Technical Report No. I (02-03)

Using Posters to Understand Students' Ideas about Science and Technology

Swati Mehrotra, Ritesh Khunyakari,
Sugra Chunawala and Chitra Natarajan

HOMI BHABHA CENTRE FOR SCIENCE EDUCATION
TATA INSTITUTE OF FUNDAMENTAL RESEARCH
February 2003

Technical Report No. I (02-03)

Using Posters to Understand Students' Ideas about Science and Technology

Swati Mehrotra, Ritesh Khunyakari
Sugra Chunawala and Chitra Natarajan

HOMI BHABHA CENTRE FOR SCIENCE EDUCATION
TATA INSTITUTE OF FUNDAMENTAL RESEARCH

February 2003

Acknowledgements for cover illustrations:

1. Arpan Bandopadhyay (Std. VII, Apeejay School, Nerul, Navi Mumbai)
2. Snehal A. Agharkar (Std. IX, New English School, Thane)

Acknowledgments

The opportunity for collecting the data for this study was provided by the celebration organised on the occasion of the National Science Day at the Homi Bhabha Centre for Science Education. We are grateful to the organisers of the events, in particular to Mr. A. D. Ghaisas, for involving us in administering the poster competition and giving us all the freedom in choosing the themes.

We are grateful to all the project assistants, scientific staff members and the administrative staff of the Centre for their help in conducting the poster competition and administering the questionnaire. We owe special thanks Mr. A. T. Mavalankar, Mr. Manoj Nair and Ms. Rakhi Banerjee for their assistance in several aspects including the task of judging the winners, and to Ms. Shweta Naik and Ms. Aruna Khamkar for the translation of the questionnaire and its typing..

The students, who came from about 25 schools, spread out across the city and its suburbs, participated most enthusiastically in the competition and even stayed back to answer the questionnaire. We are grateful to them for their co-operation and to their parents and guardians who had accompanied them and patiently waited for their wards to complete.

Converting the data embedded in the competition posters into a coherent report on students' ideas about science and technology involved several tasks. We thank Prof. Arvind Kumar, Centre Director and Prof. H. C. Pradhan, Dean HBCSE Faculty for their critical comments during the analysis of posters and seminar presentation, and the Centre's academic staff for their encouraging remarks. An assistance that gave shape to the study in the report form is the photocopying by Mr. G. Mestry and Mr. J. J. Tambe, to whom we are thankful.

The study has been nudged along by our participation in an international project on multi-lingualism, where we share with its other participants an earnest desire for all young people to be able to freely express themselves in a multiplicity of ways. The report has been enriched by the insights and inputs of Carole Bloch, Dr. Suman Karandikar, Dr. Anita Patwardhan and Dr. Aruna Giri.

Education can get closer to its lofty goals of helping to create human resources only if students can express themselves freely and creatively through language and other symbolic forms, design, drawing and constructive pursuits. The posters the students made give a glimpse into the richness of students' thoughts, imaginations and aspirations, in this case about science and technology.

SM, RPK, SC, CN

Contents

List of Figures

Chapter 1

Introduction

Since the age of cave dwellers, long before language came into existence, humans have used drawing and painting to communicate their ideas. Among other things, cave paintings have served as links to the modern times; links that we use to trace the evolution of human traditions and culture. Thus, paintings not only portray aesthetic art but also disseminate knowledge through generations. According to Tony Godfrey (2002)

> *Drawing is not just a medium or a technique: it is a human activity with a rich and complicated history.*

Even today, the visual arts in one form or the other are widely used for communication. Art continues to captivate the human mind. The skills related to art develop in each individual with age. Emmalou Tilburg (1987) says, "From ancient drawings in the cave to children's drawings, pictures express what people see on the outside and feel on the inside."

1.1 *Children and drawing*

The skills of drawing and craft are imparted as part of most school curricula, recognizing children's need to express themselves in a variety of forms. It would be interesting to see what children may derive from exercising their skills, and also what we may learn about children from their drawings.

Why children draw

Children may draw to satisfy a variety of needs: to satisfy their natural curiosity of exploring the world around them to expressing their feelings about or knowledge of the world.

Sensory exploration: Children explore the world through their senses. Sensory exploration is a healthy part of growing up. Natural curiosity in children leads to imaginative thinking and creativity. Sight is obviously an important sense for children, but the other senses are just as crucial. It is not enough for children, or even adults, to just look at well-designed objects − they need to feel, touch and explore. They also need to be able to appreciate and realize the objects. Sensory exploration combined with drawing leads to communication. Children explore their environment and express it through their drawings.

Expression of thoughts and feelings: Frustration and other kinds of emotions are likely to arise in young children and they may not be able to deal with them and express verbally as adults do. Often, children use art activities as a means of expressing themselves. Besides portraying the artists' feelings, ideas and thoughts vividly, as well as appealing to the aesthetic sensibilities, drawing is a window to the artists' personality. On the other hand, symbols used in the visual arts in general, and in drawings, sketches and posters in particular, have become integral to expressing and communicating scientific ideas.

Reflection of knowledge: Sometimes children's drawings are representations of the world as they know it. Children attempt to depict what they see and know quite faithfully. The activities that children see around them influence them in ways that are clearly reflected in their drawings. For the most part, children put into their drawings their experience and objects which are of importance to them. In a study among Indian middle school students, it was found that students often drew their favourite fruits and flowers in relatively larger proportion with repect to the plant (Natarajan et al, 1996).

Studies show that drawings by children and adults serve to communicate the individuals' learning potential. A study by Molich and Rolf (2000) on ideas about multimedia, showed that in contrast to interviews or think-aloud-tests where the users talk about the multimedia while using it, drawing can be used for reflection and expression of graphical experiences.

This aspect is made use of in the teaching and learning of science. When children draw, they can reproduce the visualization and represent the meaning of the activities and dynamics of a scientific process or concept. This also helps them to talk about the concepts, as they point at the drawing and develop related words and meanings. The drawings are therefore useful if they have elements that enable children to explain the dynamics and make it easier for them to put words to their learning content.

Developmental theories about children's drawings

Are there age-related stages in drawing development? Several theories have been formulated to explain the stages of artistic development in general, and the development of children's drawings in particular. Lowenfeld's (1947) theory of artistic development comprises of 5 stages.

The *scribble stage (2 to 4 years)* is the period of orientation. In the *pre-schematic stage (4 to 6 years)*, circular images with lines appear, which seem to suggest a human or animal figure. Three more stages follow.

Schematic (7 to 9 years): The child in this stage becomes aware of the concept of space. Objects in the drawing have an apparent relationship to what is up (skyline) and

what is down (baseline). Sometimes the objects appear to be drawn upside down. In what is termed as an "X-ray" picture, the object is depicted as being seen from the inside as well as the outside.

Dawning Realism (9 to 11 years): In this stage, there is an upsurge in self-awareness to the point of being extremely self-critical. Realism does not mean "real" in the photographic sense, but indicates the child's experience with a particular object. Perspective is another characteristic of this stage.

Pseudo-Realistic (11 to 13 years): In this stage, the product becomes more important to the child than the process of creating the visual art,. This stage is marked by two psychological categories of individuals: "visual" individuals (influenced by visual stimuli) and those relying largely on subjective experiences.

Hurwitz and Day (1995), who state that the development occurs in "stages of graphic representation," elaborate the last three stages in Lowenfeld's theory differently.

Symbol-Making Stage (Ages 6-9 years): As children evolve through this stage more details begin to appear in their drawings, like the use of multiple baselines with a variety of symbols to express a more complex and continuous thought within the same composition.

Pre-adolescent Stage (Ages 10-13 years): In this stage caution and self-criticism begin to appear in children's artwork. Children develop interest in details, perspective, use of colour, and art techniques, which make the drawing activity exciting for them. They try to exploit the techniques that can add to the aesthetics of their drawings.

Other contributors to the theory have also tried to explain the progressive development trend observed in children's drawing in different ways. Willats (1997) found a developmental sequence in children's ability to take perspective into account in their drawings. In his study, seated children were asked to draw objects placed before them as they saw them. Nine-year-old children attempted to represent depth of objects in their drawings and young adolescents drew oblique lines representing edges receding in space, but not converging. Our own findings, where 10 year-old students in the junior group tried to depict the depth of objects (bookshelf, table, models, etc.) in their posters, agree with the above results.

<u>Cognitive understanding of children's scribbles</u>

In order to gain an insight into children's ideas through their drawings, it is necessary to understand the initial development of drawing patterns among children. Two approaches have been proposed to explain the initial developments in drawings of children: Kellog's Gestaltist approach and Karmiloff-Smith's modular approach.

Rhoda Kellogg (1969) believes that scribbles are the first signs of children's progressive development in drawings. She has identified up to twenty different basic scribble patterns (lines, patches, circular blobs, spirals, and other definite shapes), which are the basic building blocks of later graphic development. Basic scribbles combine to form intermediate pre-representational structures, which in turn combine to form representational forms like people, sun, flowers and trees. These events reflect the developments in the child's cognitive domains.

In contrast to the earlier propositions, according to Karmiloff-Smith's modular approach, pictures appear first (not scribbles) and the mental representations are not coherently organised. Children's drawings are restricted to the 'habitual' (e.g. stereotypical drawing in young children) and they find it difficult to extend their imaginative and creative potential beyond their previously formed mental images. (Karmiloff-Smith, 1990; Zhi et al, 1997).

In due course, children's drawings show gains in organization, detail, and representation of depth. Several tests have been devised that can indicate the stage of a child's intellect and cognitive development (Roger Wales, 1990). One such test is based on the studies conducted to understand young children's ability to "Draw-A-Person". A specific developmental sequence was observed in children's drawings of a person. Their earliest productions consisted of an irregular "tadpole" figure. In course of time, the child elaborates the figure by adding features like a trunk, or features to the trunk. The "Draw-A-Person" test has been introduced as an intelligence test as long ago as 1926 (Goodenough, 1926). In fact children's drawings are often used to analyse children's personalities (Tilburg, 1987). Piaget also asserts that the process of elaboration in children's drawing favours the progressive restructuring of the child's cognitive structures (Piaget, 1972).

Most theories suggest that children's drawings progress from scribbles, through simple forms to more complex graphic structures, which allow more natural representations of the 'real world'. However, according to Goodnow (1977) and Freeman (1980) certain factors, like graphic, conceptual and resource constraints operate while children draw. The drawings are affected by how children see visual/physical relations, how well they control their physical movements, how they are able to place the layout of their drawing on the paper, and how they understand what is being asked of them. Thus, the final projection is a result of interplay of these factors and constraints, which must be considered while interpreting children's drawings.

<u>What drawings tell us about children</u>

Together with an understanding of why children draw and the studies on developmental progression in children's drawings, drawings can be used to learn some aspects

about children. Koppitz comments that, “Drawing is a natural mode of expression for boys and girls. It is a non-verbal language and form of communication; like any language, it can be analysed for structure, quality and content.” (Tilburg, 1987, Koppitz, 1983)

Emotions: Every parent knows that getting young children to talk about emotional experiences is often difficult. But new research suggests that one way to overcome this problem is giving children an opportunity to draw while they talk (The Express newspaper, 1999). Gross and Hayne (1998), conducted two studies involving 60 children between the ages of 3 and 6 years. In the first experiment, half the children were asked to tell a trained interviewer about the time they were happy, sad, or scared (the *tell* group), while the other half were given 10 magic markers and asked to draw about the time they were happy, sad, or scared (the *draw* group). The researchers found that the children who were given an opportunity to draw about their emotional experiences reported more information (after drawing) than the children who were merely asked to tell about their experiences.

Other aspects: The researchers also assert that drawing increases the amount of information that young children report about their own past experiences, regardless of their age or the emotional content of the target event. These psychologists hypothesize that drawing may facilitate children's reports for at least four reasons: (a) drawing may reduce the perceived social demands of the interview; (b) it may facilitate memory retrieval; (c) it may help children organize their narratives; (d) it may facilitate their interview performance simply because it extends the duration of the actual interview (includes drawing time). Yet the researchers caution that drawing, like all other forms of interviewing, is not immune to the negative effects of misleading or aggressive questioning. Besides, it is hypothesised that drawing does not merely mirror the environment; it also reflects values and preferences (Dennis, 1966). Koppitz (1983) cautions that drawings tend to reflect attitudes of the moment and will change over time.

1.2 *Representation versus signs/ expressions*

Among the earliest manifestations of representational abilities is the understanding that one object may stand for another; that is, the emergence of symbolism. Symbolic representation involves the use of some form of reference (object, action, vocalisation, thought) to represent another. This representation may be literal (e.g. drawing), obey social convention (language) or it may be completely arbitrary (symbolic play) (Thomas and Silk, 1990).

It has been realized that one of the main avenues for young children to explore reading and writing is through play, where children come to grapple with the symbolic nature

of written knowledge. The marks that we make on the page are not meaningful in themselves, but as symbols to represent real meaning (Bloch, 1997)

1.3 *Cultural differences in children's drawings*

Theories on children's drawings assume a more or less universal sequence of development. The evidence that substantiates this assumption comes from features like the 'mandala' form of scribble that is found in almost all cultures. Art pervades all cultures, the differences between cultures being reflected in the characteristic form of art produced by the individuals. Thus drawings are especially reflective of the socio-cultural environments in which they are produced. Several studies highlight the role of social, cultural and environmental components on children's drawings. Drawing can help one to cross the boundaries of culture and language, thus overcoming the limitations of verbal communication.

The drawings by Kosovar Albanian children from a Macedonia refugee camp are a case in point (The Express newspaper, 1999). Osman Mejzinolli, a refugee artist from Brenica, set up art classes for children aged 6-9 years in the Neprostino Refugee Camp in Macedonia. The result was a series of dramatic and moving pictures depicting scenes of tanks and guns, policemen with knives, houses on fire and dead people lying on the road with blood by their side. The children were not asked to draw these pictures - they simply used the opportunity to express what they had seen and been through.

Another instance of art reflecting cultural traditions involves the Walbiri community in Central Australia, consisting of aboriginal groups, which have maintained their traditional language and culture. Roger Wales (1990) reports two main traditions of pictorial representations among the groups. One, typical of the far north of Australia, characterized by so-called 'X-ray figures', showing the skeletal structures of the animals, etc., represented in the dreaming stories. The other, associated with central desert tribes, uses simple graphic devices like straight and wavy lines and circles to represent relations between different elements in the stories.

A study was conducted to analyse Israeli children's understanding of ethnic identity using Human Figure Drawing (HFD) as a tool to understand their social categories (Ilana Ben-Dov, 2002). Each of the 178 Jewish Israeli children, aged 3 to 6 years was asked to draw a "typical Arab" and a "typical Jew", and was presented with open questions about these drawings. The study reported an age-related improvement in the identification and understanding of the categories of Jew and Arab. It also reported a shift in attitudes towards ethnic groups: an increase in negativity towards Arabs and positivity towards Jews.

In a cross-cultural study, Cox-Bishop (2000) compared *Inuit* children's drawings with those of American mid-western children. They tried to statistically determine any gender differences by examining the drawings of each child item-by-item, noting technique, line quality and use of colour and space. They were surprised to find very few differences and concluded that a child's art was reflective of his or her culture. They suggested that each of the children may have been similarly influenced by satellite television, common text-books and teachers educated in the southern culture. However, other studies done in different cultures have found gender differences in art.

1.4 *Gender differences*

Several theories account for gender differences in schoolchildren's art. Socialization factors have been stressed (Cox, 1993; Koppitz, 1968), reflecting differences in boys' and girls' socialization (Block, 1984; Rheingold & Cook, 1975; Thorne, 1993). Another theory posits that in early childhood, gender schemas develop and organize gender-related information (Basow, 1992). Gender schemas crystallize and exaggerate children's gender socialization, thereby increasing expression of “gender-appropriate" content in drawings. In sum, artistic gender differences may be due to children's gender socialization and schemas.

Gender differences between boys and girls emerge in the "artistic" scribbling of children as young as preschool age. Boyatzis and Eades (1999) found that judges who were unaware of the sex of the children were still able to identify the sex of the young artists because boys tended to draw with darker colours, drew harsher lines and selected more masculine subjects than same-aged girls.

