Teaching of Astronomy in Asian-Pacific Region

Bulletin No.14

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Joint International Forum of Teaching Astronomy.
Kyoto Computer School, August 28th 1997.

Observing from the Classroom:- Robotic Telescopes and Remote Operation.

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Abstract.

Practical astronomy in which the students are introduced to the heavenly bodies and the concepts that explain their behaviour has been inspirational and highly motivating for generations of pupils. It has always been difficult to provide practical astronomy lessons in England. Weather and lattitude frustrates most planned observing sessions.

Robotic telescopes could provide service observing for schools and the Internet has made it possible. The first robotic telescope on the Internet was inaugurated in December 1993 at Bradford University to demonstrate that it was possible for school students to make observations from the classroom. Service observing using the Internet from the classroom is discussed and the experience of the Bradford project evaluated.

The lessons of the first telescope have led to a new telescope being commissioned at a good site in the Canary Islands to provide service observing for UK school students and possibly direct observing or eavesdropping for Japanese students. Eavesdropping and direct observing from remote locations are defined; the technicalities are discussed and a development programme suggested.

Background.

A knowledge of astronomy has always formed an essential part of an education. In recent times it has been recognised by governments as one of the key topics that inspires students to study maths and physics which are the essential precursors to a career in the wealth-creating physical sciences, engineering and technology.

A major attraction of astronomy is its accessibility. Everyone experiences the dramatic daily theatre of night and day; the passage of the sun across the sky, the pale moon queen of the night but often visible in the daytime and the enchanting stars glittering in velvet skies. For most people the seasons are equally dramatic and similarly there is the drama of the tides for those who live near the oceans.

The inclusion of astronomy in the syllabus is normally limited to classroom work with verbal explanations. Experimental confirmation of the dynamics and size of the solar system and the local Universe are less easy to demonstrate. In the UK the uncertainty of the weather, the severe cold on clear winter nights and the long light evenings in the summer make the inclusion of the simplest experimental astronomy into the syllabus difficult. When the weather and lattitude are compounded with the complexities of the observing processes, experimental astronomy for school classes is almost impossible. For the young minds much of the wonder of astronomy is lost. It is a subject confined to books.

What is a Robotic Telescope?

It has been clear since the late sixties that computers could assist in the observing processes. Numerous systems have been developed which reduce the tedium of observing and provide a degree of computer control for the telescope. The most popular of these in the late 1990's is the Meade LX200 (Meade 1995)series which can be controlled by a computer. Once it has been set up it will follow a defined observing programme. Baruch (1992) discussed computer assistance for observing and differentiated between the various levels of computer support.

Today the main types of computer supported telescopes which are potentially useful for the classroom are the Automated telescopes like the Meade and the fully autonomous robotic telescopes like the Bradford systems. The Meade is a system which, once set up, will follow an observing programme controlled by a local observer, by a remote observer or by a computer. There needs to be some human intervention for each observing session both to set up the telescope, to start it off and to close it down when the observing conditions deteriorate through weather or time. The robotic telescopes monitor their own observing conditions and select their observing programmes from a pool which are appropriate to the observing conditions. They are mainly used for service observing and remote control which becomes an immediate service observing process with a pool of one.

Robotic Telescopes are completely autonomous. The observer who is remote either in time or location need not know the details of the observing conditions and need only request observations in the most basic form with either a name or a set of co-ordinates. Such autonomous robots remove the need for the observer to know about the way in which the stars, moon and planets transit the sky or even which stars are visible when or from which location. The system will inform the observer of errors such as asking for an observation of a star only visible in the northern hemisphere from a telescope located in the southern hemisphere.

These robotic telescopes are ideal for use by school students at any level. It is sufficient to know that an image of the moon or a planet is required. The object can be selected from the major catalogues or lists of the major objects: planets, named stars and nebulae. Default values for the observing parameters can be used to obtain the image. It is also possible to request observations through the provision of equatorial co-ordinates which classical observing would require to point the telescope by using setting circles. There is no requirement to calculate the sidereal time but it is possible to replace default values to provide observing instructions that include exposures, filter types, offset positions and observing sequences to support classical photometry.

Telescope functionality.

There are two Bradford telescopes; one in the UK Pennines and one at the Observatorio del Teide in the Island of Tenerife. Both consist of an alt-az telescope mount and tube with a CCD camera on the telescope and a field of about 12 by 8 arc minutes. There is also a second wide field camera riding piggy-back on the telescope with a field of about 10 by 15 degrees. The telescope with its friction drives and optical encoders is modelled in a computer (Point) to ensure that the model plus the physical system appears to the outside world as a perfect telescope system. The field rotation and the zenith blind spot are easily dealt with by rotating the CCD camera and by scheduling observations not to go within 2 degrees of the zenith.

Each of the CCD cameras has its own controlling computer e.g. Image for the main 12 by 8 arc-minute camera. These computers are linked on a small LAN with the Point computer modelling the telescope and Control, the control computer, dealing with the communications, the scheduling and the housekeeping. Weather is the computer which controls the sensors to monitor the environment of the telescope including the weather and the enclosure roof.

Environmental monitoring:

The essential component of a robotic telescope is its ability to monitor its environment and to control its enclosure to gain access to the sky when the observing conditions are suitable.

The environmental monitoring must first ensure that the telescope and its enclosure operates safely and that it cannot be damaged by adverse weather conditions. These include wind, rain, dew, sun on the sensors, snow and ice, and lightning. It is also necessary to ensure that the observing conditions are optimised. This requires a monitoring of the light level, the degree of cloud and mist and the level of humidity. The telescope pointing programme needs to know the time and the atmospheric pressure. Effective operation of the enclosure requires the roof position, the drive motor current and the roof locks to be monitored. Robots have a peculiar impact on otherwise normal people who seem to enjoy creating artificial conditions for the robot to react to. It is therefore necessary to have sensors which detect the presence of human beings. From the point of view of security it is also desirable to have cameras which will take pictures of the system. These are also valuable in the set up phase.

In the design of these systems, which have to operate without human presence, it is important to include the design of failure modes and ensure that the system fails safe. The most regular failure is that of the mains electricity. The whole system must be able to shut down by itself without mains power. The other type of unforseen problems are those caused by insects, small animals and birds.

Quality Indices.

The user of the system requests that an image be taken to support their studies. If the image is to be useful to them, it is necessary for the image to be associated with a degree of quality assurance and authentication. The returned images are in the standard astronomical format used for images: the FITS format (Flexible Image Transport System). There is also a GIF format image provided. The FITS format includes a large header of data to support the image. This data includes a complete set of data from the environmental sensors and a preliminary analysis of the image. This analysis looks for circular objects with a given profile which it counts as stars. It then provides the position of these objects with details of their relative brightnesses.

A global quality index is also calculated to be associated with the image. This is calculated assuming that the observer wished to do stellar photometry with the image. For star fields that are in focus with a telescope unbuffeted by winds and without diffuse objects in the field a good-quality image parameter will be produced. For images of the moon, with no point objects in the field, planets which do not have a point like profile or diffuse objects such as galaxies the image quality parameter will automatically default to poor.

An important component of quality assurance is to provide a surfeit of data. This enables the observer themselves to check the internal consistency of the data and so assure themselves of its validity.

The Internet changes everything.

A computer controlled telescope was not the only requirement to make observations accessible from the classroom. It was necessary to have a user friendly communications system with an interface that could be easily understood with the computing skills found in the normal classroom. First the Internet made it possible to consider remote and service observing using email and FTP communications. The problem with such a system was that there were no conventions which reflected classroom computer practice. Whatever was developed it would be special for this project and would require users to learn how to use it.

The arrival of the World Wide Web changed all this. Users of windows and the Internet would know how to interact with the system and the standard page designs with interactive sections could be developed to cover all aspects of telescope control and service observing. Astronomy could finally be brought into the classroom.

The whole of the Bradford telescope system uses the World Wide Web for communications with the user and it operates with most of the available browsers. The site operates from a Sun Sparc station running Unix. The computer is called Baldrick. It is accessed on the Internet at the URL http://www.telescope.org/. At this location there are basic astronomy projects for schools, research projects, a large database of information about the telescope and its systems, a guide to astronomy developed in collaboration with Armagh Observatory and Bradford Technology Ltd. There are many pictures and publicity details but primarily there is the interface to allow users to register with the telescope and submit observing requests.

With registration, they are allocated their own user space on Baldrick where they can check the status of their requests. Baldrick receives all the requests into a request pool from which it produces an approximate observing macro-schedule for each hour of the night for each telescope. Every evening this schedule is loaded up to the telescope. At the telescope it forms a new pool from which the telescope can generate a micro observing-schedule in real time as soon as the environmental conditions of the telescope become suitable for observing. The micro schedule ensures the urgent objects that are about to set are observed first and that urgent objects anywhere in the sky are observed next. The system then observes the rest of the requested objects as near as possible to their transit across the southern meridian.

Astronomy from the classroom. Robotic systems.

The major projects that are available at the telescope are educational projects funded by the Nuffield Foundation and the UK Particle Physics and Astronomy Research Council. These projects are constructed around the UK National Curriculum for ages ten to sixteen with the research project aimed at the sixteen to eighteen year olds.

The projects have an Introduction to Astronomy followed by the Earth in space and the Planets for twelve year olds. This extended to a general view of the Solar System for thirteen/fourteen year olds with the Galaxy and the Universe for the fifteen/sixteen year olds. The projects introduce the Internet to the students, they provide a whole series of relevant facts and work topics spread across a range of abilities. The work topics include observations to be made by the robotic telescope.

The most surprising aspect of the whole project has been the effects on the students. The reports from teachers are all the same. The introduction to the Internet and the World Wide Web normally has a very positive effect in the classroom. The students are excited by the new technology and keen to 'have a go'. This soon fades as the students realise that the World Wide Web and the Internet are rather like a large library and when used properly can provide a vast amount of data.

This attitude to the Internet completely changes when they have access to the telescope. The fact that the telescope takes the images that they have requested and returns that image to them appears to be highly motivating for a whole range of students. The students are in control and the whole experience electrifies the class. The teachers who have used the system assure us that in spite of the poor returns from the Oxenhope telescope, die to the UK weather, the students remained excited by their use of the robot and the astronomy involved. The whole system was an extremely good motivator for the students even though they did not leave the classroom. It is this aspect of the robotic telescopes which the teachers are convinced is so valuable for education.

The future.

It is clear that robotic telescopes have a great deal to offer in the classroom. Our experience has shown that almost all observing requests from school students are for the Moon, the Planets, and a small number of nebulae and galaxies. The efficiency of a robot telescope on a good site means that one telescope can service a very large number of pupil requests every night. The standard requests could all be obtained in about half an hour. Most of the time would then be taken by the observations required for research programmes. This may change as the students become more sophisticated. That is unlikely for some considerable time since the observations are closely linked to the national curriculum and the basics of astronomy. This are the starting observations for all students everywhere who wish to start to understand astronomy.

The major requirement for the future must be one telescope in each hemisphere that is twelve hours away from the observer in longitude. For a global service this requires three or four sites in each hemisphere and for a complete service it is desirable to have two telescopes on each site. There would always be one available for every clear night.

With this sort of provision schools can be involved in many types of research programme. Such research programmes would not be limited to the oldest school students. Programmes like searching for collision comets, Kuiper belt asteroids and Jupiter size planetary transits of nearby solar type stars are easily understood and could be structured to involve students in their design and data analysis. Every student could have their own group of solar type stars, or area of the sky to look for dangerous objects. The Internet provides an ideal publicity medium to allow all the students involved in such programmes to interact with each other, comparing notes, new ideas for programmes and congratulations to successful new discoveries.

