CHAPTER IV

DATA ANALYSIS

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4.0.0 INTRODUCTION

The present chapter deals with analysis and interpretation of data. The present study is of survey type where both qualitative and quantitative data were gathered. The qualitative data is systematically analyzed keeping in view research objectives while frequency is used to analyze quantitative data. The researcher had identified the common factors of all nine Community Science Centres in terms of structure, infrastructure facilities, financial management, human resources management and programmes conducted by them. The researcher had also mentioned the uniqueness in all centres which is apart from common components.

4.1.0 STRUCTURE OF COMMUNITY SCIENCE CENTRES

All nine Community Science Centres in Gujarat were established as non-profit charitable trust under Societies Registration Act. Community Science Centres of Gujarat were established by any one of the bodies like, Central Government, State Government, local bodies and different non-governmental organizations for science popularization in Gujarat. In Gujarat, 18 science centres were under the preview of Gujarat Council on Science and Technology (GUJCOST). GUJCOST is an autonomous body created by the Department of Science and Technology, Government of Gujarat in the year 1986 to popularize science among the people of Gujarat.

4.1.1 Establishment of Community Science Centres under Gujarat Council on Science and Technology (GUJCOST)

One regional Community Science Centre and four community science centres working under GUJCOST were taken as the sample for the present study.

Community Science Centre at Amreli was established in the year 2000. The centre was adjoined with a museum and Balbhavan. The parent organization, Girdharbhai Sangrahalaya District Community Science Centre, Museum and Balbhavan, operated this science centre.

Community Science Centre at Anand was established in the year 2004. It is the only Community Science Centre of Gujarat managed by a university i.e. Sardar Patel University, Anand.

Community Science Centre at Dang was established in 2005. Dang is a total tribal district and covers with vast forest area. The non-governmental organization (NGO) called Prayosha Pratishthan established and operating this centre. Prayosha Pratishthan is an organization of Swaminarayan sect. The word 'Prayosha' is derived from combining the alphabets from the name of saints of Swaminarayan sect, like Pramukh Swami Maharaj, Yogiji Maharaj and Shastri Maharaj. All these three saints were the former heads of Swaminarayan sect.

Community Science Centre at Vadodara was established in 1982 by some eminent industrialists and educationists of Vadodara. It is a regional level science centre and all other science centres in the sample under GUJCOST were district level science centres.

4.1.2 Establishment of Independent Community Science Centres by Different Trusts

There are Community Science Centres which are established by different trusts for imparting science education. Vikram Sarabhai Community Science Centre at Ahmedabad is the first and oldest Community Science Centre of Gujarat. It was established in the year 1966 by well-known scientist Vikram Sarabhai, a pioneer in space science. After the death of Vikram Sarabhai, the Community Science Centre was named after him.

The science centre Vigyan Nagari was established in the year 2010 in Bhavnagar city. It is established under Trust Act and managed by Monghiben Balvihar Trust. This science

centre is named after Balvant Parekh, proprietor of Pidilte Industries-Mumbai who is the main donor to establish this centre. It is named as Shree Balvant Parekh Vigyan Nagari.

Lokbharti Community Science Centre was established in year 1973. The centre is run by Lokbharti Gram Vidyapeeth which was established jointly by Mahatma Gandhi, Manubhai Pancholi Darshak, Nanabhai Bhatt, Mulshankar Bhatt and Natvarlal Buch. The Lokbharti Gram Vidyapeeth offers education in the rural areas under Nai Taleem.

4.1.3 Establishment of Community Science Centres by Gujarat Government

Gujarat Science City was established in year 2000 in Ahmedabad. It works under the aegis of Department of Science and Technology, Government of Gujarat. Gujarat Council of Science City, a registered society of Government of Gujarat runs this Community Science Centre.

4.1.4 Establishment of Community Science Centre by Central Government

Dharampur is one of the talukas of Valsad district of South Gujarat. It is also a tribal belt like Dang. Community Science Centre at Dharampur is one of the oldest Community Science Centres of Gujarat and was established in 1982. This Community Science Centre is under National Council of Science Museums (NCSM), Ministry of Culture, Government of India. NCSM has the head office in Kolkata while Nehru Science Centre in Mumbai is the zonal office for it.

Thus, it was observed that the concept of Community Science Centres in Gujarat was started in early 70s and since then it has expanded uniformly. The government and non-governmental organizations have started Community Science Centres with the motto to provide non-formal science education.

4.2.0 ORGANIZATIONAL STRUCTURE OF COMMUNITY SCIENCE CENTRES

All Community Science Centres in Gujarat were found with the following hierarchies.

Trustees
↓
Executive Committee
↓
Director or Head of centre
↓
Staff of centre like programme officer and science educators.

Apart from this common structure, different hierarchical structures were also there in Community Science Centre at Anand, Vikram Sarabhi Community Science Centre at Ahmedabad and Lokbharti Community Science Centre at Sanosara. The Vice-Chancellor was at the helm of all affairs of Community Science Centre at Anand as the centre was under Sardar Patel University while Vikram Sarabhai Community Science Centre at Ahmedabad had board of governance at the top instead of trustees. One of the managing trustees of Lokbharti Vidyapeeth was the head of Lokbharti Community Science Centre at Sanosara.

Community Science Centres under GUJCOST report to GUJCOST about their activities. Gujarat Science City reports to Department of Science and Technology, Government of Gujarat while Community Science Centre at Dharampur reports to National Council of Science Museums (NCSM), Ministry of Culture, Government of India.

4.3.0 INFRASTRUCTURAL FACILITIES AT COMMUNITY SCIENCE CENTRES

All nine Community Science Centres had the common infrastructural facilities like halls of exhibits, science laboratories or specific space for conducting experiments and lecture hall or auditorium for science popularization activities. Apart from these common features, Community Science Centre at Amreli and Community Science Centre at Dharampur had dome shaped planetarium for astronomy education, Vikram Sarabhai

Community Science had science demonstration activities and Gujarat Science City had large science exhibits for science popularization.

4.4.0 FINANCIAL MANAGEMENT AT COMMUNITY SCIENCE CENTRES

All regional level Community Science Centres get grant of ₹ 10 lakh per year from GUJCOST for conducting programmes. District level Community Science Centres get grant of ₹ 7.5 lakh per year from GUJCOST for conducting science popularization programmes. The independent Community Science Centres get funds mainly from donations. Apart from these the funds, all nine centres had input of finance from corpus' interest, corporate social responsibility (CSR) fund, fee from the science clubs, from membership as well as magazine subscription fee.

4.5.0 PROGRAMMES OF COMMUNITY SCIENCE CENTRES OF GUJARAT

The common programmes undertaken by all nine Community Science Centres were as follows.

1) Formation of science clubs in schools-The science centres had formed science clubs in different schools of Gujarat. The centres carried science education activities in these schools.
2) National Science Drama Competition- The centres organized National Science Drama for schools at district level. The winning schools were sent for state level competition.
3) National Science Seminar-The centres organized national level seminar on different topics related to science.
4) Popular science talk- Talks on specific science topic were organized for students and public.
5) Workshops for students and teachers of science and mathematics subjects-Teachers training programme as well as workshops and seminars for students and teachers were organized by centres.

6) District level Children Science Congress-The centres selected school students at district level for participating in National Children Science Congress.
7) Biotechnology awareness programme- The importance of biotechnology was shown in biotechnology corners of centres.
8) Outreach activities-The centres organized outreach activities in rural and urban areas for popularization of science. The people were made aware about eradicating superstitions in the society so that they did not get cheated or carried away by fraudulent saints and occultists. The tricks on how blood comes out of lemon, sindur (red colour) coming out from hands and cheating by giving greed of doubling the money were shown to public and thus they were warned not to come under the influence of tricks.
9) Celebration for special days- The science centre celebrated special days of scientific importance like World Environment Day, National Science Day. Biodiversity Day, etc.
10) School visit-The local and nearby rural schools visited the science centre. The staff of the science centre organized lectures, quiz contest and demonstration of experiments during school visit events.
11) Science lectures and quiz programmes- Popular science lectures and quiz were organized intermittently for science popularization by the centres.
12) Astronomy education activities- The science centre organized night sky watching and astronomy events to educate students and public about different planets and constellations, conjunction, solar and lunar eclipses, transit and occultation.
13) Science fair and exhibition-The science centre organizes science fair and exhibition for science popularization.
14) Water conservation programme-The science centre organizes water conservation programme for students and villages.

Apart from above discussed common programmes, all nine Community Science Centres had their special programmes or special identity which fulfilled the objectives of non-formal science education.

4.6.0 UNIQUENESS OF COMMUNITY SCIENCE CENTRES

The researcher had analyzed uniqueness of each of sampled Community Science Centres in Gujarat.

4.6.1.0 Uniqueness of Community Science Centre at Vadodara

Community Science Centre at Vadodara had uniqueness which helped in imparting non-formal science education.

4.6.1.1 Constituents of Community Science Centre at Vadodara

The centre had different constituents which were used for science education:

(A) Hall of Life Science-The hall contained exhibits and models on life science.
(B) Energy Hall-The hall had exhibits on sources of energy which gives message on energy conservation.
(C) Technology Hall-The hall had exhibits on technology revolution
(D) Garden on Medicinal Plants-Importance of medicinal plants was communicated through this garden.

4.6.1.2 Own Programmees of Community Science Centre at Vadodara

The centre organized specialized programmes which had gained importance.

(1) Vaho Vishwamitri Abhiyan-The Community Science Centre had taken an initiative for revival of Vishwamitri river of Vadodara by starting a campaign called ‘Vaho Vishwamitri Abhiyan’. The centre spread awareness in public for helping in rejuvenating the river. It had designed bio-shield along the length of the river by planting shrubs and trees of different species supportive of native biodiversity. The plantation was done with the help of ‘seed ball’ technology.

‘Seed Ball’ or ‘seed pellet’ was an innovation that had the potential to revolutionalize the Indian farming industry. It involved coating a regular seed with a mixture that acted as binding agent. The coating was important because it gave seed an even shape with increase in size and weight which ensured greater planting and dispersion efficiency. It enabled a free flow of oxygen and moisture retention to the seed to ensure germination.

Seed balls could simply be tossed making them very useful for farming on hills, large plain area, ravines, river banks, etc. The seed ball technology was useful to develop bio-shield on river bank areas. The seed ball coating mixture had been scientifically developed and Community Science Centre, with the help of other organizations, had taken the process of making the seed balls from the mixture and executed the plantation of seed balls along the Vishwamitri river involving students of various schools, colleges and citizens. Vaho Vishwamitri Abhiyan ensured clean flowing river, total bio-shield supporting biodiversity, eco agriculture, beautiful ghat, eco villages and town, lakes, rivulet, check dams and separate modern facilities for liquid and solid waste treatment and eco-friendly river front.

(2) Nanubhai Amin Award for Innovative Science exhibits-The centre organized the competition for students who were awarded for making innovative science exhibits. Thus the centre inspired school students for conceptualizing the innovative scientific working models. The students of standard 8 to standard 12 participated in this competition.

(3) V.W.Chemburkar Memoril Lecture-The Community Science Centre organized public lecture in memory of V.W.Chemburkar who contributed in establishing the centre. The stalwarts in the field of science were invited for public lecture.

(4) Tree Garden Award-The centre organized Tree Garden Award to spread awareness on biodiversity, environment and conservation. In this competition, the school students grew different species of trees in the school garden with the guidance of teachers. The students participated in competitions ranging from drawing, poster making and essay writing on topics of biodiversity.

(5) Bal Urja Rakshak Dal-The centre carried energy conservation awareness programme in schools of Vadodara with the help of Gujarat Urja Vikas Agency (GEDA), an organization under Government of Gujarat. The message of green energy, waste management and biodiversity was given to students.

(6) Renewable Energy Awareness programme-The centre organized awareness programmes on renewable energy for school students and public.

(7) PCRA Energy Awareness Programme-The centre carried energy awareness progrmmes in public with collaboration with Petroleum Conservation Research Association (PCRA).

(8) Save Electricity Programme-The modes, means and tips to save electricity at homes and offices are given by the centre to students and industry personnel.

(9) DIET Home Science Programme-The centre organizes activities of science experiments for teachers of District Institute for Education Training (DIET).

4.6.1.3 Science Education activities for students at Community Science Centre at Vadodara

The centre organized science education activities at the centre for school students during weekend and summer vacation.

A) Summer Batch Programme

There was a summer vacation programme for junior group ranging from standard 2 to standard 4 and senior group ranging from standard 8 to standard 9.

a) Junior Group

1) Scientific Toys Making-The scientific toys based on scientific principles were made which children could like to play.
2) Drawing and Painting-The activities on craft work like lamp making, rangoli making and clay work were carried out.
3) Web Kids-The kids played science games, quiz, puzzles and painting application on computer.
4) Chess-The children learnt to play a game of chess.
5) Magic Puzzle-The children learnt magical puzzles by magician.

b) Senior Group

1) Robotics-The students learnt to make hands-on robotic instruments like basic car, baseball batter and voice control car. The students were guided by resource person and then they individually joined different parts to make robotic instruments.
2) Drawing and Painting-The students learnt to make rangoli as well as different types of Aarti Thali from wheat flour, fabric colour and decorative material, T-shirt paint and Mehdi. The resource person guided children how to do drawing and painting and later students did hands-on drawing and painting.
3) Model Making-The students learnt to make scientific models like periscope, kaleidoscope, model based on multiple reflection and galvanometer.
4) Aero modeling-Aero models were made by students with the aim to make them understand scientific concepts on aerodynamics.
5) Calligraphy-The students learnt the art of calligraphy.
6) Electronics model making-The students learnt to make circuit of instruments like smoke alarm circuit, listening bug and metal detector.
7) Chess- The children learnt how to play a game of chess.

B) Regular Batch Activities-The regular batch activities at the centre ran on weekends i.e. Saturdays and Sundays. The centre ran the club during the months of July to October and December to March. In that batch, students from standard 2 to standard 8 and sometimes above standard 8 participated in it. The activities under regular batch included 1) Science Club 2) Vedic Mathematics club 3) Art and Craft Club 4) Electronics Club 5) Aero Space Club 6) Rocketry Club 7) Aero-modeling Club 8) Robotics Club 9) Chess Club 10) Web kids 11) Astronomy Club.

The activities and experiments in science club for senior group ranged from standard 5 to standard 8 included sound (production, propagation and reflection), cell structure and functions, acid-base and salt experiments, light-mirror and reflection, diseases and its transmission, magic with lenses and mirrors-concave and convex, transportation of material in plants, structure of matter-element, compound and mixtures, reading electricity bill, electric current and conservation of electricity, etc. The activities and experiments for junior group ranged from standard 2 to standard 4 included air and air pressure, characteristics of air, seed and its germination, floating and sinking, parts of a plant, gases and its uses, states of matter, properties of material, transparency, colour, taste, solar system, human body, diet and nutrients, etc.

4.6.1.4 Initiatives taken by Community Science Centre at Vadodara

(A) Vaho Vishwamitri Abhiyan-Community Science Centre had taken initiative to rejuvenate river Vishwamitri of Vadodara. The centre organized seed ball dropping on the bank of river Vishwamitri with the support of H.S.Patel School in Vadodara. The small drone plane was made up by engineering students. The seed-balls were placed inside the drone such that it drops on the ground when the lower portion of drone opens up. The drone dropped seed-balls on river bank and ravines. The seed-balls were made by the students of H.S.Patel School in Vadodara with raw materials given to them. After the spraying of seed-balls,

lecture on awareness of biodiversity and environment was organized. The below figures show the seed-ball dropping activity.

Figure 4.1: Seed Ball dropping activity (1) and (2) Students making seed-balls (3) Students and dignitaries with a drone (4) Drone dropping seed balls from drone to Vishwamitri ravines for plantation

(1)

(2)

(3)

(4)

Figure 4.2: Bicycle which runs on battery

4.6.1.5 Response of the students for science club activities of Community Science Centre at Vadodara

The researcher had collected the response of the students of standard 6 to standard 9 who were enrolled in summer vacation activities in May 2015 and week-end science club activities from July 2015 to September 2015 as well as December 2015 to March 2016. The researcher took a sample of 19 students who were enrolled in above activities.

The table 4.1 shows the response of the students for science club activities of Community Science Centre at Vadodara.

Table 4.1: Response of the students for science club activity at Community Science Centre at Vadodara

Sr. No.	Statement	Response	Frequency	Percentage
1.	Satisfaction with the learning method	Yes	19	100
		No	0	0
2.	Satisfaction with content knowledge of the staff/resource person	Yes	19	100
		No	0	0
3.	Satisfaction with the management of the activity	Yes	19	100
		No	0	0
4.	Satisfaction with the time duration given for the activity	Yes	19	100
		No	0	0
5.	Understanding of exhibits, models, graphics and charts	Simple	13	68
		Complex	06	22
6.	Language of text to understand the exhibits	Simple	19	100
		Complex	00	0

From table 4.1, it was concluded that,

- All students were satisfied with the learning method, content knowledge of the staff, management and time duration of the activity.
- 68 percentage of students told that understanding of exhibits, models, graphics and charts was simple.
- All students responded that language of text to understand the exhibits was simple.

The students told that the activities made them happy and science which was taught at the centre was easy to understand. The astronomy club was useful to know the constellations and planet and such activity was not possible in school due to unavailability of experts and day-time school. The activity on Vedic Mathematics gave solutions to mathematical problems in easy and interesting manner. The students told that the centre added value to their learning and the hands-on experiments made understanding easy. The students told that robotics club and science experiments demonstration in science club gave knowledge on science. The experiments hold the interest of science.

The students who participated in the seed ball dropping on the bank of Vishwamitri river opined that they got a feeling of self-fulfillment by participating in the activity. They told that the message to save river Vishwamitri from pollution touched the right chord with this activity. The students told that they knew about the centre but had not visited it.

4.6.1.6 Response of the teachers for activities of Community Science Centre at Vadodara

The researcher took a response of 14 teachers to know their opinion on activities of the centre like visit to halls of science, World Environment Day celebration, teachers' training programme and seed ball dropping event to rejuvenate Vishwamitri river.