In the same study another task required that the children selected pictures that appealed to them, and again the boys selected masculine-oriented or neutral drawings, while the girls selected feminine objects. For example, none of the boys chose a picture of a ballerina. This study suggests that sexual stereotypes might be a combination of "children being hardwired” as well as reinforcement by society (Boyatziz and Eades, 1999).

Research has consistently demonstrated that during the elementary school years, boys and girls produce different kinds of pictures (Cox, 1993; Rubenstein & Rubin, 1984). Boys often draw themes of power, competition, and depersonalized aggression, with monsters, vehicles, and weapons. Compared to girls' drawings, boys' characters are drawn further apart, in profile, and in motion. Girls typically draw static images of natural settings with people and animals; people are often drawn with facial and bodily detail and in an inactive, frontal view. In a study by Kawecki (1994), where 8 to 11 year-olds were asked to draw pictures of water, girls drew calm rivers and oceans and boys drew storms at sea. Other studies have also found technical differences: between

ages 9 and 12 years, boys drew angular, geometric shapes, but the girls were likely to produce curvier, organic forms (Rubenstein & Rubin, 1984, Machover, 1960).

Several studies have documented patterns of gender differences between cultures on aspects of visual, spatial and other imagery related tasks. Gender differences in human performance on tasks involving some visuo-spatial skills have been reported by Kimura (1999) and Snyder and Harris (1993). According to these studies, males tend to perform better than females on spatial orientation, or "mental rotation," tasks, in which a subject is required to imagine how a given figure will appear when in a different spatial orientation, or as seen from a different perspective (Kimura 1999; Masters 1998; Masters & Sanders, 1993; Peters, et al, 1995; Resnick, 1993).

Differences in attitudes and preferences of boys and girls towards technology have also been subjects of several studies (Corread, 1985; Honey, 1996; Heywood, 1998; Wolters, 1989). It has been found that girls seem to be more interested than boys in the social, cultural and ethical dimensions of science and technology. They are often less persuaded by the 'technical fix', and their interest in science and technology education increases when these can be related to their own concerns and priorities (Jenkins, 1997).

A few of these differences have also been found in our study where we have observed that more boys prefer to draw on technology as compared to girls, while more girls than boys depicted humans involved in activities like learning, teaching, experimenting or operating.

1.5 *Student's drawings for studying science concepts*

It is seen from the above discussions that drawings reveal information about the development of the children who draw, not only their visual aspects, but also intellectual and emotional ones (Gillian Figg, 2001). Besides students are seen to perform better when they are asked to draw rather than when they write.

In a study on understanding of science concepts by Maria Aguirre (1996), 43 students from grade 5 of a Western New York school were divided into two equivalent groups. One group was assessed through their writing and the other through their drawings. In general, the students who answered open-ended questions by drawing demonstrated better their interpretation of science concepts or ideas embedded in the chapter. The drawing mode permitted students to illustrate better their schemata, which made it easier to detect students' misconceptions: such as, protons have negative charge and static electricity is produced from continuous electron flow. Ramadas and Nair (1996) used an open-ended drawing test along with written tests and interviews to study 9 to 13 years old Indian students' conceptions of the digestive system. Similar studies on

students from India and UK probe6d students' understanding about light (Ramadas, 1982; Ramadas and Driver, 1989; Ramadas, 1990).

Ioannidis's (1999) study focused on students' (12 to 13 yrs old) metaphorical thinking about energy by studying students' drawings and the language used in their stories about energy. The modes were seen to elicit complimentary information. It was found that different aspects of energy, like properties, nature, result and cause, co-existed in children's thoughts. Their stories, on the other hand had elements of myths, explanatory texts, narratives containing dialogues, poems etc.

A series of studies were conducted on middle school students in the Indian context by Chunawala et al (1996), Natarajan et al (1996) and Ramadas et al (1996) to find out students' alternative conceptions about a few environment related topics in their curriculum. One of the salient features of these studies was a departure from using only paper-and-pencil tests and interviews. A variety of tasks, ranging from games, written tasks and drawing activities, besides interviews were used to elicit responses from the students on a given topic.

In the study about living and non-living Chunawala et al (1996) found that some students had opted to draw the "living thing" that they had to observe for a week and report about. Drawings were also used to complement the written questionnaires.

In another study with the same subjects, drawings were used extensively to explore students' ideas about plants and forest (Natarajan et al, 1996). There was a wide gap between students' spontaneous ideas about plants and the knowledge in the textbooks as seen from the drawings. Yet, it was noted that physical and social settings, as well as students' textbooks influenced their ideas in complex ways. The drawings highlighted the stark differences between urban school students and tribal students, in their understanding of plants and the forest.

While most of the above studies have dealt with students' ideas about topics in science, drawings have also yielded interesting information about students' conceptions of science and technology and their practitioners.

1.6 *Student's ideas about science and scientists*

In a study by Chunawala and Ladage (1998) on 8th standard Indian students' ideas about science and scientists, children were asked to draw their "Images of scientists", answer a few questions and also to write a paragraph each on the topics *Scientists at work* and *Me as a scientist.* Both drawings and writings conveyed that overall students had a positive attitude towards science and scientists. Their drawings depicted the stereotypes held by most of them. Most boys and girls drew male scientists mostly involved in chemistry related activities; they were shown working alone wearing lab-

coats and working hard. Very few students drew female scientists. Drawings complemented the writing task in this study to bring out that boys and girls had similar ideas about science and scientists and that they viewed science as a male activity and scientists as males.

According to Sjoberg and Imsen (1988) an image of science is a cumulative result of various school and out-of school influences. One of the numerous tests to study students' ideas about science is 'Draw a scientist test '(DAST) devised by Chambers (1983). It was used on around 5000 children in the age of 5-11 years. Later Newton and Newton (1992) used this test to find the stereotypic images held by children as early as six years of age. Huber and Burton (1995) made an attempt to study changes in children's drawings when their teachers attended an intervention programme, which provided them information about role models, career, sex equitable materials, participation, etc. It was found that the post-test drawings of the boys after the intervention were less stereotypic than the pre-test ones.

Research using drawings to elicit students' ideas about science concepts as well as science itself is only one aspect of drawings in education. Teachers the world over have used drawings, in the form of posters, to help students learn difficult topics in a variety of subject areas.

1.7 *Use of posters in education and in contemporary classrooms*

The cliché, "a picture is worth a thousand words" is borne out by studies that confirm that posters convey a lot more than mere verbal communication can, both in volume of content and depth (Hay and Thomas, 1999, Bird, 2001). A paper by Sahoo and Natarajan (2000) has a detailed discussion on the effectiveness of posters for science and technology literacy. Posters are not only vehicles for communicating ideas and concepts, they also form a useful teaching and learning device, and are also an effective tool for evaluation and assessment (Billington, 1997).

From children's point of view, it has been seen that they learn more readily from visuals that accompany talks or lectures than by the routine pedantic method (Dhama and Bhatnagar, 1987). The study mentioned in an earlier section, conducted by Ioannidis (1999), where students' drawings were used as tools to invoke their ideas about "energy", provided a promising pedagogy that can be used in classroom teaching or in extracting and conveying ideas and scientific concepts.

Posters not only passively communicate ideas and feelings in a visual mode, but also help students learn and adapt to different ways of thinking, working and expressing when students actively work with them. Posters and poster making are both tools that aid understanding of concepts. Making posters engages children for longer periods of

time in productive activities and enables them to vent their thoughts and express themselves more explicitly.

Posters may also be used to elicit the ideas that children gather through the process of learning. For example, in a cross-sectional study involving 586 pupils from 11 different countries, Reiss et al (2002) used drawings of young (age 7-14 years) people to elucidate what they thought was inside them. It provided insights on children's ideas of the body systems and the relative positions of the organs in the system.

With numerous advantages of posters, there are a few limitations. The most crucial limitation of the posters is the likelihood of posters being over-read during interpretation. Also, multiple opinions may help one to have a more realistic and wholesome picture, besides clarifying instances of ambiguity. Posters also suffer from students' constraints regarding their drawing skill. On the other hand, drawing has long been considered a teachable skill, at least to a certain degree.

1.8 *Expressing ideas through drawing is a teachable skill*

If children's drawings can be described in terms of a progressive development in artistic and graphic skills, how may teaching alter this progression? In other words, is drawing a learnable skill? Betty Edwards (1993) gives several evidences to support the idea of drawing as a teachable skill. The most trusted themes of the artists are their visual observations. Hence, to be able to project an object or a theme, it is essential to have prior critical observations. This aspect of drawing is highlighted in the writings of Betty Edwards (1993):

> *"A fundamental aspect of learning to draw is learning to see, not manual dexterity skill… Young children draw what they know instead of what they see. They often use generic symbols to represent people, animals and buildings. A person who can look at an object and analyse the relationships of size, shape, space, value and texture can develop drawing skill."*

Chapter 2

Methodology

Students interested in drawing had gathered at the Homi Bhabha Centre for Science Education for a poster competition on the occasion of National Science Day celebrations. Our broad goal was to engage them in expressing their ideas about science and technology through poster making. We also wished to probe their understanding of technology. This would serve as a preliminary study of students' ideas about technology. A short questionnaire was also administered to the students after they had completed their posters.

Students from standards V to IX (ages 10 to 15 years), coming from 30 different schools from in and around Mumbai city participated in the contest. The media of instruction in the different schools included English, Marathi, Urdu and Hindi. Most students could read and write either English or Marathi. For the few who were unfamiliar with either and were familiar with Hindi, there were translators.

The participants constituted two major groups - a junior group of 31 students (16 girls, 15 boys) from standards V to VII, and a senior group of 46 students (20 girls, 26 boys) from standards VIII and IX.

2.1 *Poster making*

Two themes for posters were presented to the students: (i) Images of Science and (ii) Images of Technology. Students were given 15 inches by 11 inches poster paper, which they could orient as they liked, landscape or portrait. The students had been asked to bring their own drawing materials (writing implements, paints, brushes, etc.) other than the paper. Students were free to choose their expression mode, like oil paints or watercolours, pencil sketches, etc.

Each student had to choose any one and only one of the two given themes. They were allowed a maximum of 3 hours to complete their poster on their chosen theme. We describe the analysis and assessment criteria in a later section below.

2.2 *Questionnaire*

Students were given a questionnaire after they had completed their posters. The main aim of administering questionnaires to the students was to find out the students' attitudes towards science and technology and to reconfirm the issues that were represented in their drawings. The questionnaire included questions that required them to:

- Give a title/slogan to their posters.

- List benefits and harmful uses of technology: For this the students were expected to write their choices in the space provided to them.
- Time-period depicted in their drawings: Four options viz. Ancient time, present time, near future and distant future were given and the students were required to tick in the appropriate box.
- They were even asked in this questionnaire as to what they would like to add had they been given more time for their posters.
- The extent to which they enjoyed making the poster: To find out this, a five-point scale was provided and the students had to put a tick mark at the appropriate place.

A copy of the questionnaire in English and Marathi are given in the Appendix.

2.3 *Criteria for assessment and analysis of posters*

The posters were assessed for two different purposes: to select winners of the competition and analyse the posters for students' ideas about science and technology.

Criteria for selecting winners

A poster is a result of the interplay of several factors. The artists employ their own skills to construe the features to be represented, which in turn involves constant self-evaluation and introspection. Hence it is crucial to have the assessment criteria that would consider multiple facets of the poster drawings. The 4 criteria for selecting the best posters to be awarded prizes were based on the lines of the six principles of poster production, suggested by Sahoo and Natarajan (2000). The posters were assessed on the basis of the following broad criteria.

Criterion	Elaboration
Attention-getting	The ability of a poster to draw the attention of viewers, this encompasses attributes such as layout, colour and title.
Coherence	This refers to presence of a logical sequence and the ability of the poster to be self-explanatory.
Creativity	This includes novelty in the presentation of ideas, by which we mean representation of individual's concepts and ideas in an original way.
Content	This is the ability of a poster to convey scientific ideas at a glance.

The team of judges constituted some of the researchers and others working in the area of science and mathematics education and an artist (with graphics expertise). Three prizes and a consolation prize were given away in each group.

Criteria used for poster analysis

The posters were analysed using a large variety of categories that helped us to understand different aspects of students' drawings. These categories, listed in Table 1 were arrived at after a critical examination of all the posters and questionnaires by all the researchers. They were chosen specifically to serve our objective of understanding students' ideas about science and technology. Inter-observer reliability was ensured to the extent possible.

Table 1: Criteria used for analysis of posters	
1	Topic: Is it "Images of Science" or "Images of Technology"?
2	Relevance of poster to topic chosen
3	Nature of poster drawing
4	Sex of humans depicted: males, females, unclear
5	Kinds of activity in which humans are involved
6	Objects: Number and kind
7	Human systems depicted
8	Concepts/ application: (i) Differentiation; (ii) Theory/ Practical aspects
9	Subjects: (i) Coverage of school subjects or disciplines; (ii) Technology within one/ more themes (E.g. communication)
10	Representation in Cyclic/ Linear forms
11	Scenes: (i) In or outside classroom; (ii) Space/ Earth (iii) Industrial/ Domestic; (iv) Environment related/ Unrelated
12	Applications to humans: (i) S&T for Society/ Personal use; (ii) Constructive/ Destructive processes
13	Time

The categories and terms used within the criteria that may not be explicit to the reader are explained below.

Topic: This corresponds to the title chosen by the students for making their poster. The categories were summarised as "science" and "technology".

- Science – Included elements that were related directly to teaching or learning of science in classrooms, science related formulas. Physics, chemistry and biology would be considered areas of science.

- Technology – Included drawings of computers, space shuttles, utilisation/ conservation of energy, use of appliances. These would be classified as falling under the themes of communication, medical, space, etc.

A poster was considered relevant to the topic chosen by the student, if it depicted one or more of the elements listed above under the relevant category (science and technology). For instance if a student had chosen to draw on 'Images of technology' but had drawn classroom scene and included formulas, then that poster was not considered relevant to the topic chosen.

Nature of poster drawing: This refers to the kind of drawing, which may come under the categories explained below.

- Fantasy – Depiction of imagination going beyond reality, as in Fig. 9.

- Abstract/ Symbolic – A drawing element serves as a visual symbol for something abstract, which may not have a universally accepted meaning. E.g. Flower vase with flowers in Fig. 10.

- Real symbolic – A symbol with a globally shared meaning. Eg: A zigzag line to indicate (electrical) power, shown in Fig. 1.

Sex of humans: This refers to depiction of male and female humans in the drawings. Apart from exclusive "male" and "female" categories, the analysis needed categories of "both" and "unclear".

- Both – Poster category that includes both male and female figures.

- Unclear – Human figures, which were not identifiable unambiguously as male or female. E.g. persons in space suit.

This criterion was used to describe the poster as a whole or the elements in a poster. All 4 categories and "neither" were used in describing a poster, while the categories "male", "female", "unclear" and "neither" were used to describe the presence of human figures in the poster.

Kinds of activities in which humans were involved: This refers to what humans are shown to be "doing" in the poster. Several categories appeared within this criterion.

- Teaching/ learning – Depiction of teaching or learning activity.

- Experimenting – Depicts a laboratory scene or humans involved in some kind of testing.

- Designing/ making – People are involved in making something.
- Using/ operating – Humans using a device.

Human systems: This criterion refers to the drawing of the insides of the human body in any form (organs, etc.) or the depiction of the internal structure of some human organs. Eg: a neuron or a brain drawn in the poster, as shown in Fig. 6.

Differentiating between concepts and application: This criterion helps differentiate between drawings depicting a general idea inferred or derived from specific instances and those showing the application of science or technology. It was aided by three categories of drawing elements: objects, working models and ideas.

- Objects – This refers to a tangible entity.
- Working models – This depicts the working of some objects. Eg: Signals coming from a satellite or a disc antenna, as in Fig. 1 and 6.
- Ideas – Drawing indicating the student's thought or some concept.

Representation: The categories under this criterion refer to the way ideas have been presented by the students.

