.1 Method Adopted

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METHODOLOGY

Research methodology describes the various steps of the plan of attack to be adopted in solving a research problem, such as the manner in which the problems are formulated, the definition of terms, the choice of subjects for investigation, the validation of data gathering tools, the collection, analysis and interpretation of data and the process of inferences and generalization (Koul, 2006).

The present study was intended to develop Web Based Meaningful Engaged Learning Strategy for learning Astronomy at Secondary school level.

Details of the methodology adopted for the study are presented in the following heads.

4.1 Method Adopted

The present study was intended to develop and find the effectiveness of Web Based Meaningful Engaged Learning Strategy in learning Astronomy at Secondary school level. Before developing the strategy the investigator analyzed the present status of teaching Astronomy at secondary school level through Normative Survey method. The findings of the survey prompted the investigator to develop Web Based Meaningful Engaged Learning Strategy for learning Astronomy at Secondary school level. In order to find out the effect of the developed strategy, Experimental method was adopted.

Experimental Research is the research in which at least one independent variable is manipulated, other relevant variables are controlled and the effect on one or more dependent variables is observed (Fraenkel & Walen, 1993). Experimental research is the description and analysis of what will be, or what will occur, under carefully controlled situation (Best & Kahn, 2007).

Experimental Design Selected

Experimental design is the blueprint of the procedures that enable the researcher to test hypothesis by reaching valid conclusions about the relationships between independent and dependent variables (Best & Kahn, 2007).
Since classroom intact groups were selected for the study, getting equivalent groups are practically impossible. So the investigator selected Pre-Test Post-Test Non Equivalent Group Design for the study. This design is often used in classroom experiments when experimental and control groups are such naturally assembled groups as intact classes, which may be similar (Best & Kahn, 2007).

4.2 Variables of the Study

Variables are the conditions or characteristics that the experimenter manipulates, controls or observes (Best & Kahn, 2007). The variables involved in this study are,

4.2.1 Independent Variables

The independent variables are the conditions or characteristics that the experimenter manipulates or controls in his/her attempt to ascertain their relationship to observed phenomena (Best & Kahn, 2007). Its effect on dependent variable is studied. It is also called Experimental or Treatment variable.

In this study, the independent variables are the methods of teaching i.e., Web Based Meaningful Engaged Learning Strategy and Activity Oriented Method.

4.2.2 Dependent Variables

The dependent variables are the conditions or characteristics that appear, disappear or change as the experimenter introduces, removes or change independent variables (Best & Kahn, 2007).

The major dependent variable of the study is the Achievement in Astronomy. The other dependent variables are Interest in Astronomy, Reasoning Ability in Science and Scientific Attitude.
4.2.3 Extraneous Variables

Extraneous variables are those uncontrolled variables (i.e., variables not manipulated by the experimenter) that may have a significant influence upon the results of the study (Best & Kahn, 2007).

Previous Achievement in Physics, General Mental Ability, age level of students, time of instruction etc. are the extraneous variables considered in this study.

4.3 Population of the Study

Population is the group to which the researcher would like the results of a study to be generalizable (Gay, 1990).

➢ For the Survey

The population for the survey part comprises of all Secondary school Physical Science teachers of Kerala.

➢ For the Experiment

Since Astronomy topics are included in the Science syllabus of Standards VIII and X, the population for experimental part comprises of all the students studying in Standards VIII and X in the Secondary schools of Kerala.

4.3.1 Sample Selected for the Study

Sample is the group on which information is obtained, preferably selected in such a way that the sample represents the larger group (population) for which it was selected (Fraenkel & Walen, 1993). By observing the characteristics of the sample, one can make certain inferences about the characteristics of the population from which it is drawn (Best & Kahn, 2007).

4.3.1.1 Sample selected for the Survey

For analyzing the present status of teaching Astronomy the investigator selected 120 Secondary school Physical Science teachers from four districts of Kerala (Alappuzha= 35, Pathanamthitta= 35, Trivandrum= 25, Kottayam= 25) selected through Random Sampling Method.
4.3.1.2 Sample selected for the Experiment

As Astronomy topics are included in the Standards VIII and X of Kerala State Secondary School Science Syllabus, the investigator selected the students of both Standards VIII and X as the population of the study. From this, the investigator selected samples from Standard VIII and Standard X through Purposive Random sampling method.

- **Sample selected from Standard VIII**

The investigator selected 320 students belonging to eight divisions of Standard VIII (four divisions from two higher secondary schools in Pathanamthitta district and four divisions from two higher secondary schools in Alappuzha district). Of the four schools selected, two were Government schools (Grama Panchayath Higher Secondary School, Kulanada and Government Model Higher Secondary School, Ambalapuzha) and the other two were Aided schools (SVGV Higher Secondary School, Kidanganoor and Devasom Board Higher Secondary School, Thakazhi). From each school, two divisions of Standard VIII were selected for the experiment. One division was taught using Web Based Meaningful Engaged Learning Strategy (Experimental Group) and the other division was taught using the existing Activity Oriented Method (Control Group).

The initial sample consisted of 340 students. After removing the absentees either in Pre-tests or Post-tests, the sample size was reduced to 320. Thus from Standard VIII, a total number of 160 students was considered as Experimental group(EG) and the rest of 160 students formed the Control group(CG).

- **Sample selected from Standard X**

The investigator selected 320 students belonging to eight divisions of Standard X (four divisions from two higher secondary schools in Pathanamthitta district and four divisions from two higher secondary schools in Alappuzha district).
The investigator selected the same four schools (from which the sample for Standard VIII was selected) for taking the sample from Standard X. From each school, two divisions of Standard VIII were select for the experiment. One division was taught using Web Based Meaningful Engaged Learning Strategy (Experimental Group) and the other division was taught using the existing Activity Oriented Method (Control Group).

The initial sample consisted of 334 students. After removing the absentees either in Pre-tests or Post-tests, the sample size was reduced to 320. Thus a total number of 160 students was considered as Experimental group (EG) and the rest of 160 students formed the Control group (CG).

As a whole, a total of 640 students while considering both Standards VIII and X were taken as the sample for this study. The break-up of the sample selected for the study is given in Table 4.1.

Table 4.1

*Break-up of the Sample for the Study*

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Name of the School with district</th>
<th>Type of management</th>
<th>Boys/Girls/ Co-edu</th>
<th>Number of Students Std VIII</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SVGV H.S.S., Kidanganoor, Pathanamthitta</td>
<td>Aided</td>
<td>Co-edu</td>
<td>40 40 40 40 160</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Grama Panchayath H.S.S., Kulanada Pathanamthitta</td>
<td>Govt.</td>
<td>Co-edu</td>
<td>40 40 40 40 160</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Devasom Board H.S.S., Thakazhi, Alappuzha</td>
<td>Aided</td>
<td>Co-edu</td>
<td>40 40 40 40 160</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Govt. Model H.S.S., Ambalapurzha, Alappuzha</td>
<td>Govt.</td>
<td>Co-edu</td>
<td>40 40 40 40 160</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td><strong>320 320 640</strong></td>
<td></td>
</tr>
</tbody>
</table>
4.4 Development of Web Based Meaningful Engaged Learning Strategy for Learning Astronomy

Learning strategies are strategies that are used to make learning faster, easier, enjoyable, meaningful and effective. Before developing learning strategy, perfect planning is necessary. Utmost care should be there while selecting the target group, their learning needs, the goals to be satisfied, the learning materials to be prepared, Websites as well as Web based resources to be selected and the learning steps to be implemented.

Web Based Meaningful Engaged Learning Strategy is a student centered learning strategy in which students are engaged in meaningful, challenging, authentic activities by grouping them into flexible, heterogeneous groups. It helps to satisfy the objectives of learning through the use of web resources like websites, videos, softwares, images etc. The steps followed by the investigator in the development of this strategy are given below.

STEP - I : Identification of the Goals

STEP -II : Selection of the content and conducting Content Analysis

STEP -III : Preparation of Web Based Material

STEP -IV : Determination of the stages of the strategy

STEP -V : Development of Lesson Transcript format

STEP -VI : Try-out

STEP -VII : Evaluation

The description of each step is given below.
**Fig 4.1** Steps in Developing Web Based Meaningful Engaged Learning Strategy

**STEP - I: IDENTIFICATION OF THE GOALS**

Strategy is a plan of action prepared keeping in mind some goals which are to be satisfied. So before preparing a strategy, the investigator should identify the goals by considering the nature of the subject, the target group, their age level and their learning needs.
In Kerala State Science syllabus, topics on Astronomy are included in
the Standards VIII and X. So in this study, the students of Standards VIII and X
studying in Kerala State Syllabus were selected as the target group. To create a
basic understanding of Astronomy in an easier way is the learning need. The
major and minor goals identified are,

❖ **Major Goal**

To help students belonging to Standards VIII and X to learn Astronomy
by exposing them to virtual experiences and thereby engage them in
meaningful learning.

❖ **Minor Goals**

The minor goals include the arousal of Interest in Astronomy,
development of Reasoning Ability in Science and Scientific Attitude through
Astronomy learning.

**STEP - II: SELECTION OF THE CONTENT AND CONDUCTING CONTENT ANALYSIS**

The content to be learnt through the strategy must be selected keeping in
mind the age level, interest of the learner, the nature and complexity of the
content etc.

In this study, the content selected includes units, “Celestial Sights” of
Standard VIII and “Our Universe” of Standard X of Kerala State Syllabus.

➢ **Contents and Curricular objectives of unit “Celestial Sights”**

The contents included in the unit “Celestial sights” are,

1. Phases of Moon
2. Star Constellations
3. Solar System
4. Planets
5. Asteroids
6. Comets
7. Meteors
8. Expedition to Moon
9. Chandrayaan Project

The curricular objectives of this unit are,

1. To make students understand the phases of moon.
2. To make students learn to recognize star constellations through star gazing with the aid of star chart.
3. To make students understand the practical uses of star gazing, like determining time, position and direction and learn how to apply this in daily life.
4. To know about the Solar system and its members like planets, satellites, asteroids, comets and meteors.
5. To understand the movements of celestial objects and recognize them in the sky.
6. To know about the expeditions to moon.
7. To make students understand India’s Chandrayaan mission, its objectives and other details.

➢ Contents and Curricular objectives of unit “Our Universe”

The contents included in the unit “Our Universe” are,

1. Malayalam Month
2. Asterism
3. Uses of sky watching
4. The Sun
5. The Colour and Temperature of stars
6. Evolution of Stars
7. Galaxy
8. Geo Centric and Helio Centric theories
9. Big Bang theory
10. Space Research in India
11. Artificial Satellites

The curricular objectives of this unit are,
1. To make students understand that due to the rotation of Moon around the Earth, the stars in the vicinity of Moon changes and on the basis of this, Asterisms are formed.

2. To make students understand that due to the revolution of Earth around the Sun, the Sun seems to move among the stars.

3. To develop concepts like Ecliptic, Solar constellation and Njattuvela.

4. To make students understand the structure of the Sun.

5. To develop students knowledge about the birth of the stars, its evolution, different stages and the energy production in it.

6. To make students understand that the stars along with the Sun that we see in the sky are the part of the galaxy named Milky Way.

7. To make students understand that this universe is made up of different galaxies including our home galaxy Milky Way.

8. To make students understand the evolution of this Universe by knowing about Big Bang theory.

9. To collect data regarding the Space research conducted so far and to understand the role of India in space research.

10. To develop an understanding about the different artificial satellites and its uses.

**STEP – III: PREPARATION OF WEB BASED MATERIAL**

Preparation of Web Based Material is a very crucial step in the development of this strategy. It includes mainly five phases such as

- **PHASE -1:** Planning
- **PHASE -2:** Information Gathering
- **PHASE -3:** Designing
- **PHASE -4:** Developing
- **PHASE -5:** Testing
PHASE-1: Planning

In this phase, the investigator has to plan what all resources related to the content (videos, audios, animations, images) are to be selected, the authoring programs (HTML, PHP, VRML, JAVA) to be implemented and the type of storage device (servers, hard disks, CD ROMs, DVDs, USB drive) to be used. While selecting these resources, the investigator should keep in mind the nature of the subject, age level and interest of the students and the facilities available in the school.

In this study the investigator decided to select the resources related to Astronomy such as softwares, videos, animations, images etc. and to use PHP 6 (Hypertext Preprocessor), Java Script and jQuery for making Web Based material.

PHP is a server-side scripting language designed for web development and generally used as a general-purpose programming language. PHP is now installed on more than 244 million websites and 2.1 million web servers. It was originally created by Rasmus Lerdorf in 1995. While PHP originally stood for Personal Home Page, it now stands for PHP: Hypertext Preprocessor. PHP language was preferred due to the ease in developing a website. The amount of programming is comparatively less and the site can be quickly developed.
jQuery is a multi-browser JavaScript library designed to simplify the client-side scripting of HTML (Hyper Text Markup Language). JavaScript (JS) is an interpreted computer programming language. It was originally implemented as a part of web browsers so that client-side scripts could interact with the user, control the browser, communicate asynchronously, and alter the document content that was displayed. JavaScript and jQuery was used for adding extra styles and other graphical designs in the site.

The site is developed offline and stored in a hard disk. As a backup, it is also copied onto a flash drive and a CD.