Robotic Telescopes.

A key part of the Bradford programme is the design of low cost robust robotic telescopes that could be made anywhere in the world and which would share their control software and its development. Such a model T telescope named in the convention of the model T Ford motor car would be constructed at a price that many more organizations could afford. The $250k one metre, plug and play, telescope with cameras and photometer that is accessible on the Internet would truly bring the skies into the classrooms of the world.

It is hoped that the first stage of this programme of collaboration will be the use of the Tenerife telescope by school students in Japan. When it is daytime in Japan and the students are in their classrooms, it is night time in Tenerife.

http://www.telescope.org/

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Meade Instrument Corporation 16542 Millikan Avenue, Irvine, California 92714 - 5032 (1995)

Teaching through experience

Observation of Total Solar Eclipses

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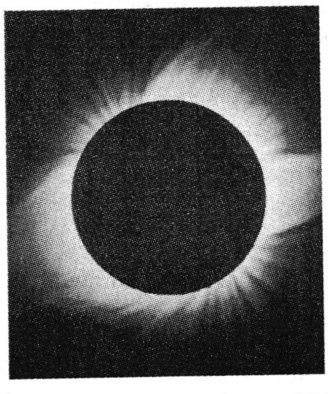
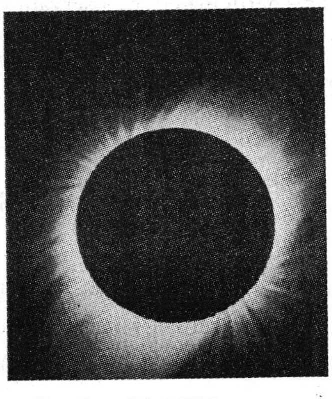
1. Introduction

A 92-person entourage of the Meisei University Eclipse Observation Team was dispatched to 3 points in 2 countries, Paraguay and Chile in South American, on November 3, 1994 to observe the total solar eclipse. In the following year, an observation team was both sent to Dundlodh, in northwestern India on October 24, 1995, and then to Siberia on March 9, 1997, for both academic research and educational purposes. In both cases, the team was blessed with good weather and successful observation results. Table 1 illustrates the breakdown of participants of the three observation teams dispatched.

Table 1

	Observation	student	teacher	total
November 3, 1994	Vapol cue, Paraguay	66	15	92
	Chaco, Paraguay	5	1	
	Putre, Chile	3	2	
October 24, 1995	Dundlodh, India	36	5	41
March 9, 1997	Pervomaisky, Russia	3	3	6





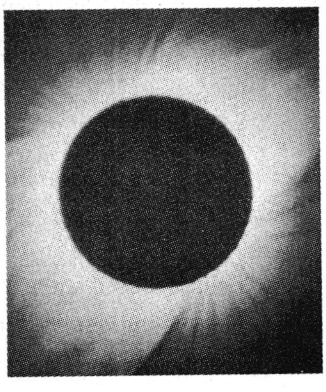


Photo1 November 3, 1994 October 24,1995 March 9, 1997

Table 2: Observation of the total solar eclipse at Dundlod (Meisei University)

Telescope No / Type	Objective Lens / Mirror			Filter	Camera or CCD camera	Scientific Objective	Results
	Diameter	Focal length	F-ratio				
1 Refractor	15 cm	1050 mm	7	wide band filter (wavelength band of 5800~6200Å)	Camera (Nikon F4)	Photometric observation of the corona.	18 frames from 1/1000 sec to 4 sec.
2 Refractor	15 cm	1050 mm	7	no	Camera (Nikon F4)	Color images of the corona.	36 frames from 1/500 sec to 4 sec.
3 Refractor	15 cm	1050 mm	7	no	Camera (Asahi Pentax 6×7)	Color images of the coronal fine structures.	10 frames from 1/1000 sec to 2 sec.
4 Refractor	15 cm	1050 mm	7	5303Å (interference filter)	CCD camera (analog)	CCD images of the E corona. (field of vision: 20' ×24')	East limb.
5 Cassegrain	28 cm	2800 mm	10	wide band filter (wavelength band of 5800~6200Å)	CCD camera (digital)	CCD images of the K corona. (field of vision: 10' ×15')	East limb.
6 Refractor	7.5 cm	500 mm	6.7	polarization	Camera (Nikon F2)	Polarimetry of the corona.	12 frames from 1/60 sec to 1 sec.

2. Observing an Eclipse as an Educational Experience

Observation of a total solar eclipse is the most effective teaching material among educational experiences of nature used as text. This is because a total solar eclipse is both a rare, golden opportunity, and one of the most wonderful phenomena that we can witness in terms of seriousness and somberness.

Numerous preparatory educational programs were provided to make the best of the experience. The curriculum titled "In Search For the Solar Corona" (4 credits) offered throughout the year include both observation team members and regular students. The purpose of the course is to academically study eclipse observations to heighten the intellectual interest. Tools including slides, video, OHP and other teaching materials for lecture were used, but were not enough to satisfy the group that strongly desired an actual experience.

During the preparatory stage of observations, the participants were not only the student working on their graduation papers but also all the members of the observation team that gathered under the established observation theme, where each and every participant eagerly prepared observation materials and participated in observation training programs, etc.

The entire entourage finally departed for the observation site after an almost 6-month prep-course in diverse educational activities.

3. At the Observation Site

The "Eclipse Observation Forum '94" took place in Paraguay two days prior to the total solar eclipse in joint effort with the National University of Asuncion . Junior high and high school students from amongst the audience of roughly 500 that gathered for the Forum stepped on stage to sing a Japanese song.

For observations in Russia, we carefully selected 6 of our best members, with consideration to the extremely challenging observation conditions in northernmost Siberia during the coldest time of the year. Invited by the Russian Science Academy, the observation team went to Moscow and joined counterparts from Slovak, Gruziya, Italy, and France that conjoined to participate in a 6 country, 29-person International Eclipse Observation Team. (Table 3)

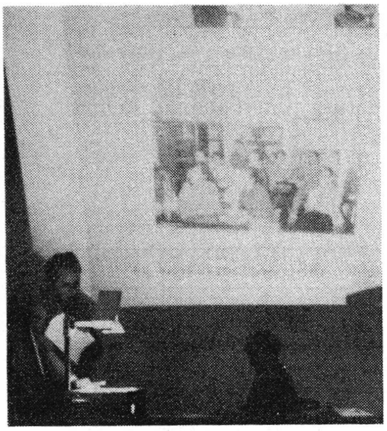
Table3: International Eclipse Observation Team

Country	Affiliation	Observer	Observation of the 1997 Total Solar Eclipse
Russia	Moscow State University,Sternberg AI	Iraida S Kim and 4 others	5303,6374,H α
	Russian Academy of Sciences,Izmiran	Boris Filippou and 4 others	polarization of whitelight corona and 3D corona structure
	Moscow Stare Technical University	Valery Nagnibeda and 2 others	fin structure of solar limb at 3.4mm wavelength
Slovak	Slovak Central Observatory	Teodor Pinter	white light corona-photograph,CCD-TV camera
		Morian Lorcuc	white light outer corona up to 50 solar radius
		Bohus Lav Lukue	spectrum of solar corona take by CCD-TV,flash spectrum
		Ladij Lav Drugo	white light corona-photograph with CCD-TV camera
		Miklas Vango	Large scale of the corona and Halle Bopp comet
	Observatoty Banska Bystrica	Daniel Ocenas	CCD-TV camera
Gruziya	Abastumani Astrophsical Observatory	Vaja I.Kulijanishvili	polarization
Italy	Club Alpino Italiano	Vittorio Napoli	white light corona(200mm,45mm)
	GEOS,SAT	Francesco Feragsli	white light corona(800mm,35mm)
France	Observatory de Meudon	Sareyan Jean Pierre	white light corona(400mm,)
Japan	National Astronomical Observatory	Yoshinori Suematsu	polarization,CCD-TV camera
	Meisei University	Noritsugu Takahashi	polarization,Large scale of the corona
		Kazumasa Inoue	photometric observation of the corona
		Nana Yamada	
		Shigenori Shimizu	
		Takayuki Yamazaki	

4. Conclusion

The highly motivated students that gathered to observe the eclipse learned observation methods and techniques, along with knowledge on what an eclipse is, situation of the observation region, natural conditions and diverse other academic areas. By experiencing comprehensive learning on the theme "Total Solar Eclipse" the learning activity was not only boosted in efficiency but also readily converted into teaching material that left a vivid impression.

In fact, the students participating in the experience were greatly affected by the concepts of the universe, nature, world, and creation of man. It is also expected that the experience with nature and international exchange will become invaluable asset for these students to treasure forever.



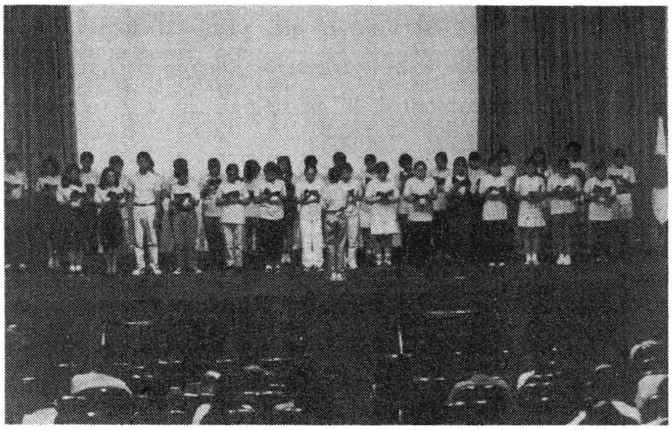


Photo 2. International Eclipse Forum
Professor Troche, National University of Asuncion
Sing a Japanese song

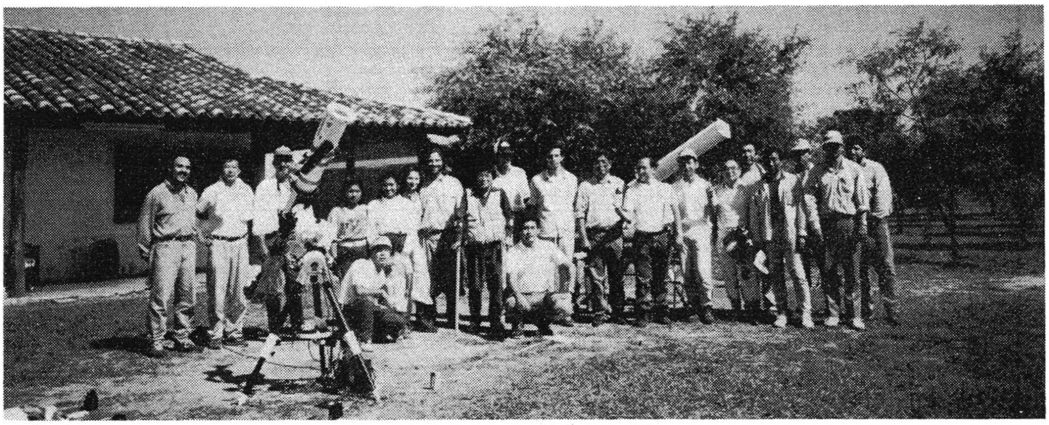


Photo 3. Snap shot of Observation Team in Paraguay and Chaco

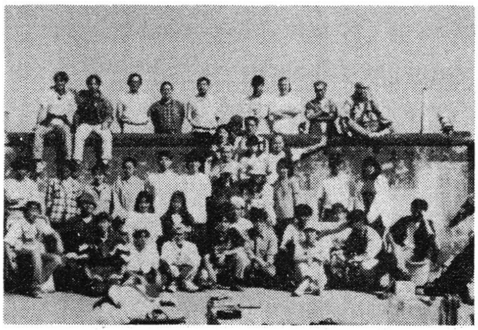


Photo 4. In Dundlodh

Photo 5. In Siberia

Investigation of The Increasing Popularity of Astronomical Education

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1. Introduction

We conducted questionnaire surveys in both 1983 and 1993 to clarify the current spread and situation of interest in astronomy in Japan. This paper report the results of the 1993 survey. The survey included a:

a) keyword study to learn the level of understanding of 100 terms related to astronomy and the universe;

b) image survey to clarify the image on astronomy through multiple choice answers; and

c) experience survey consisting of both multiple choice and free answers.