- Linear – Posters where one or more ideas have been presented in a straight line. Eg: Shown in Fig. 11.
- Cyclic – Posters where the ideas have been presented in a cycle. Eg: Shown in Fig. 5.

Scenes: This criterion refers to the depiction in the posters of scenes inside the school (classroom or laboratory) or outside school. Eg: Classroom scene shown in Fig. 3; Outside the classroom scene shown in Fig. 2. The "outside the classroom" category when shown in a poster has been further analysed as an "industrial scene", a "domestic scene" or "both" within the poster.

Time depiction: This refers to the time period indicated by the drawings. The categories used were "ancient", "present time" technology and science, or "futuristic" ideas.

The criteria explained above together with a few relatively obvious criteria, terms and categories, listed in Table 1, have been used to classify the posters as well as the large variety of elements within each poster. The result of the classification and our analysis of these results follow.

2.4 *Presentation of results and analysis*

The results of the analysis of the posters of both the junior and senior groups of students were tabulated under the different categories in terms of numbers and percentages. The sample size being small, the percentages give only a rough idea of the trends seen and should not be considered strictly significant. Nevertheless, they help bring to light relative differences and rough estimations of the trends noticed.

It is found convenient to report the results under the following major heads:

- General remarks about the posters of the junior group
- General remarks on the posters of the senior group, and
- Comparison between male and female students' posters

We did not find any major differences between the results of junior and senior groups. This may have resulted from insufficient sample size. Hence, we have not discussed the comparison between these groups under a separate head. However, numerically significant findings are reported.

Chapter 3

Results and analysis: Junior group (V-VII Standard)

The junior students' (Total number = 31) posters and their responses to the questionnaire provided interesting insights into their ideas about science and technology. It was found that most of the students, about 71%, in the junior group opted to draw on the topic "Images of Science", and remaining smaller proportion opted for "Images of Technology".

3.1 *Relevance to topic*

All the posters on "Images of Technology" (29% of all the posters) were related to the topic chosen. That is, they had elements in categories such as technological objects, models, etc. As explained in the criteria section, posters were considered as related to "Images of Science" if they depicted human systems, concepts, equations, places of learning science (classrooms, laboratories), environment and ecology related scenes or ideas.

It was interesting to note that about half the posters on "Images of Science" (39% of the total) did not relate to the topic chosen by them. These posters included technological objects and abstract depictions like a flower vase, which could not be directly related to either technology or science. This may be related to a few factors: the students' understanding of the terms "science" and "technology", their ability to draw and their expression of artistic freedom. Disinterest in the task may also have led to a decrease in relevance of drawings to the topic. However, responses to the questionnaire indicated that most students (81%) enjoyed drawing the poster very much, while 16% enjoyed it "somewhat" and only one student was "unsure". Most of the students had interest in drawing the poster and drawing *per se*. This suggests that low interest in drawing the poster did not cause reduced relevance of some of the posters to the topics chosen. According to Cox (1992), infants start to scribble by the end of their first year and continue to be eager artists until middle childhood and adolescence. The responses in this study showed that children and young adults (10-14 years) in this study continued to be interested in drawing.

Figure 1: A "Real symbolic" scene ("Images of Technology" by a boy)

In the questionnaire the students were asked to suggest a suitable slogan or title for their posters. A third of the suggested titles related to the wonders or uses of Science or Technology (38%). A few (12%) slogans were either irrelevant or incomplete. A fourth of the students wrote on the power of Science and Technology (23%). A few titles made references to temporal aspects of Science and Technology, E.g. "World in 5000 AD" and "The next generation can make splendours".

3.2 *Nature of poster drawing*

Depictions in any form by individuals are a result of reflection on the experiences in their life. Yet, not all depictions seem to directly portray real life. Among the junior group, almost half the posters (45%) appeared to depict real life scenes. Abstract/ Symbolic drawings - poster (or element) is conveying a message that has to be extracted from the drawings - constituted a large proportion (39%), and indicated that children do have many innovative and imaginative ways of expressing their ideas when provided a suitable opportunity. A few drawings (10%) were real symbolic, where real objects and scenes were drawn to symbolise a message as in Fig. 1. Fantasies in children are thought of as the beginnings of innovation and creativity and 2 of the students depicted fantastic images of science and technology (Fig. 3).

According to Sahoo and Natarajan (2000),

Direction of information is another factor affecting layout. Viewer tracks information in a definite spatial sequence…

Though most (83%) posters did not have any particular style of representation, it was notable that in the junior group there were 2 cyclic representations (Fig. 2) and 3 linear ones.

3.3 *Time depiction*

The questionnaire explicitly asked the students about the time frame that they had portrayed in their posters. Two thirds of the students (65%) responded with "present time" and 19% stated that they had drawn a picture of the "near future". A few (13%) stated that they had portrayed the "distant future". But only one

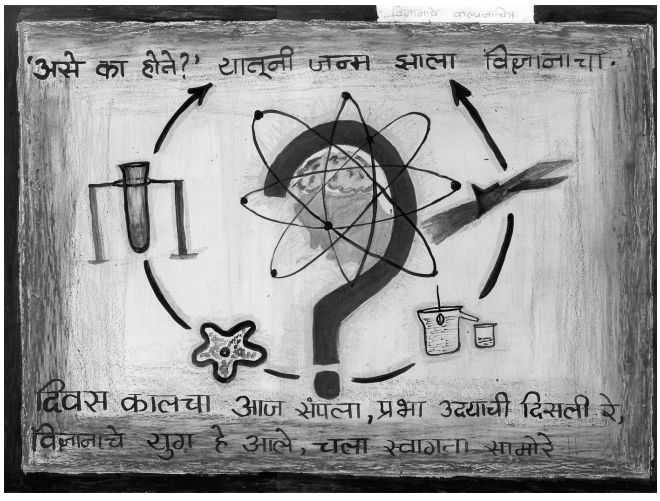

Figure 2: Poster exhibiting "Cyclic" representation (by boy)

student said that the poster was both about the present and a past (ancient) time. In the question where a title or slogan was requested, a few titles referred to temporal aspects (16%), E.g. "World in 5000 AD" and "The next generation can make splendours". In our analysis of the posters, however, a majority of the posters (87%) were seen to have represented present time while only a few had shown future time as in Fig. 3. This might imply that several students thought their depictions to be futuristic when their drawings depicted objects of real life. The students possibly did not recognise their depictions as actual achievements in science and technology.

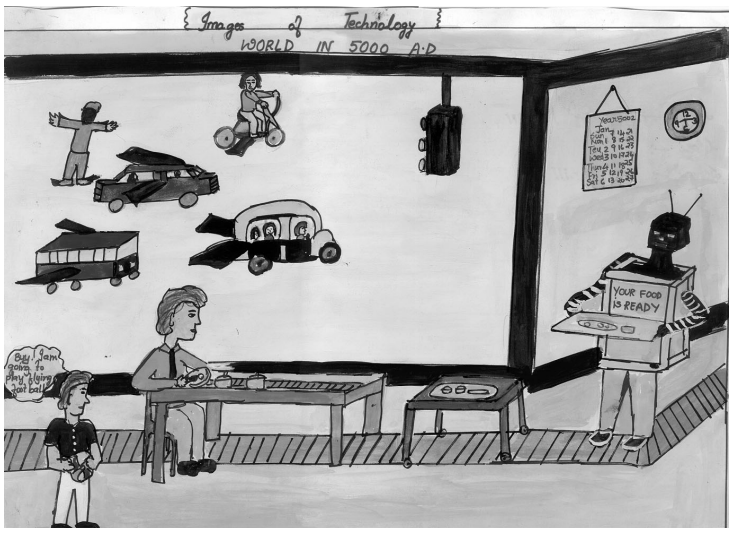

Figure 3: Poster depicting the "Future age"- World in 5000 A.D. Imaginative and fantastic ideas of the child artist (a girl) include robot as waiter and flying traffic.

3.4 *Science, Technology and Society*

Science and technology are intimately linked to society. We were curious to see whether the students had portrayed this aspect in their posters. To analyse this, we studied the posters and elements under several criteria: sex of humans depicted, kinds of activities in which humans are involved, human systems, concepts and applications, and number and kinds of objects. Uses of science and technology to humans and benefits and harms, though important aspects of the relations between science, technology and society, are discussed in separate sections below.

We found that 45% of the students depicted only objects (without humans) that directly related to science or technology in their posters. Humans alone (without objects) were rarely shown (only two students), while 39% of posters had both humans and objects and a few (10%) of the posters depicted neither objects related to science, technology nor humans, but were merely symbolic.

Male and female figures

Of the total of 20 posters that depicted human figures, about a third (7) showed only male figures, 12 showed both male and female figures, while just one poster showed only female figures (no male ones). Two students showed human figures not identifiable as either male or female.

Among a total of 102 human figures, 4 could not be identified as male or female. Of the figures whose sex could be identified, about half were female figures (44%) (Fig. 4 and 5). This shows that though individual posters were not balanced in the depiction of male and female figures, there was an overall balance in the distribution of male (52%) and female figures as elements in all the posters put together.

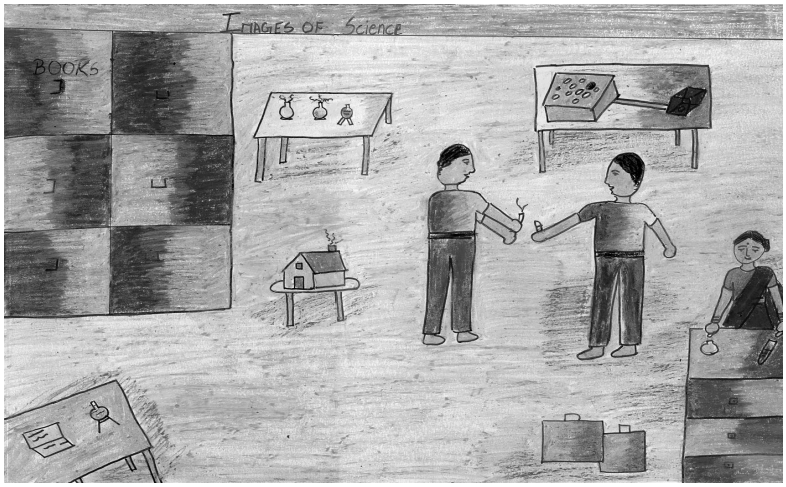

Figure 4: Poster showing a school laboratory scene. An attempt is made by this Std. V girl to depict the depth of objects.

Activities of humans

It was interesting to note the kinds of activities in which humans were engaged. Of the 20 posters depicting humans, about half (11 posters) showed them in an activity. It was observed that in most (55%) of the posters with humans in activity, they were shown operating or using devices. While some (27%) posters showed humans conducting experiments (Fig. 4), about 18% of posters showed humans involved in teaching-learning activities (Fig. 5). However, designing and making activities, which we considered as important aspects of science and technology processes, were significantly absent in the junior group posters. The activities depicted as well as omitted are important pointers to the conceptions that children have about science and technology.

Objects, models and human systems

Students drew a large number, a total of 138 in all posters of objects, showing that they were comfortable with portraying objects around them. Communication devices formed the largest category with almost a third (29%) of the students exclusively drawing these. Three students (10% of posters) drew only modes of transport. However, about another third of the students (29%) drew both communication and transport objects. This clearly indicates students' perception of communication devices as important objects of science and technology. Interpreted together with the finding that most students thought they had depicted a future scenario, shows that the students consider communication and transport as dominating the future of science and technology.

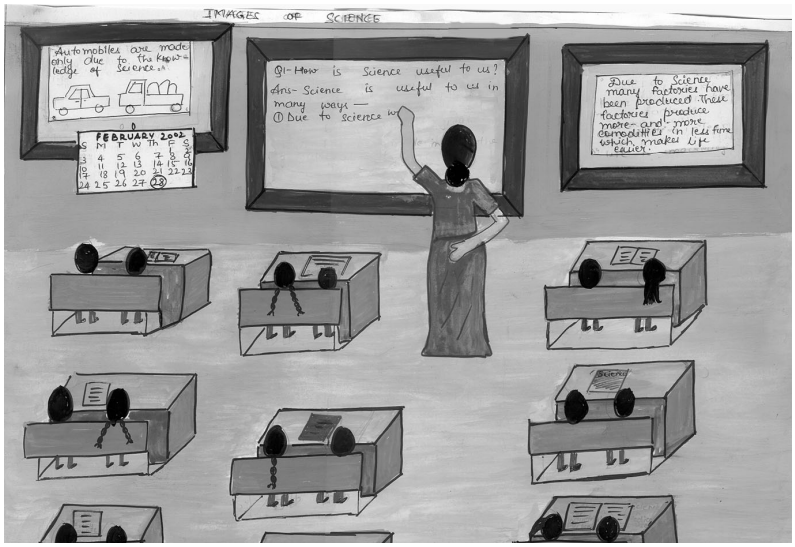

Figure 5: Poster by a girl depicting 'a typical classroom' scene: individuals are involved in "teaching/learning" activity. Note the balanced portrayal of male and female individuals.

Organs or elements of the human body, such as an eye or a neuron, were depicted in a few of the posters (Fig. 6). Over a third (39%) of the students showed dynamic objects in their drawings (a robot calculating or playing chess), while another third (35%) of the posters indicated ideas or concepts. The latter is exemplified by a poster showing a human measuring another's chest and the blurb, "This shows that our chest expands when we breathe in." A fourth (26%) of the posters showed static objects without any direct references to ideas or concepts.

Students' eagerness to draw objects of science and technology is also seen from their responses to the questionnaire. On being asked, " If you were given more time what more would you draw?" the largest proportion (23%) of students responded that they

would add more objects to their drawings. Other responses included adding colours 0and shading, human figures, scientific symbols to make their poster attractive and meaningful.

3.5 *Beneficial and harmful effects of technology*

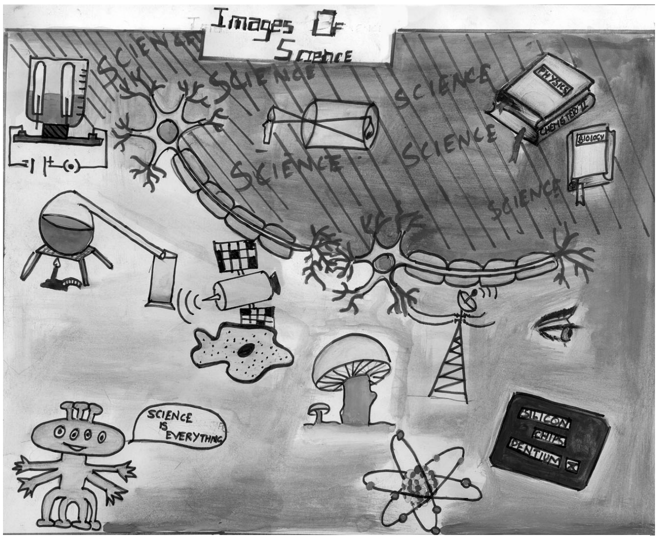

Figure 6: Poster by a boy depicting all subjects in basic sciences. The poster also portrays a few parts of human system like eye, nerve and shows a stylized grouping of ideas and objects.

The benefits and harmful fallout of science and technology are often topics of debate in schools and the print and other public media. In this context, it would be interesting to note the effect of such exposure on students' ideas as seen through their posters. The criterion of applications to humans was used in the analysis. In the poster analysis this included constructive and destructive uses, societal and personal uses, and whether these are for fulfilling basic need or for luxury. We also analysed students' responses to the questionnaire in terms of beneficial and harmful uses of technology.

In the posters, applications of science and technology were shown by 39% (over one third) of the students to be beneficial to humans, whereas one student portrayed merely harmful applications. Both beneficial and harmful aspects were depicted by 13%, (Fig. 7), while almost half (45%) the students did not portray applications of science and technology. This may have resulted from their limited knowledge about benefits and harmful aspects of technology and science. The media and textual content may have been ineffective in raising awareness in this respect.

Over a third (39%) of the students portrayed technology as being used for only constructive purposes. Another third (35%) showed neither constructive nor destructive processes, while one student portrayed it as being used for destructive purposes alone. Over a fifth of the students (23%) depicted both constructive and destructive processes. Overall, students tended to give less importance to destructive processes or uses of technology. They were perhaps awed by the idea of technology. Another reason for this could be that they were unaware of the negative implications of technology.