**PHASE -2 : Information Gathering**

In this phase, the investigator gathered a number of resources related to Astronomy from web for incorporating in the website. The resources include:

A. **Softwares**

Softwares are a set of programs that has been developed for special applications. The investigator used nine free educational softwares related to Astronomy. The descriptions of these softwares are given below.

a) **Celestia**

![Fig 4.3: Celestia displaying Jupiter, Europa and Io](image)

Celestia is a 3D Astronomy educational software developed originally by Chris Laurel. It is available under GNU (General Public License) category. It can be downloaded from the website http://Shatters.net/Celestia/. It is based on the Hipparcos Catalogue. It allows users to travel at any speed in any direction through an extensive universe. NASA(National Aeronautics and
Space Administration) and ESA (European Space Agency) have used it in their educational and outreach programs. It is available for Linux, Mac OS X and Microsoft Windows. Through Celestia, users can orbit stars, planets, moons and other space objects; track space objects such as spacecraft, asteroids and comets as they fly by, or travel to and/or fly through nebulae; irregular, elliptical and spiral galaxies.

b) KStars

![KStars Screenshot](image)

*Fig 4.4 Screenshot of KStars showing the night sky from New Delhi*

KStars is a free planetarium program using the KDE (K(Kool) Desktop Environment) Platform for Unix-like computer operating systems. It can also be used on the Microsoft Windows platform using 'KDE for Windows'. It provides an accurate graphical representation of the night sky, from any location on Earth, at any date and time. The display includes up to 100 million stars (with additional add-ons), 13,000 deep sky objects, constellations from different cultures, all 8 planets, the Sun and Moon, and thousands of comets and asteroids. It has features to appeal to users of all levels, from informative hypertext articles about Astronomy, to robust control of telescopes and CCD cameras, and logging of observations of specific objects.
c) **Lunar Phase Simulator**

![Lunar Phase Simulator](image)

Fig 4.5 : A view of Lunar Phase Simulator

Lunar Phase Simulator is a free software which demonstrates how the Earth-Sun-Moon geometry give rise to the phases of the Moon as seen from the Earth. A distant view of an observer looking down on earth as well as a perspective of an observer looking into the sky is used in the simulator. It is written in Adobe Flash. It is available in all major platforms.

d) **Moon Phase 3.3**

![Moon Phase 3.3 Software](image)

Fig 4.6 : Moon Phase 3.3 Software

Moon Phase 3.3 is a free astronomical software which displays the moon phase of current day as an icon in the Activity field. To get a more accurate information on moon distance, moon rise, moon transit and moon set
times and also the sun rise, sun transit and sun set, just change the time zone, latitude and longitude (or click on the map).

e) Nightshade Astronomy Simulator Software

![Nightshade Software](image)

*Fig 4.7: Nightshade Software*

Nightshade is free, open source astronomy simulation and visualization software for teaching and exploring Astronomy, Earth science, and related topics. It is designed specifically for the planetarium and educator community. Nightshade is currently available for Linux, Windows, Mac OSX, and other platforms. It can be downloaded from http://www.NightshadeSoftware.org.

f) Solar System 3D Simulator

![Solar System 3D Simulator](image)

*Figure 4.8: A view of Solar System 3D Simulator*

Solar system 3D simulator is a software application that generates a realistic model of Solar system and planets in three Dimensions (3D) on a computer. It displays the sun, planets and their orbits and the Moon. It can be downloaded from http://www. Sciencefair-projects.org. It gives a detailed description about the physical and chemical nature of the planets along with its
images. It is very useful in learning about Solar system and its members and is appealing for both adults and kids.

g) **Stellarium**

![Stellarium Screenshot](image)

*Fig 4.9: Screenshot from Stellarium Software*

Stellarium is a free educational software originally developed by a French programmer Fabien Chereau. It is written in C++ and operates in operating systems like Linux, Windows, Mac OS X. It can be downloaded from the Website http://www.Stellarium.org. It can display over 600000 stars from the Hipparcos catalogue and the Tycho-2 catalogue. It shows the different asterisms and the illustrations of the constellations. Through Stellarium, students can really see what they can see with their eyes, binoculars or small telescopes. It takes audience on a journey to the stars, constellations and celestial highlights of the sky (both day and night). It will create an understanding in children that stars are present during day time also.

h) **World Wide Telescope**

![World Wide Telescope](image)

*Fig 4.10: World Wide Telescope viewing a Hubble image of the Whirlpool Galaxy (M51)*
World Wide Telescope is a free computer program created by Microsoft which displays the astronomical sky as maps, the 3D universe and Earth Science data. It was originally developed by Curtis Wong and Jonathan Fay and can be downloaded from the website http://www.Worldwidetelescope.org. It can be used to visualize arbitrary or abstract data sets and time series data using the power of a PC graphics card to render up to a half million data points. Images are taken from Hubble Space telescope and approximately ten Earth bound telescopes.

**i) Day Light Simulator**

![Day Light Simulator](image)

*Fig 4.11: Screenshot from Day light simulator*

It is a simulation showing daylight and nighttime regions on a flat map of Earth. Daily and yearly motions of the sunlight pattern can be shown. It can be downloaded from the website http://astro.unl.edu/classaction/animations/cordsmotion/daylightsimulator.html

**B. Videos:**

The videos related to the topics selected on Astronomy were downloaded from the Websites of NASA, ISRO, BBC, YouTube and other Science related websites. Videos include that of Ecliptic, chromosphere of Sun, Big Bang theory, Galaxies, Star Constellations, Moon Expedition, Sun Spots, Solar Prominence, Evolution of Stars, Star Formation, Solar wind, Celestial
Sphere, Zodiac Signs, Moon Phase, Chandrayaan launch, First moon video given by Chandrayaan, Solar Eclipse, Lunar Eclipse etc.

![Fig 4.12: Video of Constellations of the Zodiac](image1)

C. Images:

The images used are mainly in the three formats namely, GIF (Graphic Interchange format), JPEG (Joint Photographic Experts Group) and PNG (Portable Network Graphics). The images related to Astronomy topics were collected using Google Image Search.
PHASE- 3: Designing of the website

The investigator decided the authoring program as PHP 6, Java Script & jQuery for designing the website. The following criteria were considered while designing the website.

✓ **Purpose of the website:** The chief purpose of the website is instructional.

✓ **Goals of the website:** Attaining learning objectives was identified as the goal.

✓ **Target group:** The investigator selected Standard VIII and X students of Kerala state syllabus as the target group.

✓ **Content:** The investigator selected two chapters related to Astronomy namely, “Celestial Sights” of Standard VIII and “Our Universe” of Standard X of Kerala State Science Syllabus for preparing the website.
Methodology

Based on these criteria, a site map was prepared. It is a list of all main topic areas of the site, as well as sub-topics. This serves as a guide to find whether all contents are there in the site and to understand the navigational system. Then a design of the website was prepared based on the above criteria.

PHASE- 4: Development

In this phase, the actual website is created. The individual graphic elements were taken and used to create the website. First of all the home page is created followed by a “shell” of interior pages. The shell acts as a template for the content pages of the site, as it contains the main navigational structure for the website. Once the shell is created, then the content should be taken and must be distributed in the appropriate areas. Then, PHP codes are generated and it will be interpreted by a web server with a PHP processor module which in turn generates the resulting web page. PHP commands can be embedded directly into an HTML source document rather than calling an external file to process data. It has also evolved to include a command-line interface capability and can be used in standalone graphical applications.

As mentioned earlier, the site was developed using PHP 6. This was done using software called DREAMWORKS in which PHP programming can be implemented. The latest version of this software, DREAMWORKS 5.5, was used. Coding is used to link all the text, images and hyperlinks (links created between collection of pages using which, one can move to and from pages) together within the site. Each page was treated separately as a different function. A menu was created within the first page which holds the links to all the other pages. Links were created from the web page to the images and videos such that they are displayed under the proper topic.

Under every question and answer session, the style for the answers to be displayed is done using jQuery. Error notifications were programmed using
JavaScript. All the graphic elements are incorporated and made functional during this phase.

PHASE -5: Testing

*Fig 4.16: A Screenshot of the Web Based Material Developed for Standard VIII*

In this phase, the developed website will be tested for its functionality, compatibility (viewing differences between different Web Browsers) thus ensuring that the prepared website can be viewed properly in the most recent browser versions. Then the website will be loaded to the server and a final check has to be done to confirm that all files have been uploaded correctly and that the site is fully functional.

The site can be opened and viewed perfectly on the latest version of Google Chrome as the latest version of PHP was used in designing the website. The software applications used are not incorporated to the site as EXE files cannot be linked into PHP websites. Hence, they can be opened externally after installing them in the computers/laptops where it is being used. The softwares are stored in the CD. The user has to install it in the computer and the use it for instructional purpose. The instructions for using CD are given as Appendix XI.

The developed Web Based materials for Standards VIII and X are given in the next section.
WEB BASED MATERIAL PREPARED FOR STANDARD VIII

On Unit “CELESTIAL SIGHTS”

Prepared By,  
Mrs. Rakhy Radhakrishnan  
UGC- SRF Research Fellowship Awardee  
School of Pedagogical Sciences  
Mahatma Gandhi University  
Kottayam

Guided By,  
Dr. P. J. Jacob  
Professor  
School of Pedagogical Sciences  
Mahatma Gandhi University  
Kottayam

Instructions for using the CD are given as Appendix XI.
WEB PAGE: HOME- Celestial Sights

[Image of a webpage with celestial sights and navigation options]

CELESTIAL SIGHTS
STUDY MATERIALS FOR STANDARD VIII
DEVELOPING WEB BASED MEANINGFUL ENGAGED LEARNING STRATEGY FOR LEARNING ASTRONOMY AT SECONDARY SCHOOL LEVEL

Prepared By
Mrs. Rakhy Radhakrishnan M.Sc, M.Ed.
UGC-SRF Research Fellow
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Guided By
Dr.(Prof). P.J. Jacob
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School Of Pedagogical Sciences
M.G. University, Kottayam.
WEB PAGE: PRELIMINARY CONCEPTS - Sun, Earth & Moon

SUN

Sun is a star which is situated at the center of the Solar System. It is the main source of energy on Earth.

Click here for more images of Sun

EARTH

Earth is the third Planet from the Sun and the fifth largest of the eight Planets in the Solar System. It is sometimes referred to as the Blue Planet.

Click here for more images of Earth

MOON

The Moon is the only natural satellite of our Planet Earth.

Click here for more images of Moon

Now try to answer the following questions:

- Where does the Sun rise?
  - Answer
- Where does the Sun set?
  - Answer
- What is the Moon rise?
  - Answer
- Where does the Moon set?
  - Answer
**WEB PAGE: PHASES OF MOON**

Observe the following software moon phase 3.3. It shows the shape of moon seen from earth during different days.

![Moon Phase Software 3.3](image)

Now observe the following video. Here also you can see the change in the shape of moon.

Now try to answer the following questions:

What do we call the day on which the moon is seen fully?  
Answer

What is the day on which the moon is not visible at all?  
Answer

What change of the shape happens to the moon from a new moon day to a full moon day?  
Answer

Observe the following software and images to see more about the phases of Moon:

![Lunar phase simulator](image)

Images of Lunar Phase

Have you seen the change in the appearance of the moon in a month?  
Answer

What is the reason for this variation in the appearance of the moon?  
Answer

To find the reason see the following links:

![Solar system simulator](image)

Day and Night simulator

Lunar phase simulator

Images of Lunar Phase
WEB PAGE: STARS- Stars, Celestial Sphere, Star Constellation

Have you seen a lot of twinkling stars in a clear night sky?

Click here for more images.

What is the name of the imaginary sphere formed by joining the two hemispheres?

To know more in detail see the following video:

Click here for more images.

STAR CONSTELLATION

Open the above software and observe the stars.

You have seen many stars in the night sky. Have you ever tried to connect them using imaginary lines and thus form some images?
**WEB PAGE: STARS- Star Constellation (Contd.)**

Let us watch the following videos to know more about Star Constellations.

Open the following software named Stellarium, change the time and observe the star constellations.

Some of the Star constellations are given below:

<table>
<thead>
<tr>
<th>Constellation</th>
<th>Click here to see more images</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orion</td>
<td></td>
</tr>
<tr>
<td>Aries</td>
<td></td>
</tr>
<tr>
<td>Taurus</td>
<td></td>
</tr>
<tr>
<td>Virgo</td>
<td></td>
</tr>
<tr>
<td>Libra</td>
<td></td>
</tr>
</tbody>
</table>
WEB PAGE: STARS- Star Chart, Change in Position of Moon & Stars with time
WEB PAGE: SOLAR SYSTEM- Solar System, Geo-centered & Helio-centered concepts of Solar System

**SOLAR SYSTEM**

Observe the right sky.

**SOLAR SYSTEM Simulator**

What all objects can you see with the Stars in the sky?

Now change the time.

Observe the objects shining like a Star in the west after Sun set. Also change the line and observe the same object. It can be seen in morning before Sunrise in the east.

What is it?

Is it a Star?

See the Solar System

What all objects can you see there? Name them.

Click here to see more images

**GEO CENTERED AND HELIO CENTERED CONCEPTS OF SOLAR SYSTEM**

Observe the above two images

Can you notice any difference in them?

What is the difference?
Earlier it was considered that Earth was the centre of the universe and Stars including the Sun revolves around the Earth. It was Copernicus, a Polish scientist, who lived five centuries ago discovered that Sun is the centre of the Solar System and the Planets revolve round the Sun. Click here to view images

**PLANETS**

Open the software and observe the Planets.

Earlier there were nine Planets in the Solar System. But now there are only eight Planets.

Which Planet lost its position as a Planet?

Answer

Does Pluto have the same type of orbit as that of other Planets? What is the difference?

How and why Pluto lost its status as a Planet?

Answer

**TERRESTRIAL PLANETS**

Planets which are mainly composed of solid substances like iron, rocks, and nickel are called terrestrial Planets.

- **Mercury**
  
  It is the planet which is nearest to the Sun. It can be seen approximately 2 hours after sunset and 2 hours before sunrise.

  Click here for more images of Mercury

- **Venus**
  
  After Sun and Moon, it is the brightest object in the sky. It is also called Morning Star and Evening Star as it is seen just before sunset and just after sunrise. It is the hottest planet.

  Why Venus is seen as a bright star?

  Answer

- **Earth**
  
  Due to the specialty of the Atmosphere, life exists on Earth. It is our home planet.
WEB PAGE: SOLAR SYSTEM: Terrestrial Planets, Jovian Planets
**WEB PAGE: SOLAR SYSTEM: Asteroids, Comets & Meteors**

**ASTEROIDS**

Between the orbits of Mars and Jupiter there are a group of Celestial objects which revolve round the Sun. What are they called?

![Asteroid Image]

Asteroids can be seen only with the help of a telescope.

**COMETS**

Among the known members of the Solar System, Comets travel the farthest. They revolve round the Sun in an elliptical orbit. Comets consist of condensed gases, sandrock pieces. When they come closer to the Sun condensed gases evaporate and appear like a long tail.

![Comet Image]

**METEORS**

During some nights we can see certain objects in the sky burning down through the Atmosphere. They are Meteors.