The table 4.2 shows the response of the teachers for activities conducted by Community Science Centre at Vadodara

Table 4.2: Response of the teachers for the activities of Community Science Centre at Vadodara

Sr. No.	Statement	Response	Frequency	Percentage
1.	Satisfaction with the learning method of instructors	Yes	8	57
		No	6	43
2.	Satisfaction with content knowledge of the instructors	Yes	7	50
		No	7	50
3.	Satisfaction with the management of the activities	Yes	10	71
		No	4	29
4.	Satisfaction with the time duration given for the activities	Yes	6	43
		No	8	57
5.	Satisfaction with the facilities of the centre	Yes	14	100
		No	00	0
6.	Satisfaction with the overall services of the centre	Yes	14	100
		No	00	0

From Table 4.2, it was concluded that,

- 57 percentages of teachers were satisfied with the learning method of instructors or resource persons.
- 50 percentages teachers were satisfied with the content knowledge of the instructors or staff members.
- 71 percentages of teachers were satisfied with the management of the activities
- 43 percentages teachers were satisfied with the time duration for the activities.
- All teachers were satisfied with the facilities of the centre and overall services of the centre.

The teachers responded that the exhibits and events at the centre were good brainstorming exercise for them and students. They told that schools did not have wide space for exhibits and it was restricted to formal learning. The centre was free to include science activities and exhibits at its discreet and thus catered to students, teachers and public. The teachers opined that centre gave an optional way of learning science different from textbooks. The teachers responded that they came to the centre because the experiments of science gave an edge for making understand the subject more accurate. The animation, charts and experiments were penetrated deep in the mind of enrolled students.

The teachers told that hands-on experience with robotic equipments, electronics, chemicals and colours made them confident and a feeling of fulfillment. The teachers responded that they learnt new things on science which was never known in school studies. Their interest and curiosity in science and technology increased which would inspire to learn more about science. They became confident of asking questions. They told that the science centre had different halls of science where models of different science subjects like biology, physics, chemistry, biotechnology and technology are kept which presents a vast picture of science. The teachers said that the centre was a place where all science subjects were given equal importance whereas in formal education they have to incline towards science groups for future study.

The teachers told that they liked the free-choice environment at science centre. The models and exhibits at the centre gave an idea to make models for school projects and science fair. The teachers responded that they got knowledge of all science subjects at a stretch during visit at a centre. The models and experiments which were demonstrated by the staff of a person or a resource person deeply penetrated in their mind and increased their visualization. The teachers responded that the experiments were not directly based on school syllabus but it helped in visualization of the concepts of science.

4.6.1.7 Response of the public for the activities of Community Science Centre at Vadodara

The researcher had taken the response of activities done by the science centre for public for science popularization. The activities like seed ball dropping on the bank of river Vishwamitri, World Environment Day celebration and tree walk at Kamatibaug were taken for the response. The researcher took a sample of 26 persons for this purpose.

The general public appreciated the efforts made by the science centre for rejuvenating the Vishwamitri. They welcomed the initiative of the centre and also suggested the seed ball technique should be expanded to other areas where Vishwamitri flows. The science centre celebrated World Environment Day with a launch of book on rainwater harvesting

and an exhibition on wild life. A lecture and exhibition on wildlife conservation was also organized. They appreciated the centre's efforts to spread the message of environment awareness.

The centre organized a tree walk at Kamatibaug in Vadodara for the awareness regarding heritage trees present in the Kamatibaug. The people told that it is very necessary to know the heritage trees of Kamatibaug. They felt pride about the natural history of Vadodara. The public keenly listened to the talk given by the director of science centre and were highly involved in the walk. They were satisfied with the content knowledge of the director, management and time duration given for the activity.

4.6.1.8 Publications of Community Science Centre at Vadodara

The centre published 'Vigyan Vani' magazine which was published quarterly. The magazine contained news on science subjects, science articles written by experts and staff members of the centre. The articles were mainly factual information on scientific concepts, the reason behind the concepts and its consequences on humans and society. The magazine contained activities carried out by the centre in the quarter. The tactics of hands-on science experiments were published with figures in the magazine. The magazine was widely subscribed in schools, educational institutions and households. The centre published educational material for students as per necessity like special events like World Environment Day, solar and lunar eclipses, etc.

The centre had its own website where information and activities of the centre, its achievements and reports were published. The centre got media coverage about its events and activities in local newspapers and television channels. The centre gave updates on social media also.

4.6.1.9 Photos of Activities and Exhibits of Community Science Centre at Vadodara

Community Science Centre at Vadodara had different activities and exhibits to understand science in non-formal method. Different activites and exhibits are explained here.

Figure 4.3: Demonstration of experiments (1) and (2) Concept of temperature

(1)

(2)

Figure 4.3 (1) and (2) shows the experiment explaining phenomena of temperature with respect to substances. The water is boiled and temperature is measured which shows 100 degree centigrade because boiling point of water is 100 degree centigrade. There is ice in the glass and when temperature is measured it shows 0 degree centigrade because melting point of ice is 0 degree centigrade. Now salt is sprinkled on ice. Due to sprinkling, thermometer shows the temperature below 0 degree centigrade. The reason is salt stops the melting of ice and keeps ice temperature intact. This activity is for students of standard 4 to 6.

Figure 4.4: Model Making (1) Multiple Refraction (2) Double Cone

(1)

(2)

Figure 4.4 (1) shows the experiment on concept of multiple reflections. The side part of plastic box is cut corresponding to size of mirror. The mirror is pasted on the inner side of the box. Paste other mirror at the opposite side of the first mirror. Place any object (here car) between both mirror. Now if we see through one side of mirror, multiple reflection of car is seen. Thus the phenomenon of multiple reflections is demonstrated.

Figure 4.4 (2): This model is made to understand centre of gravity. Two funnel is taken and pasted to make double cone. Make a heightened slant from PVC pipe. Double cone is kept on slant. Due to centre of gravity, the double cone will not slip from the heighted slant. But the cone will move from lower to heighted slant sans gravity. The double cone does not slip from the height because the heightened slant is at centre of gravity due to shape of double cone. The gravity of double cone starts from lower portion of slant. So the cone moves upwards.

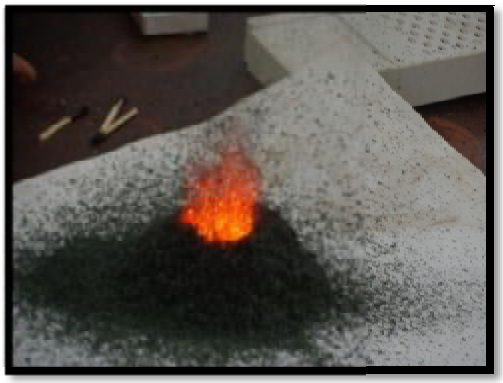
Figure 4.5: Demonstration of experiments (1) Solid expands on heating (2) Litmus test (3) Oxygen and fire (4) Chemical Reaction

(1)

(2)

Figure 4.5 (1): The solid bead is heated on fire. Due to heat the solid changes its shape and expands. Thus the phenomenon of solid expands on heating is shown.

Figure 4.5(2): Litmus test is done to know acid and base. The litmus paper turns blue when drops of acid are placed on litmus paper. The litmus paper turns red when drops of base are placed on it.



(3) (4)

Figure 4.5 (3): Lit the candle. It douses when glass is kept on it due to unavailability of oxygen.

Figure 4.5 (4): Ammonium Chromate on heating burns and forms volcano like shape.

Figure 4.6: Magical cards explaining illusion

(1) (2)

Figure 4.6 (1) and (2): The two figures explain illusion. The magical cards portray a figure of old man and queen simultaneously.

Figure 4.7: Activities of science club (1) Robotics (2) Learning though Animation

(1) (2)

Figure 4.7(1): In robotics club, instruments working on robotic sensor are made.

Figure 4.7(2): The students understand chemical reactions through graphics on projection

Figure 4.8: Exhibits on (1) Flying Ball (2) Magnetism

(1) (2)

Figure 4.8 (1): This exhibit is called flying ball. Press the switch of the exhibit. When blower kept in the cylindrical box starts, the ball kept on aluminum cap will lift in the air. The ball will be in air till the blower is on. As per Bernoulli's principle, when the air is passed from the opposite side of the circular surface. The air pressure on the other side of surface decreases. Due to decrease of air pressure, the ball lifts in the air. The aeroplane keeps flying in the sky at the lower air pressure due to this principle.

Figure 4.8(2): The principle of electromagnetism is shown in this exhibit. There is a meter on the left portion which is attached to two ends of copper coil. There is a magnet

joined between the coils. When the magnet is turned upside down, electric field is generated in the meter.

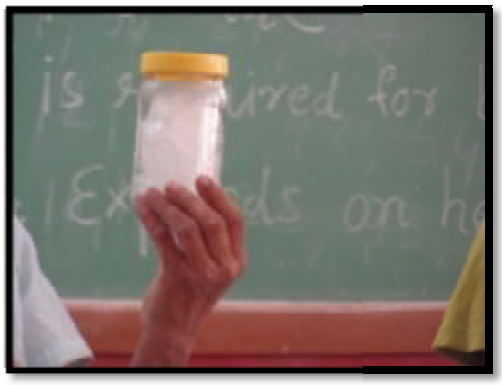
Figure 4.9: Demonstration of experiments (1) Mass of stone (2) Centripetal force (3) Air expands on heating (4) Condensation

(1) (2)

Figure 4.9(1): A stone is tied with a string and its mass is noted. Now the stone is immersed in water. Now again when stone's weight is noted, the stone has loosed the mass. The water gathered near stone reduces the mass of the stone.

Figure 4.9(2): This experiment shows the concept of centripetal force. The paper cup is half filled with water. The strings are attached to the cup. Now the cup is revolved with one hand. The water in the cup does not force out of cup but it remains intact in the glass. This is because the water in the cup does not come out of cup due to centripetal force generated by revolving the cup. The centripetal force on cup does not allow water to fall. If there was centrifugal force the water would have forced out.

(3)



(4)

Figure 4.9(3): Water is boiled in a vessel. There is jar in which water is kept and balloon is placed on top of the bottled jar. Due to boiling of water in jar, water vapour is produced in the jar. The air starts filling in balloon and it starts blowing. This experiment shows that air expands on heating. This activity makes us understand how big balloons called ‘gubbara’ go in the sky because there is hot air inside balloon. The gubbara falls from certain height because air becomes cool at height.

Figure 4.9(4): This experiment is done to make understand condensation. Ice cubes are filled in bottle. After some time, droplets are formed outside bottle. In bottle, there is low temperature while on outer parts of bottle the temperature is high. So there is temperature difference.

Figure 4.10: Exhibits on (1) Pedal Power Light (2) Thermodynamics

(1)

(2)

Figure 4.10(1): This exhibit is called Pedal Power Light. This exhibit is made to understand the concept of transformation of potential energy into electric energy. The DC

(Direct Current) generator is attached to pedal power from which battery can be charged. This can be used for body exercise also.

Figure 4.10(2): This exhibit shows the concept of thermodynamics where there is expansion of air as it comes from higher pressure to lower pressure. The balls in the box rise as soon as switch is turned on. Air is blown through a hole. The pressure in the lower chamber is high due to high wind velocity compared to the upper chamber. Thus the air flows and expands to the upper chamber. The flow of air is a stream line flow. Since the out-coming air has high velocity it lifts the thermocol balls. Due to some weight of the thermocol balls they are lifted to a limited height only. In practical application, for lifting the rocket up, the out-coming vapor generates a thrust in the upward direction.

4.6.2.0 Uniqueness of Community Science Centre at Amreli

Community Science Centre at Amreli had uniqueness which helped in imparting non-formal science education.

4.6.2.1 Constituents of Community Science Centre at Amreli

The Community Science Centre at Amreli had following constituents which were used for science education.

(1) Tara Ganga Science Park-There were exhibits related to scientific phenomenon at this park.
(2) Planetarium-A dome shaped building for giving knowledge on astronomy was there.
(3) Biotechnology Corner-Exhibition on importance of biotechnology.
(4) Computer Centre-The students and public learnt basic computer courses at this centre.
(5) Balbhavan-There was a Balbhavan which was under aegis of Shri Girdharbhai Sangrahalaya. It was affiliated with the National Balbhavan-New Delhi. It conducted activities for children in music, arts and heritage.
(6) Girdharbhai Sangrahalaya-There was museum where culture and history were preserved for education as well as archeological purpose. The excavations by

Archeological Department, artifacts and exhibits were kept for conservation. The museum displayed artifacts ranging from pottery, stones, terracotta, ancient coins, etc. The museum had collection of fossils, miniature, paintings, crafts of kathis (community residing in Kathiavaad) of Saurashtra region of Gujarat and its history. It housed natural history section which focuses on flora and fauna of Saurashtra region. The display of extinct species of birds and animals and other species were places in the museum.

4.6.2.2 Own programmes of Community Science Centre at Amreli

(1) Astronomy Education Programme-There was a planetarium called 'Tara Darshan' in the centre. It was meant for educating and communicating astronomy to students and public.
(2) Gram Sabha-The centre organized Gram Sabha (villagers meet) for awareness on science topics.
(3) Krishi Shibir-The centre organized Krishi Shibir (workshop on agricultural practices) with agriculturist as experts. The health camps were organized for students and community especially females for health awareness.
(4) AIDS Awareness Programme-The centre ran a special centre for awareness against sexually transmitted diseases with the support of Gujarat State AIDS Control Society. The centre gave advice to prostitutes, eunuchs and homosexuals against sexually transmitted diseases. There was a facility for AIDS check-up at the centre. For the AIDS awareness. The staff went to different areas of the district for making aware prostitutes, eunuchs and homosexuals.
(5) Computer Centre-There was a computer centre which runs basic computer courses like Microsoft Office, basic internet, Flash, Autocad and Pagemaker.
(6) Puppet Show-The centre organized puppet shows related to science topics for children.

The puppet shows and programmes on astronomy education at planetarium had developed centre's own identity. The centre organized programmes of science education

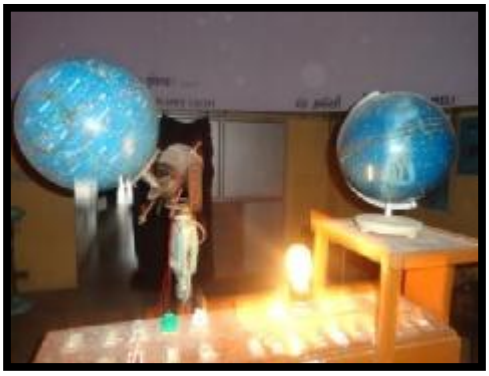
jointly with other organizations of Amreli. The centre had adopted a school of Amreli where science activities were carried out frequently by the centre.

4.6.2.3 Specific Tools and Techniques use for Science Education

Community Science Centre at Amreli had specific techniques for imparting non-formal science education.

(1) Astronomy Education-There was perforated sky vision globe at planetarium. The globe was made up of aluminum and painted with a blue colour. The diagrams of constellations were carved on the globe by making holes on the globe. There was a bulb in the globe. When bulb lights up, the images of different constellations were projected on the dome shaped wall.

Figure 4.11: Astronomy education activity (1) Perforated Sky Vision Globe a Planetarium (2) Students understanding constellations



(1)

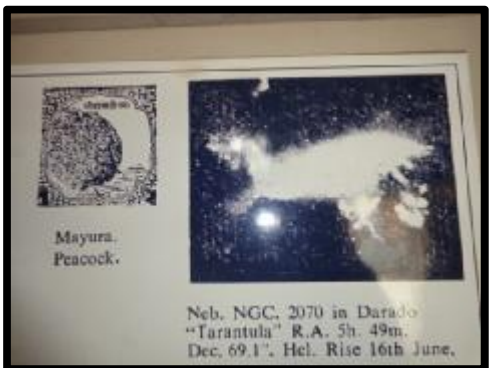
(2)

Figure 4.11(1): Perforated sky vision globe at planetarium

Figure 4.11 (2): Students understanding constellations

(2) The constellations were made understood by using simile method.

Figure 4.12: Constellations (1) Darado (2) Sagitarius



(1)

(2)

Figure 4.12 (1): The shape of Darado Nebula resembles peacock

Figure 4.12 (2) The shape of constellation called Sagitarius resembled man with arrows and bows (Dhanur Dhari)

The students understood and remembered the Darado Nebula by remembering peacock while the shape of constellation named Sagitarius resembled man with arrows and bows.

(3) Comparing with religious references-The resource person of Community Science Centre made understood the scientific terms by giving reference of religious references. For e.g. the star named Sirius was considered as Lord Shiv. Another star near Sirius was labeled as Durga. The star named Procyon was considered as Lord Ganesh. The constellation Pleiades was labeled as Kartikeya. While the constellation Taurus was called Vrishabha, Sinha (Leo constellation) was named as the vehicle of Goddess Durga. Nebula Lepus was the vehicle of Kartikeya. Thus the constellations were named after family of Lord Shiv.

Another example was taken about enzymes (Enzymes are molecular catalyst and they accelerate chemical reaction. One enzyme reacts with lakhs of molecules of substance). This was compared with Gopis dancing around Krishna and Radha. As a simile with religious reference, Lord Krishna was compared with an enzyme while Gopis were molecules of the substance. Thus by giving example of Krishna and Gopis, the concept of enzyme was made understood at the centre.

The term ‘Pollution Control’ was explained with one story of Krishna Leela. Lord Krishna, during childhood, was playing with his friends on the banks of river Yamuna. The ball fell into the river. There was cobra (Kali Naag) in the river. Bal Krishna jumped into Yamuna, took control on cobra and told him to move out of the river. The resource person of the centre made students’ learns pollution by educating students that cobra was pollution of the river Yamuna.

(4) Use of tools-Community Science Centre had equipment of weights. Each weight showed the weight on moon and planets of solar system. Thus students can know gravitational forces on moon and planets of solar system.

Figure 4.13: Tools for astronomy education (1) Weighning machines for planets (2) Carving Sky map on an umbrella

(1)

(2)

Figure 4.13(1): Weight machines showing the weight at different planets of solar system
Figure 4.13(2): Carving Sky Map on an umbrella.

(5) Portraying Cartoons and Graphics-Community Science Centres had biotechnology corner where importance of biotechnology was shown through graphical stories and cartoon characters.

Figure 4.14: Charts showing cartoons for explanation of DNA

(1)

(2)

(3)

(4)

Figure 4.14 (1) to 4.14 (4), the term of DNA (Deoxyribonucleic acid) was explained through graphical story and cartoon characters in Gujarati language.

4.6.2.4 Response of the students for the activities of Community Science Centre at Amreli

The researcher took the interview of 31 students of standard 8 and 9 taken in the sample to know their response related to the activities at the centre like, astronomy education, awareness on biotechnology, importance of handkerchief and Mathematics Quiz on the occasion of birthday of noted mathematician Ramanujan.