Responding to the questionnaire asking the students to list the benefits and harmful uses of technology, about half (45%) the students were able to list at least 2 benefits of technology and only one could list more than 4 benefits. The largest single category of benefits listed (16% of respondents) was in the area of communication and transport, followed by education (13% of respondents). The benefits of technology in the area of environment were least realized by the students - only one respondent explicitly mentioned its uses in that area. Other benefits listed were in the area of household, entertainment/ luxury, and medicine.

Figure 7: Poster by a girl depicting beneficial and harmful uses of science and technology.

A fourth (26%) of the respondents mentioned only one harmful effect of technology. Significantly, a fifth (19%) of the respondents did not list any harmful effects of technology. It was difficult for any of them to mention more than 4 harmful uses of technology. Over half the respondents (51%) highlighted the harmful effects of technology in the area of environment. Another notable area where technology was mentioned for its destructive uses was warfare (47% of respondents). A few students listed only the positive effects even when specifically asked for the harmful effects of technology. The responses seem to reflect students' exposure to environmental harm caused by technology through the public media as well in the school curricula. The overall positive perception about technology is similar to the results found by Chunawala and Ladage (1996) in the case of students' ideas of science.

3.6 *Luxury and basic needs*

Do students from urban India consider technology as essential to fulfil basic needs or as a luxury? The posters were analysed for these aspects based on the results under the criterion of applications of science and technology for societal and personal use.

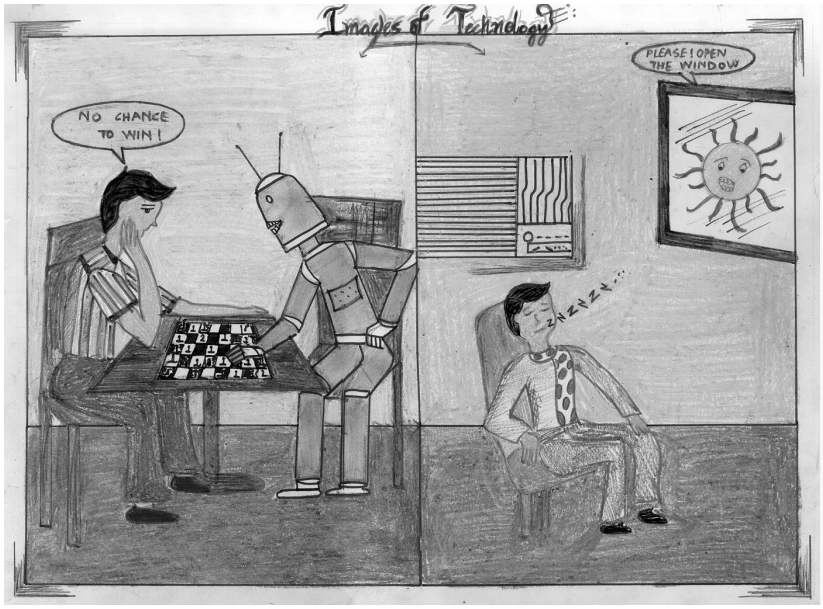

Figure 8: The portrayal of technology being useful for "entertainment and luxury" (by girl).

An equal (16%) percentage of students showed that science and technology was used for "luxury", "necessity" or "entertainment and luxury" by society (Fig. 8). Thus, almost a third of the students had depicted luxury uses, less than a fifth had shown the category we had classified as "necessity". Almost half (45%) depicted technology for both personal as well as society use, while 38% drew exclusively societal uses and 2 students drew exclusively personal uses.

A majority (61%) of students agreed that technology had benefited them in drawing the poster. Yet, over half the students (57%) could not list any instances of benefits. A few (13%) could list 2 instances of how technology was useful to them while making their poster, and one student listed more than 4 instances. When asked to explain how technology had been useful to them in making the poster, several (29%) students gave irrelevant explanations, while a few (10%) could not give any. Of those who explained (16%) gave the use of stationery in drawing the poster.

It appears that students had drawn science and technology uses as more for "luxury" than for "basic needs". Besides, they found it difficult to come up with specific ways in which technology had helped them in their task of making the poster.

3.7 *Scenes and locations*

Science and technology are facets of human endeavours. It is expected that the products and processes of science and technology would be located in environs inhabited by humans. On the other hand, communication and space technology are increasingly becoming common parlance in urban India. The posters were analysed to see whether students associated S&T more with earth related scenes or with outer space, whether they placed it in domestic or industrial environs, and looked for indoor or outdoor scenes. We also analysed the posters for classroom oriented – implying exclusively in school context – or outside locales.

Almost all, except two, posters depicted scenes from outside the classroom or laboratory. Over a fifth (23%) of students showed scenes from both earth and outer space in their drawings. About 13% exclusively focused on earth and an equal number of posters depicted locations in outer space.

Among the scenes located on earth, domestic and industrial scenes were both illustrated in 19% of the posters. While 16% were exclusively domestic scenes, only one student showed an exclusively industrial locale. Greater incidences of domestic scenes than industrial ones may be due to students' familiarity with home surroundings.

In contrast to the drawings where only about a third (29%) of the students showed environmental issues, over half the respondents had referred to the environment in response to the questionnaire, most of which came in response to the question on harmful uses of technology. Perhaps, when not forced to think about harmful effects, students tended to focus on positive issues of S&T in their drawings, and these included issues besides the environment.

3.8 *School subjects*

The sample in the junior group consisting of students from standards V, VI and VII, had studied science as a subject (as environment studies) for at least 3 years. They had also encountered references to technology in other subjects like social studies. Mathematics was also integral to some of the science subjects, while being a separate school subject. Within science itself, the present curriculum is taught through an integrated textbook on "General Science", which does not explicitly differentiate areas of biology, physics and chemistry. Experimental aspects of science and laboratory practices and demonstrations are alluded to in the textbooks, and sometimes practised by teachers. The posters were analysed to find out the effects of these curricular aspects in students' understanding of science and technology. The drawings were

analysed in terms of concepts in different school subjects, technology ideas falling largely within a theme (like communication, medical, etc.) or within a combination of themes and depiction of theory and practical aspects.

A fourth of the students (26%) covered all the natural science areas in their drawing but a relatively large proportion (29%) of the posters had drawings that were directly related to physics. Biology formed the main area of drawing for 13% of students. One student each drew illustrations in chemistry, a combination of mathematics and biology, and a combination of chemistry and biology.

Almost half (45%) the students had drawn technology within a specific theme, whereas about a third (29%) represented technology in a combination of several themes.

Over half (55%) the students' posters showed practical applications of science and technology, whereas two students based their posters on theoretical aspects alone, and a fifth (19%) represented both. This shows that a significant number of students could integrate theory and practice in their drawings. Perhaps this bolsters the idea that there is a possibility of improving students' conceptual understanding by supplementing the theory taught with a good amount of praxis.

3.9 *Conclusions*

The analysis of posters by junior students, drawn with enthusiasm and interest, and their responses to the questionnaire, gave interesting results about their ideas related to science and technology.

Most of the students in this group opted to draw on the topic "Images of Science". However, their depictions were not relevant to the topic chosen. The posters of students who opted the "Images of Technology" topic, on the other hand, were largely relevant to their topic of choice. Some of the factors that may have influenced the relevance or lack of it in the posters include students' understanding of the terms "science" and "technology", their ability to draw and their expression of artistic freedom.

Almost half the posters depicted real life scenes of the present time. Yet, most of these students thought that their depictions were futuristic. The students possibly did not recognise their depictions as landmarks already reached in science and technology.

The students not only thought that depicting the future, but several posters also had symbolic representations. These suggest that, given suitable opportunity, children express their ideas in innovative and imaginative ways. A few students had given

importance to information flow in the poster: 2 posters had cyclic representations, and 3 were linear.

Students felt comfortable portraying the objects they saw or knew about. They drew a large number of objects; about half the posters had only objects that directly related to science or technology. Communication devices were perceived by students as important objects of science and technology, and formed a large class of objects drawn by them. Together with the finding that most students thought they had depicted a future scenario, it appears that these students considered communication and transport to be the dominant S&T features of the future.

Humans by themselves, without associated objects, were rarely shown. Though most individual posters did not have an equal distribution of male and female figures, there was an overall balance in the distribution of male and female figures among all the posters put together.

The benefits and harmful fallout of science and technology are often topics of debate in schools, the print media and television. What the posters reveal regarding students' depiction of benefits and harm associated with S&T suggests that a combination of factors influenced students in a complex way. The overall positive perception about technology is similar to the results found by Chunawala and Ladage (1996) in the case of students' ideas of science. Students, who tended to give less importance to destructive aspects of technology, were perhaps awed by the idea of technology. Several titles suggested by the students also related to the wonders or utility of science or technology

It was only when the students drew environmental scenes in posters, or responded to a specific question on harmful uses of technology, that they depicted or listed the negative implications of technology. The students did not cite any benefits of technology to the environment. These results possibly reflect students' exposure to the media, which often mentions the environmental harm caused by technology, and rarely its benefits. The analysis suggests that students tended to focus on positive issues of S&T in their drawings unless forced to think about its harmful effects.

A larger proportion of the uses of S&T drawn by students were for "luxury" rather than for "basic needs". They even found it difficult to come up with specific ways in which technology had helped them in the poster-making task.

S&T is connected to innovation. Technology is also closely associated with designing and construction. These aspects were significantly absent in the posters of the junior group. Besides, almost all posters depicted scenes from outside the classroom or laboratory, domestic scenes being more frequent than industrial ones. On the other hand, a significant number of students were able to integrate aspects of theory and

practice in their drawings. Thus, the students depicted theory and practice wherever they saw it happening. Perhaps this bolsters the idea that there is a possibility of improving students' conceptual understanding, especially in S&T by supplementing the theory taught with a good amount of praxis.

Over all, it can be said that students in this group found it difficult to demarcate technology from science. The domestic application of technology had greater impact on the students than industrial applications. Praxis seemed to be more influencing and so it can be concluded that in order to improve and broaden the students' understanding of science and technology, practical must form an important component of teaching and learning. The activities and processes depicted as well as those omitted are important pointers to the conceptions that children have about science and technology. This will probably enable greater understanding of the subject accompanied with sustained interest.

Chapter 4

Results and analysis: Senior group (V111-IX Standard)

A larger number of senior group students (46) than in the junior enrolled to in the drawing contest. About half the students (52%) in the senior group opted to draw on "Images of Science" while a little less than half (46%) opted for "Images of Technology" and one student did not mention the topic. Their posters were analysed along the same lines, as were the juniors' posters.

4.1 *Relevance to topic*

The analysis revealed that three fourths of the posters had drawings related to the topic chosen, while only a fourth (26%) of students' posters did not relate to the topic chosen by them. The senior students were marginally better than the juniors in relating their posters to their chosen topic. Most of the students (70%) responded to the questionnaire stating that they had enjoyed drawing the poster very much. About a tenth of the students either enjoyed it somewhat (13%) or not much (11%) and 3 were unsure.

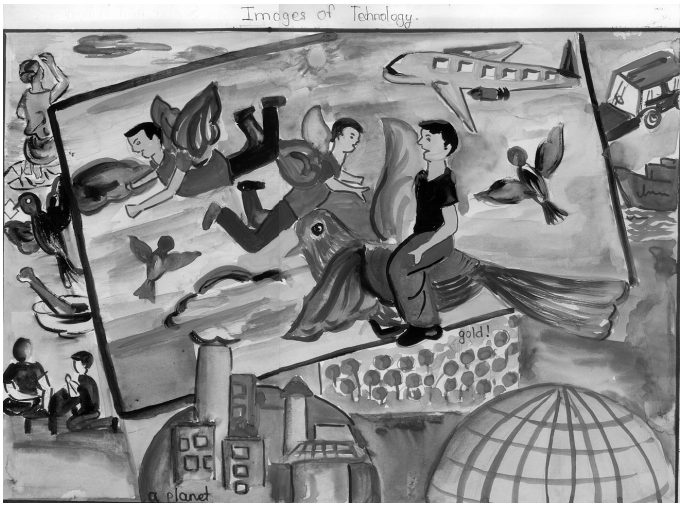

Figure 9: Poster depicting the world of "Fantasy" portrayed by a girl student of Std. IX.

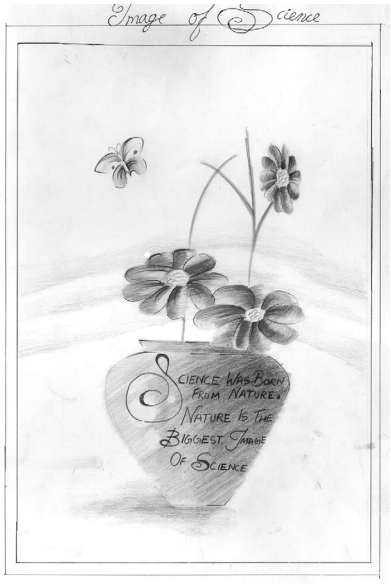

Figure 10: Poster by a girl showing "Abstract/Symbolic" theme.

4.2 *Nature of poster drawing*

An equal proportion of senior students depicted scenes that showed fantasies (28%), abstract/ symbolic (26%), real life (24%) and real symbolic (22%). The percentages indicate that children in this age group are more inclined to the world of imagination and fantasies. About 15% of abstract ideas in the slogans given by students in response

to the questionnaire came from students who opted to draw on "Images of Science". About half the number (7%) came from those who opted to draw on "Images of Technology".

Several students appear to love to spread their wings of imagination to visualise the unreal and the non-existing. It might be useful to harness the creative and innovative characteristics of these students for enriching their learning process.

Most posters (89%) did not have any particular style of representation. Four of the posters were linear and only one representation was cyclic (Fig.14).

4.3 *Time depiction*

A time progression of technology was given in their slogans by 13% of the students, while only one student referred to progression in Science. The time trends depicted by students in their posters are similar in content to the ones they mention in response to the questionnaire. However, the proportions of different periods depicted and stated vary marginally.

About 74% of the posters drew "present time", 17% the future and 9% were about ancient time. In the questionnaire, 70% of the students stated that they had shown present time in their posters, 22% said they gave a picture of the future (15% near future) and 4% wrote that they drew about ancient time. Two students stated in the questionnaire that their posters showed a combination of two periods: one stated present and ancient time, while another gave present and the near future. It was seen that senior students were better able to reflect on the period of their drawings.

4.4 *Science, Technology and Society*

The slogans to their posters given by senior students in response to the questionnaire reveal that only one included both science and technology aspects. It is creditable that given a situation where the students had to compartmentalise science and technology, all but one student gave titles referring either to technology or to science. Thus, students are capable of presenting the images of science or technology as separate entities. However, it is seen from the analysis of the elements of the drawings that they find it difficult to portray an interlaced relation between the two. (This may have been an artefact of our contest conditions where the students were forced to differentiate between science and technology. In fact delineating the differences between the two inter-related areas is of great concern to scientists, technologists, philosophers, historians and sociologists of science and technology.)

Interestingly, a fifth of the slogans (20%) were related to wonders and uses of Science, while only two referred to wonders of technology. A larger proportion of students'

slogans were about the power of technology (13%) than about the power of science (7%). One student even referred to science as a profession. Seniors' posters yielded interesting information about their drawings of human figures, the activities the humans were engaged in and the number and varieties of objects they had drawn.

Male and female figures

The posters of 26 students had a total of 47 human figures, of which 23 were identifiable unambiguously as male and 10 as female figures. About a third of the students (31%) who drew human figures showed exclusively male figures, 27% showed only female figures while two students showed both male as well as female figures. In a third of the posters, the human figures could not be clearly identified as male or female. Interestingly, a much larger proportion of students in this group relative to the juniors depicted exclusively male or female figures and much fewer individual students were gender balanced in their posters. In fact, it may be inferred that several students preferred to mask the gender of the human figures they had drawn.

Activities of humans

What activities were the humans doing? It was observed that in 74% of the cases, humans were shown operating or using devices, followed by 17% involved in teaching or learning. Most of the humans were showed operating communication or domestic devices. About 9% of posters showed humans involved in experimental activities. However, none of the students showed designing or making activity.