Why meteors burn down while falling through the Atmosphere?

![Meteors Image]
WEB PAGE: MOON EXPEDITION

It was the Soviet Union that began the first expedition to the Moon 50 years ago. It began with the launching of Sputnik 1 in October 1957. It is believed that Sputnik 1 has orbited Earth at a height of about 250 km.

Lalita, a dog, was the first animal to orbit the Earth and she was the occupant of Sputnik 2 launched on November 3, 1957.

Later, America, Japan, and European Space agency conducted an expedition to the Moon. It was America that sent man to the Moon for the first time. Apollo 11 was the space flight that landed the first time humans, Americans Neil Armstrong and Buzz Aldrin, on the Moon on July 20, 1969.

In 2008, India started its expedition to the Moon. What is the name of the project?
WEB PAGE: MOON EXPEDITION - Chandrayaan Project

Chandrayaan I is the India's first ever mission to explore the Moon. It was launched from the Satish Dhawan Space Centre in Sriharikota on 22nd October 2008 by the PSLV C-11 space vehicle and reached the orbit of Moon on 8th November 2008. On November 15th, it started revolving around the Moon in polar orbit of 100 km height. On 14th November it created history by separating the Lunar Impact Probe (LIC) from the mother vehicle and landing it near the south pole on the surface of the Moon.

Click here to view more images

Let us see the animated video of Chandrayaan.

Now watch the actual launch of Chandrayaan.

We can now see the first Moon Video given by Chandrayaan.

The aims of this project were,

- To study the Moon for the next two years by remote sensing with the help of ten scientific equipments.
- To enhance our knowledge about the only natural Satellite of Earth, the Moon.
- To increase India's technological experience in the field of Space Research and to train new generation Indian scientists to face fresh challenges in interplanetary research.
WEB PAGE: REVIEW QUESTIONS

1. When we observe the Moon from the Earth on different days, we can see that the shape of the Moon is changing. What do we call this change of shape of the Moon?
   A. Since the time taken by the Moon for its rotation and revolution around the Earth is the same  
   B. Since the time taken by the Moon for its rotation is less than the time taken for its revolution around the Earth  
   C. Since the time taken by the Moon for its rotation is greater than the time taken for its revolution around the Earth  
   D. Since the Moon does not revolve around the Earth
   Answer

2. Whenever we observe the Moon from any point on the Earth, we can see only one face of it. Why?
   A. Lunar Eclipses  
   B. New Moon  
   C. Lunar Phases  
   D. Because the Moon does not rotate
   Answer

3. After Sun and Moon, Venus is the brightest object in the sky. What is the reason for this brightness of Venus?
   A. Because the Moon produces light by itself  
   B. Because the full Moon faces the Sun  
   C. Because Venus gets heated due to friction while it travels through the solar system  
   D. Because 75% of the light which Venus gets are reflected by the dense clouds
   Answer

4. We can’t see Moon on a New Moon day. Why?
   A. On New Moon day, Moon along with the Sun moves to west so that the part of the Moon which Sunlight is falling is not visible to the person standing on the Earth.  
   B. The Moon does not rise on a New Moon day  
   C. On New Moon day, Sun rises before the Moon  
   D. On New Moon day, Sun rises after the Moon
   Answer

5. Why Mars is known as “Red Planet”?
   A. Because its temperature is very low  
   B. Because its density is lower than that of Earth  
   C. Because its size is half that of Earth  
   D. Because it has the presence of iron on its surface
   Answer

6. Which is the hottest planet of solar system?
   A. Earth  
   B. Venus  
   C. Mars  
   D. Saturn
   Answer
**Methodology**

**WEB PAGE:**MORE - Additional Information: Solar Eclipse, Lunar Eclipse

### SOLAR ECLIPSE

A Solar Eclipse occurs when the Moon passes between the Sun and Earth, and the Moon fully or partially blocks the Sun. This can happen only at new Moon, when the Sun and the Moon are in conjunction as seen from Earth. In a total Eclipse, the disk of the Sun is only obscured by the Moon. In partial and annular eclipses only part of the Sun is obscured. An Eclipse is a natural phenomenon. Nevertheless, in some ancient and modern cultures, Solar Eclipses have been interpreted as supernatural causes of events or real events. A total Solar Eclipse can be frightening to people who are unaware of its astronomical explanation, as the Sun seems to disappear during the day and the sky darkens in a matter of minutes. Because it is dangerous to look directly at the Sun, observers should use special eye protection or indirect viewing techniques when viewing a partial eclipse or the partial phases of a total eclipse. It is safe to view the total phase of a total Solar Eclipse with the unaided eye and without protection.

### LUNAR ECLIPSE

A Lunar Eclipse occurs when the Moon passes directly behind the Earth into its umbra (shadow). This can occur only when the Sun, Earth, and Moon are aligned exactly, or very closely so, with the Earth in the middle. Hence, a lunar eclipse can only occur the night of a full Moon. The type and length of an Eclipse depend upon the Moon’s location relative to its orbital nodes. Unlike a Solar Eclipse, which can only be viewed from a certain relatively small area of the world, a lunar Eclipse may be viewed from anywhere on the night side of the Earth. A lunar eclipse lasts for a few hours, whereas a total Solar Eclipse lasts for only a few minutes at any given place, due to the smaller size of the Moon’s shadow. Also, unlike Solar Eclipses, lunar Eclipses are safe to view without any eye protection or special precautions, as they are no brighter (indeed dimmer) than the full Moon itself.
WEB BASED MATERIAL PREPARED FOR STANDARD X

On Unit “OUR UNIVERSE”

Prepared By,  Guided By,
Mrs. Rakhy Radhakrishnan  Dr. P. J. Jacob
UGC- SRF Research Fellowship Awardee  Professor
School of Pedagogical Sciences  School of Pedagogical Sciences
Mahatma Gandhi University  Mahatma Gandhi University
Kottayam  Kottayam

* Instructions for using the CD are given as Appendix XI.
WEB PAGE: HOME: Our Universe

Prepared By
Mrs. Rakhya Redhakrishnan M.Sc., M.Ed.
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Guided By
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Professor & Director of Research,
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M.G. University, Kollam.
WEB PAGE: PRELIMINARY CONCEPTS- Sun, Earth, Moon & Star Constellation

Sun
- Sun is a star which is situated at the centre of the Solar System. It is the main source of energy on Earth.

Earth
- Earth is the third planet from the Sun and the fifth largest of the eight planets in the Solar System. It is sometimes referred to as a "Blue Planet."

Moon
- The Moon is the only natural satellite of our planet Earth.

Star Constellation
- It is a group of stars seen in the sky which can be grouped to form some images or figures. So far, 88 constellations have been officially identified.
WEB PAGE: ASTERISM/ BIRTH STAR

Asterism / Birthstar

Open the software. Find the position of Moon. How change the time and note the stars / asterisms of that week. The position of Moon on different days is different. Are the same.

What is your observation?

Answer

Which Star is seen in the vicinity of Moon in the figure?

Answer

Which Star do you think, will be near the Moon in the next month?

Answer

The Moon takes approximately 27 days to revolve around the Earth. Then after 27 days, does the position of the Moon change each day?

Answer

How many Asterisms are there altogether?

Answer

Applications Of Asterisms

In ancient days, the position of celestial objects were used to mark important events. See the following pictures. These are pictures of some kings and queens who used asterisms.

Maharasa Grees Chithra Thiruva: Modern Thirumal Ram Varma

Ohanan Thirumal Lakshmi Chai

Now find the answer to the following question:

What star was seen near the Moon when Maharasa Grees Chithra Thiruva was born?

Answer

See the Calendar

Hey aren’t you seen asterisms enacted in calendar?

If the asterism of December 29 is marked in the calendar as Chithra. What does its mean?

Answer
WEB PAGE: MALAYALAM MONTH

Open the software and notice the bright star sets at dawn in the Eastern horizon before sunsets one morning note the time it vanishes. Then change the date and observe the star after five days at the same time.

Find answer to the following questions:

Q.1 Is the star at the same position as before?
Answer

Now observe the star continuously for a month at interval of five days.

Q.2 What is your inference from the observation?
Answer

Given below is a figure which shows the position of Earth, Sun and Stars. Analyse the figure and answer the questions given below.

Q.3 Which is the constellation seen in the background of the Sun by an observer on the Earth? When the Earth is at A?
Answer

Q.4 When the Earth is at B?
Answer

Q.5 After one revolution, the Earth is again at A?
Answer

Q.6 Earth takes 365 days to cross these 12 constellations. What is this orbit along which the Sun appears to move among the Stars?
Answer
WEB PAGE: ECLIPTIC

The Ecliptic is divided into 12 equal parts. These are the 12 zodiac constellations. Each constellation is known by the shape of the stellar distribution in it.

Given below is a figure which shows the positions of Star constellation in the background of Sun.

**answer to the following questions**

Q.1 To an observer on Earth, in which constellation is the Sun seen?

**Answer**

Q.2 In which constellation will be the Sun be seen next month?

**Answer**

Q.3 Now, find how Malayalam month is evolved?

**Answer**
WEB PAGE: USES OF SKY WATCHING - NJATTUVELA

What are the purposes for which sky watching might have helped?
Answer

The Sun takes nearly 366 days to pass past 27 asterisms once. Then the Sun will stay about 13–14 days with one Asterism. This period of time for which the Sun appears together with an asterism is Njattuvela.

Find answer to the following questions

Then how much is the duration of one Njattuvela?
Answer

In which month does the Thiruvithira Njattuvela occur?
Answer

In which month does the Aswathi Njattuvela occur?
Answer
WEB PAGE: SUN: Sun, Structure of Sun

The Sun is a white hot gaseous sphere. What we see is the photosphere which is its outer layer. The temperature there is approximately 6000 Kelvin. But at its core the temperature is 1.5 million Kelvin and the pressure is extremely high. The source of the Sun's energy is the fusion of hydrogen taking place in the core.

STRUCTURE OF SUN

The Sun consists of a core in which nuclear fusion of hydrogen takes place. The energy due to the fusion flows out of the core in the form of gamma rays through the radiative zone by repeated absorption and reemission. The convective zone, outside the radiative zone receives this energy and transfers it to the photosphere through the process of convection. We see the light radiated by the white hot photosphere. The chromosphere which is the thin layer outside the photosphere and the corona which is an extensive region outside it, can be considered as the atmosphere of the Sun.

See the following video. The chromosphere and the corona are not visible generally. But during a total solar eclipse they are visible why?  

Answer
WEB PAGE: SUN: Sun Spots, Solar Wind, Solar Prominence

SUN SPOTS

Though the temperature of the photosphere comes to 6000 kelvin, there are certain regions of lower temperature (about 3500 kelvin) in it that appear as black spots. These are known as Sun Spots.

SOLAR WIND

From the surface of the Sun, there is a massive flow of helium nuclei and hydrogen nuclei. This is solar wind.

SOLAR PROMINENCE

Sometimes huge flame rise from the surface of the sun and fall back in the form of an arch. They are the Solar Prominences.

Click here for more images
**WEB PAGE: STARS:** Colour and Temperature of Stars, Evolution of Stars

**COLOUR AND TEMPERATURE OF STARS**

<table>
<thead>
<tr>
<th>Colour</th>
<th>VeLOCITY</th>
<th>Surface Temperature (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blue</td>
<td>2,000 - 6,000</td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>6,000 - 12,000</td>
<td></td>
</tr>
<tr>
<td>Orange</td>
<td>12,000 - 18,000</td>
<td></td>
</tr>
<tr>
<td>Red</td>
<td>18,000 - 30,000</td>
<td></td>
</tr>
<tr>
<td>Blue</td>
<td>30,000 - 60,000</td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>60,000 - 100,000</td>
<td></td>
</tr>
</tbody>
</table>

*Analysis the colour of different Star and find whether all stars have the same colour?*

What is the reason for the change in colour of stars? [Answer]

**EVOLUTION OF STARS**

Energy is generated in the Sun and the Stars by the process of fusion taking place at their core. At very high temperature, four hydrogen nuclei combine to form a Helium nucleus. In the Sun, 40 lakh tons of Hydrogen is converted into Helium every second.

Now let us find how a star is evolved. For that click the video given below.

Then after a supernova, there are two things that would occur.

The gaseous clouds in the interstellar space is the birthplace of stars. They are known as nebula. They contain the gases hydrogen and helium, and a small quantity of certain other elements. The contraction of gaseous cloud in the nebula due to gravitation, initiates the birth of a star. Gases and dust move continuously and come closer and contract to the centre of the nebula due to increased gravitation. This cramming due to gravitation provides the temperature required to initiate fusion. A star becomes visible to us only when the energy due to fusion is produced.
WEB PAGE: STARS: Evolution of Stars (Contd.)

Let us see what changes occur in stars when energy production goes on in them.

A. Low-mass stars
- Nebula
- Protostar
- Main-sequence star
- White dwarf

B. Medium-mass (Sun-like) stars
- Nebula
- Protostar
- Main-sequence star
- Red giant
- Planetary nebula
- White dwarf

C. High-mass stars
- Nebula
- Protostar
- Main-sequence star
- Red supergiant
- Supernova explosion
- Neutron star
- or
- Black hole

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WEB PAGE: STARS: Evolution of Stars, Chandrasekhar Limit (Contd.)

**CHANDRASEKHAR LIMIT**

White Dwarf

**Science as a Life time mission**

- Black Hole
- White dwarf stars

The radii of white dwarfs DECREASE with INCREASING mass because of the increasing strength of gravity.

*When the mass exceeds 1.4 M, electron degeneracy is no longer strong enough to resist the pull of gravity and the white dwarf abruptly collapses into a neutron star. (animation by G. Rieke) 1.4 M is called the Chandrasekhar limit in honor of the astronomer who first explained the nature of white dwarfs (and won the Nobel prize for his work).*

The mass of all white dwarfs observed is less than 1.44 times the mass of the sun. This limit was found out theoretically by the Indian born astronomer, Subramanian Chandrasekhar. This limit is known as Chandrasekhar limit.

Now find the answer to following questions. What is the probability of a star to become a black hole?

**Answer**

What type of Stars become Neutron stars?

**Answer**
WEB PAGE: GALAXY

Open the software and run the demo. Observe the galaxy.