The table 4.3 shows the response of the students for the activities of Community Science Centre at Amreli.

Table 4.3: Response of the students for the activities of Community Science Centre at Amreli

Sr. No.	Statement	Response	Frequency	Percentage
1.	Satisfaction with the learning method	Yes	31	100
		No	00	0
2.	Satisfaction with content knowledge of the instructor	Yes	31	100
		No	00	0
3.	Satisfaction with the management of the activity	Yes	31	100
		No	00	0
4.	Satisfaction with the time duration given for the activity	Yes	31	100
		No	00	0

From the table 4.3, it was found that cent percent students were satisfied with the learning method, content knowledge of the instructor and management as well as time duration of the activity of the centre. The students who participated in the activity responded that their understanding of astronomy was strengthened. They learnt new things on astronomy which was never known before. Their interest in constellations increased and they will do star grazing activity from their home. The students opined that they increased their curiosity about astronomy and now onwards when they will watch night sky they will definitely watch these constellations. They inspired to learn more about moon, universe and solar system. They responded that they had not visited the centre as they were engrossed in their school and household activities. The students responded that they got the knowledge on biotechnology during the visit of Biotechnology corner. They liked cartoon characters and graphical representation and were excited to see the exhibition.

4.6.2.5 Response of the teachers for the activities of Community Science Centre at Amreli

The researcher took interview of 15 teachers to know their level of satisfaction and opinion on activities of the centre. The response on activities like astronomy education,

awareness on biotechnology, importance of handkerchief and mathematics quiz on the occasion of birthday of noted mathematician Ramanujan were taken by the researcher.

The table 4.4 shows the responses of the teachers for the activities of Community Science Centre at Amreli.

Table 4.4: Response of the teachers for the activities of Community Science Centre at Amreli

Sr. No.	Statement	Response	Frequency	Percentage
1.	Satisfaction with the learning method	Yes	9	60
		No	6	40
2.	Satisfaction with content knowledge of the instructor	Yes	11	73
		No	4	27
3.	Satisfaction with the management of the activities	Yes	5	33
		No	10	67
4.	Satisfaction with the time duration given for the activities	Yes	7	46
		No	8	54
5.	Satisfaction with the available facilities for the activities	Yes	10	67
		No	5	33
6.	Satisfaction with overall services of the centre	Yes	12	80
		No	03	20

From table 4.4, it was found that,

- 60 percentages of the teachers were satisfied with the learning method of the science centre. They appreciated the centre for making perforated sky vision globe.
- 73 percentages of the teachers were satisfied with the content knowledge of the staff.
- 33 percentages of the teachers were satisfied with the management of the activities at the science centre.
- 46 percentages of teachers were satisfied with the time duration given for the activities.
- 67 and 80 percentage of teachers was satisfied with the available facilities and overall services of the centre respectively.

The teachers opined that the cartoon characters and graphical representation increased the interest of learning. The students could memorize the terms by recalling the cartoons. The students opined that the quiz was very much helpful in knowing the contribution of Ramanujan in mathematics. The teachers responded that events of science and mathematics were necessary for students as parents and other public in Amreli was not interested in science. The science education was not given importance in the district. They appreciated the centre's initiatives for science education. They responded that the Mathematics quiz organized by the centre was not properly crafted. They did not like the selection process for playing the quiz, chaos during the quiz, time allotted for the quiz and centre's failure in handling the activity. They told that the centre should provide learning material so that they can use them in school teaching.

4.6.2.6 Response of the Anganwadi workers for the activities of Community Science Centre at Amreli

The Community Science Centre organized a health check-up camp for Anganwadi female workers at Chalali Taluka of Amreli district. The Ayurvedic doctor treated Anganwadi workers of Chalali with Ayurved medicines. The researcher interviewed 20 Anganwadi workers to know the response of the activity. The table 4.5 shows the responses of the Anganwadi workers.

Table 4.5: Response of the Anganwadi workers for the health camp organized by Community Science Centre at Amreli

Sr. No.	Statement	Response	Frequency	Percentage
1.	Satisfaction with the management of the activity	Yes	20	100
		No	0	0
2.	Satisfaction with the time duration given for the activity	Yes	20	100
		No	0	0
3.	Satisfaction with the available facilities for the activity	Yes	20	100
		No	0	0
4.	Satisfaction with overall services at field by the centre	Yes	20	100
		No	0	0

From table 4.5, it was found that all the Anganwadi workers were satisfied with the health camp organized by Community Science Centre at Amreli. They were satisfied

with the management and time duration of camp and thanked the centre for organizing the activities. They were satisfied with the available facilities and overall services at field. They knew about the centre but had not visited it as they were residing at taluka places.

4.6.2.7 Publications of Community Science Centre at Amreli

There were no brochures, pamphlets and annual reports published by the science centre. The centre did not publish annual report in a systematic manner but it documented its activities. The activity report consisting of activity photos were published every year. The centre did not publish science popularization material for students and public. However, during special events of science and astronomy, the centre published informative material for students. The material was not given to all but only to students who shows keen interest in science. The centre did not sell their publication to public. The activities of the centre were widely covered by local newspapers and television channels. The centre has its own website but was not updated regularly.

4.6.2.8 Photos of Activities of the Community Science Centre at Amreli

Apart from the given regular activities, the community science centre at Amrali also organized different activities as per the need of the local community at different time. Figure 4.5 states those activities.

Figure 4.15: Activities like Medical Camp, Quiz and Importance of handkerchief

(1)

(2)

(3)

Figure 4.15: (1) Medical camp for Anganwadi worker (2) Mathematics Quiz (3) Activity of importance of handkerchief at the community science centre at Amrali.

4.6.3.0 Uniqueness of Community Science Centre at Anand

Community Science Centre at Anand also had unique programmes which fulfilled the objectives of non-formal education.

4.6.3.1 Own Programmes of Community Science Centre at Anand

1) Awareness against food adulteration-The centre conducted demonstrations and workshops for awareness against food adulteration. The demonstration on how to check adulterated milk and food products were performed for students and public.
2) Nutrition Week-The centre celebrated nutrition week in association with the home science colleges of Anand. The nutritional and health aspects of persons were discussed in this programme.
3) University Extension Programme-The centre helped in extension programmes of the university. There were outreach activities in rural areas for agriculture, environment, nutrition, etc in different parts of Anand. The centre did survey on diabetes and awareness on proper utilization of kitchen appliances to rural fraternity with the help of students of social work.

4) Review of Educational Books-The centre did review of textbook of science of standard 8.
5) Anveshan-The centre organized Dr Vikram Sarabhai Science Project for undergraduate and postgraduate students. The students made science models which helped in converting knowledge into application skills.
6) Dr. Vikram Sarabhai Elocution competition-The centre organized elocution competition for school students which helped in nurturing their communication skills.
7) The staff of the centre went for training and workshops at different places for their advancement of knowledge.

4.6.3.2 Initiatives of Community Science Centre at Anand

The centre had created its own identity in Anand because the experts for science education were easily available from Sardar Patel University as the centre was affiliated with the university. Also the University had its own community radio station called Radio Campus 90.4 FM. It was the first Community Radio Station of Gujarat. So Community Science Centre produced education programmes jointly with the community radio station. It communicated science to students and public with the help of the radio station. Talks of science topics and dissemination of science news were done through Radio Campus. The centre got academicians from all fields of science from university departments. So the topics of science were deeply understood with credibility. The centre organized quiz using social media, thus utilizing internet as a means of education. After students got hands-on experience with working models, on-the-spot Question and Answer session was organized so that students could revise their learning and centre's staff and school teachers could gauge what students had learn from the visit to the centre.

The centre had installed energy saving devices like smokeless chulha and solar fans in its office. It had also installed rainwater harvesting system at its place to create awareness on conservation of rainwater. It provided expertise for installation for household purpose.

The centre organized science quiz using social media. The centre explained scientific concepts with graphical stories with the help of cartoon characters.

Figure 4.16: Charts showing importance of biotechnology

(1)

(2)

(3)

(4)

Figures 4.16: (1) to (3) shows charts on importance of biotechnology in graphical stories and cartoon characters (4) Slogan for conserving ground water.

4.6.3.3 Response of the students for the activities of Community Science Centre at Anand

The sample of 25 students of standard 8 was taken to know the response of activities. The researcher took response of students for activities like demonstration of experiments at Hall of Science, lecture on concept of light, visit at Biotechnology Corner, lecture on general science, quiz on topic of Cancer and lecture on energy conservation.

The table 4.6 shows the response of the students for activities of Community Science Centre at Anand:

Table 4.6: Response of the students for the activities of Community Science Centre at Anand

Sr. No.	Statement	Response	Frequency	Percentage
1.	Satisfaction with the learning method	Yes	25	100
		No	0	0
2.	Satisfaction with content knowledge of the instructor	Yes	25	100
		No	0	0
3.	Satisfaction with the management of the activity	Yes	25	100
		No	0	0
4.	Satisfaction with the time duration given for the activity	Yes	25	100
		No	0	0
5.	Understanding of exhibits, models, graphics and charts	Simple	13	52
		Complex	12	48
6.	Language of text to understand the exhibits	Simple	16	64
		Complex	09	36

From the table 4.6, it is concluded that,

- All students were satisfied with the learning method, content knowledge of the instructor and management as well as time duration of the activity of the centre.
- 52 percentages of students were able of understand exhibits, models, graphics and charts at the centre
- 64 percentages of students told that the language of text to understand the exhibits was simple.

The students who participated in the activity responded that their understanding of scientific phenomenon was strengthened. They learnt new things on science and technology which was never known before. The students opined that they increased their curiosity about science subjects and now onwards science will be easy to understand. They responded that they had not visited the centre earlier as they were engrossed in their school and other activities at home. The students liked the lecture on light and were curious to learn more on light. They told that the time duration was less and more should

have been covered. The students responded that they learnt the concepts on astronomy and physics which increased their curiosity for science. They told that the lecture would help in making models in science exhibition in the school. The students responded that the quiz was informative and it will be useful to know the subject of biology in the long run. The students and teachers were satisfied with the content knowledge of quiz master, management and time duration given for the activity.

4.6.3.4 Response of the teachers for the activities of Community Science Centre at Anand

The researcher took response of four teachers who participated in the activities. The researcher took response for activities like demonstration of experiments at Hall of Science, lecture on concept of light, visit at Biotechnology Corner, lecture on general science, quiz on topic of Cancer and lecture on energy conservation. Table 4.7 shows the response of the teachers for conduction of activities of the centre.

Table 4.7: Response of the teachers for the activities of Community Science Centre at Anand

Sr. No.	Statement	Response	Frequency	Percentage
1.	Satisfaction with the learning method	Yes	4	100
		No	0	0
2.	Satisfaction with content knowledge of the instructor	Yes	4	100
		No	0	0
3.	Satisfaction with the management of the activity	Yes	4	100
		No	0	0
4.	Satisfaction with the time duration given for the activity	Yes	4	100
		No	0	0
5.	Satisfaction with the available facilities for the activity	Yes	4	100
		No	0	0
6.	Satisfaction with overall services of the centre	Yes	4	100
		No	0	0

From table 4.7 it was concluded that all teachers were satisfied with the learning method, content knowledge of the staff, management of the activity, time duration given to understand exhibits and models and facilities and services of the centre. The teachers

liked the models and exhibits at the centre. They responded that the centre had made science easy for school students. The models and exhibits were a great source for students and they can make such type of models for science fair. The teachers suggested organizing frequent workshops on making of the models of the hall. The teachers told that the educational materials given to them by the centre would be useful in study and centre should publish educational materials more frequently. They told that as the popularity of Light Emitting Diode (LED) lights was increasing, the lecture on LED lights would have great impact for learning. The teachers told that the centre should provide learning material so that students and teachers can revise as per their suitable time.

4.6.3.5 Response of the public for the activities of Community Science Centre at Anand

No public visited the centre during the time of data collection by the researcher. Hence no data about responses of the public were collected by the researcher.

4.6.3.6 Publications of Community Science Centre at Anand

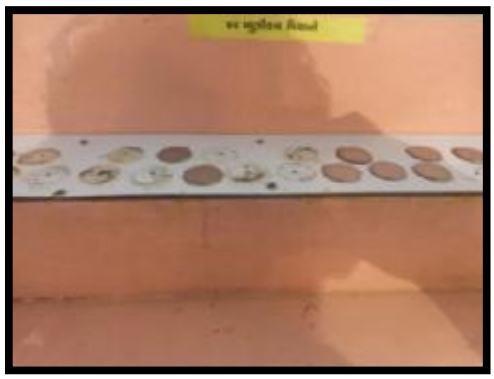
There were no publications by the centre. The university magazine included activities of the centre intermittently. The yearly list of activities was prepared by the centre as an annual report. The activities were communicated through social media also. The centre published pamphlet, posters, charts and leaflets, as and when required, during special events on science like astronomical events and special days. The centre distributed educational charts and posters to students who participated in centre's activities and winners of quiz as well as winning participants of different competitions organized by the centre. The centre did not sell any educational materials and publications to students and public. The centre got media coverage for conducting science events.

4.6.3.7 Photos of Exhibits of Community Science Centre at Anand

Community Science Centre at Anand had different activities and exhibits to understand science in non-formal method. Different activites and exhibits are explained here.

Figure 4.17: Exhibits on (1) Viscosity (2) Flow of Electricity

(1)



(2)

The photograph shown in Figure 4.17 (1) is related to viscosity. This exhibit is called ‘painting with liquid’ which explains the term viscosity. There is a slab made up of glass. The slab is divided into three partitions. In each partition oil of different viscosity is kept. Now lift the slab from one side and then again place it in previous position. We see art painting with the help of liquid. All three liquids have different viscosity. The liquid (oil) which has less viscosity will flow back soon and will be in previous position where it was placed. While the liquid which has more velocity will flow and spread in lower side and thus painting will be formed.

The exhibit in Figure 4.17 (2) explains the concept of flow of electricity. There are coins set on electronic object. Place the fingers on coins. We will hear melodious song from electronic object. The circuit of electronic object is attached with coins. When our fingers touch coins, the negative electric charge of our body goes in circuit and thus circuit is completed. Due to the flow of electric current, the music is produced in electric object.

Figure 4.18: Exhibits explaining magnetism

(1)

(2)

The exhibit in Figure 4.18 (1) and (2) explain the poles of magnet. There are magnets attached to four wooden plates. On wooden plates, Ram, Sita and Ravan are written. The two plates of Sita and Ravan do not perfectly match because the plates of Sita and Ravan are of similar poles (Sita do not pair with Ravan). The two plates of Sita and Ram perfectly matches because the plates of Sita and Ram are of opposite poles (Sita pairs with Ram).

Figure 4.19: Exhibits explaining Concept of sensor

(1)

(2)

Figures 4.19 (1) explains the concept of sensor. A plastic ball is placed in a hole. Now try to catch the ball with hands from the window attached with exhibit. You will see the ball is pulled inside. The reason is at the entrance of the window, there is a Light Dependent Resistor (LDR). When you place your hands inside hole to touch the ball, the light falling at sensor will become dim due to shadow of hands. As a result the intensity of light will change and so the ball will pulled in.

Figure 4.19 (2) is called ‘musical pigeon hole’. There are pictures of Lord Ram, Lord Krishna and Lord Shiv arranged over a box. When the feet of holy picture is touched, a devotional song starts playing. This is due to sensor called Light Dependent Resistor (LDR). When hand is placed on a hole near the picture, the intensity of light on the LDR goes down and the sensor triggers another circuit which starts the audio music (In this case, devotional music).

Figure 4.20: Exhibits explaining concept of illusion

(1)

(2)

Figure 4.20 (1) explains the concept of illusion. There are two groups of circle. See the black circles of two groups. In a group where all circles are placed closely, the black hole will be bigger in comparison to a big black circle in another group where all circles are places at a distant. In reality, both black circles are of same size. This is due to illusion. In Figure 4.20(2), there are colourful balls drawn on a big circular shaped object. This big object is attached with small circles with strings. When the small circles are rotated, the big circle also rotates. See the rotating colourful small and balls. We feel this illusion effect when we concentrate on only one ball.

Figure 4.21: Exhibits explaining (1) Elasticity (2) Simple Microscope (3) Phases of Moon (4) Concept of Sound

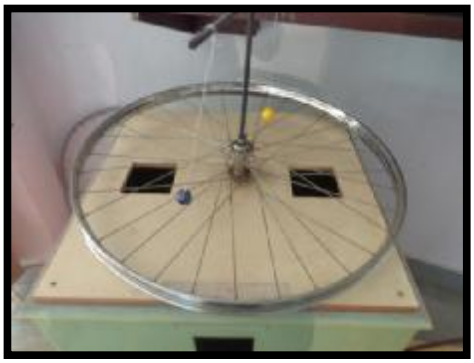
(1)

(2)

Figure 4.21 (1) is a model which explains the principles of elasticity. A heavy wheel is suspended between an iron rod with the help of string. Hold the iron rod and rotate it slowly in a circular motion. Due to this the string will engulfed on rod. Now keep a wheel in a free flow. The wheel will rotate upside down. The reason is when the string is layered on the rod; potential energy is stored in a wheel. When the wheel comes down due to gravitational pull, it again goes in upward direction because of kinetic energy stored in a wheel. Now again the potential energy is stored in a wheel. Thus the elasticity of wheel is maintained.

Figure 4.21 (2) is a model of simple microscope. Take out the filament of bulb by breaking the backside of the bulb. Fill the bulb with water and keep the bulb on the microscope made up of wood. Keep any object of micro-size on the stand and view the object which is kept inside the bulb. The micro object will become bigger in size. Due to curved surface of the bulb and water filled in it, the bulb acts as a concave mirror and thus the micro- size object becomes bigger in size.

(3)



(4)

Figure 4.21 (3) is an exhibit shows phases of moon and rotation of earth around sun. There are few holes on right side of exhibit. Each hole represents a phase of moon. The first hole represents first phase and the last hole represents full moon. Now watch from the circular portion of the exhibit. There is a circular ball and a bulb near the ball. Imagine a circular ball as earth and a bulb as sun. The part of a ball lighted is day time on earth while the darker part is night time on earth.

Figure 4.21 (4) is an exhibit shows the concept of sound. There are two plastic beads hanged on cycle ring with the help of stand. When the cycle ring is rotated, the beads collide with spokes of ring and music is produced.