The results of the analysis indicate that students associate the idea of "technology" with the use or operation of a product of technology. They do not perceive it in terms of a process of designing or making, or for that matter in terms of knowing about, as in "technological literacy". On the other hand, technological literacy may be defined in the following manner, and we subscribe to it.

"The ability to use, manage, understand, and assess technology"

(Glossary of ITEA-TfAA project, 2000)

Objects, models and human systems

Most students (89%) did not depict any human system in their drawing. The human systems drawn by the rest (11%) included neurons, brain and digestive system. This shows that some students did associate the internal systems in humans with the image of science and technology (because some drawings of technology had science ideas too). Though these topics were related to their curricular information, students seemed

to find it difficult to translate on to their posters what they had studied in their classrooms. On the other hand, their drawings showed numerous objects. It may be concluded that students tended to portray a narrow vision of science and technology.

Students showed as many as 301 objects in their drawing. Communication devices were shown exclusively by the largest proportion of students (18%). Exclusively modes of transport were drawn by 9% of the students, and weapons alone formed the objects in 7% of the posters. Besides, 2 posters had both communication and weapons, while weapons, transport and communication together were depicted in 48% of the posters. Another 14% of objects did not fall in any of these categories. Therefore, it appears that students greatly emphasised transport, weapons and communication. This trend is somewhat similar to the one seen among the junior group except that the latter did not draw any weapons at all.

It is interesting to note that 41% of the students have portrayed objects to the exclusion of humans in their posters. Just one student had drawn exclusively humans in the poster, while a little over half the posters (52%) had both humans and objects. Two students showed neither tangible objects nor human figures. About 28% of the students showed working models in their drawings, while 37% of posters were purely based on ideas or concepts. Another third of the posters (35%) showed application of technology to objects, which are neither associated with ideas nor shown as working models.

Figure 11: The poster, drawn by a girl, is a collage of ideas from several subjects.

The preponderance of objects in students' drawings is accentuated by their response to the questionnaire. On being asked what they would do if given more time, most students replied that they would add more objects to their posters. Other responses included embellishing their drawings with more colours and shading, drawing human figures and scientific symbols, all of which would go to make their poster attractive and meaningful. We may infer from the analysis of objects, models and human systems that over half the students in this group were able to portray the association between humans and objects. From the discussion above, most often they showed humans engaged in some activities.

4.5 *Beneficial and harmful effects of technology*

Majority (61%) of students could not portray application of science and techno-logy - either beneficial or harmful. A fifth (22%) showed beneficial applications to humans, while just two students portrayed harmful applications. Several students (13%) could project both beneficial and harmful aspects in their posters.

Most students (65%) refrained from depicting either explicitly constructive or destructive purposes of technology, choosing to be neutral instead. While 15% portrayed technology being exclusively used for constructive purposes, 9% showed only the destructive uses of technology. About a tenth of the students seemed able to depict technology for both constructive and destructive purposes.

Yet, only one student had portrayed both the negative and positive aspects of technology while giving slogans in response to the questionnaire. Overall, it seems that this group of students spontaneously thought of science and technology less in terms of its beneficial and harmful aspects, and more in terms of a collection of objects, activities, models and ideas.

In contrast to the absence of benefits and harm of S&T in students' spontaneous ideas, when explicitly asked to list these in the questionnaire, 28% of the students were able to list at least 3 benefits of technology. Two students listed more than 4 benefits of technology. A large number of students (28%) listed benefits of technology exclusively in the area of communication and transport. This was followed by benefits exclusively in the areas of household, progress and speed, each of these areas being listed by 11% of the students. Notably, three students listed benefits of technology in exclusively in the area of education. The same number of students listed benefits of technology from a combination of communication, transport and medicine. A lone student explicitly mentioned the benefits of technology in the area of environment. Other benefits listed were in household, entertainment or luxury and medicine. These observations correspond to the distribution in the categories of objects drawn by students in their posters.

Figure 12: Poster by a boy showing scene from earth and space.

When asked to list harmful effects of technology, a third of the students (30%) could mention one harmful use of technology;

another third (35%) listed 2 harmful uses, while 22% could list 4 harmful uses of technology. None could list more than 4 harmful uses. The largest number of students (28%) listed harmful effects of technology exclusively in the area of environment. Other areas that were exclusively covered under destructive effects of technology included warfare (20%), causing poverty/ unemployment (7%) and a combination of areas such as warfare and environment. Several students (12%) listed harmful aspects in a combination of unemployment and environment. One student each gave deleterious effects of technology in households and several combinations of areas.

Thus, when cued, students did suggest a large number of benefits and harm related to technology use distributed over several aspects of our physical and social environments.

4.6 *Luxury and basic needs*

In the analysis of students' ideas of S&T in terms of societal and personal use, half the students showed technology for both personal as well as society use. A sizeable number of students (17%) depicted S&T as being useful for entertainment and luxury. While several (15%) exclusively drew societal uses of S&T, two drew exclusively personal uses of technology.

In this context, it is interesting to see that in response to the questionnaire, most students (76%) agreed that technology had benefited them in drawing the poster. A large number of students (40%) could list one or more points on the use of technology in drawing the poster. Most of the uses of technology in making posters related to stationary (26%), while 24% gave irrelevant reasons. Some students (9%) even said that they had seen the technology equipment and hence they could portray them in the posters.

Thus, a majority of students appeared to think of technology and science as beneficial to the society and in a very limited way in terms of personal use. The posters indicated that students were aware of science and technology in different contexts of use, personal and individual. The low instances of exclusively personal uses in the posters may be caused by students' notion that technology was expensive. Therefore its use is either restricted to a certain strata of the society or it is used jointly by many members of society.

4.7 *Scenes and locations*

Science and technology may be located on earth or in space. Among the earthly locales, they may be inside or outside the classroom, at homes or in factories. All but one student depicted scenes from outside the classroom. That students find it easier to think of S&T outside the classroom connects with our observation that students have

viewed technology largely in terms of communication and transport related objects, environment and even households. They rarely think of technology in relation to academics or its institutions. Perhaps, classrooms contribute less to technological literacy than does the media outside. The students also fell short of context for depicting drawings relevant to "Images of Science," a poster theme based more on the academic aspect.

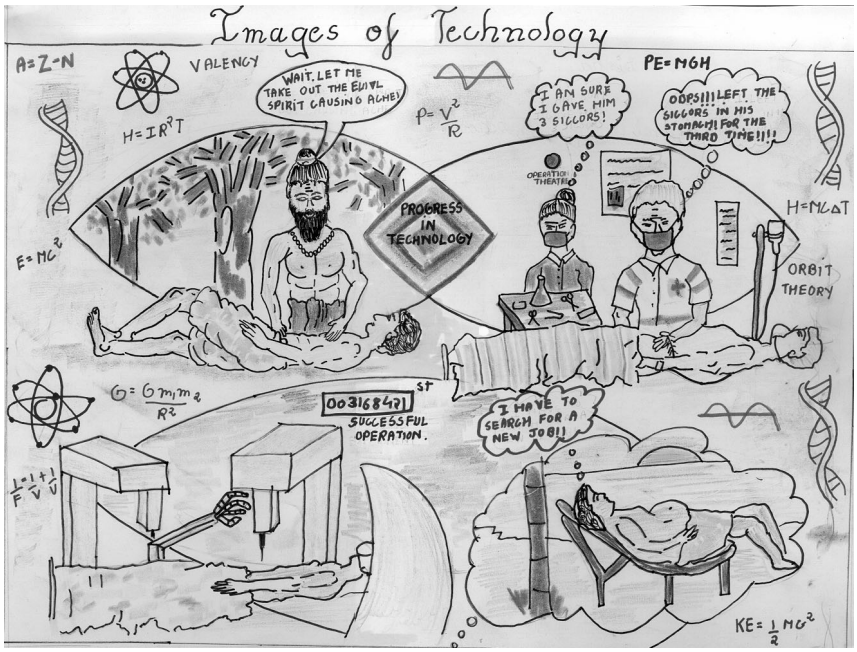

Figure 13: Poster drawn by a boy depicting all the sciences and featuring progress in technology as well. It also has an element of humour in it.

A large number of students (41%) showed scenes from both earth and space in their drawings. About 17% exclusively focused on space and three posters were earth-bound. This shows an overall good mix of ideas about space and earth in students' images of science and technology.

A fair understanding of science and technology in both industrial and domestic sectors surfaced in senior students' posters. Close to a third (28%) of the illustrations showed a mixture of domestic and industrial scenes. Two posters depicted exclusively industrial scenes and one was exclusively domestic.

As in the juniors' case, most senior students' (75%) drawings were not related to the environment, which shows that concern for the environment surfaced in only a fourth of the posters. Besides, we had seen that over half the students did not give harm or benefits of technology in their posters. Together the results seem to suggest that

students' listing of environment related issues in the questionnaire (over 60%) were more a "learned" response rather than an internalised concern for the environment.

4.8 *School subjects*

Nearly 21% covered all the basic sciences in their drawing, three students had drawings that were directly related to physics and biology and one student's poster featured illustrations from Chemistry. About a tenth (11%) of the posters showed technology exclusively within a particular theme (communication, etc.), whereas 20% represented technology within a combination of themes. A large number of students (39%) showed only practical applications, while 17% represented both theory and practical applications in their posters. Overall, the coverage of various science subjects by the students was poor which further confirms the observations about classroom knowledge. Not many students thought of technology within a variety of themes, restricting instead to one or themes like communication and transport.

4.9 *Conclusions*

Each of the two given topics were chosen by about half the students in the senior group and a majority of senior students' posters had elements relevant to the theme chosen by them. The seniors' posters were imaginative and included fantasy and abstract symbolic drawings. A majority of students depicted images from the present day scenario in the theme chosen by them, and most of them were also aware of the time frame of their posters. There were several depictions of future and ancient time as well. The posters showed a mix of scenes from space and earth, and on earth, there were scenes from factories and homes.

Though individual students had to make a poster only on one of the themes, the images of science drawn by students were different from their portrayal of images of technology. However, it is seen from the analysis of the elements of the drawings that they find it difficult to portray the relation between science and technology or their interface with society. In fact they found it difficult to portray either beneficial or harmful applications of science and technology in their posters, though when explicitly asked, they were able to list such applications and effects. When they did show science or technology harnessed for any purpose, they more often showed it for societal use rather than personal or individual.

It was found through the analysis of students' slogans that they related science to wonders and technology to power. On the average, there was about one human figure per poster, with identifiable male figures being over twice as many as identifiable female ones. Most of these humans were shown operating or using devices, which were more often communication or domestic devices. Notable, none of the students showed designing or making activity.

A few students associated the internal systems in humans with the image of science and technology. More students drew ideas and concepts than working models, but the drawings had an abundance of objects, even to the exclusion of human figures in several posters.

Senior students appeared to spontaneously think of science and technology less in terms of its beneficial and harmful aspects, and more in terms of a collection of objects, activities, models and ideas drawn from a variety of subjects like physics, chemistry and biology, and themes like communication and transport.

The analysis revealed that students applied their classroom knowledge in making their posters only to a limited extent. For instance, they could not portray the relationship between science, technology and environment. However, they were able to realise the applications of science and technology around them, though they did not depict them unambiguously in terms of benefits and harm. Senior students overall had covered more themes and subjects as would be expected from their greater exposure to school and the media.

4.10 *Major differences between the junior and the senior groups*

The two groups of students, junior and senior, were in the age range of 10 to 13 and 13 to 15 years respectively. They were asked to make posters on the same themes, given similar instructions and responded to the same questionnaire.

According to Lowenfeld's (1947) theory of development of children's drawings, the juniors would be expected to fall in the "dawning realism" and "pseudo-realistic" stages. According to Hurwitz and Day (1995), however, they would be categorised as being in the pre-adolescent stage. This implies that we would expect to see an increased interest among children in the aspects of details, perspective, use of colour, and art techniques, which make the drawing activity exciting.

Almost all the students in this study enjoyed drawing the poster. The study found several similarities in the drawings of the two groups, especially in the content of the posters and in their preference for depicting the present period. Similar proportions of students located the objects or processes of science and technology in different places, like the classroom, outside, space, etc.

There were some differences, however, that mostly related to the students' differential exposure to concepts in science and technology, their ability to process the complex linkages of science, technology and society and their imagination constraints. The salient differences and the possible factors that may have influenced them are discussed here.

Equal number of students among the seniors chose the two given topics, while among the juniors, there was a preference for the topic “Images of Science”. Besides, the gender difference in the choice of topics was also more pronounced among the seniors than the juniors.

Limited exposure to the term "technology" among the junior group may be one of the factors contributing to the skewed choice of topics among them. The difference may also have arisen through differential interest in technology. According to Doornekamp (1991), the general interest in technology among older students is significantly greater than in their younger counterparts. The same study has also suggested that early upbringing has a strong differential effect on the attitudes of boys and girls through role modelling and inferred expectations. We may extend this to explain socio-cultural differences in expectations from younger and older children about their understanding of and familiarity with technology.

Seniors were marginally better than the juniors were at drawing elements relevant to the topic of their choice. The senior students indicated progression in time and drew future scenarios almost twice as often as did the juniors. Ability to draw objects and processes relevant to the chosen topic may be affected by what students think is included in the topic and their ability to visualise the objects and processes. It may also be influenced by their conceptual understanding as well as by their aesthetics and other considerations besides their ability to draw. According to Thomas and Silk (1990), as children grow their drawings become more meaningful and their ability to understand gets better. This may also be reflected in the small differences in relevance and time depiction among the two groups, which are close in age.

Chapter 5

Gender comparison between senior and junior groups

The analysis so far has focussed on students' ideas about S&T among the junior and senior groups independently. The senior students' ideas in relation to the juniors have also been briefly discussed. Each of these discussions included analysis of the depiction of gender aspects in the drawings of human figures in the posters. This section relates to a comparison between the male and female students about their perception of S&T. The analysis finds that the pattern of responses among boys and girls was different in the two groups, though an overall gender comparison masks this picture. Besides the heads under which the results were discussed earlier, the very topic chosen by students showed interesting patterns in the gender comparison. Responding to the questionnaire, boys (70%) as well as girls (75%) said that they enjoyed making their poster "very much".

5.1 *Choice of topic*

Figure14: 'Dynamic' picture of technology shown by a girl.

A total of 77 students (31 juniors) participated in the competition, of which 36 were girls (16 junior girls). The proportion of boys was greater in the senior group. Overall, equal proportion of boys (59%) and girls (58%) chose to draw on "Images of science". However, this masks a difference between the choices of the juniors and seniors: all the junior boys but one chose to draw on "Images of science", while the choices of junior girls were divided equally between the two topics. Among the older group, "Images of Science" was the favoured choice among the girls (65%), while over half the boys (62%) preferred "Images of Technology". Even if one were to discount the stark difference between the choices of topic among the boys in the two groups, it is clear that boys increasingly opt for technology, as they grow older. This

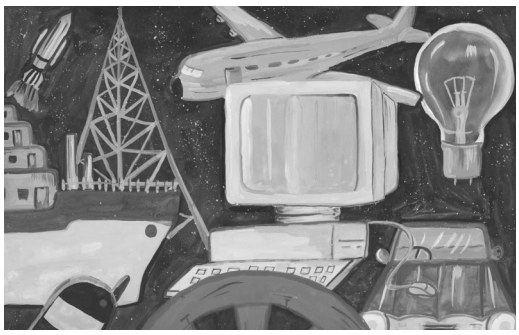

Figure 15: ' Static' picture of technology shown by a boy.

may be in conformity with many studies on attitudes towards science and technology. Honey (1996) noted that people consider technology as an exclusive province of men, and women have been at the mercy of technology as its users rather than creators. Heywood (1998) infers from several studies that many factors influence students' preference for technology. Some of the factors that had strong differential effects on the attitudes of boys and girls were early upbringing, role models and inferred expectations (Besterfield-Sacre, Atman, Shuman, 1995; Bame, 1989). Complex factors may have led to the difference in topic choices among the boys and girls at the junior and senior levels.