Q1 What is Galaxy?

Answer

There are billions of galaxies in the universe. They Spin about their own axis. Our Galaxy Milky Way is supposed to take nearly 200 years to complete a rotation.

There are different types of galaxies

- Spiral
  - NGC 4414
- Elliptical
  - M87
- Irregular
  - Small Magellanic Cloud

Click here for more images

Milkyway Galaxy

Observe the galaxy Milky Way.
WEB PAGES: GALAXY (Contd.) & BIG BANG THEORY

Now answer the following questions

Q.1 What is its shape?
Answer

Q.2 In this , where is the position of the Sun?
Answer

Q.3 In which parts are the density of stars greater?
Answer

The observations through telescope led to the finding that the galaxies are receding from each other at unbelievable speed. These observations are in agreement with the theory of the expanding universe. It is believed that the universe was formed nearly 1400 million years ago as a result of a huge explosion (the Big Bang) resulting in a state of unimaginable density and temperature.
WEB PAGES: SPACE RESEARCH IN INDIA & SATELLITES

The establishment of TERLS (Thumba Equatorial Rocket Launching Station) was the first step towards the Space Research in India. In 1969 ISRO (Indian Space Research Organization) was established under the department of Atomic Energy Research. Successive activities paved way for establishing a rocket launching centre at Satishdaata. With the launching of Aryabhata, the first Indian satellite, in 1975 India too gained a foothold in the field of space research.

You have heard about Satellites like Aryabhata, Bhaskara I, Isro, Indian etc. These are Satellites. Aryabhata is the first artificial satellite of India. So far India has launched about 50 satellites.
WEB PAGES: SATELLITES (Contd.) – Uses of Satellites & Equatorial Satellites

Equatorial Satellites

Equatorial Satellites rotate around the earth along an orbit above the equator. If their period of revolution is the same as the period of the rotation of the earth, they are called Geosynchronous Satellites.

Even synchronous satellite launching vehicle (SSLV) are used to launch equatorial satellites. The orbit of equatorial satellites is comparatively higher than that of polar satellites.

Polar Satellites

The satellites revolving along an orbit passing above the north and south poles of the earth at an altitude of 200-1900 km are called Polar Satellites.

Even though it is capable of remote sensing as they do not remain at same position, they are not useful for communication purposes. In order to put these satellites in orbits, PSLV (Polar Satellite Launch Vehicle) is used.
Chandrayaan-1 found water on the Moon

India's first Moon mission Chandrayaan-1 found water on the Moon. This is a notable finding that could validate space scientists' belief that it is possible to find water on a near Earth-like planet. This is a significant finding for the potential of life on the Moon. Researchers are excited about the finding, as it suggests that the Moon could have the potential to sustain life. The discovery could also have implications for future moon missions and landing sites.

The Chandrayaan-1 mission was launched in 2008 and is the first Indian mission to the Moon. It is a joint mission between the Indian Space Research Organisation (ISRO) and NASA. The mission was designed to gather data on the Moon's surface and subsurface, and to search for water and other resources that could be used for future missions.

The Chandrayaan-1 spacecraft carried a suite of instruments, including the Moon Mineralogy Mapper (M3), which was designed to detect water on the Moon. The M3 instrument was designed to detect water in the form of ice and other hydrated materials, which could be used for future missions to the Moon.

The Chandrayaan-1 mission was successful in detecting water on the Moon, and the findings have been published in several scientific journals. The results of the Chandrayaan-1 mission have been eagerly awaited by the scientific community, and the findings have been well-received.

The Chandrayaan-1 mission was a significant milestone in India's space exploration programme, and it has laid the groundwork for future missions to the Moon and beyond.
STEP - IV: DETERMINATION OF THE STAGES OF THE STRATEGY

Web Based Meaningful Engaged Learning Strategy is implemented through five stages namely,

STAGE 1: Providing Task  
STAGE 2: Accessing Data  
STAGE 3: Interpret and Produce Data  
STAGE 4: Communicate  
STAGE 5: Evaluate

Fig 4.17: Stages of Web Based Meaningful Engaged Learning Strategy

The description of the stages is given below.

STAGE 1: Providing Task

In this stage, teacher provides authentic, challenging, interdisciplinary tasks through various web resources after grouping students in heterogeneous groups. For example: For the topic “Phases of Moon”, students will be shown various shapes of Moon during a month through the images, videos and softwares available in the Web Based material. Students have to identify the difference in the shape of the Moon during that period and find reason for it.
**STAGE 2: Accessing Data**

Here students listen to the teacher, conduct discussions, and access resources provided by the Web Based Materials prepared. For example: students access the various videos on phases of Moon and see the position of Earth, Sun and Moon by means of the softwares like Moon Phase 3.3 and Moon Phase simulator. From this they can assess data to solve the task provided to them.

**STAGE 3: Interpret and Produce Data**

In this stage, students organize the data collected through STAGE 2 and determine the reason for the phenomena. They will develop an explanation and compare the result. For example, students will develop an explanation for the phases of Moon and compare their results by checking the shape of Moon in another month through videos and Moon Phase 3.3 software.

**STAGE 4: Communicate**

In this stage, students presents, explains, and describes their explanation in the classroom. They will conduct a discussion to reach at a reliable conclusion. For example, students will present and describe various explanations for the phases of Moon. Each group may generate different explanations and conduct discussions to justify their explanation. On the basis of their discussions they will reach at a reliable conclusion about the reason for Phases of Moon.

**STAGE 5: Evaluate**

Here students evaluate their conclusion by applying it to a new situation. If the conclusion needs any further clarification they can go to the previous stages and conduct discussion. For example, after generating the reason for the phases of Moon, the students will apply the conclusion generated from the previous stage to a new situation. They can test whether the same conclusion is valid for the next month also. i.e., whether the same change in the shape of the Moon (phases of Moon) is obtained if they apply the conclusion for the next
month. They can use the Moon Phase 3.3 software to find whether the same change in the shape of Moon is happening in the coming months also.

**STEP- V: DEVELOPMENT OF LESSON TRANSCRIPT FORMAT**

Lesson transcript is a plan of action to be followed by the teacher to satisfy the objectives of teaching. The general format of the lesson transcript for the developed strategy (Web Based Meaningful Engaged Learning Strategy) is given as follows.

**Lesson transcript format for Web Based Meaningful Engaged Learning Strategy**

<table>
<thead>
<tr>
<th>Name of the Teacher :</th>
<th>Topic :</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard :</td>
<td>Duration of lesson :</td>
</tr>
<tr>
<td>Subject :</td>
<td>Strength :</td>
</tr>
<tr>
<td>Date :</td>
<td></td>
</tr>
</tbody>
</table>

**Goals of the Lesson:**
Here the goals of the lesson should be specified briefly.

**Technology Utilization:**
What all technologies are being used must be specified
Eg: computer, Projector, CD ROMs, Web Sites

**Pre Requisites:**
It includes the previous knowledge of the learner.

**Websites and Softwares used**
A short description of the websites and softwares used must be given briefly.
### Methodology

<table>
<thead>
<tr>
<th>Lesson Activities</th>
<th>Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Stage 1: Providing Task</strong></td>
<td></td>
</tr>
<tr>
<td>Teacher provides authentic, challenging, interdisciplinary tasks through web resources after grouping students into heterogeneous groups</td>
<td></td>
</tr>
<tr>
<td><strong>Stage 2: Accessing Data</strong></td>
<td></td>
</tr>
<tr>
<td>Students conducts discussion, listens to teacher, search internet, use web resources for accessing data</td>
<td></td>
</tr>
<tr>
<td><strong>Stage 3: Interpret and produce Data</strong></td>
<td></td>
</tr>
<tr>
<td>Students organise the data, determine reason, compare results, develop an explanation for the phenomena</td>
<td></td>
</tr>
<tr>
<td><strong>Stage 4: Communicate</strong></td>
<td></td>
</tr>
<tr>
<td>Students will explain, describe and present the explanations they got from the previous stage and reach at a reliable conclusion</td>
<td></td>
</tr>
<tr>
<td><strong>Stage 5: Evaluate</strong></td>
<td></td>
</tr>
<tr>
<td>Students will evaluate their conclusion in a new situation. They can go to the previous stages if they need any clarification</td>
<td></td>
</tr>
</tbody>
</table>

**Follow-up activities**

Based on this lesson plan format, lesson transcripts for the whole units on Astronomy of Standards VIII and X were prepared.

**STEP-VI: TRY-OUT**

The lesson transcripts developed along with the Web Based Material prepared was given for try-out and on the basis of the feedback, some modifications were made. The details are given in section 4.5.2
STEP – VII: EVALUATION

The Strategy developed was evaluated by Physical Science teachers who were present at the class during the try-out and students who underwent the try-out. Along with this, the investigator herself approached some Physical Science teachers of various schools of Pathanamthitta and Alappuzha districts and presented a demonstration of the developed strategy along with the Web Based material for evaluation using the Strategy Appraisal questionnaire. Based on their suggestions necessary modifications were made. The details are given below.

➢ **Strategy Appraisal Questionnaire for Teachers**

A Strategy Appraisal questionnaire (for teachers) was prepared for collecting feedback from the teachers. It consisted of 12 statements selected from an initial pool of 20 statements regarding the objectives, content and learning experiences provided by the Strategy. The respondents have to go through the statements and write down their opinion in Yes or No format. For validation, the questionnaire was given to the same team of experts who validated the strategy under study. It was administered among the 50 Physical Science teachers who were present at the class during the try-out and the demonstration of the developed strategy organized for them. The responses to the questionnaire prepared for this purpose were subjected to percentage analysis and the results are given in the Table 4.2
Table 4.2

*Responses of Physical Science teachers gathered through Strategy Appraisal Questionnaire for teachers*

<table>
<thead>
<tr>
<th>Sl No.</th>
<th>Statements</th>
<th>Responses</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Does this strategy make Astronomy learning more interesting?</td>
<td>Yes 90</td>
<td>No 10</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Does there is provision for much teacher-pupil interaction in this strategy?</td>
<td>Yes 78</td>
<td>No 22</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Does this strategy develop intrinsic motivation among students?</td>
<td>Yes 80</td>
<td>No 20</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Do you think that by this strategy student will get immediate feedback?</td>
<td>Yes 78</td>
<td>No 22</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Does students get distracted during learning in this strategy?</td>
<td>Yes 25</td>
<td>No 75</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Is self evaluation possible in this strategy?</td>
<td>Yes 85</td>
<td>No 15</td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>Is there much provision for pupil-pupil interaction in this strategy?</td>
<td>Yes 92</td>
<td>No 8</td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>Does this strategy develop interest in Astronomy among students?</td>
<td>Yes 95</td>
<td>No 5</td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>Do you think that virtual experiences in Astronomy can be given through this strategy?</td>
<td>Yes 94</td>
<td>No 6</td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td>Is this strategy feasible in our school settings?</td>
<td>Yes 80</td>
<td>No 20</td>
<td></td>
</tr>
<tr>
<td>11.</td>
<td>Do students acquire knowledge independently through this strategy?</td>
<td>Yes 86</td>
<td>No 14</td>
<td></td>
</tr>
<tr>
<td>12.</td>
<td>Do you think that by learning through this strategy, learned concepts will be retained for a longer period?</td>
<td>Yes 75</td>
<td>No 25</td>
<td></td>
</tr>
</tbody>
</table>

From the above table, the following results are obtained.
90% of the Physical Science teachers said that this strategy makes astronomy learning more interesting. 78% of the Physical Science teachers reported that in this strategy there is much teacher-pupil interaction. 80% of the Physical Science teachers viewed that this strategy develops intrinsic motivation among students. 78% of the Physical Science teachers said that by this strategy student gets immediate feedback. 75% of the Physical Science teachers expressed that in this strategy student will not get distracted during learning. 85% of the Physical Science teachers said that self evaluation is possible in this strategy. 92% of the Physical Science teachers said that in this strategy there is much pupil-pupil interaction. 95% of the Physical Science teachers said that this strategy develops interest in Astronomy among students. 94% of the Physical Science teachers said that through this strategy virtual experiences in Astronomy can be given.

80% of the Physical Science teachers said that this strategy is feasible in our school settings. 86% of the Physical Science teachers said that students acquire knowledge independently through this strategy. 75% of the Physical Science teachers said that by learning through this strategy, learned concepts will be retained for a longer period.

From the results it is evident that the developed strategy is feasible under the present school settings and will promote Astronomy learning.

 Strategically Appraisal Questionnaire for Students

A Strategy Appraisal questionnaire (for students) was prepared for collecting feedback from the students. It consisted of 12 statements selected from an initial pool of 20 statements dealing with the content, provisions for interaction and learning experiences provided by the Strategy under study. The respondents have to go through the statements and write down their opinion in Yes or No format. For validation, the questionnaire was given to the same team of experts who validated the strategy under study. After the completion of the study, it was administered among 160 students (80 students of Standard VIII and 80 students of Standard X) who underwent the try-out. The responses to
the questionnaire prepared for this purpose were subjected to percentage analysis and the results are given in the Table 4.3

**Table 4.3**

*Responses of students gathered through Strategy Appraisal Questionnaire for students*

<table>
<thead>
<tr>
<th>Sl No.</th>
<th>Statements</th>
<th>Responses</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Does there are provision for interacting with your co-learners?</td>
<td>Yes: 92</td>
<td>No:  8</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Is Astronomy learning in this way an interesting experience?</td>
<td>Yes: 95</td>
<td>No:  5</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Do you get virtual experiences in Astronomy?</td>
<td>Yes: 88</td>
<td>No:  12</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Does your ideas were also considered during the discussion of ideas?</td>
<td>Yes: 90</td>
<td>No:  10</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Do you got immediate feedback?</td>
<td>Yes: 88</td>
<td>No:  12</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Does the media(softwares, videos, images) used by the teacher were very interesting?</td>
<td>Yes: 95</td>
<td>No:  5</td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>Does your attention was distracted during the class?</td>
<td>Yes: 12</td>
<td>No:  78</td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>Can you remember the concepts for a long time if taught in this way?</td>
<td>Yes: 89</td>
<td>No:  11</td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>Does the tasks provided by the teacher was very difficult to solve?</td>
<td>Yes: 10</td>
<td>No:  90</td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td>Does the materials shown by the teacher was very difficult to understand?</td>
<td>Yes: 8</td>
<td>No:  92</td>
<td></td>
</tr>
<tr>
<td>11.</td>
<td>In the beginning of the lesson, whether you were made aware of the objectives of the lesson?</td>
<td>Yes: 85</td>
<td>No:  15</td>
<td></td>
</tr>
<tr>
<td>12.</td>
<td>If you have doubts about the conclusion reached, is there any provision to go back and go through the initial stages?</td>
<td>Yes: 86</td>
<td>No:  14</td>
<td></td>
</tr>
</tbody>
</table>
On analyzing the above table, the following results were obtained.