The survey was conducted by mailing the questionnaires to various schools, with the purpose of each student filling out their own form. As shown in Table 1, this study targeted a total of 987 students of the grade indicated. The samples were selected so as not to affect the survey results according to the tendencies of the survey area, choosing one class per school, with as many schools as possible participating in the survey.

Table 1

age	total (people)	male	female	total (school)
9 age (primary school)	138	68	70	5
12 age (primary school)	244	136	108	8
15 age (junior high school)	202	110	92	5
18 age (high school)	318	117	201	5
21 age (university)	85	69	16	2

2. Keyword Survey Result

(1) Constellation

The Cassiopeia, Orion, and other notable seasonal constellations, as well as the Gemini and 12 other zodiacs are well known. However, the names and clusters of stars composing constellations are hardly known.

(2) Sun

The sun spot and corona are well known. However, the photosphere, facula, granule, and other parts of the sun are not much known.

(3) Planet

Even elementary school students know the names of the solar planets, though they are not included in the teaching material.

(4) Other Celestial Bodies

Though Halley's Comet is well known, the others are not.

(5) Calendar

Calendar, vernal equinox, summer solstice, star festival, leap year, and other terms used in daily living are well known.

(6) Unit

Though there seemed to be strong scientific knowledge, the overall terms were not known, other than kilometer and first magnitude star.

(7) Spaceship

Black hole and big bang were well known from the 3rd grade on in elementary school, though it is not mentioned in the text.

(8) Rocket and Space Development

The space shuttle is well known. Though the term artificial satellite is known, most were not aware of the names of Japanese scientific satellites.

(9) Notable Figures (People)

Copernicus, Galileo, and others are well known.

(10) Observatory and Telescope

Names of domestic observatories and foreign space observatories are hardly known.

3. Image Survey Results

An image survey was conducted on the impressions of astronomy and the universe. The results are shown in Figures 11 through 22.

Figure 11. Appears to be difficult.
Figure 12. Very romantic and fulfills dreams.
Figure 13. Ideal.
Figure 14. Space studies will benefit mankind sometime.
Figure 15. It is valuable in daily living if known.
Figure 16. Space research and development is extremely costly.
Figure 17. Mankind will live in space in the future.
Figure 18. There must be alien forms of life.
Figure 19. The boundaries of the universe is unlimited.
Figure 20. Astronomy fans do not tend to worry about insignificant areas.
Figure 21. Astronomy fans can have good personal relationships.
Figure 22. Astronomy fans value nature.

4. Experience Survey Results

A survey was conducted to see where the interests lie and what experiences were available. The results are shown in Figures 23 through 25.

(1) Area of Interest

Astronomy amounted to roughly 6.4% among the diversified list of interests.

(2) Club Participation

Fervid astronomy fans with club membership experience amounted to 3.6%.

(3) Experience with a Telescope

Those with observation experience through a telescope amounted to 50% in junior high school, and 70% in college.

(4) Experience in a Planetarium

Learning experiences in a Planetarium exceeded 80% in elementary school, and remained about the same thereafter. According to the survey conducted in 1983, the experience reached 80% by high school, which seems to assume that new Planetariums are being constructed and used around the country.

5. Summary

The current trends and spread of interest toward astronomy in Japan can be understood through these studies. It is most beneficial if the survey results could serve as an impetus to promote and spread astronomical studies among those concerned.