4.6.4.0 Uniqueness of Community Science Centre at Dang

Community Science Centre at Dang also had unique programmes which fulfilled the objectives of non-formal education.

4.6.4.1 Own Programmes of Community Science Centre at Dang

The centre had chalked out activity plan as per the tribal culture. There was a special activity at the centre called as ‘Aadar’ where tribal communities were made aware not to burn their farm land after harvesting the crops. In this awareness programme the community members were educated to use the grass as well as woods of these farms for making different household items and manure. The below figures show the awareness activities done by Community Science Centre-Dang.

Figure 4.22: Activities of Community Science Centre-Dang (1) Aadar awareness (2) Celebration of International Year of light

(1)

(2)

Figure 4.22 (1): The staff of Community Science Centre-Dang is making aware to farmer not to burn the farm land.

Figure 4.22 (2)**:** Awareness to tribes on light on the occasion of International Year of light by staff of Community Science Centre-Dang.

The centre organized outreach programmes in distant areas for tribal children and spread the importance of science. The centre organized anti-alcohol, anti-tobacco and anti smoking drive in different places of Dang. The centre conducted awareness drive on eradicating superstition. Teachers training programmes based on above activities were organized intermittently by the centre.

The staff went to different schools of Dang to show different exhibits which worked on scientific principles. The centre's personnel talked with students on different scientific phenomena with reference to local biodiversity. E.g. To make understand the importance of trees, the examples of bamboos, sag were told to them as those trees were found in abundant in Dang. Also, to make language simpler the words were shortened. E.g. in Gujarati, gravitational force is called 'Gurutva Aakarshan'. But for simplicity the staff only used word 'Aakarshan'.

4.6.4.2 Response of the students for the activities of Community Science Centre at Dang

The researcher took the response of the students for conduction of activities like demonstration of exhibits and models at Hall of Science and visit at biotechnology gallery. The two students of standard 7 visited at the centre and the researcher took a sample of all two students for the study. The students responded that the exhibits were useful to know the concepts of science. They were satisfied with the content knowledge of the staff person. The students opined that the charts and graphics of biotechnology helped in gaining knowledge on biotechnology. The students told that the language of graphs were complex to understand.

4.6.4.3 Response of the teachers and public for the activities of Community Science Centre at Dang

No teachers and public visited the centre during the time of data collection by the researcher. Hence, the data were not collected for their response for conduction of activities.

4.6.4.4 Publications of Community Science Centre at Dang

The centre did not had publications like magazines, books, journal, annual reports and pamphlets. However, yearly activity report was submitted to GUJCOST. The centre did not distribute or sell any publications. During training programmes of teachers and students, subject related content was provided. Also those students who showed keen interest in science got charts, kit and educational materials. The centre did not have its own website because technical persons to develop and maintain the website are not available in Dang. The centre had presence on social media which was updated as and when required. The centre got coverage in local newspapers.

4.6.4.5 Photos of Activities and Exhibits of Community Science Centre at Dang

Community Science Centre at Dang had different activities and exhibits to understand science in non-formal method. Different activites and exhibits are explained here.

Figure 4.23: Activities of the centre (1) Awareness programme on eradicating superstitions (2) Students takes pledge of environment conservation

(1)

(2)

Figure 4.24: Figure (1) Chart explaining mutation of crops Figure (2) Gyroscope made from bicycle wheel

(1)

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Figure 4.24 (2): A gyroscope is made from a bicycle wheel. A gyroscope is a spinning wheel or disc in which the axis of rotation is free to assume any orientation itself. A gyroscope is used in navigation systems where magnetic compass would not work, aerial vehicles and recreational boats. When the object is steady, gravitational force is strong on

object and when it is in motion, the force is weak. An airplane flies on same principle. Gyroscope is also used to turn the object in one direction during speed.

Figure 4.25: Exhibits explaining (1) Centre of Gravity (2) Concept of Collision (3) Smokeless Chulha (4) Biogas plant

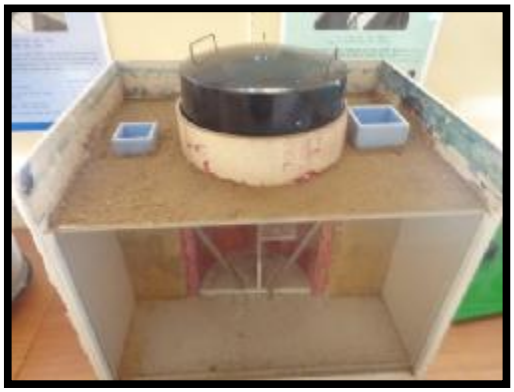
(1)

(2)

Figure 4.25 (1) is an exhibit which explains the concept of centre of gravity. There are four pipes. Putting at fulcrum, one can find the centre of gravity of pipe.

Figure 4.25 (2) is an exhibit showing the concept of oscillation with respect to momentum. There are two pendulum attached with rod. Pull one pendulum on one side and observe. After sometime, the pendulum starts oscillating and the first one slows down. Again after sometime, when first one stops, the second pendulum gains momentum. The action continues. Thus the momentum of pendulum depends on oscillation of others.

(3)



(4)

Figure 4.26: Exhibits on (1) Solar Steel and (2) Concept of illusion

(1)

(2)

Figure 4.26 (1)**:** This is a model of solar steel. We get distilled water from it. The unwanted minerals from water can be removed with the help of solar steel. The distilled water is used in laboratories, hospitals and battery charging.

Figure 4.26 (2)**:** This is a model of rotating rings which shows the concept of illusion. The three rings are attached with each other and can be rotated with the help of electric motor. The rings are attached such that it forms the bowl shape like structure. When the model is switched on, the rings rotate and we feel that rings are floating in air. This is due to illusion.

Figure 4.27: Exhibits on (1) Relation of voltage and electricity (2) Barmuda Hall

(1)

(2)

Figure 4.27(1): This exhibit explains the concept of voltage and electricity. Two paws are made up of aluminum plates. When we put our hands on these paws and switch on the exhibit's power, we will feel electric shock due to high voltage. There is three volt battery

in the exhibit. There is induction coil joined with the battery. This induction coil generates high voltage due to which we feel electric shock.

Figure 4.27(2): This exhibit is called Barmuda Hall which explains the concept of centrifugal force. There is horn of loudspeaker set in the mechanism of exhibit. There is a heavy iron bead under the box chamber. Place a bead and push towards hole. We will notice that the bead will rotate on a circular path of horn. It will not fall underneath inside the hole. Also we will notice that the bead will gain momentum while rotating when it goes downward side. The bead does not fall due to centrifugal force. The ball takes longer time in completing circular path when the radius of horn (expanse of horn) decreases.

4.6.5.0 Uniqueness of Community Science Centre at Dharampur

Community Science Centre at Dharampur had uniqueness which helped in imparting non-formal science education.

4.6.5.1 Constituents of Community Science Centre at Dharampur

Community Science Centre at Dharampur had different constituents which were used for science education.

A) Exhibition Halls-There were three exhibition halls:
   1) Hall of Popular Science-The hall of Popular Science consisted of interactive panels and exhibits on topics of forest and its relation with humans, climate change, agriculture and health.
   2) Perception Hall- The hall had exhibits in which perceptions of humans were defined and working exhibits based on perception are there. It explored perception on properties of objects such as shape, size, distance and motion.
      (Perception is the understanding of the world through interaction of the sensory organs. Our sensory organs receive information from surroundings and brain processes the information and gives a meaningful understanding of

the world. We do different observations and experience surrounding our atmosphere. We used sensory organs to perceive the world around us. We see objects, size, shapes and colours by our eyes. We hear different sounds by our ear. We can differentiate odours by our nose. Our skin can feel heat, cold, touch or pricking of pin. Our tongue can taste different food. Our sensory organs through the neuron cells send messages to the brain and help us to understand and differentiate materials).

3) Hall of Fun Science-The exhibits was created which made understand scientific concepts with fun and entertainment.

B) 3D (Three Dimension) Science show-The centre had theatre in which 3D science films were shown to public. The films on science subjects were shown providing public an exhilarating and immersive experience.

C) Planetarium-There was a planetarium in the campus of the centre where movie on astronomy was shown to make acquaint pubic on stars and constellations in the night sky, facts on celestial bodies and importance of astronomy.

D) Science Park-There were various exhibits based on scientific concepts at science park.

4.6.5.2 Response of the students for the activities of Community Science Centre at Dharampur

The activities like lecture on general science, computer basics course, English learning course, astronomy education film show at Planetarium, 3D (Third Dimention) film show at 3D MAX theatre, visit to Hall of Popular Science, Perception Hall and Hall of Fun Science as well as visit to Science Park were taken to know students' choices for conduction of activities. The sample of 87 students of standard 8 to 10 was taken for this purpose.

The table 4.8 shows the response of the students for conduction of activities of Community Science Centre at Dharampur.

Table 4.8: Response of the students for the activities of Community Science Centre at Dharampur

Sr. No.	Statement	Response	Frequency	Percentage
1.	Satisfaction with the learning method	Yes	65	75
		No	22	25
2.	Satisfaction with content of the activity	Yes	65	75
		No	22	25
3.	Satisfaction with the management of the activity	Yes	87	100
		No	0	0
4.	Satisfaction with the time duration given for the activity	Yes	87	100
		No	0	0
5.	Satisfaction with the available facilities for the activity	Yes	87	100
		No	0	0
6.	Satisfaction with overall services of the centre	Yes	87	100
		No	0	0
7.	Understanding of exhibits, models, graphics and charts	Simple	56	64
		Complex	31	36
8.	Language of text to understand the exhibit	Simple	69	79
		Complex	18	21

From Table 4.8, it was concluded that

- 75 percentages were satisfied with the learning method and content of the activities.
- All students were satisfied with the management and time duration given for the activities as well as facilities and services of the centre.
- 64 percentages of students were able to understand exhibits, models, graphics and charts. 79 percentages students understood the language of text of exhibit.

The students told that the centre helped in building English speaking skills because due to their rural background they lacked English communication skills. The students nurtured the skills of formation of sentences, correct grammar and writings skills at the centre. The students told that though the language of the educational film was Hindi, the content of

the 3D film was too heavy to understand. The students told that serene atmosphere of centre, especially science park was good to study.

4.6.5.3 Response of the teachers for the activities of Community Science Centre at Dharampur

The activities like lecture on general science, astronomy education film show at Planetarium, 3D Film show at 3D MAX theatre, visit to Hall of Popular Science, Perception Hall and Hall of Fun Science as well as visit to Science Park were taken to know preferences of teachers for conduction of activities. The sample of 22 teachers was taken for this purpose.

The table 4.9 shows the response of the teachers for conduction of activities of Community Science Centre at Dharampur.

Table 4.9: Response of the teachers for the activities of Community Science Centre at Dharampur

Sr. No.	Statement	Response	Frequency	Percentage
1.	Satisfaction with the learning method of the centre	Yes	22	100
		No	00	0
2.	Satisfaction with content of the activity	Yes	22	100
		No	00	0
3.	Satisfaction with the management of the activity	Yes	22	100
		No	00	0
4.	Satisfaction with the time duration given for the activity	Yes	22	100
		No	00	0
5.	Satisfaction with the available facilities for the activity	Yes	22	100
		No	00	0
6.	Satisfaction with overall services of the centre	Yes	22	100
		No	00	0

All teachers were satisfied with the learning method, content of the activity, management, time duration, available facilities and overall services of the centre. The teachers told that the animation and special effects were of high quality but the flow of the film was not proper. It was too informative that was impossible to remember. The teachers told that

the centre acted as a great support for students and public as the science was important subject for society. The research concluded that the teachers appreciated the halls of science for its uniqueness in understanding scientific concepts. The teachers praised the efforts done by the science centre for producing specific models for specific science topics like vibration and optical illusion. The interactive exhibits were excellent to understand scientific concepts. They told that the schools were not in a position to make models as their working style was different from science centres. The non-formal method of learning in the centre made a base of science very strong and teachers could give a reference of exhibit during school teaching. They told that the learning science to rural school children was very essential and science centre had helped in making science interesting to them.

4.6.5.4 Response of the public for the activities of Community Science Centre at Dharampur

The activities like astronomy education film show at Planetarium, 3D Film show at 3D MAX theatre, visit to Hall of Popular Science, Perception Hall and Hall of Fun Science as well as visit to Science Park were taken to know the perception of people on science centre. The sample of 68 people was taken for this purpose.

The table 4.10 shows the response of the public for conduction of activities.

Table 4.10: Response of the public for the activities of Community Science Centre at Dharampur

Sr. No.	Statement	Response	Frequency	Percentage
1.	Satisfaction with content of the film shows	Yes	34	50
		No	34	50
2.	Understanding of exhibits, models, graphics and charts	Simple	27	40
		Complex	41	60
3.	Language of text to understand the exhibit	Simple	37	54
		Complex	31	46

From table 4.10, it was concluded that

- 50 percentages of people were satisfied with the film shows organized by the centre. 40 percentages of people told that understanding exhibits, models, graphics and charts were simple to understand.
- 54 percentages of people felt that language of text of exhibit were simple. The people responded that they were unable to understand the content of the astronomy film, but they liked the visual effects in it.

4.6.5.5 Publications of Community Science Centre at Dharampur

The centre had a brochure which was used for promotion of activities. The centre did not publish any specific books, magazines, journal and annual report. However, a booklet of yearly activities of all science centres and museums under NCSM was published wherein the activities of Community Science Centre-Dharampur was mentioned. The centre did not sell or distribute any publication to students and public. However, during special events of science and astronomy, educational material was given to students. The centre did not have its own website. However the news and events were updated on social media. The local media gave coverage of events of the centre.

4.6.5.6 Photos of Exhibits at Community Science Centre at Dharampur

Community Science Centre at Dharampur had different activities and exhibits to understand science in non-formal method. Different activites and exhibits are explained here.

Figure 4.28: Exhibits at Science Park (1) Concept of sound (2) Newton's third law of motion (3) Echo Tube (4) Compound Pendulum (5) Perspective Drawing (6) Double Cone (7) Parabolic Solar Cooker (8) Sand Clock

(1)

(2)

Figure 4.28(1): The exhibit shows the concept of production of sound. When we hit bars of different lengths gently with the small striking hammer, different bars emit sound of different pitch. The pitch of sound of a freely hung bar depends on its length. The shorter is the bar the higher is the pitch.

Figure 4.28(2): The exhibit explains Newton's third law of motion. Sit on the bench and turn the umbrella slowly by turning the central pole. The platform will turn in the opposite direction. As per Newton's third law of motion, every action has an equal and opposite direction.

(3)

(4)

Figure 4.28(3): This exhibit is called echo tube. Bring your mouth inside the tube and say any word. We will hear a distinct echo. Similarly clap once and hear several echoes. Sound waves travel through the tube at about 330 meters per second and come back reflected from the other hand. We can distinguish an echo if the reflected sound arrives at ears at least one-tenth of a second after the original sound.

Figure 4.28(4): This exhibit is about compound pendulum. Swing only the central pendulum gently. Observe that its pointed end traces a straight line. Then swing the outer platform. Watch that the pointed end starts tracing elliptical paths. The elliptical paths are generated by combining two simple harmonic motions in perpendicular directions.

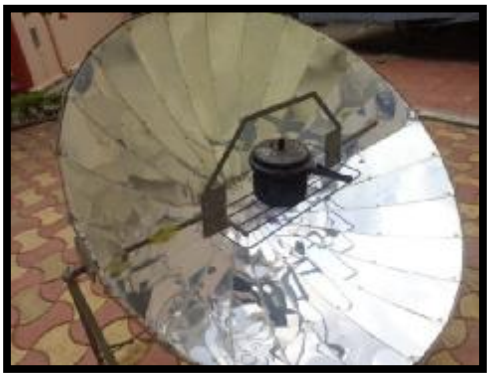
(5)

(6)

Figure 4.28(5): This exhibit is meant for perspective drawing. Look through the control hole, hold a chalk in your hand and place it on the glass coinciding with a particular point

of a tree or any other object. Move the chalk on the glass tracing the outline of your selected object. We will get a nice drawing.

Figure 4.28(6): This is an exhibit of double cone which explains the concept of central of gravity. Place the double cone at the lowest point on inclined plane and release it. It will go in upward direction and rests at higher point defying laws of gravity. The central of gravity of the double cone is at the upper most point on the plane.



(7)

(8)

Figure 4.28(7): Parabolic Solar Cooker

Figure 4.28(8): This is a sand clock which was used to measure time in ancient times.

Figure 4.29: Exhibits at the Perception Hall: (1) Virtual Harp (2) Moire Pattern (3) and (4) Optics (5) Colour Shadow (6) Ishira Plates (7) Changing Colours (8) and (9) Optical illusion (10) White light

(1)

(2)

Figure 4.29(1): This exhibit is of virtual harp which explains the concept of sensor. Each time a hand passes through the gap between any pair of pipes, your hand is sensed and a particular musical note is created electronically, creating a virtual environment where without actually plucking a string or hitting a rod you produce musical notes. As we move our hand, we would listen to an octave of music i.e. Sa,Re, Ga, Ma, Pa, Dha, Ni, Sa.

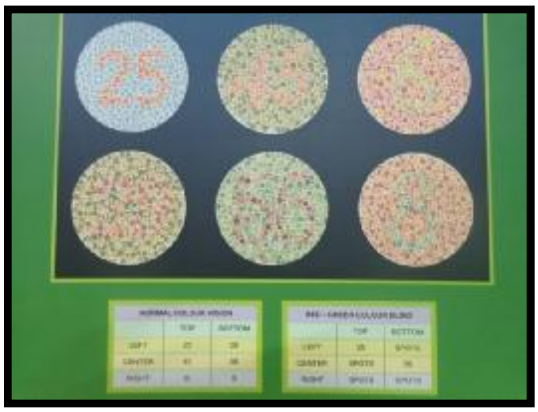
Figure 4.29(2): This exhibit explains Moire Pattern. Look at the three patterns one by one. Each one is having two layers. We will observe interesting patterns as one layer rotates over another. Also no patterns appear when two layers are exactly lined up. When two identical repetitive patterns are overlapped with imperfect alignment, a pattern of light and dark lines that we call a Moire Pattern appears. Moire Patterns are created whenever one semitransparent object with a repetitive pattern is placed over another. A slight motion of one of the objects creates changes in the Moire Pattern. These patterns can be used to demonstrate wave interference. The Moire Pattern is not a pattern in the screens themselves, but rather a pattern in the image formed in your eye.