92% of students reported that they had provisions for interacting with their co-learners. 95% of the students said that Astronomy learning in this way was an interesting experience. 88% of the students said that they got virtual experiences in Astronomy. 90% of the students said that their ideas were also considered during the discussion of ideas. 88% of the students said that they got immediate feedback. 95% of the students said that the media (softwares, videos, images) used by the teacher were very interesting. 12% of the students said that their attention was distracted during the class. 89% of the students said that they can remember the concepts for a long time if taught in this way. 10% of the students said that the tasks provided by the teacher were very difficult to solve. 8% of the students said that the materials shown by the teacher was very difficult to understand. 85% of the students said that in the beginning of the lesson, they were made aware of the objectives of the lesson. 86% of the students said that if they have doubts about the conclusion reached, they can go back and go through the initial stages.

From the results it is evident that the developed strategy can be viewed as a learning strategy which suits its anticipated goals.

4.5 Tools used for the study

In any kind of research, the investigator has to employ tools to gather data required for the study. It may be in the form of questionnaires, tests, scales, inventories etc. The tools used for this study are:

4.5.1 Questionnaire on the Present Status of teaching Astronomy
4.5.2 Lesson transcripts based on Web Based Meaningful Engaged Learning Strategy (for Standards VIII and X) - Prepared by the Investigator
4.5.3 Lesson transcripts based on existing Activity Oriented method (for Standards VIII and X ) - Prepared by the Investigator
4.5.4 Raven’s Standard Progressive Matrices
4.5.5 Achievement Tests in Astronomy (for Standards VIII and X) - Prepared by the Investigator
4.5.6 Astronomy Interest Inventory - Prepared by the Investigator
4.5.7 Test of Reasoning Ability in Science - Prepared by the Investigator
4.5.8 Scientific Attitude Scale - Prepared by the Investigator

The descriptions of the tools are given below.

4.5.1 Questionnaire on the Present Status of teaching Astronomy

From the teaching experience of the investigator itself and through discussions with Physical Science teachers, the investigator felt that teaching Astronomy is always a difficult task for Physical Science teachers. So as a prelude to the experimental study, the investigator wanted to know the status of teaching Astronomy in the Secondary schools of Kerala, so as to use this information while preparing the strategy for learning Astronomy.

After discussing with the experts in Astronomy and Teacher Education, the investigator selected certain categories of information that should be collected to know the Present Status of teaching Astronomy in Secondary schools. The categories comprises of,

1. Information about the Teacher
   It includes,
   a) the educational qualification of the teacher
   b) the teaching experience of the teacher
   c) the attitude of the teacher towards Astronomy
   d) the interest in Astronomy of the teacher
   e) the training obtained in Astronomy by the teacher

2. Information about the School
   It includes,
   a) the library facilities available on Astronomy
   b) the funds for field trips, club activities related to Astronomy
c) Laboratory equipments for Sky Watching
d) class size
e) multimedia resources available on Astronomy
f) provision of internet for browsing resources on Astronomy
g) help of colleagues in discussing Astronomy topics

3. Information about Subject matter
   It includes
   a) Nature of the subject matter(Astronomy)
   b) Availability of the resources in Astronomy
   c) Problems in transacting the syllabus of Astronomy

4. Information about the Learner
   It includes,
   a) age and intellectual capacity of the learner in learning Astronomy
   b) Interest in Astronomy of the learner

Based on these categories the investigator prepared a questionnaire containing 50 items. The questionnaire was prepared on the basis of the set of guidelines for constructing items of a questionnaire given by Gay L.R. (1990, pp 177-199). This draft questionnaire was given to a list of experts to ensure its Content Validity. Based on their suggestions, some modifications were made. Some items were rejected and the modified questionnaire containing 35 items (9 General questions, 22 closed ended questions and 4 open ended questions) were prepared and given for try-out on readily available twenty five Secondary School Physical Science teachers who are teaching Astronomy. This was done to check the clarity and ambiguity of the wordings. Based on their responses some modifications were made and a covering letter was attached to get the final form of questionnaire.

The comments from the experts ensured the Content Validity of the questionnaire. In order to ensure reliability, the questionnaire was readministered on a sample of 25 Secondary School Physical Science teachers after an interval of two weeks. The responses in the retest were similar to that
of the previous test and thus reliability was ensured through Test Retest method.

The copy of the questionnaire is given as Appendix- I

4.5.2 Lesson Transcripts Based on Web Based Meaningful Engaged Learning Strategy (for Standards VIII and X)

Since Astronomy is included in the unit named “Celestial Sights” of Standard VIII, the investigator selected this unit for preparing lesson transcripts. The investigator conducted a careful pedagogic analysis of this unit and identified the facts, concepts, principles, theories to be developed. After this, two sample lesson transcripts were prepared based on Web Based Meaningful Engaged Learning Strategy. The procedure adopted by the investigator is detailed in the section 4.4.

For validation of the sample lesson transcripts prepared for Standard VIII, they were given to some experts in the field of Teacher Education as well as Physical Science teachers (especially those who are teaching Astronomy). Based on their comments and suggestions, the investigator modified them and given for try-out to two divisions of Standard VIII of SNDP Higher Secondary School, Karamveli, Pathanamthitta. Then again the lesson transcripts were modified and restructured on the basis of the actual experience of the investigator. Thus lesson transcripts based on Web Based Meaningful Engaged Learning Strategy from Astronomy topics of Standard VIII were prepared. Sample lesson transcripts in Malayalam and its English version are given as Appendices II - A & II - B respectively.

In the Kerala State Science syllabus of Standard X, Astronomy is included in the unit named “Our Universe”. So the investigator selected this unit for the study and conducted a careful pedagogic analysis of this unit. The facts, concepts, principles, theories were identified and two sample lesson transcripts were developed based on Web Based Meaningful Engaged Learning Strategy.
The sample lesson transcripts prepared for Standard X were given to experts in the field of Teacher Education and Physical Science teachers (especially those who are teaching Astronomy) for validation. Based on their comments and suggestions, the lesson transcripts were modified and given for try-out to two divisions of Standard X of SNDP Higher Secondary School, Karamveli, Pathanamthitta. On the basis of the actual experience gained by the investigator during the try-out, the lesson transcripts were again modified. Thus lesson transcripts based on Web Based Meaningful Engaged Learning Strategy for the topics on Astronomy for Standard X were prepared. Sample lesson transcripts in Malayalam and its English version are given as Appendices III - A & III - B.

4.5.3 Lesson Transcripts Based on existing Activity Oriented method (for Standards VIII and X)

Activity Oriented Method is a child centered method of teaching in which students are asked to do some hands-on experiments and activities for making learning more effective. In this method, students are active learners rather than passive recipients of information. The teacher acts as a facilitator of learning. The teacher has to plan activities such that they are suitable for the age level as well as the interest of the learner and the activities selected must be relevant to the specific topics to be taught.

In this study, the Control group was taught through existing Activity Oriented method. The investigator selected the unit named “Celestial Sights” of Standard VIII and lesson transcripts based on existing Activity Oriented method were prepared. The unit named “Our Universe” of Standard X was analyzed and lesson transcripts based on existing Activity Oriented method was developed for Standard X. The lesson transcripts were prepared in accordance with the procedure of development of lesson transcript. The lesson transcripts prepared were given to experts in the field of teacher education and Physics. Based on their comments necessary modifications were made. Thus lesson transcripts based on existing Activity Oriented method for the topics on
Astronomy for Standards VIII and X were prepared. Sample lesson transcripts based on existing Activity Oriented method in Malayalam and its English version for Standard VIII are given as Appendices IV-A & IV- B and for Standard X as Appendices V- A & V - B.

### 4.5.4 Raven’s Standard Progressive Matrices

Raven’s Standard Progressive Matrices is a non-verbal, culture free test designed and standardized by J.C. Raven in 1936. It is used to measure general intelligence of a person. It consists of five progressive matrices sets such A, B, C, D and E. Each set consists of 12 problems presented as designs or patterns arranged in a particular order. One design will be missing and the subject has to find out the missing design in every pattern from the options given. In each set, the first problem will be the easiest one. The next problem will be more difficult than the first one and this level of difficulty will increase progressively when going to the further problems. Thus there are total 60 problems. To avoid fatigue effect, the designs are presented in bold types in the test booklet.

#### 4.5.4.1 Scoring

Students are allowed to work quickly through the matrices from the beginning to the end. The time taken is noted. For every right answer, score 1 is given. The total number of right answers gives the total score of the subject. The Response sheet of Raven’s standard progressive matrices is given as Appendix XII.

#### 4.5.4.2 Validity and Reliability

In order to establish validity, various correlational studies were conducted. A correlational study with the California Achievement test yielded a coefficient of 0.76 with the Standard Progressive Matrices. A correlation of 0.69 was found with the Standard Matrices and WISC-R Full Scale score for a sample of Mexican American students. Raven (1948) found reliabilities ranging from 0.83 to 0.93 with higher values being associated with younger subjects (under age 30).
4.5.5 Achievement Test in Astronomy (for Standards VIII and X)

Achievement test is an instrument that measures the current status of individuals with respect to proficiency in given areas of knowledge or skill (Gay, 1990). Since Astronomy topics are included in the Standards VIII and X of Kerala State Syllabus the investigator prepared Achievement test in Astronomy for the corresponding Standards. The details are given below.

4.5.5.1 Achievement Test in Astronomy for Standard VIII

Since the aim of this study was to develop and find the effectiveness of Web Based Meaningful Engaged Learning Strategy on Achievement in Astronomy at Secondary school level, the investigator selected the unit named ‘Celestial Sights’ of Standard VIII. The items were prepared keeping in mind the Taxonomy of Educational Objectives given by Bloom (1956). The procedure applied for the preparation and standardization of this test is given below.

4.5.5.1.1 Preparation of the Draft Achievement Test in Astronomy for Standard VIII

Astronomy is included in the unit named ‘Celestial Sights’ of Standard VIII. The investigator thoroughly analysed the contents of this unit and divided it into four sub units as given in the Table below.

Table 4.4
Contents of each sub unit on “Celestial Sights”

<table>
<thead>
<tr>
<th>Sub unit</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sub unit I</td>
<td>Phases of Moon</td>
</tr>
<tr>
<td>Sub unit II</td>
<td>A peep into the Sky, Star Map, Star Constellations</td>
</tr>
<tr>
<td>Sub unit III</td>
<td>Solar System, Terrestrial and Jovian planets, Asteroids, Comets, Meteors</td>
</tr>
<tr>
<td>Sub unit IV</td>
<td>Expedition to Moon, Chandrayaan Project</td>
</tr>
</tbody>
</table>

Due weightage was given to each sub unit. Proper weightage was given to the difficulty level of the questions asked. Questions were provided to
consider bright, average and dull students. Only multiple choice items were included in this test. Multiple choice questions are one of several select-type of questions that provides a stimulus question or statement and several alternatives to select between (Wright, 2008). Multiple choice items have long been the most highly regarded and widely used form of objective test item. They are adaptable to the measurement of most important educational outcomes: of knowledge, understanding and judgement, of ability to solve problems to recommend appropriate action, to make predictions (Ebel & Frisbie, 1991). Four alternatives were provided for each item in this test.

The investigator prepared 50 multiple choice items based on the Taxonomy of Educational Objectives given by Benjamin S. Bloom (1956). The maximum score was 50 and the time allotted for answering them was 60 minutes. A copy of the draft test in Malayalam and its English version is given as Appendices VI-A & VI-B. A copy of the response sheet is given as Appendix VI-C. The scoring key for this test was prepared and is provided as Appendix VI-D. For each right response, score 1 was given and the total number of right responses gives the total score of the respondent.

4.5.5.1.2 Try-out

The try-out of the draft form of the Achievement test was administered on a final sample of 370 students studying in Standard IX selected through Random Sampling technique. The investigator approached the heads of the schools selected, sought their permission and administered the try-out after obtaining their permission. The investigator tried to maintain similar conditions with regard to the time given, instructions given etc. The scoring was done as per the Scoring key prepared for this purpose. The sample selected for the try-out is given in the following table.
Table 4.5

*Break-up of the Sample for Try-out of Achievement test in Astronomy - Standard VIII*

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Name of the School</th>
<th>Type of management</th>
<th>No. of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>M.G.M H.S.S., Thiruvalla</td>
<td>Aided</td>
<td>50</td>
</tr>
<tr>
<td>2</td>
<td>SCS H.S.S., Thiruvalla</td>
<td>Aided</td>
<td>60</td>
</tr>
<tr>
<td>3</td>
<td>SNDP H.S.S., Karamveli</td>
<td>Aided</td>
<td>45</td>
</tr>
<tr>
<td>4</td>
<td>St. Alosious H.S.S, Edathua</td>
<td>Aided</td>
<td>55</td>
</tr>
<tr>
<td>5</td>
<td>St. John’s H.S.S., Eraviperoor</td>
<td>Aided</td>
<td>40</td>
</tr>
<tr>
<td>6</td>
<td>Kannasha Smaraka Govt. H.S.S., Kadapra</td>
<td>Govt.</td>
<td>25</td>
</tr>
<tr>
<td>7</td>
<td>Govt. H.S.S., Kidangara</td>
<td>Govt.</td>
<td>45</td>
</tr>
<tr>
<td>8</td>
<td>Govt. H.S.S., Omallor</td>
<td>Govt.</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td></td>
<td><strong>370</strong></td>
</tr>
</tbody>
</table>

4.5.5.1.3 *Item Analysis*

The use of item analysis before a test is administered; helps to assure that the test is a reliable and valid measure (Wright, 2008). The investigator collected 370 answer scripts obtained after try-out and scored it. These answer scripts were then arranged in the descending order of the scores and the response sheets of the lower 27% and the higher 27% were selected for item analysis.