5.2 *Relevance to the topic*

Overall, a similar proportion of boys (71%) and girls (66%) could relate their drawings to the topic chosen by them. In this case too, there was a difference between the boys and girls in the two groups. More boys (85%) than girls (60%) among the seniors could relate their drawings to the topics they chose, while among the juniors, more girls (75%) as compared to boys (47%) drew pictures relevant to their chosen topic.

Once again there is a gender reversal of the performance pattern of students in the "relevance to topic" criterion, while going from juniors to the seniors: girls being relevant more often among the juniors, and boys being relevant more often among the seniors. One of the influential factors may be that the senior boys, who all but one opted for technology, were able to draw several objects relevant to the topic. The relatively lower proportion of relevance among senior girls' drawings may come from two factors. Senior girls, a majority of whom had opted for "Images of Science" had difficulty coming up with concepts or objects relevant to science and often drew technological objects or abstract ideas instead. Besides, some of those girls who chose to draw "Images of Technology" possibly considered it a "male" subject and could not associate themselves with it.

5.3 *Nature of poster drawings*

Figure 16: 'Fantasy' of a girl. Emphasis on computer and robot with wings

A third of the senior girls (35%) and 2 junior girls used fantasy in their drawings. Among the juniors, these 2 girls were the ones who used fantasy in their drawings. Even among the seniors, girls (35%) outnumbered the boys (23%) in this criterion. Thus, girls (25%) fantasised more in their

drawings than did the boys (15%). A large proportion of the boys (39%) depicted realistic objects.

There is an apparent contradiction of these results with several studies, which report that girls have a better overall memory for objects compared to boys (McBurney, Gaulin, Devineni and Adams, 1997). However, it is to be noted that some of the students thought they were drawing an imaginary (futuristic) scenario rather than the present time objects they could see. This suggests that the difference may have been affected by our classification of "real" and "fantasy". Perhaps, the circumstance of the study encouraged fantasising among the girls. Both boys and girls in equal proportion were able to draw abstract/ symbolic and real/ symbolic drawings.

Specific representation styles were rarely seen. Even so, cyclic or linear styles were seen more among boys (17%) than among girls (9%), and more among the senior boys than in any other group.

5.4 *Time depiction*

All the junior boys and 69% of the senior boys depicted scenes from the present time in their posters. Three quarters among the girls in junior as well as senior groups depicted present time scenes. This trend in the predominance of present time referencing is also seen in the students' responses to the questionnaire.

"Progress orientation" - more than one time frame with progressive change - in science and technology was drawn by a few senior boys (15%) and none of the junior boys. Among the girls, a lone junior girl depicted this aspect. In contrast to depicting power and technology in the posters, overall students appear better able to verbalise power and progression in science and technology in response to giving slogan or title in the questionnaire: more boys (61%) than girls (25%) among the seniors and more girls (38%) than boys (20%) among the juniors. Several senior boys managed to depict it in their posters, while only one girl could.

5.5 *Science, Technology and Society*

In this section we focus on the possible gender differences in the perception of science and technology in relation to society. The posters have been analysed for the sex of humans depicted, objects, models and human systems, and for the activities that humans are shown to be engaged in. Beneficial and harmful aspects of S&T are discussed in a separate section below.

Male and Female figures

Among the 47 human figures depicted by senior boys, 14 were identifiable as male figures and 4 as females. Girls drew 9 identifiably male figures and 6 female figures. A total of 14 figures could not be clearly identified as either male or female (e.g. a human figure in a space suit). Thus, though, senior girls drew more figures that were identifiably female figures, neither the boys nor the girls were balanced. This agrees with the findings of Chunawala and Ladage (1998) where very few drew female scientists when students of Std. VIII were asked to draw their image of scientists.

However, in the drawings of the junior group, there was a greater balance between figures identifiable as male and female both among the boys (14 male, 12 female) and the girls (12 male, 10 female). Only 4 of the figures could not be clearly identified as male or female. The younger group showed less gender stereotyping of human figures in the drawings.

Activities of humans

There was a marked gender difference between the juniors and seniors in showing humans involved in activities. Three junior boys and 8 junior girls depicted such action in their drawings. On the other hand, all the senior boys (except one) who drew humans depicted them in action, which was in a single category of using or operating objects and devices. Notably, the senior and junior girls were able to project humans as being involved in a variety of activities like teaching and learning, experimenting and using/operating.

This agrees with Wolters's (1989) finding among 10 to 12 year old students in the Netherlands that "the operating of and playing with computers and electric equipment was more normal for boys than for girls." It has also been reported elsewhere that girls seem to be more interested than boys in social, cultural and ethical dimensions of science and technology (Jenkins, 1997). These ideas find a distant echo in the variety of activities of humans seen in the posters.

Objects, models and human systems

Human systems were drawn by very few students and even fewer proportion of girls. Five boys and 2 girls in the total sample depicted human systems in their posters.

Almost half the girls (50%) and boys (44%) in the overall sample depicted both humans as well as objects in their posters. This is in contradiction to a finding that 10 years old students did not associate technology objects with humans or found humans difficult to draw (Wolters, 1989). In fact, among the junior group, almost half the boys depicted humans without showing objects, and a fourth (27%) drew both humans and

objects. Though in the sample as a whole, boys drew more objects (245) than did the girls (194), junior girls drew marginally more objects (72) than did the junior boys (66). On being asked in the questionnaire, "If you were given more time what would you draw?" The largest category of responses among the boys was to add more objects to their posters, while among the girls it was about beautifying their posters. There were no notable gender differences in the categories of objects drawn by boys and girls. None of the boys, from either group, depicted exclusively weapons in their poster, while a few girls (3) from the senior group did.

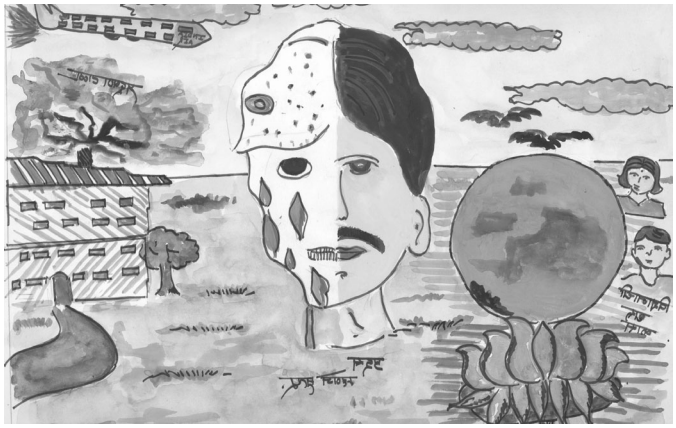

Figure 17: Symbolic depiction by a boy of beneficial and harmful effects of technology.

Categorised into objects, working models and "ideas", overall the boys' (41%) drawings showed more ideas, while the girls' drawings tended to show working models (39%) more often. Junior girls, however, showed working models more frequently (50%) than did their senior counterparts (30%), who showed more objects (40%). The frequency of the three categories was similar for the boys in the junior and senior groups. Thus, it was interesting to note that junior girls could depict technology as dynamic (as processes and ideas) rather than merely in a static sense (as objects).

5.6 *Beneficial and harmful effects of technology*

Overall both boys and girls showed in their posters more beneficial than harmful effects of science and technology. It was interesting to note that more boys (5) than girls (1) among the seniors and more girls (3) than boys (1) among the juniors could show both benefits as well as harm.

A large proportion of students, among boys and girls depicted science and technology for both societal and personal use. More boys (47%) than girls (31%) among the junior group referred to exclusively societal use, while more girls (56%) than boys (33%) in the same group referred to both the uses in their posters. Studies by Brunner et al (1990), Honey et al (1991) show that women see technological instruments as people connectors, collaboration devices often embedded in human relationships, while men

tended to envision technology as extensions of their powers. Our studies limited by sample size do not show significant gender differences in this aspect.

About half the students' posters showed technology used for constructive or destructive purposes. Equal proportion (about a fourth) of boys and girls portrayed the constructive purposes. More boys (20%) than girls (10%) portrayed both constructive and destructive processes. Very few students depicted technology exclusively for destructive purposes: 3 senior girls and 1 boy each from the senior and junior groups. Once again we have inadequate sample to agree with or contradict the findings by Honey et al (1991) that women have a fantasy that when something goes wrong with a technological device it will blow up.

In the drawings as well as in responses to the questionnaire, communication and transport formed the biggest category of benefits given by both boys and girls. However, many more boys (46%) than girls (22%) listed this category. This gender difference was less pronounced among the junior group. Several girls (17%) and only one boy wrote about technology helping to speed up work. Household benefits of technology were mentioned more by girls (17%) than boys (9%). A study by Smithers and Zientek (1991) in a different context found that most of the girls (aged 5) showed that only girls could mend clothes, while 95% of the boys in the study thought that only men could do car repairs. This may be reflected in the present context as more girls show household benefits.

The global scenario in the last few decades has made war and its associated technologies a topic of daily discussion. It appears that girls respond to the situation differently from the way boys do. In the total sample, more girls (44%) than boys (34%) listed (in response to questionnaire) the harmful use of technology in warfare. It is also interesting to note that more girls than boys referred to the connections between technology and warfare in the posters as well. A related result was found from Jenkins' (1997) study, which indicates that the terms used in warfare such as 'execute', 'abort', 'kill' are not easily reconciled with the values to which many girls attach importance. There was a difference between the junior and senior girls, where 6 senior girls and a lone junior girl mentioned warfare as the only harmful use of technology.

More boys than girls showed scenes related to the environment in their posters. There was a similar trend in listing environment-related issues among senior boys (77%) and senior girls (40%) in response to the questionnaire. Among the junior group, the trend was reversed, with more than half the junior girls and only a fifth of the junior boys listing environment related issues on the question of harmful effects of technology.

Both boys and girls listed a larger number of benefits than harmful uses, girls being marginally more positive than the boys. There was no significant gender difference in

the number of students considering science and technology for necessity, entertainment or luxury. The overall results suggest that students, irrespective of gender, hold a positive image, at least in terms of the uses of technology.

5.7 *Scenes and locations*

Almost all the boys and girls chose to draw scenes outside the classroom. These scenes were mostly from domestic and industrial areas, like watching a television (domestic) or process of recycling paper (industrial). There were no notable differences between the boys and girls either in the choice of domestic or industrial settings or in the earth or space scenes. A larger proportion of boys (30%) as compared to girls (22%) drew scenes related to the environment. The proportion was similar for the senior and junior groups.

5.8 *Subjects covered*

The posters were analysed for reference to one or more of the science disciplines, taken as physics, chemistry, biology and mathematics for the purpose of the analysis. They were also analysed for depiction of technology within one or more themes like communication, etc.

No significant gender difference was found in the choice of depicting concepts, applications, both or neither. Similar was the case with depiction of practical or theory aspects where the largest proportion of students among both boys (46%) and girls (44%) showed practical applications of science and technology.

Most students (44%) drew their posters without indicating relevance to any of the disciplines of science. The single most frequent discipline appearing in the junior boys' posters was physics (40%) followed by biology (20%). The posters with reference to a single discipline appeared almost equally among both boys and girls in the total sample. Almost a third of the girls, however, made a reference to all the disciplines, while among the boys, only about 10% did. This tendency among the girls to cover a greater variety of science disciplines was common among the junior as well senior groups.

When the technology aspects shown in the posters were analysed for their theme specificity, it was found that among the junior group, more of the boys (67%) than girls (25%) depicted technology within a single theme. Among the seniors, where the proportion drawing technology within a single theme was far fewer, there were more girls (15%) than boys (8%) who drew technology within one theme. More girls (30%) than boys (17%) portrayed technology within a combination of subjects, reflecting the general tendency of girls studied here to address a variety of subjects in their drawings.

5.9 *Conclusions*

A comparative analysis between the male and female students about their perception of S&T finds that the patterns of responses and depiction of different elements in the posters among boys and girls was different in the two groups, though an overall gender comparison masks this picture. The very topic chosen by students showed interesting patterns in gender in the junior and senior groups. While junior boys predominantly preferred "Images of science", a majority of senior boys preferred “Images of Technology”. Overall girls had a more balanced choice of topic. To top this, junior girls drew relevant elements in their posters more often than did the boys of their group, while more of the senior boys than senior girls drew posters relevant to the topic of their choice. The association of technology with a large number of objects, the difficulty in coming up with concepts relevant to science and a possible view of technology as a "male" subject may have contributed to the gender pattern in students’ choice of topic and relevance of posters to that topic.

Girls tended to draw fantasy more often than did the boys, who more often drew realistic objects. Perhaps, the circumstance of the study encouraged fantasising among the students, and girls tended to perform better on that front.

Junior girls, more than the other groups, attempted to portray technology as dynamic rather than static objects. Boys drew many more objects than did the girls, and also stated that given more time they would further increase the number. Girls on the other hand preferred to increase the visual appeal of the posters.

Overall both boys and girls showed in their posters more beneficial than harmful effects of science and technology for both societal and personal use, girls being marginally more positive than the boys. There were even fewer posters showing technology exclusively for destructive purposes. Interestingly, more girls than boys referred to technology speeding up work or its benefits in the household. More girls than boys connected technology to warfare in the posters and in the questionnaire. There was no difference between the boys and girls in their choice of scenes to draw - domestic or industrial settings; earth or space scenes. Only, a larger proportion of boys as compared to girls drew scenes related to the environment.

Both boys and girls drew less female figures than male ones, senior girls drawing marginally more often than the boys in their group. The younger group showed less gender stereotyping of human figures in the drawings than the seniors. The humans in the girls’ posters were involved in a larger variety of activities like teaching and learning, experimenting and using/operating. Girls’ greater preference for variety is also seen in the science subjects covered in their posters and a larger number of themes under which technology is portrayed.

Chapter 6

Overall conclusions and implications of the study

The analysis of the large variety of posters made with eagerness and excitement by the two groups of students yielded several important insights into students' ideas about science and technology.

The study included an analysis of the junior students' posters, the seniors' posters, a comparison between the two groups and comparison between the posters of girls and boys, both within each group as well as in the whole sample. The two groups of students, junior and senior, were in the age range of 10 to 13 and 13 to 15 years respectively. They were asked to make posters on the same themes, given similar instructions and responded to the same questionnaire.

We attempted a quantitative analysis, despite the limitations of sample size and range. Hence, the findings may be interpreted as a trend and more in qualitative terms than quantitative to provide significant inputs for further research and development in the area of science and technology education.

Most junior students, who had drawn present period, thought that their depictions were futuristic, probably not realising the landmarks already reached in science and technology. At the same time, they also tended to depict unreal or fantasy elements in their drawings. Students felt comfortable portraying the objects they saw or knew about and drew a large number of objects. The biggest category among the objects was related to communication and transport. Based on these findings, it appears that these students considered communication and transport to be the dominant S&T features of the future.

Senior students viewed science and technology less in terms of its beneficial and harmful aspects, and more in terms of a collection of objects, activities, models and ideas. Humans when drawn were shown to be operating or using objects of science and technology. These were drawn from a variety of subjects like physics, chemistry and biology, and themes like communication and transport.

The seniors found it difficult to portray the relation between science, technology, the environment and society. In fact, there were far more instances of objects in their drawings than applications of science and technology. They were, however, able to list such applications and effects when explicitly asked to do so in the questionnaire. When they did show science or technology harnessed for any purpose, they more often showed it for societal use rather than personal or individual. All the same, their slogans indicated that they related science to wonders and technology to power.

The study found several similarities in the drawings of the senior and junior groups, especially in the content of the posters and in their preference for depicting the present period. Similar proportions of students located the objects or processes of science and technology in different places, like the classroom, outside, space, etc. The abstract/ symbolic representations suggest that, given suitable opportunity, both junior and senior students can express their ideas in innovative and imaginative ways.

Almost all students showed more positive aspects of science and technology than negative ones: more benefits than harm, more constructive than destructive activities, more positive consequences. Environmental scenes in the posters were an exception to this general finding. The students did not cite any benefits of technology to the environment. These results possibly reflect students' exposure to the media, which often mentions the environmental harm caused by technology, and rarely its benefits. Students also listed the negative implications of technology, when specifically asked to do so in the questionnaire. The analysis suggests that students tended to focus on positive issues of S&T in their drawings unless forced to think about its harmful effects.