(3)

(4)

Figure 4.29(3) and Figure 4.29(4) explain the concept of optics. Sit on the chair on one side of the glass and ask your friend to sit on the other side. Adjust the intensity of light with the help of the knob provided on your right such that half of you face is illuminated. Position your head in such a way that your face is aligned with your friend's face. We will see a combined face with half yours and half your friend's. The glass is a special glass. When illuminated on your side it acts like a mirror and when illuminated on the

other side it acts like a transparent glass. This feature creates a picture, which are half you and half your friend.



(5) (6)

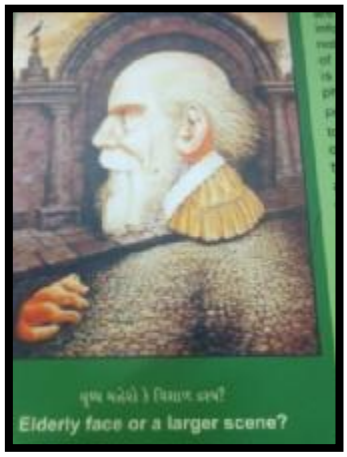
Figure 4.29(5): This exhibit explains colour shadow. Put the hand in and watch the shadow in colours. The shadows are cyan, magenta and yellow. The reason of these shadows is that hand casts shadows in three different places of three lights. We get a shadow in cyan where the hand blocks the red light. We get a shadow in magenta where the hand blocks the green light. We get a shadow in yellow where the hand blocks the blue light. The rest screen is white as all three primary colours mix.

Figure 4.29(6): Eye doctors use Ishira plates to determine the severity and type of colour deficiency. Someone with normal colour perception can see the numeral among the dots. But someone with red-green deficiency would have trouble discerning the red among the green.

(7) (8)

Figure 4.29(7): This exhibit explains the concept of changing colours. When we look at screen, we will find an outline of scenery on the glass. Look at the scenery through the screen placed in front of it and rotate the screen. Observe change in colours of the objects of the scenery. Different objects of the scenery are made of pieces of transparent adhesive tape and a polarized light is projected on it from the back. The pieces of tape rotate the planes of polarization of constituent colours of light passing through it to different degrees. Another polarizing sheet is placed in-front of the scenery which is rotated. The rotating polarizing film allows light of particular colours to come through and as a result we see changing colours through the analyzer.

Figure 4.29(8): This exhibit explains concept of white light. This is a disc with segments in seven colours of Newton's optical spectrum (red, orange, yellow, green, blue, indigo and violet). When the disc is rotated, the colours blur together and the eye unable to respond rapidly enough, sees the colours mixed togehter to form white. We cannot distinguish the difference in colours. In this way, Newton demonstrated that white light is a combination of different colours.



(9) (10)

Figure 4.29(9): The figure explains optical illusion. The lines appear both straight and curved.

Figure 4.29(10): This template shows optical illusion. The picture shows both elderly face and larger scene.

Figure 4.30: Exhibits at Fun Section: (1) Sand Pendulum (2) Acrobatic stick (3) Vortex (4) Electromagnetism (5) Rising Arc (6) Bending of Light (7) Sensor (8) Direction of Pole star (9) and (10) Images in mirror (11) and (12) Pressure Balance

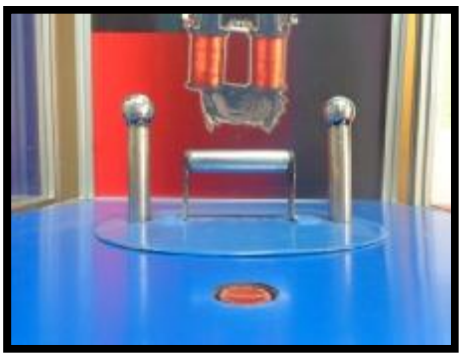
(1) (2)

Figure 4.30(1): This exhibit is called sand pendulum. Clean the platform top with the brush. Fill up the cone with sand closing the bottom of the cone with the finger. Give a gentle swing to the cone and allow the sand to drip. Observe the pattern formed by the

dripping sand. Here the cone acts like a compound pendulum which swings in two perpendicular directions. These generated patterns are known as lissajous figures. They were first invented by a French physicist.

Figure 4.30(2): This exhibit is called acrobatic stick. The straight stick can pass through a curve pitch. The reason is when we press the switch, the rotating stick is generating a three dimensional surface which is hyperboloid. The curved slits through which the stick passes are in the form of hyperbola. This form is obtained by the intersection of the hyperboloid with a plane transparent surface at the middle.

(3)



(4)

Figure 4.30(3): This exhibit shows the concept of vortex and explains the formation of cyclonic storms. Press the switch and observe that the water starts rotating at the top of the water column. Slowly the entire water column is in motion. After few seconds, an air bubble starts forming at the centre. Slowly the vortex grows reacting the bottom of the container. As the water starts rotating, the speed of rotation is high at the periphery and low at the centre. Also, water is being sucked down from the centre at the bottom of the container. A vortex is formed due to the combined effect of the above.

Figure 4.30(4): This exhibit explains electromagnetism. Hold the handles and try to lift the disc up. It is easy to lift up. Now press the switch and try to lift it again. This time it is hard to lift up the disc. The disc is made of mild steel and there is a strong electromagnet shown at the bottom. When this electromagnet is activated, it attracts the steel disc downwards. This attractive force resists your effort.

(5)

(6)

Figure 4.30(5): This exhibit is called rising arc which explains heating with respect to electromagnetic effects. When we switch-on the exhibit, the electric arc move up until it breaks at a point. The arc strikes across the narrowest part of a gap where insulation of air broken by applying 25000 volts across the terminals. The arc is forced upward by a combination of heating and electromagnetic effects. Thus the arc takes an increasingly longer path until the applied voltage becomes insufficient to maintain the arc. This phenomenon is observed in horn gap arresters to provide temporary earthing to protect electrical equipment from high voltage.

Figure 4.30(6): This exhibit explains the concept of bending of light. When we turn the knob, the rod vanishes as it enters the liquid in the container. The reason is the light bends on passing from one material to another. If the amount of bend is identical in different materials then such materials shall have the same index of refraction. The rod and liquid have the same index of refraction. So the incident light bends to the same extent when passing through the rod and the liquid. Hence the rod cannot be distinguished in the liquid.

(7)

(8)

Figure 4.30(7): This exhibit explains the concept of sensor. To get water, just bring your hand below the jug. Water supply will stop immediately when you remove your hand. The flow of water is controlled by a photo-electric circuit with a view to stop wastage of water.

Figure 4.30(8): The upper pointer of the exhibit point towards the direction towards polestar.

(9)

(10)

Figure 4.30(9) and (10): This exhibit is called ‘float in the air’. Stand by touching the centre of the nose at the corner of the frame. To float, lift your left leg off the ground. To fly a little higher, flap your right arm gently to give yourself more lift. You will float in

air without any support. One will see only the right half of your body, made whole by the mirror reflection. Here, two mirrors are placed at right angles to each other.

(11)

(12)

Figure 4.30(11): The total pressure of the body gets distributed when we sit on the chair so pins do not prick our skin.

Figure 4.30(12): Place the hand gently at the bottom of the pin screen. We are touching thousands of pins at a time and many messages are sent to our brain simultaneously. We withdrew your hand immediately due to reflex action as the brain has no prior information of the situation. When we touch the screen for the second time we may be at ease in touching the sharp pins as we are conditioned to the situation. Though the pins are quite sharp, yet we never get hurt as the total pressure of the palm gets distributed among so many pins touching the palm which is not sufficient for one pin to prick the skin. By moving the palm, we can create interesting patterns or see the topography of your palm by pressing our palm gently against the pins.

Figure 4.31: Birds and Peacock at Life Science Park

4.6.6.0 Uniqueness of Gujarat Science City at Ahmedabad

Gujarat Science City at Ahmedabad had uniqueness which helped in imparting non-formal science education.

4.6.6.1 Constituents of Gujarat Science City at Ahmedabad

Gujarat Science City had different constituents which were used for science education.

1. Hall of Science-The hall consisted of vast array of exhibits and working models on scientific concepts and importance of science in human life.
2. Hall of Space-The hall had exhibits and panels depicting achievements and careers in space science and space research.
3. Mission to Mars Ride-There was a simulator in which people experience a visit of our solar system.
4. Simulator Ride- Ride Simulations provided the experience of riding a roller coaster, flying in an aerobatic aircraft, a journey into space and many more. It was a self-contained capsule in which people take an experience of aerodynamics.
5. Electrodome-This was a museum for electricity where principles of electricity are explained with exhibit panels, charts, computer graphics and working models.

6. Planet Earth Pavilion-There was a special dome structured pavilion which focused on aesthetics of planet Earth. The main section of the Planet Earth pavilion included (i) the celestial trio (Sun, Earth and Moon), (ii) The dynamic Earth, (iii) Resources of the Earth, (iv) The Planet Ocean, (v) Water, the fountain of life, (vi) The Atmosphere. (v) Children's activity area. The sections covered evolution of life, resources of ocean, rocks, minerals, fossils, energy from earth, cyclone, tornado, volcanic eruption, flood, fire on the earth, human anatomy as well as marine and freshwater aquarium. The subjects like agriculture, petroleum, geology and socio-economic use of resources were covered. Through laser technique, the message of environment conservation was communicated. There was planetarium where concepts on formation of universe and solar system were communicated through documentary film. It had a planetarium, earthquake experience simulator ride and functions of coalmines.
7. Life Science Park- In Life Science Park, there was a butterfly park where public could understand lifecycle of butterflies. There was Tissue Culture Laboratory where concepts of tissues and cellular biology were placed in chart form. At Cretaceous Park, different types of cactus were grown and conserved. At Bird Corner, different species of birds were kept. Various aromatic, medicinal and economic plants were also there.
8. Energy Education Park- The Energy Education Park exhibits were classified according to five basic elements (Panchmahabhut) as mentioned in ancient Indian Philosophy. These elements were (i) Tej (Energy from the Sun), (ii) Marut (Energy from the Wind), (iii) Ap (Energy from the Water), (iv) Kshiti (Energy from the Earth) and (v) Byom (Exploration of Space). In Energy Park, there were working models on to make understand wind energy, drilling, tidal energy and solar energy.
9. Musical Fountain- There were dancing musical fountain which worked on principles of digital electronics, hydrodynamics and electromagnetism. The students and public understood acoustics, hydraulics and light-water synchronization.

10. Children Activity Centre-The activities related to children like debate, competitions and events were held at this centre.
11. IMAX 3D Theatre-The people watched 3D films in this theatre.
12. Science Shop-The shop contains scientific toys, books and audio-visual materials on science literature, kits to make science models from where people can buy for educational purposes.

The spacious halls, pavilion and galleries were meant for science education with mix of entertainment.

4.6.6.2 Activities of Gujarat Science City at Ahmedabad

(A) Academic Programme on Science and Mathematics

1. Organization of talent nature programs in science and mathematics for teachers and students.
2. Organization of talent nurture programs in Science and Math Olympiads for school students and teachers.
3. Meet the Scientist Programme: Interacting with eminent scientist.
4. Career Counseling in frontiers of science for higher secondary students.
5. Organization of Children's Science Congress and short term training workshop in Science Communication.

(B) Material Development

1. Development of Activity modules on Science and Technology (S&T) Communication through puppetry, popular science writing, illustration and journalism, organization of nature camps, learning Mathematics through Origami, training module in hydroponics-fun with plants soil less condition, model rocketry, telescope making, night sky observation, etc.
2. Design and Development of theme based posters like S&T for sustainable development, water for life, save our Sky, atom for peace, etc. and theme based activities.

3. Development of standard reference library and interactive website.

(C) Training Students Volunteers

1. Involvement of students and volunteers as interns and providing necessary training and guidance for professional development.
2. Skill enhancement of promising science writers and communicators.
3. Exposure into different modules of science popularization activities.

(D) Media Resource Centre

1. Design and develop necessary back ground materials as media kits on important scientific events and activities.
2. Arrange interviews of renowned scientists and technocrats.
3. Design and Development of audio- visual materials, multimedia presentation and theme based slide shows, etc.

(E) Science Olympiads-Gujarat Science City organized Junior Science and Maths Olympiads for the students of standard 8 and 9. The Olympiad was aimed to boost the young children to do excel in the science as well as to prepare them for the National and International Science Olympiads. The organization had orientation programmes on Science Olympiad for awareness and more involvement of student and the teachers of the state.

(F) Science Matters: Popular Science Lecture Series-Gujarat Science City had started a popular science lecture series titled as “Science Matter”. The series highlighted on the frontier areas of science and technology for the spreading of new knowledge and awareness among the student as well as the public.

(G) Summer Vacation Programmes-Gujarat Science City organized summer vacation programmes for school children on science activities

4.6.6.3 Styles for imparting science education at Gujarat Science City at Ahmedabad

The study found that Gujarat Science City had chalked out specific styles and tools of science education. Simulation is a technique where students experience the reality of the scenario and gather meaning from it. Mars Ride and earthquake experience ride were one such example where simulation method was used for understanding science to students and public. Hydraulic Simulator was being made to make understand to concept on space travel and earthquake tremors.

There was a Laser show at Planet Earth Pavilion. The laser show was conceptualized in such a way that it gave a message of the importance of environment conservation. The characters in the show were sketched with laser. This was example of amalgamation of education and laser technology.

Figure 4.32: Activities (1) Laser Show (2) Talk Show on Environment (3) Simulator Ride (4) Musical Fountain

(1)

(2)

Figure 4.32(1): Public enjoying Laser show at Gujarat Science City which shows the importance of environment conservation.

Figure 4.32(2): Public listening to the talk of Miyan Fuski and Robot at Gujarat Science City.

There was a specific dark room where two statues were placed. One statue was of robot and other statue was of Miyan Fuski. (Miyan Fuski is a lead character of children's novel

'Miyan Fuski'. The novel was written by noted Gujarati author Jivram Joshi who contributed in literature for children). There was an interaction between two statues on the importance of conservation of resources. The robot and Miyan Fuski were chatting with each other to communicate importance of Mother Nature to public. The interaction was done through voice-over in the background. Thus, this exhibit was a combination of literature and science.

There was artificial coal mine made of fiber where exhibits were made to explain the process of getting coal to its distribution. The wreckage of houses in Kuchchh earthquake of 2001 was used in building this coal mine.

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Figure 4.32(3): Public in a simulator at Gujarat Science City where our solar system is made understood with the help of movie on screen.

Figure 4.32(4): Dancing musical fountain at Gujarat Science City which works on principles of digital electronics, hydrodynamics and electromagnetism.

4.6.6.4 Response of the students for the activities of Gujarat Science City at Ahmedabad

The researcher took a sample of 26 students of standard 9 and 10 as well as college students to know the response of activities done by Gujarat Science City. The response on activities like celebration of National Technology Day, laser show, visit to Planet Earth, astronomy education film show at planetarium, coal mine experience, experience at Mars Simulator Ride, visit for exhibits at Hall of Science and Hall of Space and Noble

Laureates Meet as well as Nobel exhibition during Vibrant Gujarat Summit 2017 were collected by the researcher.

The table 4.11 shows the response of the students for activities of Gujarat Science City.

Table 4.11: Response of the students for the activities of Gujarat Science City at Ahmedabad

Sr. No.	Statement	Response	Frequency	Percentage
1.	Satisfaction with the management of the activities	Yes	26	100
		No	00	0
2.	Satisfaction with the time duration given for the activities	Yes	13	50
		No	13	50
3.	Satisfaction with the available facilities for the activities	Yes	26	100
		No	00	0
4.	Satisfaction with overall services of the centre	Yes	26	100
		No	00	0
5.	Understanding of exhibits, models, graphics and charts	Simple	19	73
		Complex	07	27
6.	Language of text to understand the exhibit	Simple	22	84
		Complex	04	16

From table 4.11, it was concluded that

- All students were satisfied with the management of activities, overall facilities for the activities and services of Gujarat Science City.
- 50 percentages of students were satisfied with the time duration given for the activities. 27 percentages of students told that the exhibits, models, graphics and charts were simple to understand.
- 84 percentages of students responded that language of text for exhibit was simple.

They responded that due to chaos and crowd, they were not able to understand the working of exhibits. They told that due to hurry and non-serious public the demonstration was not done properly. The scientific concepts were not communicated properly to them. The students who visited the Earth Pavilion told that Gujarat Science City had many resources which the schools did not have. The lecture of experts gave an extra edge to

students and their knowledge was enriched. The students opined that Science City invited experts from field of science. Thus they got exposure to science topics. In school, curriculum was given importance and the education was restricted to specific scientific concepts. In Science City, the experts talked about science deeply and there was holistic view of disciplines. The different sections and halls having interactive exhibits were very much useful for their study purpose. They responded that resource persons were more learned than school teachers and their talk was more interesting, educative and with global perspective. Hence the curiosity to learn science was grown.

The students told that the exhibits at Hall of Science and Hall of Space were interactive and easy to understand. They responded that there were too many exhibits at halls and at other sections. So it was time consuming to see all at a stretch but visiting Gujarat Science City at regular intervals would be better.

Gujarat Science City organized Noble Laureates Meet which was a part of Vibrant Gujarat Summit 2017. Total nine Noble Laureates across the world came to participate in the event. The students told that it was a good exposure for students as they got an opportunity to listen to Noble Laureates about science, their Noble prize achievements and future of science. The students responded that Noble Laureates delved into insights of scientific research and they inspired them to pursue research in science and technology. There was Noble Laureates Exhibition at Gujarat Science City as a part of Noble Laureates Meet during Vibrant Gujarat Summit 2017. Prime Minister of India, Narenda Modi inaugurated this exhibition. The students told that the exhibition was resourceful and informative. They appreciated the efforts to put all knowledge in one package. The exhibits which were interactive were easy to understand. However, the students were of the view that there was load of information and it was lost in clutter. They told that the crowd was not properly managed and science communicators who were positioned to explain the exhibition were confused.

4.6.6.5 Response of the teachers for the activities of Gujarat Science City at Ahmedabad

The researcher did not find any teachers during data collection at Gujarat Science City.