Item analysis can be done through two major statistical tools namely,

a) Item Difficulty Index and

b) Item Discriminating Power

**a) Item Difficulty Index**

It is an index of the easiness or difficulty of an item for a group of examinees (Aiken, 2003). It is calculated by the following equation.

\[
DI = \frac{U + L}{2N}
\]

Where  
U= Number of correct responses in the Upper group
L= Number of correct responses in the Lower group
N= Number of students in each group
By applying this equation, the difficulty index of the items was calculated. The larger the value of the difficulty index is, the easier the item (Ebel & Frisbie, 1991). So the investigator selected the items with difficulty index in the range 0.35 to 0.65 for this study.

b) **Item Discriminating Power**

It is a measure of how effectively an item discriminates between examinees who score high on the test as a whole (or on some other criterion variable) and those who score low (Aiken, 2003). It can be calculated by the following equation.

\[
\text{Index of Discriminating Power, } DP = \frac{U - L}{N}
\]

Where  
- U= Number of correct responses in the Upper group
- L= Number of correct responses in the Lower group
- N= Number of students in each group

Item discriminating power was calculated using the above equation. Items with discriminating power greater than 0.40 are considered to be very good items (Ebel & Frisbie, 1991). So the investigator selected items with discriminating power above 0.40 for the final test. Twenty five items were discarded based on the values of discriminating power and difficulty index of the items. The details regarding the difficulty index and discriminating power are given as Appendix VI- E. Thus the final form of Achievement test for Astronomy of Standard VIII containing 25 items was prepared. The time duration of the test was decided to be 30 minutes.

**Distractor Analysis**

Distractor analysis is a step in item analysis involving an examination of the pattern of student selection of the various distractors from a multiple choice question (Wright, 2008). The investigator conducted the distractor analysis and made necessary modifications to improve the quality of the test.
4.5.5.1.4 Preparation of the Final Test

After item analysis, the investigator selected 25 items out of 50 items for the final test. The details regarding the weightage given to Content, Objectives, Difficulty level and Blueprint are given below.

**a. Weightage given to Content**

The weightage given to the content is given in the following table.

**Table 4.6**

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Content</th>
<th>No. of Items</th>
<th>Score</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Sub unit I</td>
<td>2</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>2.</td>
<td>Sub unit II</td>
<td>7</td>
<td>7</td>
<td>28</td>
</tr>
<tr>
<td>3.</td>
<td>Sub unit III</td>
<td>12</td>
<td>12</td>
<td>48</td>
</tr>
<tr>
<td>4.</td>
<td>Sub unit IV</td>
<td>4</td>
<td>4</td>
<td>16</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>25</td>
<td>25</td>
<td></td>
<td>100</td>
</tr>
</tbody>
</table>

**b. Weightage given to Objectives**

The weightage given to the objectives is given in the following table.

**Table 4.7**

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Objective</th>
<th>No. of Items</th>
<th>Score</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Knowledge</td>
<td>3</td>
<td>3</td>
<td>12</td>
</tr>
<tr>
<td>2.</td>
<td>Understanding</td>
<td>6</td>
<td>6</td>
<td>24</td>
</tr>
<tr>
<td>3.</td>
<td>Application</td>
<td>10</td>
<td>10</td>
<td>40</td>
</tr>
<tr>
<td>4.</td>
<td>Analysis</td>
<td>2</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>5.</td>
<td>Synthesis</td>
<td>2</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>6.</td>
<td>Evaluation</td>
<td>2</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>25</td>
<td>25</td>
<td></td>
<td>100</td>
</tr>
</tbody>
</table>
c. Weightage given to Difficulty Level

The weightage given to the difficulty level is provided in the table given below.

Table 4.8

*Weightage given to Difficulty Level in the Achievement Test (Final Form) - Standard VIII*

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Difficulty level</th>
<th>No. of Items</th>
<th>Score</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Easy</td>
<td>8</td>
<td>8</td>
<td>32</td>
<td></td>
</tr>
<tr>
<td>2. Average</td>
<td>12</td>
<td>12</td>
<td>48</td>
<td></td>
</tr>
<tr>
<td>3. Difficult</td>
<td>5</td>
<td>5</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>25</td>
<td>25</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>

d. Blueprint

The Blueprint of the final form of the Achievement test is given below.

Table 4.9

*Blueprint of the Achievement Test (Final Form)- Standard VIII*

<table>
<thead>
<tr>
<th>Objective Type</th>
<th>Knowledge</th>
<th>Understanding</th>
<th>Application</th>
<th>Analysis</th>
<th>Synthesis</th>
<th>Evaluation</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>3</td>
<td>6</td>
<td>10</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>25</td>
</tr>
</tbody>
</table>

[1]^1: Figure inside the bracket indicates number of questions and figure outside the bracket indicates total scores.
The copy of the final form of the Achievement test in Malayalam and its English version is given as Appendices VI- F & VI-G.

**Scoring**

Scoring was done as per the Scoring key prepared for this purpose. For every right answer, a score 1 was provided. The total number of right answers gives the total score. The response sheet of the final form of the test is given as Appendix VI- H and its scoring key as Appendix VI- I.

**4.5.5.1.5 Validity**

Validity is that quality of a data gathering instrument that enable it to measure what it is supposed to measure. Although there are many types of validity, for an achievement test, Content Validity and Concurrent Validity are important. So the investigator tried to establish Content validity and Concurrent validity.

1) **Content Validity**

The investigator prepared the test after a thorough analysis of the content. Items were prepared after careful examination of textbooks keeping in mind the opinion of experts and the suggestions from the teachers. Adequate weightage was given to the content areas and the instructional objectives. Through these methods the investigator ensured the content validity.

2) **Concurrent Validity**

In order to establish the concurrent validity, the investigator calculated the coefficient of Correlation between the scores obtained in the Achievement test and the First Terminal Examination in Physics conducted in the school. The coefficient of correlation was found to be 0.82. This value shows that the test has good concurrent validity.

**4.5.5.1.6 Reliability**

It is the degree to which a test consistently measures whatever it measures (Gay, 1990). In order to check the reliability of the test, the
investigator used Split-Half method. In this method, the test will be divided into two equivalent halves (only for scoring and not for administration). A single test is conducted and two sets of scores for the two halves are calculated. The correlation between these two sets of scores gives the measure of the accuracy with which the test measures the individual.

A sample of 100 students studying in Standard VIII was used for establishing reliability. By separating the scores obtained for odd items and even items, two sets of scores were obtained. The correlation between them was calculated and it was found to be 0.87. Thus, the reliability of the test was ensured.

**4.5.5.1.7 Objectivity**

This test contains only multiple choice type items and the scoring was done with the help of prepared Scoring key. This ensures the objectivity of the test.

**4.5.5.1.8 Practicability**

The test is economical, easy to administer and it contains all necessary instructions. Since its duration is 35 minutes, it is not time consuming. As the test is in the form of a booklet with separate Response sheets, it can be reused. The investigator used the Window Stencil Method for scoring. These all ensures the practicability of the test.

**4.5.5.2 Achievement Test in Astronomy for Standard X**

The aim of the present study is to develop and find the effectiveness of Web Based Meaningful Engaged Learning Strategy on Achievement in Astronomy at Secondary school level. As the topics on Astronomy are included in Standard X also, the investigator selected the unit named “Our Universe” of Standard X. The items were prepared keeping in mind the educational objectives given by Bloom (1956). The procedure applied for the preparation and standardization of this test is given below.
4.5.5.2.1 Preparation of the Draft Achievement Test in Astronomy for Standard X

The investigator selected the unit “Our Universe” of Standard X for preparing the Achievement test in Astronomy. The contents were thoroughly analysed and divided it into four sub units as given in the Table below.

Table 4.10

*Contents of each sub unit on “Our Universe”*

<table>
<thead>
<tr>
<th>Sub unit</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sub unit II</td>
<td>Colour and Temperature of Stars- its dependence, Birth of a Star, Stages of Star Evolution, Galaxies, Big Bang Theory</td>
</tr>
<tr>
<td>Sub unit III</td>
<td>Space Research in India, Artificial Satellites- their uses, Geostationary Satellites, Polar Satellites</td>
</tr>
</tbody>
</table>

Due weightage was given to each sub unit. Proper weightage was given to the difficulty level of the questions asked. Questions were provided to consider bright, average and dull students. Only multiple choice items were included in this test. Four alternatives were provided for each item in this test. Based on the blueprint, the investigator prepared 50 multiple choice items. The maximum score was 50 and the time allotted was 60 minutes. A copy of the draft test in Malayalam and its English version is given as Appendices VII-A & VII-B. A copy of the response sheet is given as Appendix VII-C. The scoring key for this test was prepared and is provided as Appendix VII-D. For each right response, score 1 is given and the total number of right responses gives the total score of the respondent.
4.5.5.2.2 Try-out

The investigator conducted the final try-out of the test on a sample of 370 students studying in Standard XI selected through Random sampling technique. The investigator tried to maintain similar conditions with regard to the time allotted, instructions given etc. The scoring was done as per the scoring key prepared for this purpose. The sample selected for the try-out is given in the following table.

Table 4.11

*Break-up of the Sample for Try-out of Achievement Test in Astronomy for Standard X*

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Name of the School</th>
<th>Type of Management</th>
<th>Number of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>M.G.M H.S.S., Thiruvalla</td>
<td>Aided</td>
<td>52</td>
</tr>
<tr>
<td>2</td>
<td>SCS H.S.S., Thiruvalla</td>
<td>Aided</td>
<td>55</td>
</tr>
<tr>
<td>3</td>
<td>SNDP H.S.S., Karamveli</td>
<td>Aided</td>
<td>48</td>
</tr>
<tr>
<td>4</td>
<td>St. Alosious H.S.S., Edathua</td>
<td>Aided</td>
<td>60</td>
</tr>
<tr>
<td>5</td>
<td>St. John’s H.S.S., Eraviperoor</td>
<td>Aided</td>
<td>35</td>
</tr>
<tr>
<td>6</td>
<td>Kannasha Smaraka Govt. H.S.S., Kadalpa</td>
<td>Govt.</td>
<td>20</td>
</tr>
<tr>
<td>7</td>
<td>Govt. H.S.S., Kidangara</td>
<td>Govt.</td>
<td>45</td>
</tr>
<tr>
<td>8</td>
<td>Govt. H.S.S., Omalloor</td>
<td>Govt.</td>
<td>55</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td></td>
<td>370</td>
</tr>
</tbody>
</table>

4.5.5.2.3 Item Analysis

The investigator collected the completed 370 response sheets obtained by try-out and scored it. After arranging these response sheets in the descending order of the scores, the response sheets of the lower 27% and the higher 27% with respect to the total scores, were selected for item analysis. Item analysis was done through the two major statistical tools namely,
a) Item Difficulty Index and
b) Item Discriminating Power

a) **Item Difficulty Index**

The investigator selected the items with difficulty index greater than 0.35 for this study.

b) **Item Discriminating Power**

The investigator selected items with discriminating power greater than 0.40 for the final test. The details regarding the difficulty index and discriminating power are given as Appendix VII - E.

**Distractor Analysis**

The investigator conducted distractor analysis also. Necessary modifications were made to improve the quality of the test.

On the basis of item analysis, 25 items from the draft test were discarded. Thus the final form of achievement test in Astronomy for Standard X containing 25 items was prepared. The time duration was decided to be 30 minutes.

**4.5.5.2.4 Preparation of the final test**

The final form of the Achievement test was prepared after item analysis. The details regarding the weightage given to the Content, Objectives, Difficulty Level and Blueprint are given below.

a. **Weightage given to Content**

The weightage given to content in the final test is given in the following table.
Table 4.12

Weightage given to Content in the Achievement Test (Final Form) - Standard X

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Content</th>
<th>No. of Items</th>
<th>Score</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Sub unit I</td>
<td>11</td>
<td>11</td>
<td>44</td>
</tr>
<tr>
<td>2.</td>
<td>Sub unit II</td>
<td>8</td>
<td>8</td>
<td>32</td>
</tr>
<tr>
<td>3.</td>
<td>Sub unit III</td>
<td>6</td>
<td>6</td>
<td>24</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>25</td>
<td>25</td>
<td>100</td>
</tr>
</tbody>
</table>

b. Weightage given to Objectives

The weightage given to objectives in the final test is given in the following table.

Table 4.13

Weightage given to Objectives in the Achievement Test (Final Form) - Standard X

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Objective</th>
<th>No. of Items</th>
<th>Score</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Knowledge</td>
<td>2</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>2.</td>
<td>Understanding</td>
<td>6</td>
<td>6</td>
<td>24</td>
</tr>
<tr>
<td>3.</td>
<td>Application</td>
<td>9</td>
<td>9</td>
<td>36</td>
</tr>
<tr>
<td>4.</td>
<td>Analysis</td>
<td>3</td>
<td>3</td>
<td>12</td>
</tr>
<tr>
<td>5.</td>
<td>Synthesis</td>
<td>3</td>
<td>3</td>
<td>12</td>
</tr>
<tr>
<td>6.</td>
<td>Evaluation</td>
<td>2</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>25</td>
<td>25</td>
<td>100</td>
</tr>
</tbody>
</table>

c. Weightage given to Difficulty Level

The weightage given to Difficulty level in the final test is given in the following table.
Table 4.14

**Weightage given to Difficulty Level in the Achievement Test (Final Form) - Standard X**

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Difficulty level</th>
<th>No. of Items</th>
<th>Score</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Easy</td>
<td>8</td>
<td>8</td>
<td>32</td>
</tr>
<tr>
<td>2.</td>
<td>Average</td>
<td>12</td>
<td>12</td>
<td>48</td>
</tr>
<tr>
<td>3.</td>
<td>Difficult</td>
<td>5</td>
<td>5</td>
<td>20</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>25</strong></td>
<td><strong>25</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

**d. Blueprint**

The blueprint of the final form of the Achievement test is given in the following table.