Figure 1. Constellation

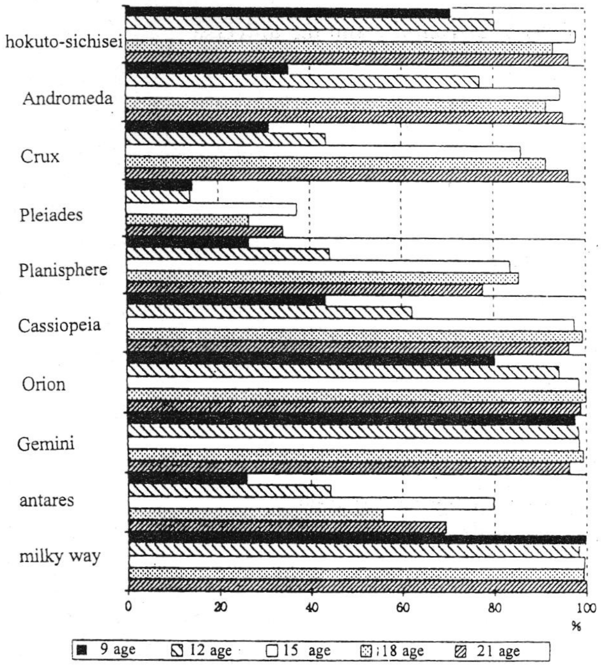


Figure 2. Sun

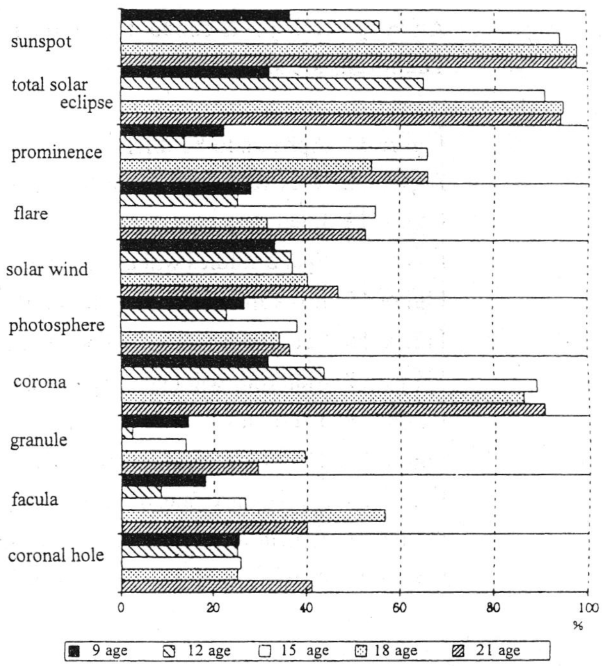


Figure 3. Planet

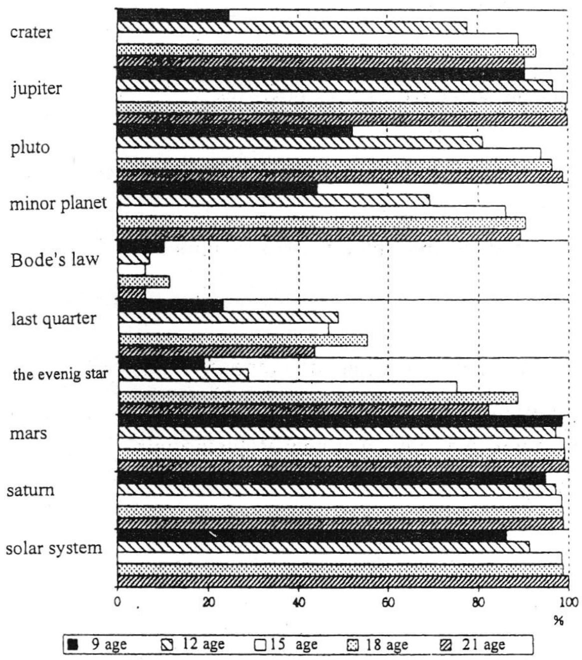


Figure 4. Other celestial body

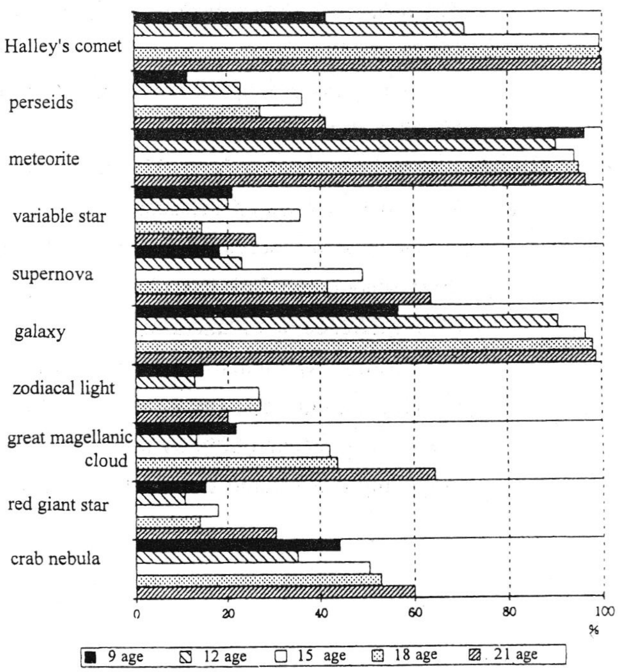


Figure 5. Calendar

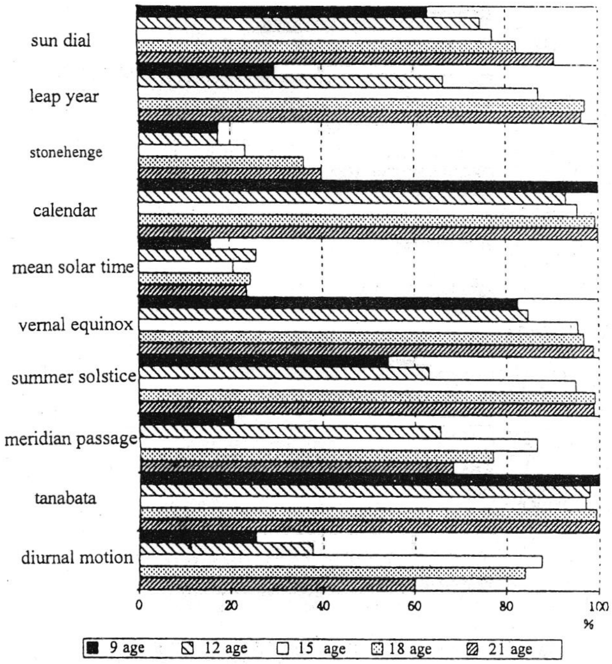


Figure 6. Unit

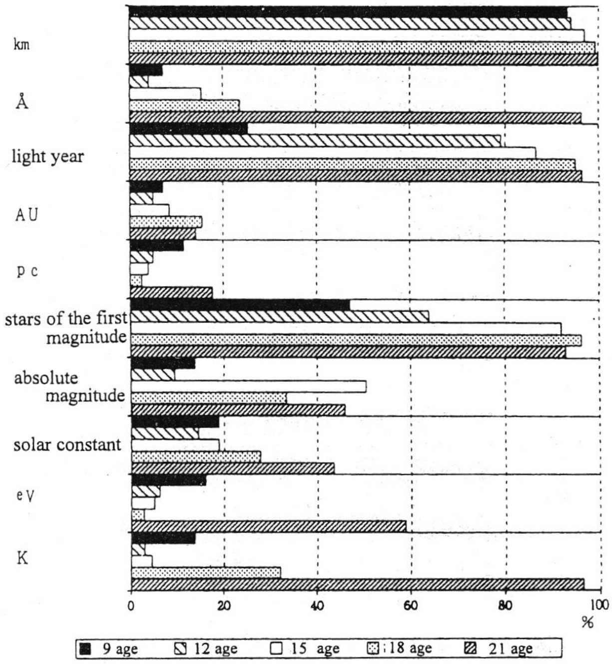


Figure 7. Cosmology

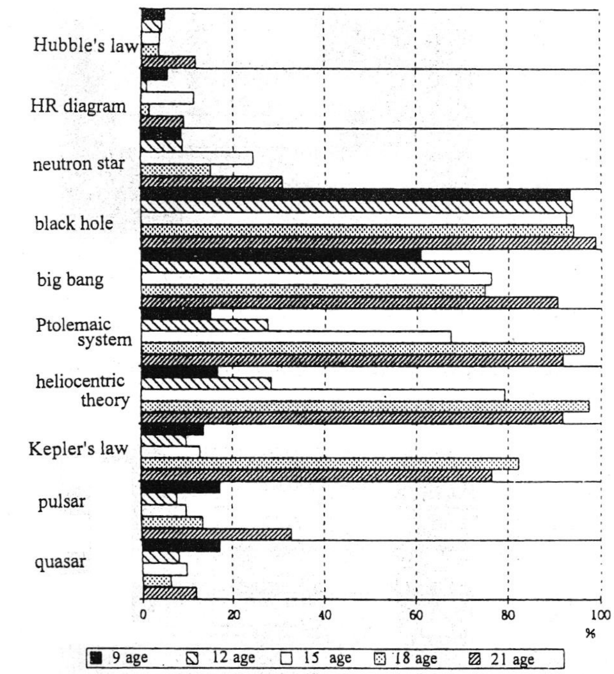


Figure 8. Rocket and space development

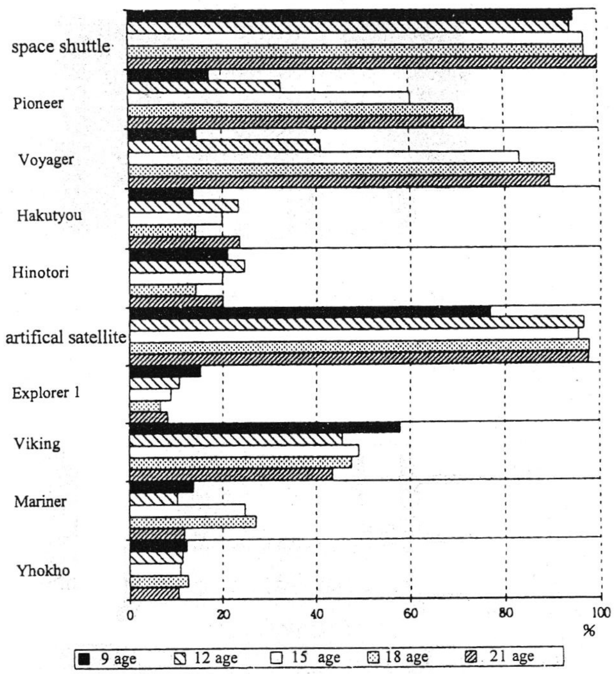


Figure 9. Notable figures

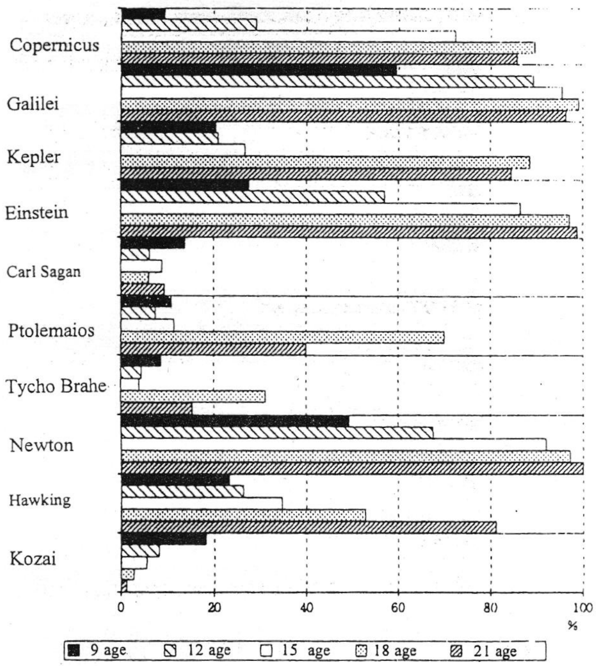


Figure 10. Observatory and Telescope

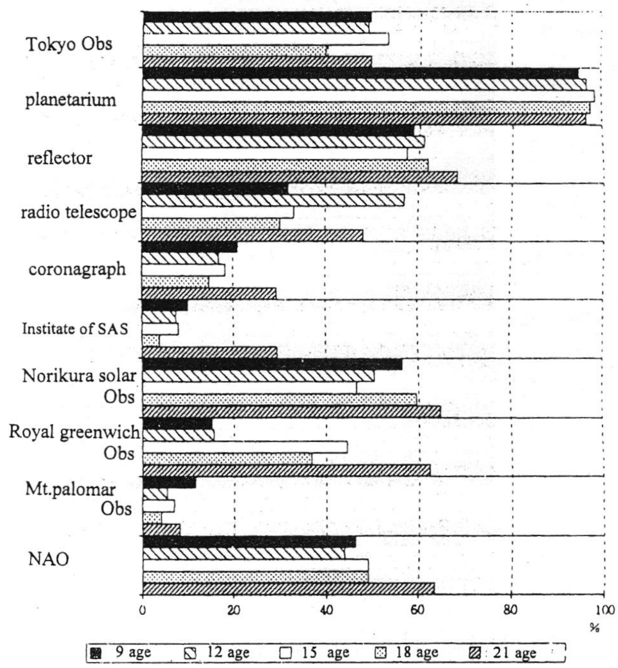


Figure 11. Appears to be difficult.

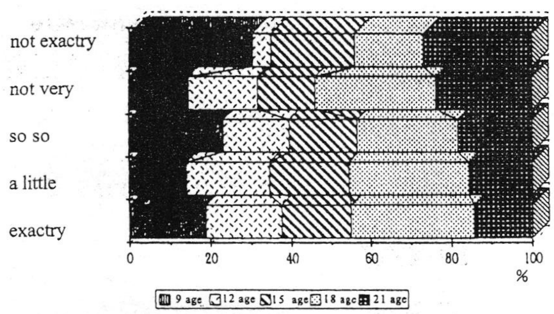


Figure 12. Very romantic and fulfills dreams.

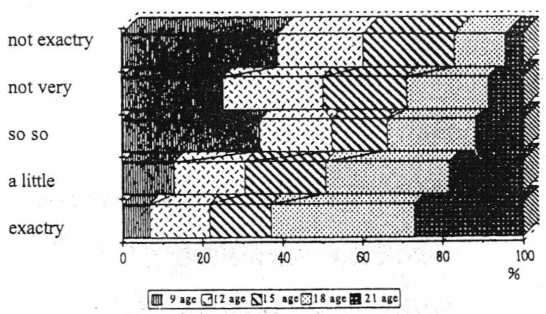


Figure 13. Ideal.

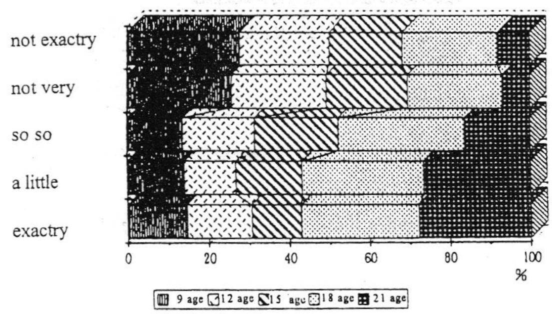


Figure 14. Space studies will benefit mankind sometime.

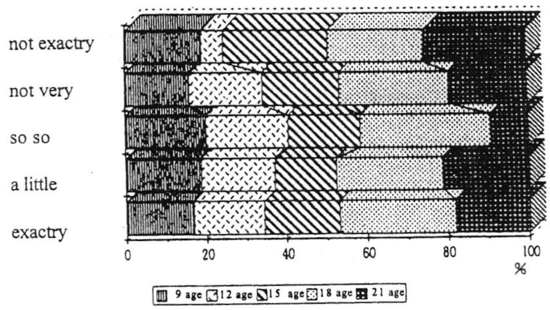


Figure 15. It is valuable in daily living if known.

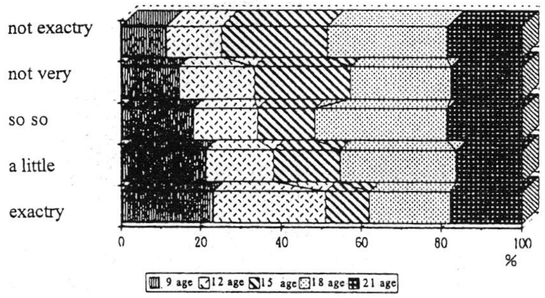


Figure 16.

Space research and development is extremely costly.

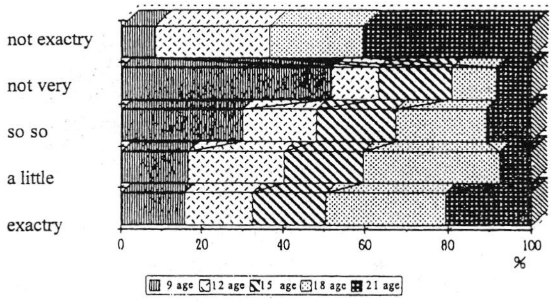


Figure 17. Mankind will live in space in the future.

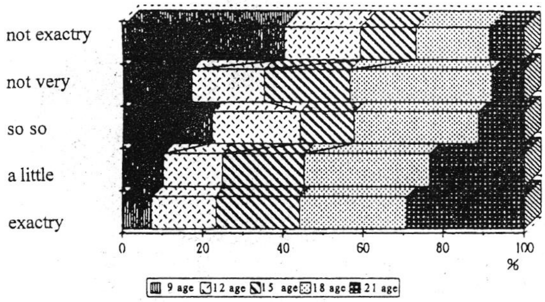


Figure 18. There must be alien forms of life.

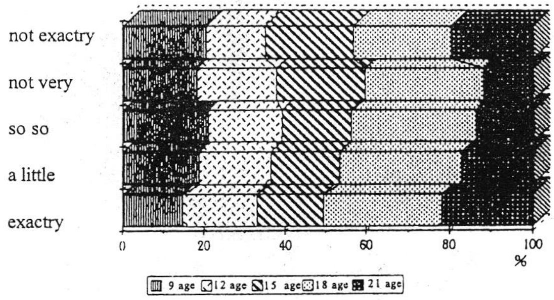


Figure 19. The boundaries of the universe is unlimited.

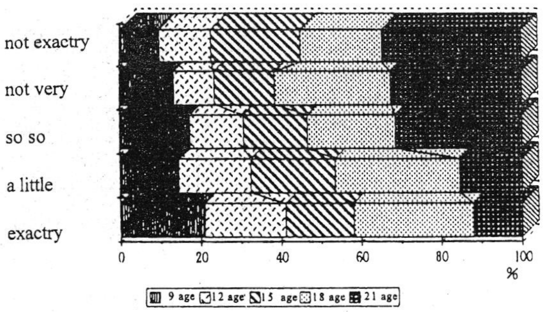


Figure 20.

Astronomy fans donot tend to worry about insignificant areas.