4.6.6.6 Response of the public for the activities of Gujarat Science City at Ahmedabad

The researcher took a sample of 54 people to know the response of activities of the centre. The response on activities like celebration of National Technology Day, laser show, visit to Planet Earth, astronomy education film show at Planetarium, coal mine experience, experience at Mars Simulator Ride, visit to life science park and energy education park, visit for exhibits at Hall of Science and Hall of Space and interactive show on Nature Conservation by robot and Miya Fuski (a novel character) were collected by the researcher.

The table 4.12 shows the response of the public for activities of Gujarat Science City.

Table 4.12: Response of the public for the activities of Gujarat Science City at Ahmedabad

Sr. No.	Statement	Response	Frequency	Percentage
1.	Satisfaction with the management of the activities	Yes	32	59
		No	22	41
2.	Satisfaction with the time duration given for the activities	Yes	54	100
		No	00	0
3.	Satisfaction with the available facilities for the activities	Yes	54	100
		No	00	0
4.	Satisfaction with overall services of the centre	Yes	54	100
		No	00	0
5.	Understanding of exhibits, models, graphics and charts	Simple	09	17
		Complex	45	83
6.	Language of text to understand the exhibit	Simple	14	26
		Complex	40	74

From table 4.12, it was concluded that 59 percentages of people were satisfied with the management of the activities. All people were satisfied with the time duration given for the activities, available facilities for the activities and overall services of the centre.
17 percentages of persons told that understanding exhibits of halls were simple. 26 percentages of persons told that the text related to exhibits were simple. The public also appreciated various sections of Planet Earth.

4.6.6.7 Common responses of the students and public for Gujarat Science City at Ahmedabad

The students and public responded that the astronomy film show was informative and interesting. They told that the animated and visual effects of film show on astronomy were effective in conveying the concept of universe. They felt the film complex but overall they understood our solar system.

There is Mars Simulator Ride at Hall of Space. The students and public liked the simulation technique made by Gujarat Science City. They told that the ride gave the experience of journey to different planets of solar system and the commentary during the ride was informative. They told that the message of nature conservation by Gujarati character Miya Fuski was full of infotainment.

4.6.6.8 Publications of Gujarat Science City at Ahmedabad

Gujarat Science City published brochures for students and public. It published education material for awareness on science topics which were given to students during training programmes. The centre communicated in media for popularization of activities.

4.6.6.9 Photos of Exhibits of Gujarat Science City at Ahmedabad

Gujarat Science City at Ahmedabad had different activities and exhibits to understand science in non-formal method. Different activites and exhibits are explained here.

Figure 4.33: Exhibits at the centre (1) Astronomy show at planetarium (2) Resonating Tube (3) Electricity (4)Rock and Minerals (5) Concept of Alternating Current and Direct Current (6) Model of Atom

(1)

(2)

Figure 4.33(1): People watching astronomy show at planetarium

Figure 4.33(2)**:** This is a resonating tube. It is a device in which we can generate a node and anti-node pattern with the help of source of sound. Here the source of sound is a speaker.

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Figure 4.33(3): People experiencing phenomenon of electricity through exhibit

Figure 4.33(4): Exhibit showing rocks and minerals

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Figure 4.33(5): This exhibit explains the concept Alternating Current (AC) and Direct Current (AC). Direct Current is the unidirectional flow of electric charge which Alternating Current is the movement or flow of electric charge which periodically reverses direction.

Figure 4.33(6): This is the model of an atom. The atom is a basic unit of matter consisting of a dense, central nucleus surrounded by a cloud of negatively charged electrons.

Figure 4.34: Exhibits at the centre (1) Aero Mobil (2) Pneumatic Rocket (3) Corrioles Effect (4) Force and Energy (5) Hydropower (6) Benham's Disc (7) Defect of Vision (8) Tidal Power (9) Ocean Thermal Energy (10) Geothermal Energy

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Figure 4.34(1): The exhibit is known as Aero Mobil. Pedal slowly to lift the ball up to either of the red rings and control your pedaling to keep it at the same level. By pedaling,

you drive an air compressor. The laminar flow of the compressed air floats the ball and keeps it in position due to Bernoulli Effect. To keep the ball at the same position, you need to control your pedaling.

Figure 4.34(2): This working model is called pneumatic rocket. When the exhibit is switched on, the rocket shoots up and we can understand Newton's laws of motion.

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Figure 4.34(3): This exhibit explains Corrioles effect. It is caused by the rotation of the earth and the inertia of the mass experiencing the effect. This force causes moving objects on the surface of the earth to appear to veer to the right in the northern hemisphere and to the left in the southern. This effect is responsible for the rotation of large cyclones.

Figure 4.34(4): The exhibit explains force and energy. The balls are hanged at a height. When they are released to fall, the kinetic energy, sound, electricity and light are produced and due to these effects, the ball kept at the base rings up and oscillates.

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Figure 4.34(5): Historically water wheels and water mills have been used to extract power from flowing water and convert it into mechanical power for turning grinding stones and another machinery. Although water wheels are now out of use, they are still put into use in some remote areas. Hydropower or water power is power that is derived from the force or energy or moving water.

Figure 4.34(6): This exhibit is called Benham's Disc. When our eye scans a black and white pattern containing fine details, we sometimes see subtle colours. Receptor cells in retina, responsible for detecting colours, are called cones. Three types of cones detect three primary colours, but with equal response. If we stare at a particular place on this spinning disk, we are looking at alternating flashes of black and white. The white flash excites all three types of cones, but not equally. This leads to an imbalance that partly explains why we see colours.

(7)

(8)

Figure 4.34(7): This exhibit explains defect of vision. Myopia, or near sightedness, is caused when an eyeball is too long, or the cornea is too flat. So images are focused in the vitreous inside the eye rather than on the retina at the back of the eye. As a result, the vision gets blurred. The corrective lens should be concave in order to diverge the image to focus it on the retina. Hypermetropia, or far sightedness, is caused when the eyeball is too short or the cornea s bulged. So images are focused beyond the retina at the eye. As a result, the vision gets blurred. The corrective lens should be convex in order to converge the image to focus it on the retina. Adjust the lens to correct the defects in vision.

Figure 4.34(8): This exhibit is about tidal power. The tidal forces produced by the moon and sun, in combination with earth's rotation, are responsible for the generation of the tides. Tidal Power, also called tidal energy converts the energy of tides into electricity.

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(10)

Figure 4.34(9): This exhibit shows concept of Ocean Thermal Energy Conversion (OTEC). Ocean is the largest energy collector and energy storage system. The heat stored in the vast expanse of water can be converted into electricity by this process.

Figure 4.34(10): This exhibit is on the concept of geothermal energy. It is the heat from the earth. The shallow ground, hot rocks and molten rock called magma are resources of geothermal energy.

Figure 4.35: Medicinal Plants, Butterfly Park and Cactus Park

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Figure 4.35(1): Jasmine is used in making perfumes and incense sticks.

Figure 4.35(2): This plant called Kalanchoe is used as medicine for removing kidney stone.

(3)

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Figure 4.35(3): Butterfly Park

Figure 4.35(4): Cactus Corner

4.6.7.0 Uniqueness of Lokbharti Community Science Centre at Sanosara (Dist. Bhavnagar)

Lokbharti Community Science Centre at Sanosara had uniqueness which helped in imparting non-formal science education.

4.6.7.1 Constituents of Lokbharti Community Science Centre at Sanosara

The centre had different constituents which were used for science education.

1) Science Laboratory-There was a laboratory where science experiments were performed to understand scientific concepts. There were models and puzzles on mathematics also.
2) Science Hall-There were working models on science based on scientific principles.
3) Science Park-The Park had exhibits which explained the concepts of science.
4) Energy Park-The Park had exhibits which explained the importance of renewable sources of energy.
5) Exhibition Space-There was charts, aquarium and space for doing demonstration of experiments at the centre.
6) Medicinal Garden-The garden had plants of medicinal importance
7) Biodiversity Garden-The science centre had biodiversity garden where species of flowers were conserved.

4.6.7.2 Institutions associated with Lokbharti Community Science Centre at Sanosara

Lokbharti Gram Vidyapeeth had sprawling campus with nested institutions like Krishi Vigyan Kendra, Wheat Research Station, College of Education, Primary Teachers Course (PTC) college, College of Rural Development, Gaushala, Nursery, National Social Service (NSS) Centre, Agricultural Observatory, Kalabhavan, Kaushalya Sanwardhan Kendra (Skill Development Centre) and facility for Hydroponics.

4.6.7.3 Specialty of Lokbharti Community Science centre at Sanosara

The centre used renewable sources of energy like solar energy and wind energy for household purposes. There were solar panels on the terrace of the centre. The LED lights and fans of the centre ran on solar energy. There was rain water harvesting facility in the centre. The rain water flowed from rooftop of the centre and stored in under-ground water tank. The rain water was filtered through natural filters. (Generally, households use filters with membrane. In such type of filters, minerals get deposit in membrane. There is soil pollution when one throws out these minerals). So the centre used natural filters. In Gujarati, it is called 'Desi maatla' method. The water is filtered with sediment and carbon filters. There was spinning wheel (Ambar Rentiyo) with which textile cloth could be made. Also, the architectural structure of the centre was such that the temperature of the building remained balanced in all season. In winter one did not feel cold while in summer one did not feel hot. The medicinal garden and biogas plant were remarkable for study. There were herbs and shrubs which helped in awareness on biodiversity.

Lokbharti Community Science Centre was the resource centre of all Community Science Centres which were under Gujarat Council of Science and Technology (GUJCOST). GUJCOST gave the responsibility to become a resource centre as Lokbharti Gram Vidyapeeth had excellent contribution in education and rural development. The centre got advantage from resources in terms of experts, knowledge generation and research though adjoining entities of the centre.

4.6.7.4 Own Programmes of Lokbharti Community Science Centre at Sanosara

(1) Darshak Lokganga Project-The centre organized science education programmes in villages and schools in remembrance of one of the founder members of Gram Vidyapeeth, a noted literaturist, Manubhai Pancholi 'Darshak'. Under this project science education programmes like quiz contest, science games, lecture series, demonstration of experiments and training programmes were carried out.

(2) Ravi Shala (Sunday School) programme-The centre organized Ravi shala (Sunday School) on every Sunday for students where science activities were performed for students.

(3) Agricultural programmes-Lokbharti Vidyapeeth had Krishi Vigyan Kendra, rural education colleges, Gaushala and agricultural observatory in its campus. With the help of all these entities, the centre conducted training programmes, seminars and workshops for farmers and students of the institution.

4.6.7.5 Response of the students and teachers for the activities of Lokbharti Community Science Centre at Sanosara

The researcher took the response of the students and teachers to know the effectiveness of activities of the centre. The activities like quiz competition, biodiversity awareness programme and film show on science were taken into consideration for this purpose.

Lokbharti Community Science Centre organized a quiz competition and film show on science under Darshak Lokganga Project at Kantharia Primary School located in Vallabhipur taluka in Bhavnagar district. The researcher took a sample of 15 students and one teacher of standard 8 to know the response of the activities. The students were happy with the quiz and film show. They told that it was full of edutainment. The teacher told that the centre was very active in science popularization since decades and it was a good resource for school students.

The researcher had not collected the response of public as there was no visit of public at the centre during the time of data collection.

Lokbharti Community Science Centre had set an example to live science for life. The centre had proactively put into practice the use of renewable sources of energy, rain water harvesting technique, architectural marvel as well as biodiversity and nature conservation. The centre understood that these practices are itself science learning. The students got inspired from the tools and techniques operated by the centre. Moreover, the

centre believed that whole Lokbharti Gram Vidyapeeth acted as a science centre as all the adjoining organizations was utilized for science learning.

4.6.7.6 Publications of Lokbharti Community Science Centre at Sanosara

Lokbharti Community Science Centre published science education materials for students and rural public. Different institutions of Gram Vidyapeeth also helped in producing educational materials. The multimedia content was produced with the help of other non-governmental organizations. E.g. the e-content for quiz came was made by Centre for Environment Education (CEE)-Ahmedabad.

4.6.7.7 Photos of Exhibits and Activities at Lokbharti Community Science Centre at Sanosara

Lokbharti Community Science Centre at Sanosra had different activities and exhibits to understand science in non-formal method. Different activites and exhibits are explained here.

Figure 4.36: Exhibits at centre: (1) Community Solar Cooker (2) Electric Autorickshaw (3) Wind Mill (4) Solar Pump

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Figure 4.36(1): This is called Community Solar Cooker. The sun rays fall on the mirror of cooker which in turn reflects on kiln where cooking takes place due to accumulation of heat.

Figure 4.36(2): This rickshaw runs on electric battery.

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(4)

Figure 4.36(3): This huge wind mill is used to lift water from a deep well to storage tank on terrace and also to fill deep well from storage tank.

Figure 4.36(4): This is solar water pump.

Figure 4.37: Wheat Field and Biogas Plant

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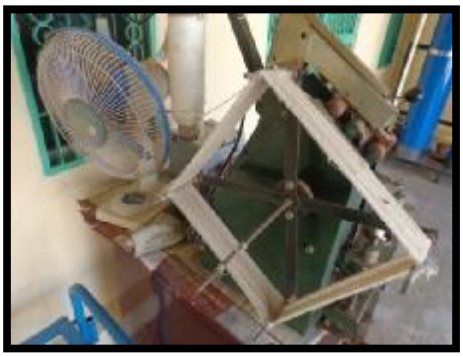
(2)

Figure 4.37(1): Wheat Field at the campus of the centre

Figure 4.37(2): This is biogas plant. The slurry of biogas plant is used as fertilizer.

Figure 4.38: Tools for learning science (1) Spinning wheel running on solar energy (2) Water purification plant (3) Solar lamps (4) Flowers to understand biodiversity



(1)

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Figure 4.38(1): There are fan and spinning wheel (Rantiyo) at the centre which works on solar energy.

Figure 4.38(2): There is water filtration plant at the centre which uses indigenous filters like sediment filter, activated carbon-filter and carbon filter.

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Figure 4.38(3): Solar lamps

Figure 4.38(4): There are different types of rose flowers in the centre. This is meant to make understand biodiversity.

Figure 4.39: Experiment on dispersion of light

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Figure 4.39 (1) and (2): This is an experiment to show dispersion of light. There is water in the bowl. Keep a metal strip in the bowl. When sun rays fall on strip, the dispersion of light is seen on the wall.

Figure 4.40: Activities: (1) Experiment on Respiratory system of tree and (2) Use of mobile technology for quiz

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(2)

Figure 4.40(1): Polythene is tied on leaves. After sometime, there are water droplets inside the polythene and it is filled with good amount of water after few hours. The tree exhales carbon dioxide during respiration and thus hydrogen reacts with oxygen of atmosphere to form water vapor. This explains the respiratory system of tree.

Figure 4.40(2): Mobile technology is used to show science films and to play science quiz to students.

Figure 4.41: Learning tools at the centre (1) Architectural structure of the centre (2) Drip irrigation (3) Solar Panels (4) Wind Mill (5) Net House (6) Hydroponics

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Figure 4.41(1): The architectural structure of the centre is in such a way that the temperature of the building is balanced in every season. We do not feel cold in winter and hot in the summer inside the building.

Figure 4.41(2)**:** There is drip irrigation in whole campus which helps in conserving water.

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Figure 4.41 (3) and (4): There are solar panels and wind mill on the terrace of the centre from which electricity is generated and is used to run electric appliances of the centre.

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Figure 4.41(5): There is net house in the institution.

Figure 4.41(6): Hydroponics is a method of growing plants without soil and using mineral nutrient solutions in a water solvent.

Figure 4.42: Exhibits at the centre (1) Magical lamps (2) Finding capacity of lungs (3) Mathematics Puzzle (4) Clap Operator Switch

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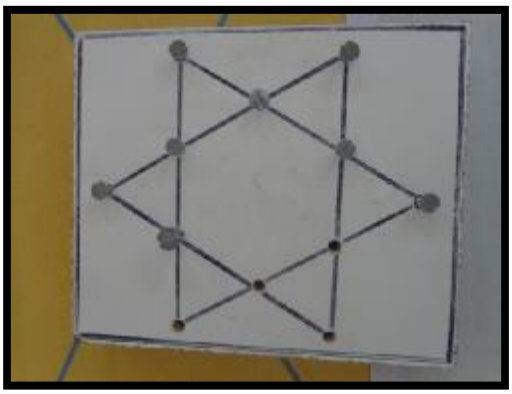
Figure 4.42(1): This exhibit is on magical lamp which explains the importance of lateral thinking. We see that bulbs are glowing without attached with electric holder. In fact, the electrical joint of the bulb that we see is not the real joint. The bulb is attached to electricity with the electrical joint but that joint is buried under sand.

Figure 4.42(2): This exhibit shows our capacity of lungs. When we suck the pipe, the liquid in the bottle rises. The liquid keeps on rising until we stop sucking the pipe.



(3)

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Figure 4.42(3): This is mathematics puzzle. A board is given here. A star shape is drawn on it. At each corner of the star, there is a pin inserted. Take out a pin from any one of the corner. This implies that, that corner will remain empty. For inserting a pin at this empty space we take out a pin from the corner which is not exactly adjacent to the empty corner. Follow this to take out the pins and to insert the pins in the empty corner. Play a puzzle in such a way that at the end only one corner remains with a pin.

Figure 4.42(4): This exhibit is called Clap Operator Switch. It explains how sensor works. When we clap, the bulb switches on. This is due to sound sensor fit near the bulb.

4.6.8.0 Uniqueness of Vikam Sarabhai Community Science Centre at Ahmedabad

Vikram Sarabhai Community Science Centre (VASCSC) at Ahmedabad had uniqueness which helped in imparting non-formal science education.

4.6.8.1 Constituents of Vikram Sarabhai Community Science Centre at Ahmedabad

The centre had different constituents which were used for science education. The centre has vast resources to impart non-formal science education. The centre had special laboratories for Physics, Chemistry, Mathematics, Biology, Model Rocketry, Robotics and Electronics. There was a science park at the premises of the centre where exhibits based on scientific concepts were kept for understanding science.