Table 4.15

**Blueprint of the Achievement Test (Final Form) - Standard X**

<table>
<thead>
<tr>
<th>Objective Type</th>
<th>Knowledge</th>
<th>Understanding</th>
<th>Application</th>
<th>Analysis</th>
<th>Synthesis</th>
<th>Evaluation</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sub unit I</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>2</td>
<td>6</td>
<td>9</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>25</td>
</tr>
</tbody>
</table>

[1]₀: Figure inside the bracket indicates number of questions and figure outside the bracket indicates total scores.
The copy of the final form of the Achievement test in Malayalam and its English version is given as Appendices VII- F & VII- G.

**Scoring**

Scoring was done as per the Scoring key prepared for this purpose. For every right answer, a score 1 was provided. The total number of right answers gives the total score. The response sheet of the final form of the test is given as Appendix VII- H and its scoring key as Appendix VII- I.

**4.5.5.2.5 Validity**

Here the investigator ensured the Content Validity and Concurrent Validity of the test through the following procedure.

1) **Content Validity**

Before preparing the test, the investigator thoroughly analysed the content area and adequate weightage was given to the content as well as the instructional objectives. Opinion of the experts and teachers in this field were also collected for preparing the test. Also the investigator used standard textbooks for preparing the items. These all ensured the Content validity of the test.

2) **Concurrent Validity**

The investigator found out the coefficient of Correlation between the scores obtained using the achievement test and the First terminal examination in Physics of the students. It was found to be 0.89. This value shows that the test has good concurrent validity.

**4.5.5.2.6 Reliability**

For establishing reliability, the investigator used Split Half method and the reliability was found to be 0.79. This shows that the test has high reliability.

**4.5.5.2.7 Objectivity**

The test contains only objective items and the scoring was strictly on the basis of prepared Scoring key. This establishes the objectivity of the test.
4.5.5.2.8 Practicability

The test contains only 25 items with all its necessary instructions. Only 35 minutes are needed to conduct the test. The test is in the form of test booklet with separate Response sheets. So it can be reused. For scoring, the investigator used Window Stencil method. From all these, it is evident that the test is economical, easy to administer and not time consuming. Hence the test is practical in the existing conditions.

4.5.6 Astronomy Interest Inventory (AII)

Interest Inventories provide information about the student’s preferences which are more stable than the verbally claimed interests (Rao & Babu, 2004). In this study, in order to find secondary school students’ interest in Astronomy, the investigator prepared an “Astronomy Interest Inventory” after consulting the opinions of Mr. Jeffrey Livas, Astrophysicist, NASA (Ask an Astrophysicist), Scientists of ISRO and other eminent personalities in this field. It was found that a person interested in Astronomy will have the following preferences.

1. Interest in Mathematics, Science (especially Physics)
2. Interest in Computer
3. Interest in making and using telescopes and other scientific instruments
4. Interest in doing challenging work at diverse conditions. ie., to work at unconventional hours as well as at high altitudes and remote areas
5. Interest in working with others like foreign persons as members of a team
6. Interest in further research in Astronomy
7. Good imagination power, reflective thinking
8. Curiosity, patience
9. Good communication skills like writing articles for Science magazines, public speaking etc.
10. Good observational skills
11. Good problem solving skills
12. Interest in extra curricular activities related to Astronomy like doing projects, conducting space related exhibitions; participating in Youth Space camp, Satellite Building Workshop, International Astronautical Congress; interacting with scientists of NASA, ISRO; celebrating World Astronomy Week etc.

The procedure adopted by the investigator in preparing Astronomy Interest Inventory is described in the following section.

4.5.6.1 Preparation of Draft Form of Astronomy Interest Inventory

After reviewing the related literature and collecting the opinion of experts, the investigator prepared a draft Interest inventory containing 90 items. Then it was again given for seeking the opinion from the experts. Based on their comments, some items were discarded and some others were retained. Thus a draft form of Astronomy Interest inventory containing 76 items was prepared for preliminary testing. The investigator used the Forced choice triad format in constructing the items of the Inventory. Forced choice items consists of two or more options, equated as to attractiveness or other qualities, where the subject must choose one (Domino & Domino, 2006). Each item consists of three statements of activities and the subject has to select the activity which is most favourable to him/her.

4.5.6.2 Try-out

The draft form of Astronomy Interest Inventory was administered to a sample of 160 students studying in Standards IX and XI in the schools given in the table.
Table 4.16

**Break-up of the sample for Try-out of Astronomy Interest Inventory**

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Name of the School</th>
<th>Type of Management</th>
<th>Number of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Std IX</td>
</tr>
<tr>
<td>1</td>
<td>SNDP H.S.S., Karamveli</td>
<td>Aided</td>
<td>30</td>
</tr>
<tr>
<td>2</td>
<td>Kannasha Smaraka Government H.S.S., Kadapra</td>
<td>Govt.</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td></td>
<td><strong>160</strong></td>
</tr>
</tbody>
</table>

The draft form of the Astronomy Interest Inventory in Malayalam and its English version is given as Appendices VIII- A & VIII- B.

**Scoring**

As per instructions, students were asked to mark their response according to their interest in the response sheet provided. After collecting back the response sheets, scoring was done. A score of 1 is given to the subjects who have opted the activity related to Astronomy in the Triad given. For other responses, zero score is given and the total scores were calculated. The Response sheet is provided as Appendix VIII- C and the Scoring Key as Appendix VIII- D.

**4.5.6.3 Item Analysis**

After scoring, the response sheets of 160 students were arranged in the descending order of the total scores and the highest 27% and lowest 27% with respect to the total scores were separated. The response sheets of these two extreme groups were used for finding the discriminating power. The discriminating power of each item was calculated by applying the following formula.

\[
D = \frac{U - L}{N}
\]

Where, \(U\) = Number of respondents who have selected activities related to Astronomy in the Upper group.
L = Number of respondents who have selected activities related to Astronomy in the Lower group.

N = Number of respondents in each group

4.5.6.4 Preparation of the Final form of Astronomy Interest Inventory

After calculating the index of discriminating power the investigator selected 45 items with discriminating power in range 0.35 to 0.65. These items were arranged and necessary modifications were made. Thus the final form of the Astronomy Interest Inventory with 45 items was prepared. The discriminating power of each item is given as Appendix VIII - E. The final form of the Astronomy Interest Inventory in Malayalam and its English version are given as Appendices VIII- F & VIII- G. The Response sheet and the Scoring Key are given as Appendix VIII -H and Appendix VIII -I respectively.

4.5.6.5 Validity and Reliability

The Concurrent validity of Astronomy Interest Inventory was found by correlating the scores of the inventory with the ratings of the teachers. It was found to be 0.72. This shows that this inventory has high concurrent validity.

The reliability of the Astronomy Interest Inventory was ensured through Split-Half method and the Reliability coefficient was found to be 0.81. This shows that the prepared inventory has high reliability.

4.5.7 Test of Reasoning Ability in Science

The process of supporting an argument with evidence using certain kinds of rules is called Reasoning (Sternberg, et al., 2008). In Science, we observe various phenomena, make hypotheses and after verifying the hypotheses reach in valid conclusions through various types of reasoning. This Reasoning Ability in Science should be nurtured through various methods of teaching.

In order to find the effect of Web Based Meaningful Engaged Learning Strategy on Reasoning Ability in Science the investigator prepared a Test of
Reasoning Ability in Science for Secondary school students. The procedure adopted by the investigator in preparing this test is described as follows.

4.5.7.1 Preparation of Draft Form of Test of Reasoning Ability in Science

After reviewing the related literature and consulting the opinion of experts in the field of teacher education and Science education, the investigator decided to include items based on the five types of reasoning like Analogical reasoning, Inductive reasoning, Deductive reasoning, Eclectic reasoning and classification as reasoning. An initial pool of 60 items (12 items from each type of Reasoning) was prepared after referring the Science textbooks up to Class X and these items were given for expert advice. On the basis of expert advice, some modifications were made and a draft form of Test of Reasoning Ability in Science was prepared for initial try-out. A copy of the draft form of Test of Reasoning Ability in Science in Malayalam and its English version is given as Appendices IX -A & IX- B.

4.5.7.2 Try-out

The draft form of Test of Reasoning Ability in Science was administered to a sample of 160 students studying in Standards IX and XI of the Schools given in the Table below.

Table 4.17  
Break-up of the sample for Try-out of Test of Reasoning Ability in Science

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Name of the School</th>
<th>Type of Management</th>
<th>Number of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SNDP H.S.S., Karamveli</td>
<td>Aided</td>
<td>Std IX</td>
</tr>
<tr>
<td>2</td>
<td>Kannasha Smaraka Government H.S.S., Kadapra</td>
<td>Govt</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td></td>
<td>160</td>
</tr>
</tbody>
</table>

Scoring

Students were asked to mark the response in the Response Sheet provided. On completion, the response sheets were collected back and scoring
Methodology

was done as per the Scoring key prepared. A score of 1 was given to subjects who have given the right answer. For other responses, zero score was given and total scores were calculated. A copy of the Response sheet is provided as Appendix IX-C and Scoring key is provided as Appendix IX-D.

4.5.7.3 Item Analysis

After scoring, the response sheets of 160 students were arranged in the descending order of the total scores and the highest 27% and lowest 27% with respect to the total scores were separated. The response sheets of these two extreme groups were used for finding the discriminating power. The discriminating power of each item was calculated by applying the formula given below.

Index of Discriminating Power, \( D = \frac{U - L}{N} \)

Where, \( U \) = Number of respondents who have selected correct responses in the Upper group.

\( L \) = Number of respondents who have selected correct responses in the Lower group.

\( N \) = Number of respondents in each group

4.5.7.4 Preparation of the Final form of Test of Reasoning Ability in Science

After calculating the index of discriminating power the investigator selected 30 items with discriminating power in range 0.44 to 0.75. These items were arranged and necessary instructions were added. Thus the final form of the Test of Reasoning Ability in Science with 30 items was prepared. The discriminating power of each item is given as Appendix IX-E. The final form of the Test of Reasoning Ability in Science in Malayalam and its English version is given as Appendices IX-F & IX-G. Scoring was done as per the Scoring key prepared. A score of 1 was given to subjects who have given the right answer. For other responses, zero score was given and total scores were calculated. A copy of the Response sheet is provided as Appendix IX-H and Scoring key is provided as Appendix IX-I.
4.5.7.5 Validity and Reliability

The Content validity of the Test of Reasoning Ability in Science was established through an inspection of the items included in the test by a set of experts. The Concurrent validity of the test was found by correlating the scores of the test with the Physics scores obtained by the students in the first terminal examination. It was found to be 0.98. This shows that this test has high concurrent validity.

The reliability of the Test of Reasoning Ability in Science was ensured through Test-Retest method over an interval of 30 days and the Reliability coefficient was found to be 0.87. This shows that the prepared test has high reliability.

4.5.8 Scientific Attitude Scale

According to National Society for the Study of Education (NSSE, 1960), “Scientific Attitude can be defined as open-mindedness, a desire for accurate knowledge, confidence in procedure for seeking knowledge and the expectation that the solution of the problem will come through the use of verified knowledge”. Some others define it as “Scientific mindedness” (Burnett, 1944), “Habit of scientific thinking” (Noll, 1933), “Spirit of Science” (Educational Policies Commission, 1966) and as “an ardent curiosity, fertile imagination and the love of experimental inquiry” (Dewey, 1933). Developing Scientific Attitude is a major objective of Science teaching. It will make the pupil open-minded, curious, honest, objective and thereby use science for human welfare. Scientific Attitude scale is the information form that attempts to the measurement of Scientific Attitude of an individual (Rao, 2003).

4.5.8.1 Preparation of draft form of Scientific Attitude Scale

For preparing the Scientific Attitude scale, the investigator reviewed the works of Noll (1935), Davis(1935), Washton (1961), Diedericich (1967), Billeh and Zakhariades (1975), Kozlow & Nay (1976), Srivastava (1980), Moore & Foy (1997) and Gakhar & Kaur (2004) on Scientific Attitude and identified the six components of Scientific Attitude defined by Billeh and Zakhariades (1975).
to be more appropriate for the construction of Scientific Attitude Scale. These components are given as follows.

**Dimension I - Rationality**
- a) Commitment to the value of rationality
- b) Tendency to test traditional beliefs
- c) Seeking for natural cause of events and identification of cause and effect relationships
- d) Acceptance of criticalness
- e) Challenge of authority

**Dimension II – Curiosity**
- a) Desire for understanding new situations that are not explained by the existing body of knowledge
- b) Seeking to find out the ‘why’ and ‘how’ of observed phenomena
- c) Give emphasis on the questioning approach for novel situation
- d) Desire for completeness of knowledge

**Dimension III – Open-mindedness**
- a) Willingness to revise opinions and conclusions
- b) Desire for new things and ideas
- c) Rejection of singular and rigid approach to people; things and ideas

**Dimension IV – Aversion to superstitions**
- a) Rejection of superstition and false beliefs
- b) Acceptances of scientific facts and explanations

**Dimension V- Objectivity of intellectual beliefs**
- a) Demonstration of the greatest possible concern for observing and recording facts without any influence of personal pride, bias or ambition
- b) Not willing any change on interpreting results on the basis of present social, economic or political influences

**Dimension VI – Suspended judgement**
- a) Unwillingness to draw inferences before the evidence is collected
b) Unwillingness to accept facts which are not supported by the convincing proof

c) Avoidance of quick judgements

The investigator adopted Likert method to construct Scientific Attitude Scale due to its simplicity. Likert scale is a self-reporting instrument in which an individual responds to a series of statements by indicating the extent of agreement. Each choice is given a numerical value and the total score is presumed to indicate the attitude or belief in question (Fraenkel & Walen, 1993).

After a thorough study, the investigator prepared 75 statements on the basis of the components of Scientific Attitude given by Billeh and Zakhariades (1975) and given to experts for comments. Based on their comments, some statements were modified and some other were eliminated. Then the statements were arranged in a random manner containing equal number of positive and negative statements. Since the investigator selected a five point scale, for each statement the subject can give any one of the five responses namely Strongly Agree (SA), Agree (A), Undecided (U), Disagree (D) and Strongly Disagree (SD), according to the degree of strength of his/her attitude. Thus the draft form of Scientific Attitude Scale containing 60 statements for try-out was prepared. The copy of the draft form of Scientific Attitude Scale in Malayalam and its English version is given as Appendices X- A & X- B.