Technology is known to be closely associated with designing and making (construction). Notably, none of the students showed designing or making activity. These aspects were significantly absent in any of the posters of either the junior or the senior group.

Besides, almost all posters depicted scenes from outside the classroom or laboratory, domestic scenes being more frequent than industrial ones. On the other hand, a significant number of students were able to integrate aspects of theory and practice in their drawings. Thus, the students depicted theory and practice wherever they saw it happening. Perhaps, this suggests a possibility of improving students' conceptual understanding, especially in S&T by supplementing the theory taught with a good amount of praxis.

The differences between the groups mostly related to the students' differential exposure to concepts in science and technology, their ability to process the complex linkages of science, technology and society and their imagination constraints.

Over all, junior students found it more difficult to demarcate technology from science and most of them chose the topic "Images of Science". Equal number of students among the seniors chose the two given topics, while the gender difference in the choice of topics was more pronounced among the seniors than the juniors. Limited exposure and differential interest may have contributed among other factors to these differences.

Seniors were marginally better than the juniors were at drawing elements relevant to the topic of their choice. The senior students indicated progression in time and drew future scenarios almost twice as often as did the juniors. Besides, the seniors were more aware of the time frame they had depicted in their posters. Senior students overall had covered more themes and subjects as would be expected from their greater exposure to school and the media.

Ability to draw objects and processes relevant to the chosen topic may be affected by what students think is included in the topic and their ability to visualise the objects and processes. It may also be influenced by their conceptual understanding as well as by their aesthetics and other considerations besides their ability to draw.

The differences between boys and girls could be discerned at two levels: in both the groups together and as a difference between the groups.

The very topic chosen by students showed interesting patterns in gender in the junior and senior groups. Junior boys predominantly preferred "Images of science", while a majority of senior boys preferred “Images of Technology”. Girls chose both topics more or less equally. Junior girls also drew relevant elements in their posters more often than did the boys of their group, while more of the senior boys, than senior girls drew posters relevant to the topic of their choice. Junior girls, more than the other groups, attempted to portray technology as dynamic rather than static objects. Interestingly, more girls than boys referred to technology speeding up work or its benefits in the household. More girls than boys connected technology to warfare in the posters and in the questionnaire.

Boys drew many more objects than did the girls. They even wanted to add more objects if given more time. Girls on the other hand preferred to increase the visual appeal of the posters. Girls tended to draw fantasy while boys more often drew realistic objects.

The younger group showed less gender stereotyping of human figures in the drawings than the seniors. The humans in the girls’ posters were involved in a larger variety of activities like teaching and learning, experimenting and using/operating. Girls’ greater preference for variety is also seen in the science subjects covered in their posters and a larger number of themes under which technology is portrayed.

The association of technology predominantly with objects, the constraints of recollecting and depicting science concepts, and a possible view of technology as a "male" subject may have all contributed to the gender pattern in students’ choice of topic and relevance of posters to that topic.

The activities and processes depicted as well as those omitted are important pointers to the conceptions that school students have about science and technology. Praxis and action were more often seen in the posters than concepts and theoretical ideas. This suggests that in order to improve and broaden students' understanding of science and technology, activities and experiments must form an important component of teaching and learning.

In fact, making posters and responding to questions are seen to form complimentary methods of diagnosing students' ideas. A multiplicity of expressions, including imagining, designing, drawing and making, are absent or devalued in school teaching and learning today. More importantly, they also need to form a part of the process of assessment. This will probably enable a greater understanding of subjects, accompanied by sustained interest.

References

Basow, S. A. (1992). *Gender stereotypes and roles* (3rd ed.). Pacific Grove, CA: Brooks/Cole.

Beittel, K., (1972).*Mind and Context in the Art of Drawing*, Holt Rinehart and Winston, Inc., United States of America

Bell Clive (2002) *Art* Rupa & Co., New Delhi

Billington, H.L. (1997). Poster presentations and peer assessment: novel forms of evaluation and assessment, *Journal of Biological Education*, Vol. 31, 218-220.

Bird, M.D. (2001). Talk less, say more. *Science and Children*, January 2001, 47-50.

Bloch, C., *Chloe's story: First steps into literacy*; Juta & Co. Ltd, Kenwyn.

Block, J. H. (1984). *Sex-role identity and ego development*. San Francisco: Jossey-Bass.

Boyatzis, Chris J, Eades, J. (1999). Gender Differences in Preschoolers' and Kindergartners' Artistic Production and Preference**.** Sex Roles: *A Journal of Research, Issue:* Oct,

Brunner, C., Bennet, D., Clements, M., Honey, M., Moeller, B. (1990*).* Gender and technological imagination. *Paper presented at the annual meeting of the American Education Research Association,* New Orlenes, LA.

Chambers, D. W. (1983). Stereotypic images of the scientist: The Draw-a-Scientist-Test. *Science Education* 67:255-265.

Chapman, Laura (1978). *Approaches to Art in Education* Harcourt Brace Jovanovich, Inc., New York

Chunawala S., Apte, S., Natarajan, C,. Ramadas, J.(1996) . Students' ideas related to living and non-living. *Technical report no 29*, Homi Bhabha Centre for Science Education, June 1996.

Chunawala, S. and Ladage S.(1998). Students' ideas about science and scientists, *Technical report no 38*, Homi Bhabha Centre for Science Education , Tata Institute of Fundamental Research, Mumbai.

Corread, I. (1985). Twelve years of technology education in France, England and the Netherlands: how do people perceive the subject? http://216.239.39.100/www.iteawww.org/PATT11/Correarddef.pdf

Cox , M.V. (1993). *Children's drawings of the human figure*. Hillsdale, NJ: Erlbaum.

Cox-Bishop, M. (2000), *The Gaston Gazette Online*, URL http://www.gastongazette.com, Feb 24, 2000.

Dennis, W. (1966). *Group values through children's drawings*. New York: John Wiley & Sons.

Dhama O.P., Bhatnagar O.P. 1997 Second edition, *Education and Communication for Development*, Oxford & IBH Publishing Co. Pvt. Ltd., 413-444, 455-462.

Doornekamp, G. (1991). Gender differences in the acquisition of technical knowledge, skills and attitude in Dutch primary education: the need for technology education. *International Journal of Technology and Design Education,* Vol. 2, No. 1.

Dust, K. (1999). *Motive, Means and Opportunity: Creativity Research Review* [online]. URL : http://www.nesta.org.uk/lowfat/kdust_rep.html (18 January, 2001).

Edwards Betty (1993) *Drawing on the Right Side of the Brain: How to Unlock Your Hidden Artistic Talent* Harper Collins Publishers, London

Elizabeth M. Koppitz (1983), "Projective drawings with children and adolescents," *School Psychology Review,* XII (No.4), 421-27

Fourtner Charles, R., Bisson Mary and Loretz Christopher A. *Using posters in case studies: The scientific poster as a teaching tool.* http://ublib.buffalo.edu/libraries/projects/cases/posters.html

Gillian, F. (2001). *Children's drawing,* Series edited by Janet Atkin.

Godfrey T. *Drawing encounters*, Roland C. (2002) The art room. Site maintained by School of Art and Art History, University of Florida. http://www.arts.ufl.edu/art/rt_room/teach/encounters/drawing_encounters.html

Goodenough, F. L.(1926), *Measurement of Intelligence by Drawings* (New York: Harcourt, Brace & World)

Goodnow, Jacqueline 1977 *Children's Drawing* Fontana/Open Books Publishing Limited, London

Gross, J., & Hayne, H. (1998). Drawing facilitates children's verbal reports of emotionally laden events. *Journal of Experimental Psychology*: Applied, 4, 163-179

Hay Ian, Thomas Susan 1999. Making sense with posters in biological science education. *Journal of Biological Education,* Vol. 33, No. 4, 209-214.

Heywood, J. (1998). Pupils' attitude towards technology: A review of studies which have a bearing on the attitudes which freshmen bring with them to engineering. http://file.engrng.pitt.edu/file

Honey, M. (1996). The maternal voice in the technological universe. *CCT reports*, Issue no. 6.

Huber, R. and Burton, G. (1995). What do students think scientists look like? *School science and mathematics,* 95 (7), 371-376.

Hurwitz, A. and Day, M. (1995). *Children and their Art.* Harcourt Brace College Publishers, Texas, 1995. http://www.d.umn.edu/~jbrutger/HurDay.html

Ilana Ben-Dov (2002), *Development Of Category, Stereotype And Prejudice Toward Arabs Among Jewish Children Of Pre-School Age (3-6),* http://www.tau.ac.il/education/toar3/etakzir2001-2.doc

Ioannidis. G.S. (1999): *Children's drawings and stories about energy* http://www. Ipn.uni-kiel.de/projeckte/ese/book/bo62-ioa.pdf

Jenkins, A. (1997). *Quality matters so let's get serious about it*, Times Higher Education Supplement, April 7

Karmiloff-Smith, A. (1990) *Constraints on representational change: Evidence from children's drawing.* Freeman (1980) http://www.ich.ucl.ac.uk/ich/html/academicunits/neurocog_dev/aks/aksmith2.html

Kawecki, I. (1994). Gender differences in young children's artwork. *British Educational Research Journal,* 20, 485--490.

Kellog, R. (1969). *Analyzing Childrens's Art*, Palo Alto, California, National Press Books. http://ibs.derby.ac.uk/~steve/devpsy/lecture5.shtml

Kimura, D. (1999). *Sex and Cognition, A Bradford book,* The MIT press Cambridge, Massachusetts

Koppitz, E. (1968). Body part size estimation in children. *Perceptual and Motor Skills*, 47, 1047--1050.

Levine, Marilyn A. *Creating posters for humanities and social sciences*, http://www.lcsc.edu/ss150/poster.htm

Lowenfeld,V., (1947). *Creative and Mental Growth*. Macmillan Co., New York

Machover, K. (1960). Sex differences in the developmental pattern of children as seen in human figure drawings. In A.I. Rabin and M.R. Howorth (Eds.), *projective techniques with children,* New York: Grunea and Stratton.

María Aguirre (1996). Effect of open-ended questions on Spanish-dominant LEP students' ability to demonstrate in-depth science concept development and use scientific vocabulary*, NYSABE Journal, 11,* Fall 1996 http://www.ncela.gwu.edu/miscpubs/nysabe/vol11/nysabe113.htm

Masters, M.S. & Sanders, B. (1993). Is the gender difference in mental rotation disappearing? *Behavior genetics*, 23, 337-341

Menn, D. (1993, October). *Multimedia in education*. PC World, M52-M60.

Molich, Rolf (2000): *Brugervenligt web-design*. Ingeniøren/bøger, ISBN 87-571-2285-7 (chap. 11)
http://www.hum.auc.dk/huminf/semesterplan/efteraar03/5%20humdat.pdf.

Natarajan C., Chunawala S., Apte, S., Ramadas, J.(1996) . Students' ideas about plants. *Technical report no 30,* Homi Bhabha Centre for Science Education, June 1996.

Newton, D.P. and Newton, L.D. (1992) Young children's perception of science and scientists, *International Journal of Science Education,* 14(3) 331-348.

Peters, M., Laeng, B., Latham, K., Jackson, M., et al (1995). A redrawn Vandenberg and Kuse Mental Rotations Test: Different versions and factors that affect performance. *Brain and Cognition*, *28*, 39-58

Piaget, J. (1972). *The psychology of intelligence*. Totowa, NJ.: Littlefield, Adams.

Ramadas J.: Use of Ray Diagrams in Optics, *School Science*, *XX*, 10-17, 1982

Ramadas J.: Motion in children's Drawings, In I. Harel (Ed.), *Constructionist Learning: A 5th Anniversary Collection of Papers*, MIT Press, Cambridge, MA, 1990.

Ramadas, J., and Driver, R. (1989). *Aspects of Secondary Students' Ideas about light*, Centre for studies in Science and Maths Education, University of Leeds.

Ramadas, J. and Nair, U (1996). The Systems Concept as a Tool in Understanding Ideas about the Digestive System *International Journal of Science education*. 18 (3), 355-68.

Ramadas, J., Natarajan, C., Chunawala S., Apte, S. (1996) . Role of experiments in school science *Technical report no 31,* Homi Bhabha Centre for Science Education, June 1996.

Reiss et al (2002). An international study of young people's drawings of what is inside themselves, *Journal of Biological Education,* 36(2).

Rheingold, H. L., & Cook, K. V. (1975). The contents of boys' and girls' rooms as an index of parents' behavior. *Child Development*, 46, 459-463.

Rubenstein, J., & Rubin, C. (1984). *Children's fantasies of interaction with same and opposite sex peers*. In T. Field, J. Roopnarine, & M. Segal (Eds.), Friendship in normal and handicapped children (pp. 99-123). Norwood, NJ: Ablex.

Sjoberg, S and Imsen, G. (1988). *Gender and science education:1*. In Fensham P.(Eds.), (1998), Development and Dilemmas in Science Education, Falmer Press, London.

Smithers, A. and Zinetek, P.(1991). *Gender, Primary schools and the National Curriculum.* London: Engineering Council.

Snyder, P.J. & Harris, L.J. (1993). Handedness, sex, and family sinistrality effects on spatial tasks. *Cortex,* 29, 115-134

Technology for All Americans Project, International Technology Education Association 2000 http://www.iteawww.org/TAA/

The Express newspaper (1999), Exhibition of drawings by Kosovo children, URL: http://www.fas.org/man/dod-101/ops/docs99/990505-drawings.htm

Thomas, GV. & Silk, AMJ. (1990). *An introduction to the psychology of children's drawings.* NY: Harvester Wheatsheaf
http://ibs.derby.ac.uk/~steve/devpsy/lecture5.shtml

Thorne, B. (1993). *Gender play: Girls and boys in school*. New Brunswick, NJ: Rutgers University Press.

Tilburg, Emmalou Van (1987), Evaluation with a new twist, *Journal of Extension*, 25 (4); http://www.joe.org/joe/1987winter/al.html

Wales, R. (1990). Children's Pictures. In Grieve, R. and Hughes, M. (eds.) *Understanding Children: essays in honour of Margaret Donaldson,* Basil Blackwell Ltd., UK.

Wayne, D. (1966). *Group values through children's drawings* (New York: John Wiley & Sons, Inc.)

Willats. J. (1997). *Art and Representation: New Principles in the Analysis of Pictures.* Princton University Press, NJ,. (Chapters 4, 5 & 6, pp. 93-146)

Wolters, Falco de Klerk. (1989).A PATT study among 10 to 12-year-old students in The Netherlands. *Journal of Technology Education, 1*(1), 22-33.