4.6.8.2 Own Programmes of Vikram Sarabhai Community Science Centre at Ahmedabad

(A) Programmes for students-VASCSC conducted following programmes of science education for students:

1) School Science Forum-Activities related to school curriculum was conducted at laboratories of the centre.
2) Model Rocketry-At Model Rocketry laboratory, activities on model rocketry were carried out.
3) Electronics-The activities related to electronics were carried out at Electronics laboratory.
4) Robotics-The activities related to robotics were carried out at Robotics Laboratory.
5) Computer training-The students learnt basic computer courses at the centre.
6) Astronomy-The concepts on astronomy were taught at astronomy sessions.
7) Syllabus based experiments in the laboratories-The centre organized sessions for school syllabus based experiments.
8) Advanced Bachelor of Science (B.Sc.) (Physics) Programme-The centre conducted Advanced Physics programme for B.Sc. students jointly with Gujarat Science Academy and Gujarat Science City. The programme involved physics experiments, tests, career guidance in physics, visiting research institutions and had a talk with eminent physicists and scientists.
9) Guidance to science projects and models-The centre guided students on making their science projects

(B) School Science Programme-The programme included Open House, School visits, student visits, summer programme, annual programme and annual events.

1) Open House-The open house session was open for all. The session gave opportunity to lay people for exploring facets of science and mathematics at the centre with the guidance of the educators at the centre. There were different

exhibits related to science and mathematics at the centre. The public could try their hands on it and understand the scientific principles. The public could access the laboratories of the centre and can perform basic experiments on physics, chemistry, biology, electronics, model rocketry and mathematics. The premises had varieties of exhibits based on scientific concepts on which pubic could apply their hands and understand the scientific reason behind the working of models.

2) Students' visits-The students availed facilities of the centre's laboratories and did curricular and extra-curricular activities. The centre gave guidance to the students for school projects and projects for science fair.
3) Summer Programme-During summer vacation, the centre organized summer activities based on astronomy, biology, chemistry, computers, electronics, mathematics, model rocketry, physics, general science, robotics, aeronotics and photography.
4) Annual Programme-The annual programme did spread over an academic year and is designed for children of different age groups. The programme consisted of modules on physics, chemistry, biology, rocketry and computers.
5) School Science Forum-This School Science Forum was a syllabus based programme for standard 5 to 9. The aim of this programme was to make understand and strengthen curriculum based topics of science through practicals. The laboratories of the centre were used for such programme.
6) Annual Events-'Science is fun' was one of the important annual events of the centre. This event was for four to five days and was marked by various educational and awareness activities, competitions for different age groups. The activities like science fair, science poster presentation, science photography, science fiction writing, science elocution, science quiz and science talks were organized for students. Astronight, Model Rocketry, Aeronautics and science shows were conducted in this event.
7) National Olympiad Test-VASCSC co-ordinated National Olympiad Test in Physics, Chemistry, Biology, Astronomy and Junior Science conducted by Indian Association of Physics Teachers (IAPT).

(C) Capacity Building Programmes-VASCSC organized Teachers' Training Programmes to promote hands-on approaches and innovative methods in science teaching. The workshops for science and mathematics teachers were conducted to strengthen the understanding of science and to supplement present teaching system through non-formal methods. The demonstration of non-formal activities, experiments and educational games were carried out for primary and secondary teachers. VASCSC helped in setting science activity centres in different schools of the country. VASCSC provided science and mathematics exhibits, models, teaching aids and educational material to schools and other science centres across country. The science educators of the centre gave guidance how to use it.

(D) Thematic programmes-United Nations promoted science by labeling the respective year as a year for particular science subject. E.g. the year 2013, 2014 and 2015 was celebrated as International Year of Mathematics of Planet Earth, International Year of Crystallography and International Year of Light and Light-based Technologies respectively. VASCSC celebrated special talk and workshops on these subjects as per subject of celebration.

(E) Science Popularization Programmes

(1) Science Express-The centre operated and handled Science Express Exhibition Train. It was a joint project with Department of Science and Technology-Govt. of India and other organizations. Science Express was a unique and innovative mobile science exhibition mounted on specially designed train. It chugged across India in phased manner. Each phase was of six to seven months duration. The train halted at respective railway station of the city for three to four days.

The train was a distinct tool for science popularization activities to the people of India. There were total 16 coaches in this train wherein 13 were used for exhibition. There was special coach for kids where games, puzzles and other fun activities were done for them. The concepts of science were taught to kids in an entertaining manner. There was one coach in which 'Joy of Science' laboratory

was there for communicating scientific concepts to primary and secondary school students. The principal concepts of physics, chemistry, biology and mathematics were communicated to students with demonstration. Moreover there were platform activities where public could understand science in simple and lucid manner. There were outreach programmes done in the city where train halts.

(2) Radio programmes with support of Vigyan Prasar and All India Radio (AIR) were produced for sciecne popularization. E.g. For marking celebration of International year of Mathematics of Planet Earth, the centre developed a radio series of 26 episode named 'Ganit Nu Gaurav' based on mathematics with the support of National Council for Science and Technology Communication, Department of Science and Technology, Govt. of India, All India Radio and Vigyan Prasar. The radio programme was aimed to communicate contribution of great mathematicians to the world. The episodes were based on grass root innovators who with their intellectual carved innovative equipments gave value-addition to the resources.

(3) Mathematics is Fun and Science is fun-A special mathematics laboratory was there at the centre which was conceptualized by noted mathematician A.R.Rao. The laboratory had models on different concepts and formulas of mathematics. The laboratories of physics, chemistry and biology also formulated fun based activities on science topics.

4.6.8.3 Important Models used for science education at Vikram Sarabhai Community Science Centre at Ahmedabad

Newton’s cradle-This was a model in Physics which worked on Newton’s laws of motion. Five balls of equal mass were tied at equal distance from suspension. When a force was applied on one ball, only one ball oscillated with a same force applied. All other balls remained stagnant. When a force was applied on two balls, only two balls of either side oscillated with the same force which applied on two balls. This Newton’s Cradle worked on Newton’s laws of motion. When balls were not oscillating, it was in

inertia stage. The first law of Newton states that an object does not move unless external force is applied. Now, when we applied a force to one ball or many balls, the ball/s will oscillate with the force applied. i.e. Newton's second law stated that force is equal to mass of the body and acceleration. Also the third law existed in this case that action and reaction were equal and opposite. The balls accelerated with respect to the force we applied. Thus Newton's cradle worked on principles of Newton's laws of motion.

Brahma's tower- This mathematical fixture was called Brahmas tower. There were disc of three colours-yellow, blue and red. We had to make a tower of disc following the rules: 1) The large size disc should not be placed on small disc. 2) Place one disc at a time. 3) Two discs of same colour should not be placed on one another. As per the mathematical formula, the tower should be built in 2^{n-1} placement. For example, if 5 discs of three colours are taken, the tower can be built in 2^{5-1} i.e. 16 placements.

Figure 4.43: Models used by the centre (1) Newton's cradle (2) Brahma's Tower

(1)

(2)

- Soap mountain-It was an experiment to understand chemical reaction. When a detergent powder, potassium iodide and hydrogen peroxide solution was mixed, a huge mountain of foam was produced with white fumes. This was highly exothermic reaction, initiated within a few seconds. To increase the height of a mountain, detergent was more added.

$2H_2O_2 \rightarrow 2H_2O + O_2$

Hydrogen Peroxide Water Oxygen

4.6.8.4 Learning Aids produced by Vikram Sarabhai Community Science Centre at Ahmedabad

1) VASCSC published original teaching and learning material (TLM) on different science subjects.
2) There were learning aids for mathematics in the form of puzzles and models like $(a+b+c)^2$, $(a+b)^3$ model, $(a+b)^2-(a-b)^2=4ab$ model, $(a+b)^2+(a-b)^2=2a^2+2b^2$ model, $a^2-b^2=(a+b)(a-b)$ model, Phythagoras theorem model, parking puzzle, Brahma's tower, make a square, etc.

4.6.8.5 Response of the students for the activities of Vikram Sarabhai Community Science Centre at Ahmedabad

The researcher took a sample of 9 students of standard 8 and 9 who were enrolled in summer batch activities of the centre in different subjects of science. The students told that the environment of the centre was friendly and cordial. The centre carried science activities which was interesting and fun. Hence they were attracted to come to the centre. They opined that science educators explained the scientific concepts and its working models in a lucid and clear manner. They told that the exhibits at gallery were simple to understand.

4.6.8.6 Publications of Vikram Sarabhai Community Science Centre at Ahmedabad

The centre published learning materials in science and mathematics teaching and gave guidance to teachers regarding preparing hands-on activities and models. There was Science Shop at the centre from where educational materials were sold.

It published Vigyan Drishti, a bi-monthly science wall magazine in Gujarati for standard 5 and above. It covered topics on scientific concepts, reason behind occurring these concepts, mathematics puzzles and quiz. A science wall planner based on United Nation's theme of celebration was published annually which covered days of scientific relevance, birth anniversary of scientists and astronomical event. The centre published articles and

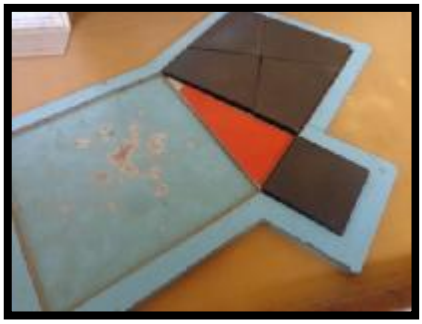
information on scientific concepts and posters of events of astronomy and scientific days. The centre had publications on general science for standard 5 to standard 11 like Drashtibhram-Ek Anokho Sangrah, Vaignanik Dr Vikram Sarabhai, etc.

4.6.8.7 Photos of Exhibits of Vikram Sarabhai Community Science Centre at Ahmedabad

Vikram Sarabhai Community Science Centre at Ahmedabad had different exhibits to understand science in non-formal method. Different exhibits are explained here.

Figure 4.44: Exhibits and models at the centre (1) Crazy cubes (2) Pythagoras theorem (3) Chaotic Pendulum (4) and (5) Understanding mathematics equation (6) Geometrical shapes

(1)



(2)

Figure 4.44(1): The puzzle is called crazy cubes. Here four cubes are provided each with different colour scheme on it. The objective of this puzzle is to arrange the cubes horizontally in a cuboids of size 1*1*4, such that no colour is repeated along any longer side. In all four cubes, out of 24 faces, seven faces are red, six faces are blue, six faces are green and five faces are yellow. To arrange them in the required way, we need each of the four colours only four times. This makes it clear that we have to hide three red faces, two blue faces, two green faces and one yellow face to obtain the required arrangement.

Figure 4.44(2): Pythagoras theorem can be explained with this arrangement. The theorem says that in a right triangle, the square on the hypotenuse is equal to the sum of the squares on the other two sides. We have a fixed right triangle and a square area on each of its sides in a tray and we also have five pieces-four congruent quadrilaterals and one

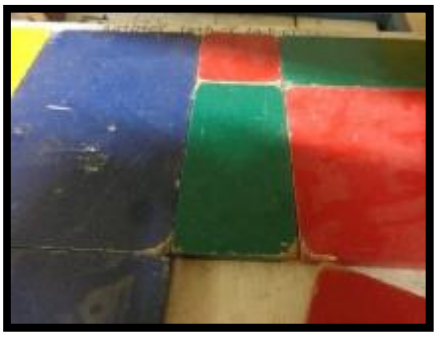
small square. Arrange the four congruent quadrilaterals to fit in the area formed by one of the sides of the triangle containing right angle and the small square piece in the area formed by the other side. Rearrange all five pieces in the square area formed by the hypotenuse of the triangle.

(3)

(4)

Figure 4.44(3): This exhibit is called chaotic pendulum. Move the pendulum at an angle of 20 to 40 degree. Watch the movement of both arms of pendulum. When the movement has slowed down, start the pendulum again. Try starting the pendulum from different angles and see how it behaves. Start the pendulum again and remember the starting angle. Try to memorize how the mass on the outer arm moves. After a while, the motion of the pendulum will have died down and it can be started again. Start from the movement of the previous run. On repetition, you will not be able to make the pendulum move in the same way as it did before, regardless how accurately you have chosen the same starting position again. In fact, you will hardly be able to predict the movement of the pendulum even for a short period of time. This is because even the tiniest amount of difference in the initial position of the pendulum will result in a completely different movement of the arms. Systems behaving this way are called chaotic pendulum.

Figure 4.44(4): The mathematical equation $(a+b)^2-(a-b)^2=4ab$ can be made understand with this arrangement of wooden pieces.



(5) (6)

Figure 4.44(5): The mathematical equation $(a+b+c)^2$, $(a+b-c)^2$ and $(a-b-c)^2$ can be made understand with this arrangement of wooden pieces.

Figure 4.44(6)**:** Various geometrical shapes can be taught with this customized model.

Figure 4.45: Exhibits at the centre (1) Parabolic Disc (2) Exhibition at Science Express Train

(1) (2)

Figure 4.45(1): This is called parabolic disc. Facing the disc, speak softly near the yellow ring. A person standing near the other disc will hear your voice clearly, especially near the yellow ring. This is due to parabolic structure of a ring.

Figure 4.45(2): Exhibition in the Science Express Train

4.6.9.0 Uniqueness of Vigyan Nagari at Bhavnagar

Vigyan Nagari had uniqueness which helped in imparting non-formal science education.

4.6.9.1 Constituents of Vigyan Nagari at Bhavnagar

Vigyan Nagari had different constituents which were used for science education.

1) Halls of Science or Science Gallery-There were exhibit and working models based on scientific concepts.
2) Science Park-In Science Park, exhibits based on scientific principles were kept for students and public.
3) Energy Park-The Energy Park consisted of exhibits which gave message for energy conservation, alternative sources of energy and energy saving.
4) Planetarium-There was mini planetarium for astronomy education.
5) Dream City (Swapna Nagari)-It was a place where small children of age 1 to 6 play on exhibits which were based on scientific concepts.
6) Environment Park-There were different species of plants, trees as well as medicinal herbs and shrubs which are meant to educate about environment, biology, medicinal importance and kitchen garden.
7) Mathematics and Puzzle Gallery-In this gallery, mathematics puzzles were there to understand scientific principles and concepts.
8) Laboratories-Vigyan Nagari had laboratories of Physics, Chemistry, Biology and computer subjects.
9) Video Unit and Studio-There was film-making studio where science programmes were produced which were shown in local cable network.
10) Computer Unit-The students were trained in basic computer courses.
11) Mobile Service Van-There was mobile van in which exhibits and working models are there. This mobile van went to rural schools and made understand science concepts, performs demonstrations, spreads message of eradicating superstitious

beliefs by showing experiments on how people were made foolish under garb of miracles.

12) Creative Room-The students learnt chess, music, art and craft, spoken English as well as prepare for competitive exams.

4.6.9.2 Own Programmes of Vigyan Nagari at Bhavnagar

(1) Science Olympiad-Vigyan Nagari organized Science Olympiad for students of standard 4 to 10. The students got practice on science, mathematics and computer subjects through this contest.

(2) Audio-Visual Programme Production-Vigyan Nagari produced television programmes on education which were broadcast on local cable television. The children were given training for theatrical performances for developing scientific temperament through enacting plays.

4.6.9.3 Response of the students for the activities at Vigyan Nagari at Bhavnagar

The researcher took a sample of 23 students of standard 8 to know the response of activities of Vigyan Nagari. The activities like demonstration of experiments at biology, chemistry and physics laboratories as well as understanding exhibits at Hall of Science, film show at auditorium and lecture series on the occasion of National Science Day were taken for the study.

The table 4.13 shows the response of the students for activities at the centre.

Table 4.13: Response of the students for the activities of Vigyan Nagari at Bhavnagar

Sr. No.	Statement	Response	Frequency	Percentage
1.	Satisfaction with the learning method of the instructor	Yes	23	100
		No	00	0
2.	Satisfaction with content knowledge of the instructor	Yes	23	100
		No	00	0
3.	Satisfaction with the management of activities	Yes	23	100
		No	00	0
4.	Satisfaction with the time duration given for activities	Yes	23	100
		No	00	0
5.	Satisfaction with the available facilities for activities	Yes	23	100
		No	00	0
6.	Satisfaction with overall services of the centre	Yes	23	100
		No	00	0
7.	Understanding of exhibits, models, graphics and charts	Simple	16	70
		Complex	09	70
8.	Language of text to understand the exhibits	Simple	19	83
		Complex	04	17

From table 4.13, it was concluded that,

- All students were satisfied with the learning method and content knowledge of the instructor, management of activities, time duration of activities, facilities for activities as well as overall services of the centre.
- 70 percentages of students told that the centre's exhibits, models, graphics and charts were simple to understand.
- 83 percentages of students felt that language of text to understand the exhibits was simple.

The students opined that the preservation of organs of body in the laboratory was good to observe. The students responded that glossy charts and graphics of biology was a good learning material. The students told that hands-on experiments infused interest in science. The working of exhibits made scientific concepts easy to understand. They told that learning with friends at the centre made their networking skills strong.

4.6.9.4 Response of the teachers for the activities of Vigyan Nagari at Bhavnagar

The researcher took a sample of 17 teachers to know the response of activities of Vigyan Nagari like demonstration of experiments at biology, chemistry and physics laboratories as well as visit at Hall of Science, film show at auditorium and lecture series on the occasion of National Science Day were taken for the study.

The table 4.14 shows the response of the teachers for conduction of activities.

Table 4.14: Response of the teachers for the activities of Vigyan Nagari at Bhavnagar

Sr. No.	Statement	Response	Frequency	Percentage
1.	Satisfaction with the learning method of the staff	Yes	9	53
		No	8	47
2.	Satisfaction with content knowledge of the instructor	Yes	6	35
		No	11	65
3.	Satisfaction with the management of activities	Yes	11	65
		No	6	35
4.	Satisfaction with the time duration given for activities	Yes	15	88
		No	02	12
5.	Satisfaction with the available facilities for activities	Yes	17	100
		No	00	0
6.	Satisfaction with overall services of the centre	Yes	17	100
		No	00	0

From 4.14, it was concluded that,

- 53 percentages of teachers were satisfied with the learning method of the staff.
- 35 percentages of teachers were satisfied with content knowledge of the staff.
- 65 percentages of teachers were satisfied with the management of activities.
- 88 percentages of teachers were satisfied with the time duration for activities.

- All teachers satisfied with the facilities for activities and overall services of the centre.

The teachers appreciated the efforts of Vigyan Nagari in popularizing science. They told that organs of human body and spacious exhibits at the laboratory were a great resource for science education. They told that lectures were educative and students got a feeling of free-choice learning. The teachers told that municipal schools did not have atmosphere of understanding science through experiments. The school had equipments to perform experiments but did not have laboratory where they could perform them. Also the schools did not have specific chemicals and materials for performing experiments. E.g. chemicals for performing chemistry experiments were not there in schools. Thus Vigyan Nagari filled the gap and performed experiments with different chemicals and showed demonstration of experiments.