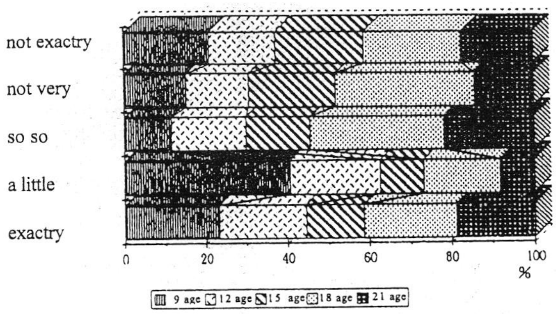


Figure 21.

Astronomy fans can have good personal relationships.

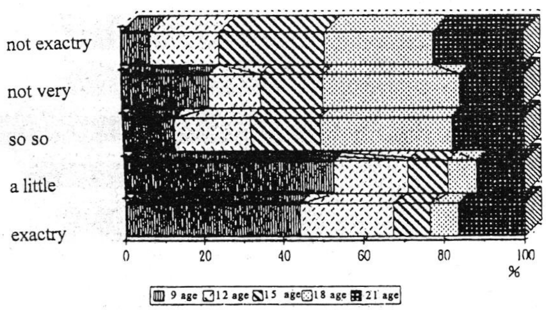


Figure 22. Astronomy fans value nature.

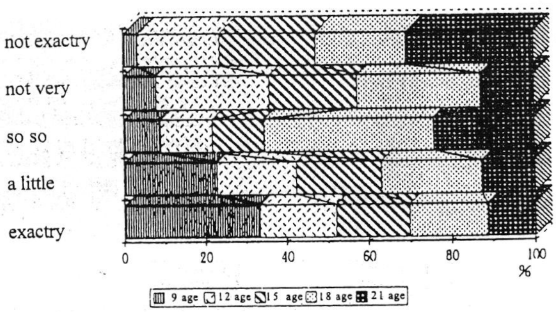
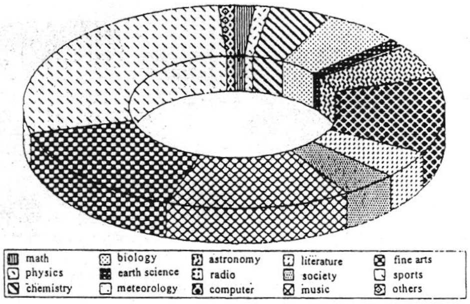
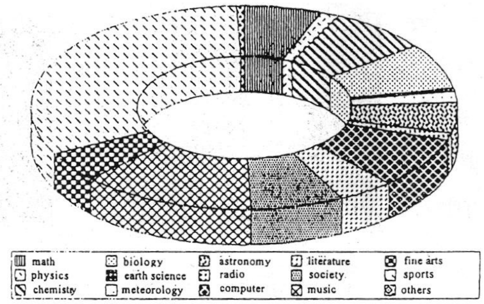


Figure 23. Area of Interest

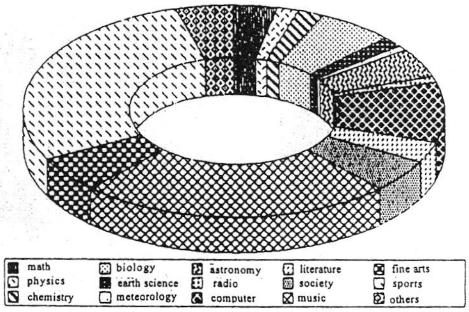
(1) 9 age



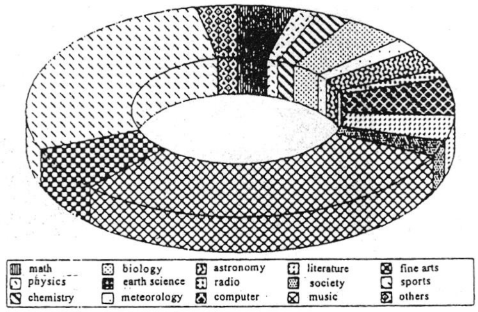
(2) 12 age



(3) 15 age



(4) 18 age



(5) 21 age

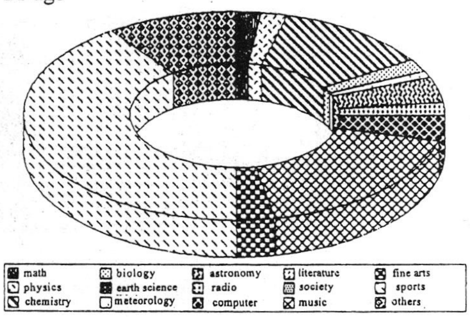


Figure 24. Club Participation

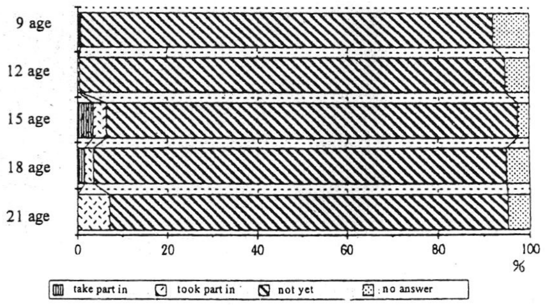


Figure 25. Experience with a Telescope

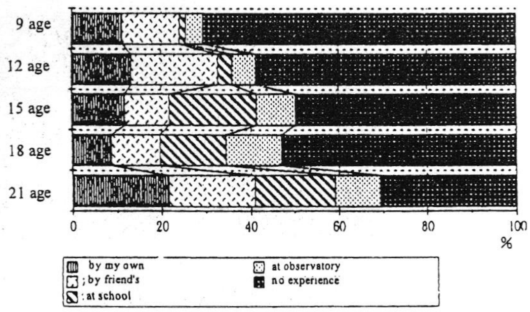
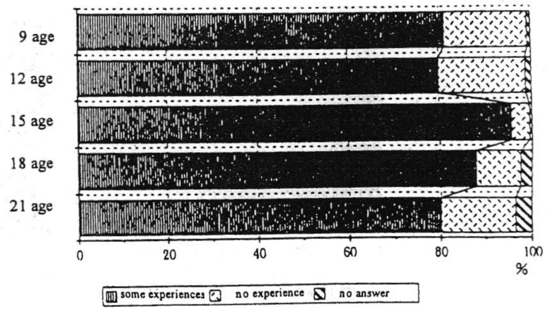


Figure 26.Experience in a Planetarium



Wonderful meeting with stars at the "SHIZEN GAKKO"

-Present status and future prospects-

Makoto Fujiwara (Hyogo Nishi-Harima Culture Center)

Abstract

In teaching of astronomy, it seems necessary and essential to enjoy watching stars in practice in their childhood. From this kind of experience, I have wondered and attempted for more than 20 years to find out how to let children to be interested in the nature surrounding them. In this paper, I report on the present status of the programs concerning astronomy in the "SHIZEN GAKKO", which is carried out by Hyogo prefecture, and future prospects on the outdoor-activity program.

1. Introduction

In the education curriculum in Japan, all of the children are establishedto study gradually and systematically on the relation between astronomy and our life. However, it is hard to realize for many reasons; for example,

(1) a luck of knowledge and skill on astronomy of teacher,

(2) observation cannot carry out because the sky is not clear, etc.

There are some occasions to study on astronomy excluding curriculum in the school, namely, 2 or 3 days stay with outdoor activities, star watching party at the public facilities for studying on the nature. However, in these occasions, it is often insufficient to setting their aims of the program, to achieving their aims, or

In the Hyogo Prefecture, the program named as the "SHIZEN GAKKO" is carried out at all of the primary schools(840) and at requested junior high schools(35). There are no other place where this kind of program is carried out in Japan. I present in this paper on the present status and future prospects of the study on astronomy in the "SHIZEN GAKKO".

2. What is the "SHIZEN GAKKO"

Japanese children in now-a-days are satisfied with their material comfort. However, their natural environment is poor. Moreover, some people point out that their wisdom seems poor, which may caused by making too much of knowledge.

In the Hyogo Prefecture, it is considered important to fostar warm-hearted people. It is also considered important that it is important on man growing process to play in the natural field and to interact with their family, their friends and their neighbors. From above viewpoint, the Hyogo Prefecture has been pushing forward the "SHIZEN GAKKO" program from 1988. This program has been carried out at about 50 facilities, the most of which are the public ones.

(1) Characteristics of the "SHIZEN GAKKO"

* Total study without the border between subjects
* Included in a one-year plan of study program
* A chance to contact to the nature, to each other, and to people where children stay, and to study with experiments.
* This program is carried out for all of the 5th year children in the elementary school and for the students in junior high school who requested it.
* 6 days stay

(2) Flowchart until the "SHIZEN GAKKO" is carried out

Object of each school → [The present status of the children] ← A one-year plan of study program

↓

Setting the aims of the program during the "SHIZEN GAKKO"

↓

Setting the study program and studying activities during the "SHIZEN GAKKO"

↓

Carrying out the "SHIZEN GAKKO" and continuing to teach

(3) Present status of the study in the "SHIZEN GAKKO"

A goal of the study program in the "SHIZEN GAKKO", is to supplement the study in their own school through the direct experiences. The program includes the activities in each subject, moral education, and moreover it includes the education on our environment and on human rights, etc. The activities related to the nature in three facilities are as listed below;

Minami-Tajima Shizen Gakko : (In the northern part of the Hyogo. At the foot of the Asako mountain.)

Observing stars, cooking with an open-air fire, climbing a mountain, craft with material in the field, walking through the woods and field, watching flowers and plants in the field, bicycle for mountains, making a fire, night hiking, playing in the river and observing creatures in the river, sleeping outdoors, making traditional Japanese-made paper, playing in snow and skiing, making a sketch, baking sweet potato, catching fish with a dragnet, catching fish with hands, bird watching, working in the woods, making a playground on the hill, drinking herb tea, baking bread, making a kite, correcting flowers and plants, correcting insects, observing the micro-world, cooking wild plants, playing with acorns, visiting a mine, visiting a power plant, visiting a sandhill, visiting a farming center, etc.

Nishi-Harima Astronomy Park : (In the western part of the Hyogo. At the top of the Ohnade mountain.)

Observing stars, observing stars through telescopes, study of stars, cooking with an open-air fire, rally with watching flowers and plants in the field, craft with material in the field, visiting a farm, visiting a greenhouse, night hiking, walking through the woods and field, watching flowers and plants in the field, digging sweet potato, digging Japanese radish, making a sketch, rice-planting, sleeping outdoors, making traditional Japanese-made paper, visiting a shiitake mushroom plant, playing in the river, hearing on tales in mountains, gathering Japanese chestnuts, making a kite, craft with vine, baking sweet potato, catching fish by hands, making konjak jelly, making a bird box, competition on cooking, dyeing with wild flowers and plants, getting wild plants, visiting a sandhill, ceramic art, baking bread, etc.

Hāha-to-Ko Island: (A island in the Seto-uchi sea)

Canoe, cooking with an open-air fire, playing around a fire, making a raft, catching fish, catching shellfish, observing stars, orienteering in the nature, hiking in the nature, night hike, playing at the sandhill, creating statue with sand, playing by the sea, making traditional Japanese-made paper, catching fish with a dragnet, observing plants, searching for creatures by the sea, searching for flowers, exploring by the sea, craft with shellfish, etc.

Although there are many activities as listed above, there seems possible to making other ǎctivities and to make the whole program more effective than present.