**4.5.8.2 Try-out**

The investigator conducted a try-out of the draft form of Scientific Attitude Scale on a sample of 160 students studying in Standards IX and XI in the Schools given in the table below.
Table 4.18

Break-up of the sample for Try-out of Scientific Attitude Scale

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Name of the School</th>
<th>Type of Management</th>
<th>Number of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Std IX</td>
</tr>
<tr>
<td>1</td>
<td>SNDP H.S.S., Karamveli</td>
<td>Aided</td>
<td>30</td>
</tr>
<tr>
<td>2</td>
<td>Kannasha Smaraka Government H.S.S., Kadapra</td>
<td>Govt</td>
<td>20</td>
</tr>
</tbody>
</table>

Total 160

Students were asked to mark their responses according to their attitude as per instructions. The answer scripts were collected and the scores were calculated according to the table given below. The copy of the Response sheet is given as Appendix X- C.

Table 4.19

Scores given to the various responses of the Scientific Attitude Scale

<table>
<thead>
<tr>
<th>Responses</th>
<th>Scores for Positive statement</th>
<th>Scores for Negative statement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly Agree (SA)</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Agree (A)</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Undecided (U)</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Disagree (D)</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Strongly Disagree (SD)</td>
<td>1</td>
<td>5</td>
</tr>
</tbody>
</table>

4.5.8.3 Item Analysis

The response sheets were scored and arranged in the descending order of the total scores. The response sheets of the highest 27% and lowest 27% with respect to total scores were separated and selected for calculating the t-value using the following formula.

\[
t = \frac{\bar{X}_H - \bar{X}_L}{\sqrt{\frac{\sigma_H^2}{N_1} + \frac{\sigma_L^2}{N_2}}}
\]

Edwards (1957)
Methodology

Where,

\[ X_H = \text{the mean score of Upper group for a given statement} \]

\[ X_L = \text{the mean score of Lower group for a given statement} \]

\[ N_1 = \text{Number of students in the Upper group} \]

\[ N_2 = \text{Number of students in the Lower group} \]

\[ \sigma_H = \text{Standard Deviation of the Upper group for a given statement} \]

\[ \sigma_L = \text{Standard Deviation of the Lower group for a given statement} \]

4.5.8.4 Preparation of the final form of Scientific Attitude Scale

The value of ‘t’ is a measure of the extent to which a given statement differentiates between high and low group. The ‘t’ value was found to range between 2.96 to 11.34. Out of sixty statements, forty statements having ‘t’ value greater than 6.44 were selected for the final scale. Of these 40 statements, 20 statements were positive statements and the other 20 statements were negative statements. Then these statements were arranged and the instructions as well as other details were added to get the final form of the scale. The ‘t’ value for each statement is given as Appendix X-D. The final form of Scientific Attitude Scale in Malayalam and its English version is given as Appendices X- E and X- F. The copy of the Response sheet is given as Appendix X- G.

4.5.8.5 Validity and Reliability

The items of the Scientific Attitude Scale were prepared on the basis of the Attitude Scale construction given by Likert (1932) and the dimension of Scientific Attitude given by Billeh & Zakhariades (1975). These two establishes the internal validity of the scale. After the preparation of the items of the scale, it was given to the experts for their opinion. They have certified that the prepared scale is effective for measuring Scientific Attitude. It ensures the Construct Validity of the scale. To establish the concurrent validity, the scores of Scientific Attitude Scale were correlated with the teacher’s ratings on
the Scientific Attitude of those students. It was found to be 0.81. This shows that the prepared scale have high Concurrent Validity.

The reliability of the developed Scientific Attitude Scale was ensured through Split Half method. The value of Reliability Coefficient was found to be 0.75. This shows that the prepared scale has high reliability.

4.6 Procedure Adopted for the Study

The present study was intended to develop and find out the effectiveness of Web Based Meaningful Engaged Learning Strategy for learning Astronomy at Secondary school level.

Before preparing the strategy, preliminary survey was conducted to find out the present status of teaching Astronomy at Secondary school level among 120 Physical Science teachers at secondary school level. A questionnaire was given to 140 Physical Science teachers from four districts of Kerala. 120 questionnaires were finally taken after discarding incomplete questionnaires.

In Kerala state syllabus, topics on Astronomy is included in Physical Science textbooks of Standards VIII and X at Secondary school level. So the investigator decided to select samples from these two Standards for the study. The investigator approached the heads of the selected schools and sought their permission for conducting the experiment. After thoroughly analyzing the topics selected, the investigator constructed the Achievement test in Astronomy for both Standards and standardized them. Astronomy Interest Inventory, Test of Reasoning Ability in Science and Scientific Attitude Scale were also developed and standardized by the investigator. Lesson transcripts based on Web Based Meaningful Engaged Learning Strategy and existing Activity Oriented method for topics on Astronomy for Standards VIII and X were prepared.

After comparing the previous achievement in Physics and General Mental Ability of students belonging to Standards VIII and X, the students were divided into two groups, namely Experimental group and Control group for both Standards VIII and X. Before starting the experimental treatment, the
investigator administered Achievement tests in Astronomy (Standards VIII & X), Astronomy Interest Inventory, Test of Reasoning Ability in Science and Scientific Attitude Scale as Pre-tests for both groups belonging to Standards VIII and X. Then the Experimental groups were taught through Web Based Meaningful Engaged Learning Strategy and the Control groups through existing Activity Oriented method. The duration of each lesson was 40 minutes.

After the experimental treatment, the investigator administered the same Achievement tests in Astronomy, Astronomy Interest Inventory, Test of Reasoning Ability in Science and Scientific Attitude Scale as Post-tests for both groups of Standards VIII and X. The investigator tried to maintain similar conditions with regard to the time allotted, instructions given during the test etc. for all the groups.

One month after the administration of the Post-tests, the Achievement tests in Astronomy was again administered to both groups belonging to Standards VIII and X to assess the retention of achievement in Astronomy. For this the investigator used the same achievement tests in Astronomy but the questions were rearranged and the order and wording were slightly changed. The response sheets were collected back and scored. The scores collected were subjected to statistical analysis.

**Scoring Procedure**

The investigator compared the Previous Physics Achievement scores and General Mental Ability scores of students belonging to the Standards VIII and X. Then the Achievement tests in Astronomy, Astronomy Interest Inventory, Test of Reasoning Ability in Science and Scientific Attitude Scale were administered as Pre-tests to the Experimental and Control groups of both Standards VIII and X. The Achievement test for both Standards consisted of 25 multiple choice questions. Thirty five minutes were allotted for answering the questions. The scoring was done using the prepared scoring key. For every
right answer, Score 1 was given and Score 0 was given for wrong answer. The maximum score of the test was 25.

The Astronomy Interest Inventory was in the form of Forced Choice Triad consisting of 45 items. Each item consists of three activities of which the respondent has to select the most favourable activity. If the respondent chooses the activity related to Astronomy he/she will get a score 1 and for other choices score 0 will be given.

The Test of Reasoning Ability in Science consisted of 30 items related to Science topics. The respondent has to select the right answer from the options given. For every right answer, a score 1 is given and for wrong answer zero score was given. Then the total score was calculated.

The Scientific Attitude Scale consisting of 40 items was made in the form of a 5 point Likert type scale. The five possible responses were Strongly Agree (SA), Agree (A), Undecided (U), Disagree (D), Strongly Disagree (SD) and the Scores 1,2,3,4,5 were given respectively for the responses on Negative Statements and the score 5,4,3,2,1 were given respectively to the responses on Positive Statements. Then the total score was calculated.

In delayed post-test on achievement in Astronomy for both Standards, the same 25 multiple choice questions (rearranged) were used. Thirty five minutes were allotted for answering the questions. The scoring was done using the prepared scoring key. For every right answer, Score 1 was given and Score 0 was given for wrong answer. The maximum score of the test was 25.

4.7 Statistical Techniques Used for Analysis

After collecting the data, they were tabulated and consolidated for Statistical analysis.

Statistical measures used were:

1. Critical Ratio
2. ANCOVA
1. Critical Ratio

\[ C.R. = \frac{M_1 - M_2}{S.E_D} \]

where C.R. = Critical Ratio  
\( M_1 \) = Mean of first group  
\( M_2 \) = Mean of second group  
\( S.E_D \) = Standard Error of the Difference between Means  

Here we calculated the Standard Error of the difference between uncorrelated means when samples are large. Its equation is,

\[ S.E_D = \sqrt{\frac{\sigma_1^2}{N_1} + \frac{\sigma_2^2}{N_2}} \]

where \( \sigma_1 \) = Standard Deviation of first group  
\( \sigma_2 \) = Standard Deviation of second group  
\( N_1 \) = Sample size of first group  
\( N_2 \) = Sample size of second group  

2. ANCOVA

ANCOVA is a statistical technique for equating groups on one or more variables when testing for statistical significance; it adjusts scores on a dependent variable for initial differences on other variables, such as pre-test performance or IQ (Fraenkel & Walen, 1993).

In applying the statistical technique ANCOVA, the procedure suggested and illustrated by Garrett (2005) was followed. It includes nine major steps as follows.

**Step 1 Computation of Correction term (C):**

Determine the correction terms \( C_x \), \( C_y \) and \( C_{xy} \) being correction of ‘x’ scores, ‘y’ scores and ‘xy’ scores respectively that are required to make adjustments of the standard deviation calculated from original measures, taking zero as the assumed mean. These are calculated using the formula:

\[ C_x = \frac{(\sum x^2)}{N} \quad C_y = \frac{(\sum y^2)}{N} \quad C_{xy} = \frac{(\sum x \sum y)}{N} \]
where, \( \Sigma x = \Sigma x_1 + \Sigma x_2 \)

\( \Sigma y = \Sigma y_1 + \Sigma y_2 \)

\( N = \) Number of scores of both the groups

\( \Sigma x_1 = \) Sum of the Pre-test scores of Experimental group

\( \Sigma x_2 = \) Sum of the Pre-test scores of Control group

\( \Sigma y_1 = \) Sum of the Post-test scores of Experimental group

\( \Sigma y_2 = \) Sum of the Post-test scores of Control group

**Step 2 Computation of total sum of squares (Total SS)**

In this step, the total sum of squares (total SS) for ‘x’, ‘y’ and ‘xy’ are calculated. These are calculated using the formulae:

Total SS for x, \( SS_x = \Sigma x^2 - Cx \)

Total SS for y, \( SS_y = \Sigma y^2 - Cy \)

Total SS for xy, \( SS_{xy} = \Sigma xy - Cxy \)

where \( \Sigma x^2 = \Sigma x_1^2 + \Sigma x_2^2 \)

\( \Sigma y^2 = \Sigma y_1^2 + \Sigma y_2^2 \)

**Step 3 Computation of sum of squares (SS) among the means of the groups**

In this step, sum of squares among the group means are calculated using the following formulae:

a) \( SS \) among means for X = \( \frac{(\sum x_1)^2}{n_1} + \frac{(\sum x_2)^2}{n_2} - Cx \)

b) \( SS \) among means for Y = \( \frac{(\sum y_1)^2}{n_1} + \frac{(\sum y_2)^2}{n_2} - Cy \)

c) \( SS \) among means for XY = \( \frac{(\sum x_1)(\sum y_1)}{n_1} + \frac{(\sum x_2)(\sum y_2)}{n_2} - Cxy \)

Where \( n_1 = \) no. of scores in the Experimental group

\( n_2 = \) no. of scores in the Control group

**Step 4 Computation of sum of squares within groups**

Sum of squares (SS) within groups can be calculated by the formulae:-

a) Within groups SS for X = \( SS_x - SS \) among means for X

b) Within groups SS for Y = \( SS_y - SS \) among means for Y
c) Within groups SS for XY = SSxy – SS among means for XY

**Step 5 Analysis of Variance of X and Y scores**

In this step, analysis of variance of ‘x’ and ‘y’ scores are taken respectively. The F-test is applied to the two sets of scores using the following formulae.

\[
F_x = \frac{\text{Mean square variance of among groups (for x)}}{\text{Mean square variance of within groups}}
\]

\[
F_y = \frac{\text{Mean square variance of among groups (for y)}}{\text{Mean square variance of within groups}}
\]

where, \( F_x \) = F ratio for x scores

\( F_y \) = F ratio for y scores

**Step 6 Computation of adjusted sum of squares (SS for y i.e, SSyx)**

The computations carried out in this step are for the purpose of computing the final (Y) scores for differences in initial (X) scores. The equation for finding adjusted sum of squares is given below.

\[
SSyx = SS_y - \frac{(SS_{xy})^2}{SS_x}
\]

From the adjusted sum of squares thus calculated, the variance can be computed by dividing each ‘SS’ by its degree of freedom.

Then F-test is applied to the adjusted, among and within variance to determine whether the adjusted means differ significantly.

**Step 7 Computation of regression coefficient for within groups**

From the SS’s in x, y and xy, it is possible to compare several coefficient of correlations. These are helpful in the interpretation of the result obtained in step 6.

The general formula used is,

\[
r = \frac{SS_{xy}}{\sqrt{SS_x \times SS_y}}
\]

It may be applied to the appropriate SS’s for total, among means and within groups.
The correlation among scores and the correlation among means may be used, in a preliminary way to decide, analysis of co-variance is worthwhile.

Regression coefficients for total, among means and within groups have been calculated using the formulae.

\[ b_{\text{within}} = \frac{SS_{xy}}{SS_{x}} \]

\( b_{\text{within}} \) is used in the computation of the adjusted y means in step 8.

**Step 8: Calculation of adjusted Y means**

It can be calculated by the formula,

\[ M_{yx} = M_{y} - b \cdot (M_{x} - GM_{x}) \]

This step is to find which mean differences noticed in step 6 are significant.

**Step 9: Significance of differences among adjusted Y means**

For calculating this, the standard error of difference between two means is calculated using the formula \( S.E_{D} = \sqrt{\frac{1}{N_{1}} + \frac{1}{N_{2}}} \). Then the ‘t’ value is found by the equation \( t = D/S.E_{D} \) and compared with the Table values.

The details of analysis and interpretation of data using the above mentioned statistical techniques are given in the next chapter.