Vigyan Nagari was a good option for understanding scientific experiments and it fulfilled diverse need of the schools. In schools there was time limit. But in Vigyan Nagari and other science centres there was no time limit to study. The content in the textbook was restricted to specific standard of the school while in Vigyan Nagari students could have value addition to the textbook knowledge. The teachers told that some staff members did not have strong knowledge on the subject. The activity was poorly managed. The teachers told that the centre should use its infrastructure and resources more efficiently for science education. They suggested to increase the activities so that resources of the centre could be used maximum.

The teachers were also of the view that Vigyan Nagari is doing business of education by selling ready-made kit which has become money-minting activity. They told that by putting exotic exhibits they are trying to portray schools in an inferior way. However teachers appreciated the centre's efforts for providing kits for project as student easily get resourceful kit at the centre. They suggested that the centre should provide hard-core science activities like Vikram Sarabhai Community Science Centre in Ahmedabad.

4.6.9.5 Response of the public for the activities of Vigyan Nagari at Bhavnagar

No general public visited Vigyan Nagari during the time of data collection. Hence, the researcher had not taken response of the public.

4.6.9.6 Publications of Vigyan Nagari at Bhavnagar

Vigyan Nagari published a monthly magazine called Science Express. The magazine contained articles on science topics, quiz and information on science and mathematics subjects. A special kit called ‘Do It Yourself Kit’ was developed by Vigyan Nagari so that students can do experiments on their own. Vigyan Nagari had vast array of educational books and audio-visual materials which were available at Science Shop of the organization.

4.6.9.7 Photos of Exhibits and Activities of Vigyan Nagari at Bhavnagar

Vigyan Nagari at Bhavnagar had different activities and exhibits to understand science in non-formal method. Different activites and exhibits are explained here.

Figure 4.46: Exhibits at the centre (1) Centripetal and Centrifugal force (2) Periodic table (3) Sola light house (4) Weighning measurements for different planets (5) Tenagram puzzle (6) Chart explaining acid and base (7) Human heart (8) Human lungs (9) Explanation of mechanical energy (10) Cartoon explaining inertia

(1)

(2)

Figure 4.46(1): The exhibit for children explains the concept of centripetal force and centrifugal force.

Figure 4.46(2): The entrance gate of Vigyan Nagari is decorated with periodic table.

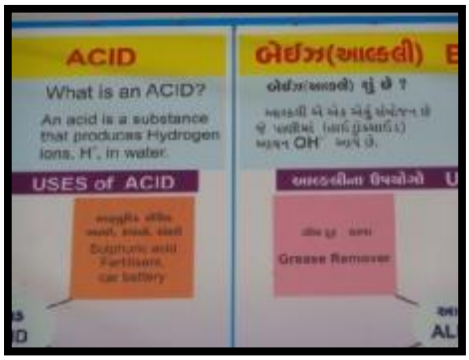
(3)

(4)

Figure 4.46(3): The exhibit of solar light house.

Figure 4.46(4): This is an exhibit from which we can able to know our weight from our planets of our solar system.

(5)



(6)

Figure 4.46(5): This is a tenagram puzzle where we have to arrange seven pieces to make a square.

Figure 4.46(6): Chart showing the concept of acid and base.

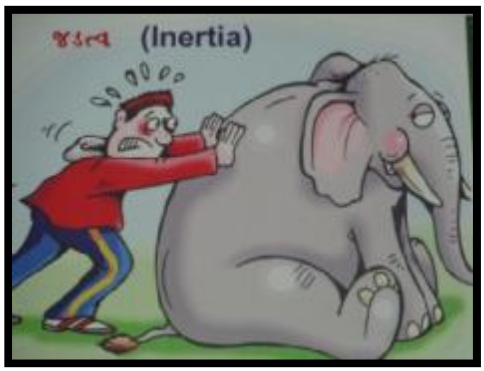
(7)

(8)

Figure 4.46(7): Human heart is preserved in the biology laboratory.

Figure 4.46(8) Human lungs are preserved in the biology laboratory.

(9)



(10)

Figure 4.46(9): The watering in plants done with the help of bicycle. This explains the concept of mechanical energy.

Figure 4.46(10): The figure explains the concept of inertia.

Figure 4.47: Explanation of models and experiments at the centre (1) Air Pressure (2) Persistence of vision (3) Brain nerves (4) Yo-Yo (5) Jerk (6) Chemical reaction

(1)

(2)

Figure 4.47(1): Two balls are hanging. Whiff the air in between the two balls. The two balls will come closer. The air pressure which is there in between the two balls becomes low. Thus, two balls comes closer which proves that the object projects from high pressure to low pressure.

Figure 4.47(2): This exhibit explains the concept of persistence of vision. Push the switch and observe. Press the switch on the model and you will see that the assembly (of two discs and strings which are binding horizontally and in angle) will rotate. Now it will look like drum because of persistence of vision. Persistence of vision is a defect of the human eye wherein if more than 16 changes occur in front of the eye, the brain will not be able to see these events as different ones but will merge them into one. This principle

is used in movie in which more than 16 pictures are shown in one second. But all characters seems living because of persistence of vision.

(3)

(4)

Figure 4.47(3): Hold the dowel with each hand. While looking in the mirror from one side, move the dowel in the other side. When your brain expects to see one thing and is presented with something quite different, peculiar sensations will be sensed by you. Your brain is forced into thinking that the image it sees in the mirror is actually of your other hand. When you move that hand, your brain naturally expects to see that hand moving. The messages from the nerves in that hand tell your brain that the hand is moving. The hand's apparent failure to move is profoundly disturbing to your brain.

Figure 4.47(4): This exhibit explains the working of Yo-Yo. Keep a wheel in middle and hold the rod from both ends with both hands. Now wrap the string on rod. Now the wheel is at upside so the potential energy is there. Leave the wheel and it will turn freely. It will go up to down till the friction will allow. This potential energy will transform into kinetic energy and vice-versa.

(5)

(6)

Figure 4.47(5): A bulb and a bucket are taken. A bucket is placed on table. A bulb is thrown in a bucket. The bulb was supposed to break but it does not. The reason is the bucket is on table and not on the floor. The bulb only collides with the base of bucket only and jerk is absorbed by the base of the bucket.

Figure 4.47(6): This experiment explains the characteristics of carbon-dioxide that is used as extinguisher. When Calcium Carbonate ($CaCO_3$) is mixed with hydrochloric acid, it releases carbon-dioxide.

4.7.0 OBSERVATIONS DURING THE RESEAERCH STUDY

The researcher had observed various activities organized by Community Science Centres. He also did overall observations of management of activities, infrastructural facilities and human resources management of Community Science Centres. The observations of the researcher are as follows.

- The science centres had different tools like charts, animated cartoons, film shows, astronomy education activities and demonstration of experiments to impart non-formal science education. The lecture and demonstration method were used during conduction of activities at science clubs for school students. The interactive exhibits, popular science lectures, astronomy events and environment awareness programmes were major activities for general public.

- One of the important tools of science centres was models and exhibits. There were small and huge working and non-working exhibits in science centres which were used to understand scientific concepts. The students were attracted with models and exhibits. The schools did not have such type of exotic exhibits for imparting science education. The students understood scientific concepts with fun with performing hands-on experiments on exhibits. The public could update and revised the knowledge on science by visiting centres and participating in its events. Thus science centres contributed in science education with sprinkling of fun and entertainment.

- All nine Community Science Centres had small and large exhibits which were conceptualized to learn scientific principles. It was observed by the researcher that Community Science Centres in Vadodara, Anand, Dang as well as Vigyan Nagari at Bhavnagar had common exhibits on subjects like illusion and optics. There were varieties of exhibits on these two topics only. It was observed that science centres remained complacent by showcasing only exhibits and became inactive in infusing scientific temperament in students and public. They remained inactive in

science popularization because of lack of institutional vision in science education, few activities, lack of staff and resource persons as well as less support from students, teachers and public.

- Community Science Centre at Vadodara and Vikram Sarabhai Community Science Centre at Ahmedabad had regular and summer vacation science club activities because these centres were very resourceful in terms of staff, resource persons and infrastructure. In other seven science centres, there were no regular and summer vacation science club activities because there were no specialized resource persons who knew activities for robotics, craft, making scientific models and toys as well as mathematics. There were no science educators and science communicators who could be resource persons for doing non-formal science education activities as in regional science centres.

- All Community Science Centres had fixed working hours. However, Community Science Centre at Amreli and Community Science Centre at Dang did not worked for whole day. Community Science Centre at Amreli remained open only for few hours in morning and evening while completely closed in the afternoon from 12 to 5 pm due to unavailability of staff members. The people did not take interest in gaining knowledge from the science centre. Community Science Centre at Dang also faced the same problem of not working for the full day time. When the staff and head were on leave, it remained closed as there was no human resource to take care of the centre.

- The researcher observed that staff of all nine science centres explained the scientific concepts in a clear manner. But in case of Community Science Centre at Amreli, during the activity on astronomy education activity at planetarium, while explaining the constellations with a simile method, the resource person did not clarified with students that in real sense, there was no hunter (simile for Orion constellation), lion (simile for Leo constellation and horse (simile for horse

nebula) in the universe. The resemblance was shown only to show interest in astronomy. The resource person did not clarify and thus students were misguided.

- The researcher came to the conclusion that all nine Community Science Centres conducted non-formal science education activities remarkably. But due to lack of technical resources and inability to manage activities properly, the activities were not conducted properly. For e.g., Community Science Centre at Amreli organized a mathematics quiz called 'Kaun Banega Mathematician' on the occasion of birthday of noted mathematician Ramanujan. The researcher observed that the quiz was poorly managed. There was lack of resources like projector, scoreboard and proper anchoring. Due to lack of these, the quiz was turned into an informal question and answer session. There was chaos during the quiz show. The students and teachers were confused with the organization and poor management.

- Hands-on experiments were important tool for making understand scientific concepts at science clubs. In case of Community Science Centre at Vadodara, the concept of hands-on experiments was not really utilized. Students did the activities like drawing and painting as well as web-kids on their own while in model making, the staff member of the science centre or the resource person performed the experiments. This was because the model making activity required skills for making the specific models. The students were not mentally prepared to make scientific toys like periscope, kaleidoscope, multiple refraction and flying squirrel. The resource person or staff member had the skills to make the scientific models and toys and thus he made them for students who were enrolled for that specific batch. However, in case of robotics activity for students of standard 5 to standard 9, the students made robotic equipment on their own. The resource person only guided them to make it. Thus the researcher concluded that in activities like model making and scientific toys making, the technique of hands-on experiment was not fulfilled during summer activities. In model making also, the staff member of the science centre or the resource person performed the experiments. This was because the model making activity required skills for

making the specific model which students found difficult to handle. The students were not mentally ready to make models.

- Vigyan Nagari at Bhavnagar was inactive in organizing activities for science. The organization had very few activities to offer to students. The centre did not promote itself to create awareness on its objectives of science popularization. The organization did not utilize their laboratories and other science educational resources to its full strength. Vigyan Nagari had not focus on science education for public. The public programmes were restricted only to special days' celebration like World Environment Day, National Science Day and astronomy events. The public did not visit the centre for gaining science education. The centre faced stiff competition from Kalyan Community Science Centre, a regional Community Science Centre under GUJCOST.

- The researcher found that the behaviour of staff members of all nine centres was very cordial during demonstration of science education activities. The students were also sincere and paid attention to the activities. However there was murmuring followed by shouting during demonstration of experiments. The topics of activities at all nine centres were not based on the syllabus of the schools. However some topics and its experiments were related to syllabus which was merely co-incidental. The text of exhibits and models of all nine Community Science Centres were in English and Gujarati. So the students and public could easily understand the principles behind the models.

- Gujarat Science City at Ahmedabad was an important organization for the popularization of science. All the constituents and sections were effective means for communicating science. It was a complete package of science, entertainment, education and tourism. The exhibits were prepared for education and entertainment. The method of simulation, working models, gigantic exhibits and films were excellent tools for understanding scientific concepts. The mission of edutainment was being fulfilled. However, the researcher found that Gujarat

Science City was positioned itself more as a tourist destination and thus the objective of science education had taken a back seat. Thus, the hardcore learning for science was not accomplished. Though Gujarat Science City was meant for science education in non formal way coupled with entertainment, yet it did not have hardcore science education activities like demonstration of experiments for children.

- The researcher observed that Gujarat Science City at Ahmedabad and Community Science Centre at Dharampur boast of too many working models and exhibits. All the panels and exhibits at halls and sections were loaded with information and knowledge. The students and public were confused with heavily stacked scientific concepts and information. It was too heavy for them to collate knowledge of all disciplines of science.

- The students did not pay attention to learn scientific principles from exhibits which were placed in halls of science and science parks. They roughly touched and handled the exhibits. However, the exhibits did not get badly affected because it was protected and covered with glass structures. The students responded that they consider the exhibits and models as their own property and in enthusiasm they behave in that manner. The students jostle to play with interactive exhibits and in this mess the science learning was vanished. The students pressed the 'on and off' button of the working models and walked away from the exhibit. They had a fight with each other for doing demonstration with interactive exhibits. It was also found that most of the students and public did not read the text which was meant for understanding the exhibits. The staff personnel and teachers responded that the nuisance by students and public was not good and discipline should be maintained but they also agreed that students get stimulus of learning the concept of science after the visit at the centre. The staff of the centres responded that although the nuisance was there in all the science centres, they took this problem in a positive manner. They said that whatever may be their

behavior towards the exhibits, they also learn the concepts and principles of scientific principles from the same exhibits, which was enough for the centre.

- The staff of science centres, where huge exhibits are placed in hall of science and science park, especially in Community Science Centre a Dharampur and Gujarat Science City at Ahmedabad, did not communicate the scientific concepts of exhibits to students and public. They remained inactive in attending students and public. The staff responded that, due to interactive panels and working models, they were rest assured that public will understand by themselves. They told that all exhibits were self-explanatory and so students and public did self-learning. The researcher observed that the staff of centres was engrossed in administrative work so much that the objective of science communication and imparting non-formal education to public was not fulfilled. However, in Gujarat Science City the instructor was kept to explain the coal mine activity and interpretation of Nobel Exhibition.

- The researcher observed that the pubic did not show interest in understanding the concepts of science. They considered science as 'teaching subject' and not as an important aspect of life. They came to Community Science Centres for entertainment. They were not able to digest the knowledge about science.

- The researcher concluded that students and public visited the Community Science Centres, especially Community Science Centre at Dharampur and Gujarat Science City at Ahmedabad as they were attracted by huge exhibits and film shows at planetarium as well as IMAX theatre. They were attracted for the visit because they were mesmerized with humongous models, simulation ride and film shows. Mostly they were spell bound by astronomy film shows and images of celestial objects, especially Jupiter and Saturn planets. However when all Community Science Centres organized the public observation of planets with the help of telescope they were confused between telescopic view of planets and multimedia images. The centres had tried to convey the difference between these two images.

Thus, due to fascination, science education was not given priority by students and public and science centres had to make efforts to educate them on astronomy.

- The public did not come to Community Science Centre at Dang though it is located in Ahwa, a district headquarter. There were different government offices and a playground near the science centre. It was found that though people came to playground and government offices, yet they did not visit the science centre. The school teachers and parents of the district were very much orthodox and did not inspire their students for learning and. They were not interested in the non-formal education at the centre. The teachers, students, parents and public were engaged in their own livelihood that they do not care to learn science at the centre. Also, the transport facility in Dang was very less. This was also one of the reasons that people did not visit the centre. The centre faced problems in conducting science education programmes as it was situated in tribal district. The building of the centre was also in a dilapidated state. The hall of science where exhibits were placed was a good place to learn science but the working models were also in bad condition and they did not work properly. It was very hard to organize the programmes as there were no resource persons available for conducting science communication activities, public science lectures and workshops in Dang. The tribals were also not interested in learning science. But still the centre worked very hard and its staff tried to make aware students and public.

- All nine Community Science Centres was found inactive in arranging science programmes on daily basis due to lack of institutional vision in science education, staff, head and non-formulation of activities. The research concluded that working exhibits and demonstration of scientific experiments were specialties of science centres except Community Science Centre at Amreli and Gujarat Science City at Ahmedabad. Community Science Centre at Amreli did not have working exhibits and demonstration of experiments. Gujarat Science City did not had demonstration of scientific experiments. The researcher founded that centres carried out its activities as compulsion as it was necessary to organize compulsory

programmes assigned by GUJCOST to use the grant. Community Science Centres took help of different non-governmental organizations for popularization of science.

- The laboratories of Vigyan Nagari were very much beneficial to students. In some schools of Bhavnagar, there were no laboratories while in other schools laboratories were there but schools did not have resources and required chemicals for scientific experiments. The schools lacked apparatus, chemicals and skilled manpower for performing experiments. In Vigyan Nagari, there were apparatus, chemicals and skilled manpower to perform scientific experiments. The diverse needs of students in science experiments were fulfilled there. It was found that the resources in laboratories, Hall of Science, library and Science Park of Vigyan Nagari remained unutilized as staff did not utilize apparatus and materials for demonstration of experiments and learning to its full strength. The public did not care to use such resources for learning. The researcher came to conclusion that the organization was in nascent stage and thus it had still not chalked out concrete plans of non-formal science education. However, the campus was spacious and infrastructure facilities were proper. Vigyan Nagari had young science graduates and engineering diploma holders who taught at the centre. Thus it gave opportunity to young people to make a career in science communication.

- The researcher observed the quiz competition under Darshak Lokganga Project organized by Lokbharti Community Science Centre at Kantharia Primary School located at Kantharia village of Vallabhipur taluka in Bhavnagar district. The researcher also observed Biodiversity awareness programme and science film show organized at this school as well as sensitization programme for Talati cum Mantri for communicating activities of Lokbharti Community Science Centre. During the activities, the leadership style of the staff member was democratic. His behaviour was positive and he was well versed with content knowledge of the subject. The language of the instruction was Gujarati which was fluent enough to understand.

- Vikram Sarabhai Community Science Centre at Ahmedabad did not allow researcher to observe centre's activities in their laboratories citing their policy regulations. However, the researcher knew some activities of the centre as he was associated with Science Express Train as science communicator in 2013. There were hard-core science activities which were very innovative which children could learn science in an easy manner. The activities like double cone, Brahma's tower, mathematics puzzles and scientific experiments were very much useful for learning.