3. An example of the Curriculum in the "SHIZEN GAKKO"

(1) An example of one-week program

	Morning	Afternoon	Evening
1st day		Walk rally with watching the nature	Group activity
2nd day	Setting telescopes, How to use telescope	Q and A on Astronomy	Watching stars, Let's find a constellation
3rd day	Experience ob Farmer	Making foods	Competing with finding a star

4th day	Observing the natural environment	Observing the natural environment	Private time
5th day	Observing the natural environment	Craft with material in the nature	Talking around a fire
6th day	Private time		

(2) Viewpoints of setting the program

1: Schedule of the programs should have enough time and program of the selection, so as for every child can pursue their own interest and act as self-directed.

2: The relation between each program and the daily curriculum and experiences in daily life should be clarified.

3: Before the program, we should let children to be interested in stars. One need noting to make the program flexible, and let children study as their interest.

4: We need an unique name for the program, which will make children interested in the program and will try to do it as much as they can.

5: We should prepare for spare schedules the first half of the week, because some programs seriously affected by weather condition, especially "watching stars".

4. Examples of the Curriculum on Astronomy

(1) Examples of the programs

Daytime programs:

- Quiz
- Answers to your question
- Study everything you want
- Make your own planisphere
- Make your own telescope
- Let's use a telescope
- Observing the solar surface
- Finding a star in daytime

Evening programs:

- Find constellations
- Guide-walk around the night sky
- Natural Planetarium
- Slide-show with a talk
- Reading a story under the night sky
- Concert under the night sky
- Watching the moon and stars 100 times larg
- Find the star: Competition
- How the stars move in the night sky?

(2) Present status and device in outdoor activities

1: In some case, the leader did not consider the conditions of that day.

→ The leader should check the location of the spot, the time of sunset and sunrise, and the end time of the astronomical twilight. If the location allows, I recommended children to watch the sunset or sunrise to make them a strong impression.

2: The weather of that day was bad and we did not watch stars at all.

→ It is also natural that there is a cloudy day. You should prepare another chance to watch stars or should prepare a program for cloudy days

3: I cannot tell which star is which.

→ I projected some slides took by 50mm lens outside and let them know the star. I have drawn a figure of constellations in a large paper, and explained how the stars align and let them know the star. I pointed the star with a white pole or with a strong light. I explained the way to the star from a landmark.

4: The star watching party cannot be carried out because there are so many participants.

→ If you can call for help for other leaders, it will be alright. If you can not, there are some ways to solve it. Examples for solving are; (1) dividing the program for 2 or 3 days, or (2) making several groups, namely, to watch stars through telescopes, watching stars by themselves, and concert under the night sky, and let them rotate.

5: Children cannot introduce stars into the field of view of the telescope.

→ If the telescope was not properly set up, then let them set up in daytime, and let the finder and the telescope to the same direction. I told sub-leaders that the setting up of the telescope is important.

If children can not use telescopes, then let them practice to enter the object in daytime. Not only the representative of the group but also all the members of the group should know how to use telescope. Otherwise, one of the group members once lost an accessory or moved the finder or broke the screw for altitude adjustment

5. Future Prospects

(1) Training session for who prepare the program

There are some conditions for setting a wonderful encounter with the starry night. The program maker should know all about the conditions and how to satisfy them. There are training sessions at Nishi-Harima Astronomical Observatory and at Minami-Tajima Shizen Gakko. It seems that these kind of training sessions should be held in all of the prefectures.

(2) Training session for leaders

All of the teachers in the elementary school and those of the science in the junior-high school could be a leader, if necessary. In the present state, teachers of the science studied on physics or chemistry in their universe, not on astronomy. Teachers in the elementary school also don't have enough knowledge and skill for astronomy. We seem to need training sessions for leaders in citizens and also sessions for training an interpreter of the starry night.

(3) Handbook for leaders

A handbook for leaders is published by a working group for star watching party in the Japanese society of the teaching and popularization of astronomy.

(4) Handbook for preparing the facilities

What kind of facilities we need for studying astronomy in any weather condition and in daytime? What kind of facilities we need for opening a training session for leaders? We seem to need a guideline for preparing the facilities.

(5) Considering about light pollution

You should select a place without light pollution. However, if there is, you may solve it by covering the light. Let's consider about the solar system, the environment of the earth, and local environment. We also seem to need considering on whether lighting up in the night will bring us happi ness or not.

(6) Extending the network of leaders to all over Japan

We have a devout feeling when we look up the starry night. It will also be a chance to have our own sense of value to the life and the happiness. One who grown up without this chance is unfortunate. I would like to make a guideline for making a local network of leaders, so as to make children all over Japan will have a chance to meet the starry night. We seem to need a star guiding group for every 10 local governments. also seem to need a global network of these groups.

(7) Tying up between public facilities and local governments

At present, most of the activities concerning astronomy are carried out by the public facilities for natural sciences or by a local government working on our environment. There are also some private associations concerning astronomy. Please make a contact with one of them to make easy to set a outdoor program with watching stars.

6. Summary

I have prepared a chance for children to meet with the wonderful starry night and let them interested in astronomy. As soon as they are strongly impressed or had a question on stars, they will watch stars by themselves and will look for an answer by themselves. This kind of experience will make them live by themselves. I would like to set a chance to meet with the starry night, and let them interested in the our earth and our universe.

Experiments and Exercises for Various High Schools
Earth Science Work Books

Bunji SUZUKI
(Misato Technological High School)

I . Over view of school system.

Formal educational system (a **6-3-3-4** system) was established on the principle of equal educational opportunity in Japan. In accordance with the provisions of the School Education Law, all elementary and secondary schools in Japan are required to use textbooks in the classroom teaching of each subject. Textbooks to be used in schools must be either those authorized by the Minister of Education, or those compiled by the Monbusho itself.

Proportion of lower secondary school graduates going on to upper secondary education, reaches 97 percents. This ratio is so high. There are several types of students in a high school. For example, student who goes on to the next stage of education to university or finds employment. Then, some students don't like a learning, and many students don't become a researcher. Many students who come to the school for only playing, they are becoming lazy and lazy in several schools. With such a situation, we can not give a lesson to them with a textbook only. Of course, experiments are very important with science education. Especially, Teaching of Astronomy needs useful observation and research work for student. So, many high school teachers make up original workbooks, in every prefecture.

I think that important fundamental opinions of education are;

(1) What is a common educational mark in all high schools?

(2) What is a different mark in each high school?

(3) We have a responsibility for all citizens(not for state) and should do an educational activity.

The workbooks are edited with these opinions.

II . Work book of Earth science.

(1) Latitude of observational site.

This experiment is a simple observation and a simple measurement.

It helps to understand celestial globe for students.

(2) Research for planetary atmosphere.

Compare the Earth atmosphere with the other planet.

I think that we must learn the Earth for one of the planets in the solar system.

(3) Solar activity and magnetic fields.

Students find solar magnetic fields collate sunspots' latitude and its activity. we expect students to understand the sun for more physically.

(4) Identify Fraunhofer lines.

Spectroscopy is the most important tool of investigation of the stars.

(5) Structure and evolution of the stars.

We also usually use this diagram for the clusters.

III. Earth Science in our school (Misato Tech. High School).

■Earthquake

- Hanshin-Awaji earthquake disaster
- Request the epicenter and seismic center
- Structure of the earth
- plate-tectonics

■Weather

- Atmospheric structure
- Compare with another planet
- Greenhouse effect
- Challenge the weather forecast

■Chemistry

- Composition of the Universe
- Atoms and molecules
- Compound and chemical compound
- Spectrum with a blazing color reaction

■Astronomy

- Cosmology
  - Hubble's Low
  - Various galaxy
  - Structure of Our Galaxy
  - Globular cluster and open cluster
- Evolution and structure of the stars
  - HR diagram
  - Evolution of the Sun
- Solar system
  - Characteristic of the planets
- Life in the Universe

■Summary of the history of the Universe

I want to tell the students about my emotion of astronomy. A good teacher is a good researcher. Also, a good researcher is a good teacher.

Planetary Atmosphere

1. Objectives

Research for planetary atmosphere.

2. Procedure

Make a graph using the lower table.

Investigate a relation of the temperature and the height.

Connect the points with a smooth curve.

Earth

Height	T.	Pressure	Height	T.	Pressure
(km)	(K)	(hPa)	(km)	(K)	(hPa)
0	288	1013.	60	247	0.220
2	275	795.	70	220	0.0522
4	262	617.	80	199	0.0105
6	249	472.	90	187	0.00184
8	236	357.	100	195	0.000320
10	223	265.	120	360	0.0000254
12	217	194.	140	560	0.00000720
14	217	142.	160	696	0.00000304
16	217	104.	180	790	0.00000153
18	217	75.7	200	855	0.000000847
20	217	55.3	250	941	0.000000248
22	219	40.5	300	976	0.0000000877
24	221	29.7	350	990	0.0000000345
26	223	21.9	400	996	0.0000000145
28	225	16.2	450	998	0.00000000645
30	227	12.0	500	999	0.00000000302
35	237	5.75			
40	250	2.87			
45	264	1.49			
50	271	0.798			

Venus

Height	T
(km)	(K)
0	720
20	575
38	425
65	255
80	215
100	185
110	190

Jupiter

Height	T
(km)	(K)
-150	360
-100	270
-50	180
-30	140
-20	125
-5	115
15	120
40	136
50	145
110	167
150	170

*Note 1000 hPa = 0.0km

Abundance(%)

Earth	N_2	O_2	Ar	CO_2
	78.1	20.9	0.934	0.333
Venus	CO_2	N_2	CO	
	96.5	3.5	0.002～1.400	
Jupiter	H_2	He	CH_4	
	89.8	10.0	0.916	

3. Questions

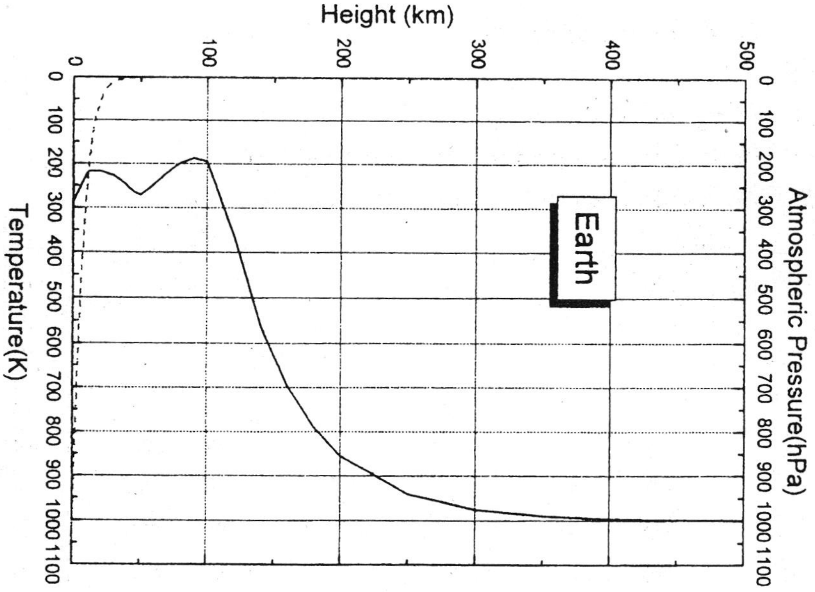
(1) **Using the graph of the temperature distribution, classify the Earth atmosphere into four layers.**

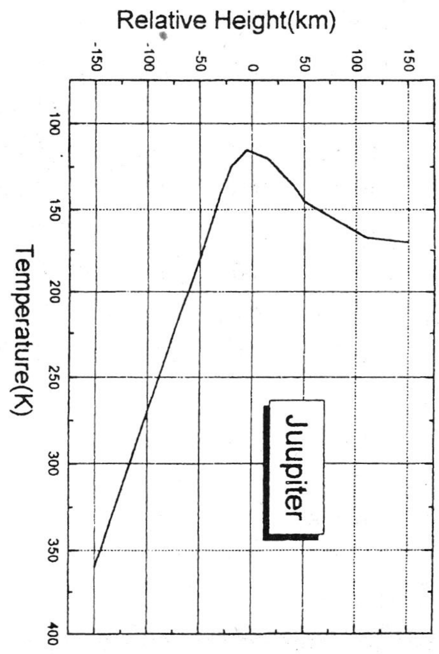
(2) **Calculate the decrease rate of the temperature, about the most lower portion of the Earth atmosphere.**

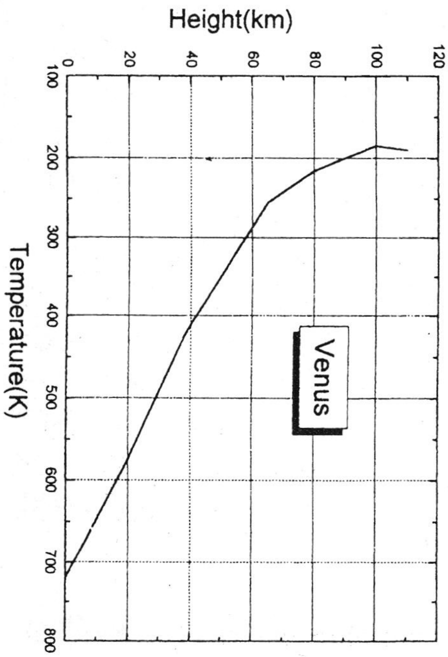
(3) **Compare the Earth atmosphere with the other planet.**

4. References (in Japanese)

Rika -Nenpyou (NAOJ), Planetary science (Asakura shoten)


Height (km)
Atmospheric Pressure(hPa)
Temperature(K)
Earth


Relative Height(km)
Temperature(K)
Juupiter


Height(km)
Temperature(K)
Venus

The Shocking Planetarium!?

Planetarium study by a teacher who hates astronomy.

Koichi Tanaka

(Kyoto municipal science center for youth, Japan)

Abstract

I had hated astronomy until just recently. I had no interest in stars except that I felt beautiful. A shocking accident happened at three years ago. I had been forced to be a planetarium operator for students. Unwillingly, I have been thinking why I hate astronomy and stars, and what is a way that students don't repeat my folly. After a while I have hit upon some ideas and been practicing since. These are effectively use of remote-controlled system, some special goods, funny and easy explanation of constellations, loud music, talk like a comedian, and so on.

1. Introduction

Our science center includes laboratories, a large exhibition room, a planetarium, workshops, audio-visual rooms and outdoor facilities. We provides an opportunity to study science for half a day once a year for every grade student, from 5th to 8th, and for part time high school students. "The study at center" is a school program of municipal schools. Mentally or physically handicapped students also participate and are given special consideration. The staff of the center prepare a course of study in each subject aimed at inculcating the students with the "scientist's sprit" as well as assisting independence in their study. All the teaching materials were used developed by the staff of the center.

The study of astronomy with the planetarium is in a course for 5th and 7th grades students and other special courses. Staff of the part of earth science is in charge of "Planetarium study". I had been a staff of the part of earth science since three years ago. In result, I had to do "planetarium study" whether I like it or not, in spite of I had hated astronomy and been not interested in stars and my specialty was geology. There are some reasons I had hated astronomy and no interest to stars. The first reason is that I had received sleepy education of astronomy by only pictures of the textbook and calculations and no real things. The second reason is that I had experienced a meeting of star watching only specialties had enjoyed and received a explanation by a bad lecturer who is boastful or kind only for girls. The third reason is that specialties use difficult words and star's names when I asked, from the first the world of star is littered by loan words and myths. The fourth reason is that specialties boasted their expensive tools when I went to watch star together, and so on.

Now I have been practicing "planetarium study" I hope it inspires students to observe the starry sky through their own eyes, and I want them to have interest to stars and don't to repeat my folly.

2. Study program

Purpose of planetarium study is that students deepen their understanding of the celestial movement and astronomical phenomena and get more interest in stars. It is expected that planetarium study will continue popular with schools. Because students who live in Kyoto city have little chance to observe stars owing to so much artificial light sources at night. But also school teachers have the difficulty with the teaching astronomy at school -for example, real stars are not in class at the daytime, to observe continuously is very difficult at school, to understand the concept of outer space is very difficult for students. We also find much importance that students records movement of the star at their notes and discover a rule of movement of the star from their records.

(1) Program for 5th grade students (60minutes).

① Today's movement of the sun (about 10 minutes).

② Explanation of starry sky of tonight including of a story of associated with stars or constellations (about 25 minutes).

③ Movement of star for a day (about 25 minutes). Students think about movement of star in the sky with time as they plot the position of one bright star every hour in their notes where "lattice" is drawn.

(2) Program for 7th grade students (60minutes).

① Today's movement of the sun (about 5 minutes).

② Explanation of starry sky of tonight including of a story of associated with stars or constellations and a imaginary space cruise (about 25 minutes).

③ Movement of planet for about one year (about 30 minutes). Students think about movement of planets in the sky with time in a mode that the earth's rotation stops as they plot the position of the planet (Saturn or Jupiter or Mars) every three months or four months in their notes where "lattice" is drawn.

(3) Other programs.

Other programs are for special causes that we fit state of students or sometimes answer school's requests. Usually the explanation of starry sky of tonight and some-for example, changing phase of the moon, a evolution of star, the disappearance of Saturn's rings, the constellations for four season, a different movement of stars at the places of all over the world (change of latitude), etc.

3. Variety goods and concepts of shocking planetarium

(1) Remote-controlled system

This is a basic item for shocking planetarium. By using this remote-controlled system permits the running of modules that is assembled beforehand, the operation of the diurnal and annual rotation systems with a jog shuttle, operator can remain in the auditorium with students, giving explanations literally from the same position as students, with confirming how much students understand. This method is particularly suited to interactive classes adopting various courses to student reaction. More importance, the system permits us dynamic performances, since the operator need not stay close to the control console.

(2) Saturn boy's goods

Saturn boy is one of the performances for studying movement of planets. Consist of performance are "play time" and picture on video. The operator with Saturn boy's helmet on unexpectedly plays Saturn boy with loud music in a spotlight and explains the movement of Saturn with talk like a comedian. The video actor is also operator himself. Students are shocked and pleased. This is very effectively to understand the movement of planets for students. Certainly every staff performs very happily. We made two video stories, one is about the changing inclination Saturn's ring the other is about the apparent movement of Saturn in the sky.

(3) Moon balls

These are special goods for performances of changing phase of the moon. And these are yellow balls, which size is about 20cm across. Students play for themselves having a moon ball in their hand. They are turning happily at the spot in a spotlight instead of Sun. It also is possible to use for performance of changing form of planets. Students look at the standing some moon balls instead of Moon or Mars or Venus or other planets, around the earth ball and light instead of sun. One of moon ball is large size about 30cm across. I use it for performance of movement of the moon. I turn around the outside of students with the moon ball in my hand. Students think why the moon is always same design as they look at the performance. I show the reverse side of ball at last as I say what is the reverse side. Students are shocked and pleased. There is a face of "Dolaemon" at the reverse side of the ball that is very popular character of an animated cartoon in Japan.

(4) A handy manual X-Y projector

This projector is one of the special goods for funny and easy explanation of constellations. This can project pictures of constellations freely at any location that operator want in the dome. Students are shocked and pleased when pretty and terrible pictures are projected. Sometimes, operator uses as a pretty pointer. I use this pointer as I make clever puns. I believe that a funny and easy explanation is better for students. I think that a lot of serious explanations for students are boring and sleepy as I had been so.

(5) Others

① Some costumes for operators. These are very important goods for performances. One of them is for a role of "Galileo Galilei", and another is for the "Miss Sailor-Moon" who is very popular character of an animated cartoon in Japan, and so on. Certainly students are shocked and pleased.

② Something thrown in. There are free gifts of star's quiz -for example, a miniature of the Saturn boy, etc. Students who are given are pleased.

4. Summary

I am beginning to understand the following things in my practicing.

(1) Students have interest in the universe - for example a being from outer space, black hole, the end of universe, etc. But there is nothing on their textbooks. We must them to give and explain the up to date information clearly.

(2) It is very pleasant for students to find even only one star for themselves. We must them to give some methods that are useful for students in observing the starry sky through their eyes. Funny and easy explanations, moderate information, and repeatedly practice in dome are enough for it.

(3) Some performances are very important for "planetarium study". Mood of planetarium dome that is dark and comfortable makes a lot of student drowsy. But also a subject of movement of star is not interesting for them very much although it is very important for science education. There are effective for them not to sleep in dome. Funny explanation, and talk like a comedian, and loud music are also effective for them. Especially, astonishing performances is very important for students who think studying astronomy at their schools is too difficult. Because in planetarium dome they can understand the position more easily than at their schools.

I think that these are the matters of course for any subjects.

As long as I am a planetarium operator, I will go on producing our "planetarium study" more delightful, more easily, more shocking.

Hand-Made Devices for Identifing the Constellations

Takashi Handa

Osaka Prefectural Nishinari Senior High School

Abstract

Students can become familiar with the cinstellations by making "quick view" tools out of simple items such as cans, bottles, umbrellas, and curtains.

1.Introduction

Teaching materials for star chart and constellation will help the students become more familiar with the cosmos and get them to want to go outside at night and look at the stars.

I would like to introduce to you the hand-made teaching materials.

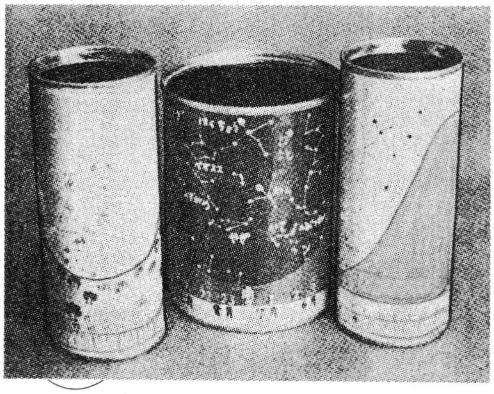
2.Hand-made astronomy education tools

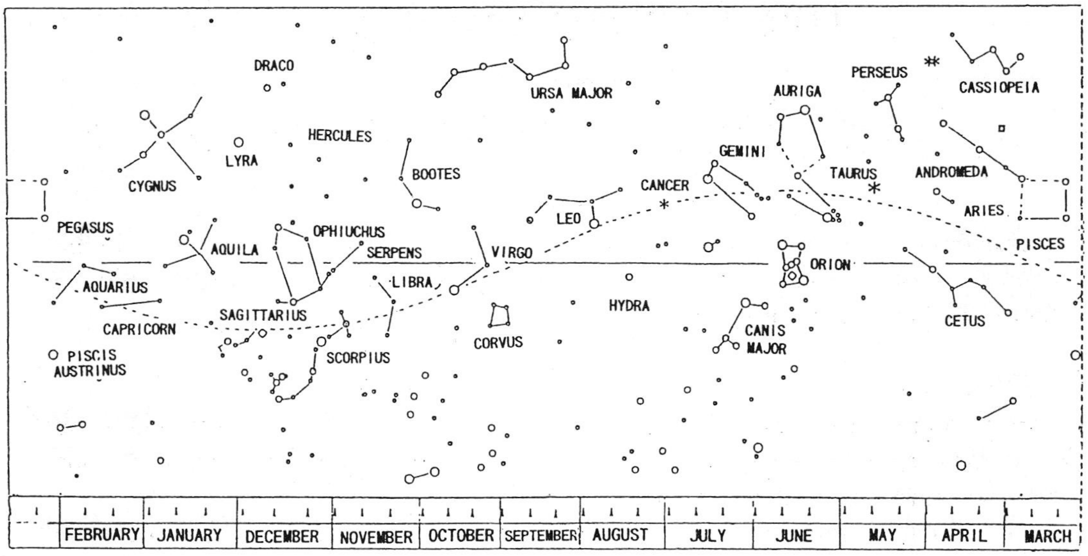
(1) The constellation "quick view" can.

In 1982, using an empty drink can, we made the first "quick view" tool that doubles as a pen holder. We soon began making a number of various.

Using an ordinary empty can and affixing a constellation chart to the outside we then attached clear plastic(overhead projector film) with a line drawn on it to represent the horizon. This clear plastic part rotates to show which stars are visible at various times of the year. The time and month scales are affixed along the upper or lower rim edges of the can.

Another variation is to use a nice looking bottle in place of the can, that can naturally double as a vase when not in use.

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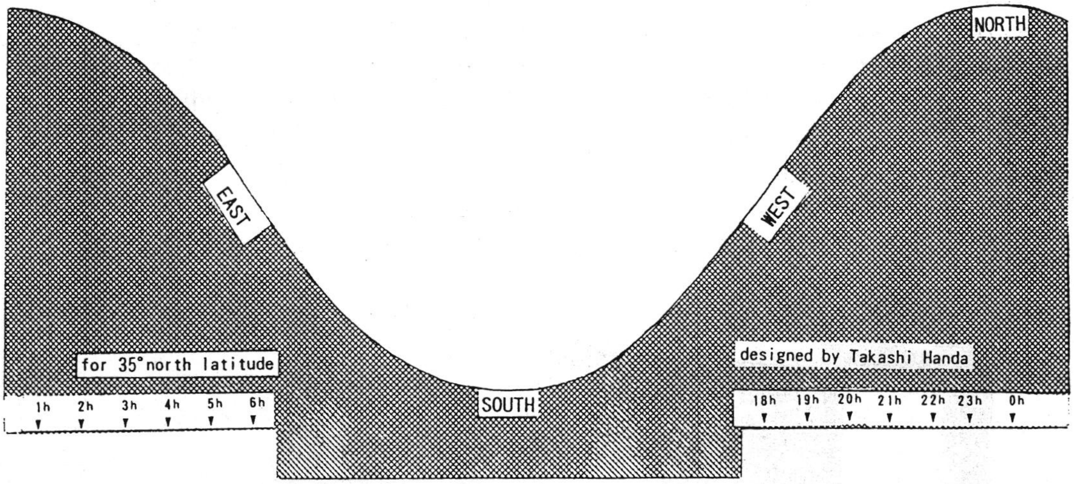
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EAST
WEST
for 35°north latitude
designed by Takashi Handa
SOUTH
1h 2h 3h 4h 5h 6h
18h 19h 20h 21h 22h 23h 0h

×0.65

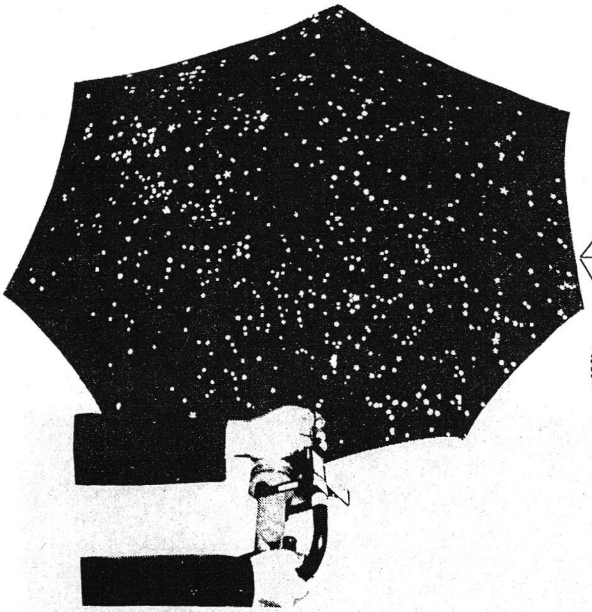
(2) The constellation "quick view" umbrella

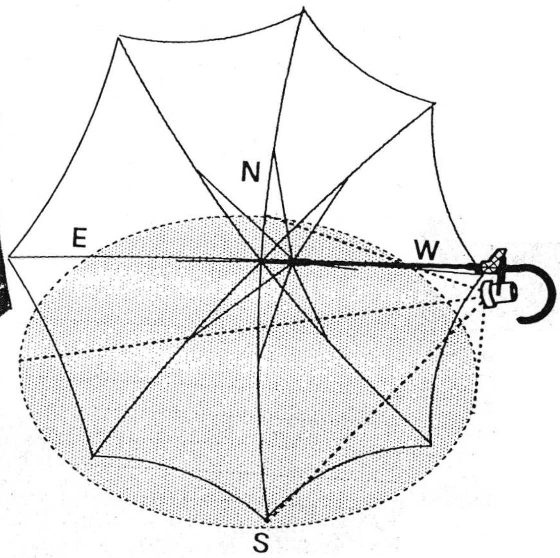
We also have made a floodlit style "quick view" umbrella using a black umbrella with a flashlight attatched to it's handle.

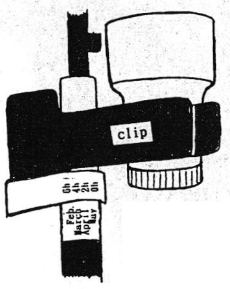
Our students attached with thread approximatery 800 various size dots of glow-in-the-dark material to the underside of a black umbrella to represent 4th magnitude stars or greater.

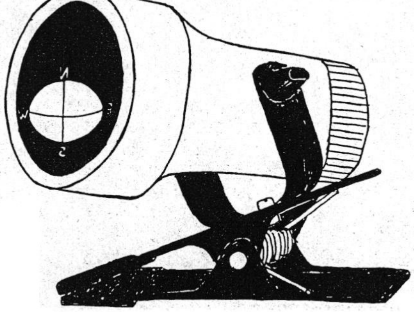
The flashlight lens is partially coverd with a rotating half opaque plastic or rigid paper cover to represent the horizon. The flashlight is then securely fastened to the umbrella handle. Time and month scales are on the handle of the umbrella.

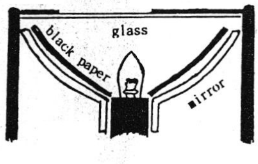
In a dark room, the flashlight is turned on to expose only certain parts of the umbrella corresponding to the month and time. After a few minutes the flashlight is turned off and we are able to see, thanks to the luminous glow-in-the-dark material, which stars are visible at particular times of the year.









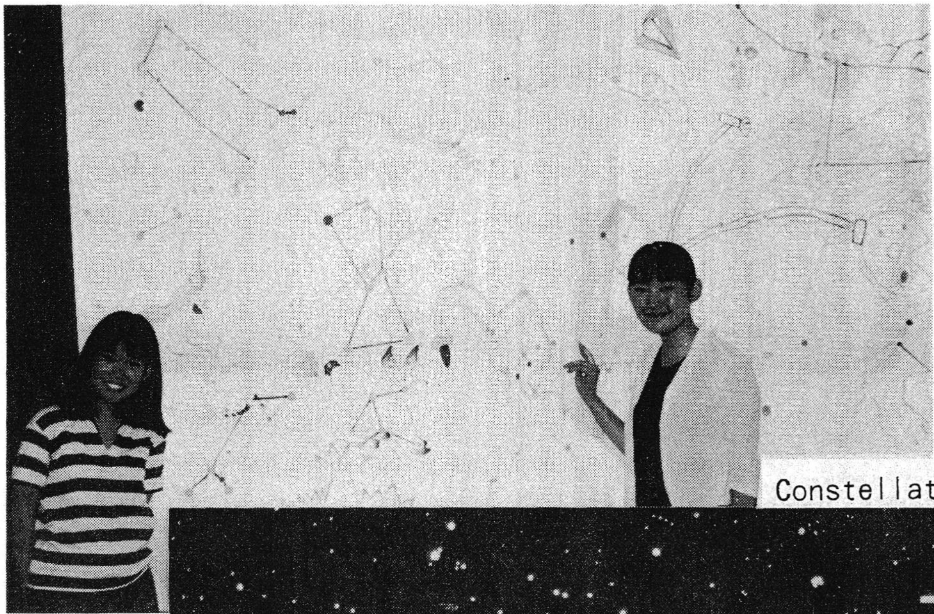


(3) Constellation Curtains and Planetarium Curtains

In order to make the earth science classroom at high school more enjoyable, successive classes of graduating 3rd year students have made colorful constellation curtains and planetarium curtains.

Each constellation curtain is actully a 4 curtain set various color paints and buttons of various size to represent the constellations in a pictographic form.

The planetarium curtain is a 6 curtain set made of double ply black curtains. Star of the 5th magnitude or greater are painted on these black curtains. Although the curtain can't move like a real planetarium, a simple pull on the curtain reveals a useful tool for talking about and studying the constellations.



Constellation Curtains

Planetarium Curtains

An Experimental Trial of Non-Gravity for Youths

Syuzo ISOBE (National Astronomical Observatory of Japan)
and
Committee for Youths using Japan Experimental Module of Space Station

It is generally informed that international space station will start to be constructed in 1998 using US space shuttle and Russian Energia and be completed in 1992. It is scheduled to start scientific and engineering experiments from 2003. The Japanese space agency, NASDA (National Aeronautic and Space Development Agency), will have its own module called as JEM (Japanese Experimental Module) which will be used for Japanese programs.

Mr. M. Mori made several educational experiments during his shuttle mission in 1994, which gave Japanese school pupils some excitements. However the experiments were not well-arranged because they are not consulted to a wide range of specialists. For a case of JEM, since we have enough time to prepare good educational experiments at program, NASDA tried to set up a committee for youths using the JEM in order to collect good ideas from public people and to polish them up.

Our committee started in 1994 to find a way of it, in 1995 we invited tentative proposals for educational experiments on the JEM from school pupils whose teachers were members of the committee, and then in 1996 we chose 8 experiments fitting to a micro-G experiment during a jet flight. Each proposed experiment is took care by one of the committee member. He had to make a minor change to have a good visual exhibition and to produce its instrument with a limited time and money.

Our jet flight experiments were carried out on October 29 and 30, 1996. The jet plane flyed up from the Nagoya airport and reached an experiment flight zone at Enshu-nada. For one micro-G experiment, the jet plane starts to descend from 8,000 m with full engine power, ascends up from 7,000 m again to 8,000 m, and then suddenly stops the engine (in reality keeping very low power but not stoppig because there is a possibility that the engine fail to start). At this moment, we get micro-G condition. It reaches to 9,000 m, descend to 8,000 m, and then the full engine power comes back. We have 20 seconds of micro-G condition. This sequence was repeated 10 times per flight at each flight.

The following 8 experiments were carried out

1. Watching a movement of Dephnia puley (LEYDIG, mizinko in Japanese word)
2. Candle burning
3. Wheel rotation
4. Break-up a glass
5. Babble in water
6. Shooting guns
7. Daruma-otoshi
8. Pendulum

Experiments of No.2, 4, and 5 are successful ones by which school pupils will probably get some degree of scientific contents. The other experiments gave us an idea of experiment refinements for the future JEM educational experiments. A video tape is produced to show these experiments. We hope you will enjoy this video and give us any comments for our future refinement.