Table of results of Junior and Senior groups (Poster)

	Senior	Junior
Is the topic Images of Science or Technology		
Science	50	71
Technology	50	29
	(100)	(100)
Does the poster relate to topic chosen		
Yes	74	61
No	26	39
	(100)	(100)
Nature of poster drawing		
Real	24	45
Fantasy	28	6
Abstract/Symbolic	26	39
Real Symbolic	22	10
	(100)	(100)
Does the poster depict		
Humans	2	6
Objects	41	45
Both	52	39
Neither	4	10
	(99)	(100)
Sex of humans depicted		
Male	31	29
Female	27	7
Both	8	50
Unclear	35	14
	()	(100)
Number of males	70	53
Number of females	30	45
Total number	33 (23m+10f)	49(26m+22f))
Kinds of activity in which humans are involved		
Teaching/Learning	17	18
Experimenting	9	27
Designing/Making	0	0
Using/Operating	74	55
	(100)	(100)
Number of objects	301	138
Kinds of objects		
Modes of transport	9	10
Communication	18	29
Weapons	7	0
All of the above	48	29

None of the above	14	32
Modes of transport+ Weapons	5	0
	(101)	(100)
Human systems depicted		
Yes	11	6
No	89	94
	(100)	(100)
Differentiating between concepts/Application		
Objects	35	26
Working models	28	39
Ideas	37	35
	(100)	(100)
Coverage of subjects within topic		
Chemistry	2	3
Biology	7	13
Physics	7	29
Mathematics	0	0
Mathematics+ Biology	0	3
Chemistry+ Biology	0	3
All	22	26
None	63	23
	(101)	(100)
Cyclic/Linear representation		
Linear	9	10
Cyclic	2	6
Neither	89	84
	(100)	(100)
Classroom oriented/Outside classroom		
Classroom	2	6
Outside	98	94
	(31)	(100)
Industrial/ Domestic		
Industrial	4	3
Domestic	2	16
Both	28	19
Neither	65	61
	()	(100)
Environment related/Unrelated		
Environment related	24	29
Unrelated	76	71
	(100)	(100)
Space/Earth		
Focused on earth	7	13
In space	17	13
Both	41	23
Neither	35	51
	(100)	(100)
Applications to humans		

Beneficial	22	39
Harmful	4	3
Both (useful and harmful)	13	13
Neither	61	45
	(100)	(100)
Time		
Ancient	0	0
Present	74	87
Future	17	10
Progress orientation	9	3
	(100)	(100)
Technology within a subject/Combination of subjects		
Within a subject	11	45
Combination of subjects	20	29
Neither	70	26
	(101)	(100)
Theory and Practical integration (showing concepts or applications)		
Theoretical	0	6
Practical	39	55
Both	17	19
Neither	44	19
	(100)	(100)
Use of science/technology for		
Entertainment	0	0
Luxury	0	16
Necessity	4	16
Entertainment+ Luxury	17	16
None	78	52
	(99)	(100)
Society use/Personal use		
Society	15	39
Personal	4	6
Both	50	45
Neither	30	10
	(99)	(100)
Constructive/ Destructive processes		
Constructive	15	39
Destructive	9	3
Both	11	23
Neither	65	35
	(100)	(100)

Table of results of Girls and Boys (Poster)

	Boys (n=15j+26s=41)	**Girls** (n=16j+20s=36)
Is the topic Images of Science or Technology		
Science	93(14), 38 (10)= 59	50(8), 65 (13) =58
Technology	7(1), 62 (16)= 41	50(8), 35(7)=42
Does the poster relate to topic chosen		
Yes	47(7), 85(22)=71(29)	75(12), 60(12)=67
No	53(8), 15 (4)=29 (12)	25(4), 40(8)=33
Nature of poster drawing		
Real	47(7), 35(9)=39	44(7), 10(2)=25
Fantasy	0(0), 23(6)=15	13(2), 35(7)=25
Abstract/Symbolic	40(6), 27(7)=32	38(6), 25(5)=31
Real Symbolic	13(2), 15(4)=15	6(1), 30(6)=19
Does the poster depict		
Humans	47(7), 0=17	6(1), 5(1)=6
Objects	13(2), 46(12)=34	38(6), 35(7)=36
Both	27(4), 54(14)=44	50(8), (5010)=50
Neither	13(2), 0=5	6(1), 10(2)=8
Sex of humans depicted		
Male	(2) (5)=7	(2) (3)=5
Female	(0) (3)=3	(1) (4)=5
Both	(3) (1)=4	(4) (1)=5
Unclear	(0) (5)=5	(2) (4)=6
Number of males	(14) (14)=28	(12) (9)21
Number of females	(12) (4)=16	(10) (6)=16
Unclear	(4)	(14)
Total number		
Kinds of activity in which humans are involved		
Teaching/Learning	(1) (1)=2	(1) (3)=4
Experimenting	(1) (0)=1	(2) (2)=4
Designing/Making	(0) (0)=0	(0) (0)=0
Using/Operating	(1) (10)=11	(5) (7)=12
Number of objects	(66) (179)=245	(72) (122)=194

Kinds of objects		
Modes of transport	7(1), 4(1)=5	13(2), 15(3)=14
Communication	33(5), 19(5)=24	25(4), 15(3)=19
Weapons	0(0), (0)=0	0(0), 15(3)=8
All of the above	33(5), 54(14)=46	25(4), 35(7)=31
None of the above	27(4), 15(4)=20	38(6), 10(2)=22
Modes of transport+ Weapons	0(0),8(2)=5	0(0), (0)=0
Human systems depicted		
Yes	13(2), 12(3)=12	0(0), 10(2)=6
No	87(13), 88(23)=88	100(16), 90(18)=94
Differentiating between concepts/Application		
Objects	33(5), 31(8)=32	19(3), 40(8)=31
Working models	27(4), 27(7)=27	50(8), 30(6)=39
Ideas	40(6), 42(11)=41	31(5), 30(6)=31
Coverage of subjects within topic		
Chemistry	0(0), 4(1)=2	6(1), 0=3
Biology	20(3),8(2)=12	6(1), 5(1)=6
Physics	40(6), 4(1)=17	19(3), 10(2)=14
Mathematics	0(0), 0	0(0), 0
Mathematics+ Biology	7(1), 0=2	6(1), 0=3
Chemistry+ Biology	27(4), 0=10	0(0), 0
All	0(0), 15(4)=10	38(6), 30(6)=33
None	7(1), 69(18)=46	25(4), 55(11)=42
Cyclic/Linear representation		
Linear	7(1), 15(4)=12	13(2), 0=6
Cyclic	7(1), 4(1)=5	6(1), 0=3
Neither	87(13), 81(21)=83	81(13), (20)=92
Classroom oriented/Outside classroom		
Classroom	7(1), 0=2	6(1), 5(1)=6
Outside	93(14), 100(26)=98	94(15), 95(19)=94
Industrial/ Domestic		
Industrial	7(1), 4(1)=5	0(0), 5(1)=3
Domestic	13(2), 4(1)=7	19(3), (0)=8
Both	13(2), 31(8)=24	25(4), 25(5)=25
Neither	67(10), 62(16)=63	56(9), 70(14)=64
Environment related/Unrelated		

Env. Related	27(4), 31(8)=29	31(5), 15(3)=22
Unrelated	73(11), 69(18)=71	69(11), 85(17)=78
Space/Earth		
Focused on earth	13(2), 12(3)=12	13(2), 0=6
In space	20(3), 15(4)=17	6(1), 20(4)=14
Both	13(2), 38(10)=29	31(5), 45(9)=39
Neither	53(8), 35(9)=41	50(8), 35(7)=42
Applications to humans		
Beneficial	33(5), 27(7)=29	44(7), 15(3)=28
Harmful	7(1), 4(1)=5	0(0), 5(1)=3
Both (useful and harmful)	7(1), 19(5)=15	19(3), 5(1)=11
Neither	53(8), 35(9)=41	38(6), 75(15)=58
Time		
Ancient	0(0), 0	0(0), 0
Present	100(15), 69(18)=80	75(12), 80(16)=78
Future	0(0), 15(4)=8	19(3), 20(4)=19
Progress orientation	0(0), 15(4)=8	6(1), 0=3
Technology within a subject/Combination of subjects		
Within a subject	67(10),8(2)=26	25(4), 15(3)=19
Combination of subjects	27(4), 12(3)=17	31(5), 30(6)=31
Neither	7(1), 81(21)=54	44(7), 55(11)=50
Theory and Practical integration (showing concepts or applications)		
Theoretical	7(1), 0=2	6(1), 0=3
Practical	60(9), 38(10)=41	50(8), 40(8)=44
Both	13(2), 15(4)=13	25(4), 20(4)=22
Neither	20(3), 46(12)=33	19(3), 40(8)=31
Use of science/technology for		
Entertainment	0(0), 0=0	0(0), 0
Luxury	13(2), 0=5	19(3), 0=8
Necessity	13(2),8(2)=10	19(3), 0=8
Entertainment+ Luxury	13(2), 19(5)=17	19(3), 15(3)=17
None	60(9), 73(19)=68	44(7), 85(17)=69
Society use/Personal use		
Society	47(7), 15(4)=27	31(5), 15(3)=22
Personal	7(1), 4(1)=5	6(1), 5(1)=6
Both	33(5), 54(14)=46	56(9), 45(9)=5

Neither	13(2), 27(7)=22	6(1), 35(7)=22
Constructive/ Destructive processes		
Constructive	33(5), 23(6)=27	44(7), 5(1)=22
Destructive	7(1), 4(1)=5	0(0), 15(3)=8
Both	27(4), 15(4)=20	19(3), 5(1)=11
Neither	33(5), 58(15)=49	38(6), 75(15)=58

Note: Numbers in bracket indicate the number of students

J= Juniors, S=Seniors

Table of results of Junior and Senior groups (Questionnaire)

	Senior	Junior
Poster theme		
Images of Science	52	71
Images of technology	46	29
Theme not mentioned	2	0
	(100)	(100)
Did you enjoy making your poster?		
Not at all	0	0
Not much	11	0
Unsure	7	3
Somewhat	13	16
Very much	70	81
	(101)	(100)
Title/Slogan for the poster		
a) Showing Progression	13	10
b) Uses/Wonders of Science	20	32
c) As a profession	2	0
d) Power of Science	7	10
e) Abstract	15	19
Both Science/Technology	2	3
Technology		
Showing Progression	13	3
Wonders of Technology	4	3
As a profession	0	0
Power of Technology	13	10
Abstract	7	6
Positive and Negative	2	0
No slogan	2	3
	(100)	(100)
If you were given more time what more would you draw?		
Science		
Add colors+ Objects	0	0
Add colors/ Textures/ Make attractive	15	9
Human figures	2	6
Scientific symbols	4	10
Objects	9	23
Nothing at all	13	6
Scientific activities	2	10
Human figures+ Objects	2	3
Scientific activities + Objects	0	3
Human figures+ Scientific symbols	2	0
Progress	2	0

Technology		
Add colors/ Textures/ Make attractive	20	6
Human figures	0	0
Present Technology-Comparison across ages	2	0
Industries	4	3
Objects	13	9
Nothing at all	2	3
Benefits	2	0
Unattempted	4	0
	(98)	(100)
Poster depicting time period		
Distant Future	7	13
Near Future	15	19
Present time	70	65
Ancient time	4	0
Present+ Ancient time	2	3
Present+ Near future	2	0
	(100)	(100)
Harmful uses of Technology		
Number listed		
Above 4	0	0
4	22	23
3	13	10
2	35	23
1	30	26
0	0	19
	(100)	(100)
Area		
Agriculture	0	4
Warfare	20	17
Unemployment/ Poverty	7	0
Environment	28	30
Entertainment	2	0
Communication	0	0
Warfare + Environment	15	17
Medicine	0	9
Environment + Entertainment	0	4
Warfare + Unemployment	0	13
Household	2	0
Maintenance/ Repairs	0	4
Unemployment + Environment	12	0
(Warfare+ Environment) + Agriculture	4	0
Communication + Environment	2	0
(Warfare+ Environment) + Communication	2	0
Warfare + Communication	2	0

Population	2	0
Communication + Agriculture	0	0
Communication + Environment + Unemployment	0	0
Not attempted	2	0
	(100)	(100)
Consequences		
Positive	2	10
Negative	98	71
Not attempted	0	19
	(100)	(100)
Benefits of Technology		
Number listed		
Above 4	4	3
4	17	19
3	28	10
2	22	45
1	26	16
Not Attempted	2	6
	(99)	(100)
Area		
Education	7	14
Warfare	0	0
Household	11	10
Environment	2	3
Entertainment/Luxury	9	10
Communication/Transport…	28	17
Medicine	0	10
Communication+ Transport+ Medicine.	7	7
Entertainment+ Luxury+ Communication	4	10
Progress	11	14
Speed	11	3
Progress+ Speed	2	0
Communication+Transport+Household	4	0
Communication+Transport+Education	4	0
	(100)	(100)
Consequences		
Positive	100	3
Negative	0	97
	(100)	(100)
Has technology benefited you in any way in making your poster?		
Yes	76	61
No	22	39
Not Attempted	2	0
	(100)	(100)

Number listed		
Above 4	0	3
4	4	0
3	7	0
2	13	13
1	20	19
Not attempted/Irrelevant	57	65
	(101)	(100)
Technology as aid in drawing poster		
Stationery	26	16
Irrelevant	24	29
Could not explain	9	10
Technology Equipment	9	3
Not Attempted	33	42
	(101)	(100)

Table of results of Girls and Boys (Questionnaire)

	Boys (n=15j,26s=41)	**Girls** (n=j16,20s=36)
Poster theme		
Images of Science	93(14), 38(10)=59	50(8), 70(14)=61
Images of technology	7(1), 58(15)=39	50(8), 35(7)=42
Did you enjoy making your poster?		
Not at all	0(0), 0	0(0), 0
Not much	0(0), 12(3)=7	0(0), 10(2)=6
Unsure	0(0), 0	6(1), 15(3)=11
Somewhat	33(5), 15(4)=22	0(0), 10(2)=6
Very much	67(10), 73(19)=71	94(14), 65(13)=75
Title/Slogan for the poster		
a) Showing Progression	13(2), 15(4)=15	6(1), 10(2)=8
b) Uses/Wonders of Science	40(6), 15(4)=24	25(4), 25(5)=25
c) As a profession	0(0) , 0	0(0). 5(1)=3
d) Power of Science	7(1) 4(1)=5	13(2), 10(2)=11
e) Abstract	27(4),7(2)=15	13(2), 25(5)=28
Both Science/Technology	7(1) 0=2	0(0), 5(1)3
Technology		
Showing Progression	0,23(6)=15	6(1), 0=3
Wonders of Technology	0(0),8(2)=5	6(1), 0=3
As a profession	0(0), 0	0(0) 0=0
Power of Technology	0(0), 19(5)=12	13(2), 5(1)=8
Abstract	7(1), 4(1)=5	13(2), 10(2)=11
Positive and Negative	0(0), 0	0(0), 5(1)=3
No slogan	0(0), 0	0(0), 0
If you were given more time what more would you draw?		
Science		
Add colors+ Objects	0(0), 0	0(0), 0
Add colors/ Textures/ Make attractive	7(1), 15(4)=12	19(3), 15(3)=17
Human figures	7(1), 0=2	6(1), 5(1)=6
Scientific symbols	13(2), 4(1)=7	6(1), 5(1)=6
Objects	40(6),8(2)=20	6(1), 10(2)=8
Nothing at all	13(2), 0=5	0(0), 30(6)=17
Scientific activities	13(2), 4(1)=7	6(1), 0=3
Human figures+ Objects	0(0), 0	6(1), 5(1)=6

Scientific activities + Objects	0(0), 0	6(1), 0=3
Human figures+ Scientific symbols	0(0), 0	0(0), 0
Progress	0(0), 0	0(0), 0
Technology		
Add colors/ Textures/ Make attractive	0(0), 23(6)=15	12(2), 15(3)=14
Human figures	0(0), 0	0(0), 0
Present Technology-Comparison across ages	0(0) , 0	0(0), 5(1)=3
Industries	7(1), 4(1)=5	0(0), 5(1)=3
Objects	0(0), 23(6)=15	25(4), 0=11
Nothing at all	0(0) , 4(1)=2	6(1), 0=3
Benefits	0(0), 4(1)=2	0(0), 0
Poster depicting time period		
Distant Future	7(1),8(2)=73	19(3), 5(1)=11
Near Future	27(4), 12(3)=17	13(2), 20(4)=17
Present time	67(10), 73(19)=71	63(10), 65(13)=64
Ancient time	0(0), 0	0(0), 0(2)=6
Present+ Ancient time	0(0), 4(1)=2	6(1), 0=3
Present+ Near future	0(0), 4(1)=2	0(0), 0
Harmful uses of Technology		
Number listed		
Above 4	0(0), 0	0(0), 0
4	20(3), 27(7)=24	25(4), 15(3)=19
3	0(0), 12(3)=7	19(3), 15(3)=17
2	13(2), 31(8)=24	31(5), 40(8)=36
1	53(8), 31(8)=24	0(0), 3 0(6)=17
0	13(2), 0=5	25(4) 0=11
Area		
Agriculture	7(1), 0=2	0(0), 0
Warfare	20(3), 12(3)=15	6(1), 30(6)=19
Unemployment/ Poverty	0(0) 4(1)=2	0(0), 10(2)=6
Environment	20(3), 38(10)=32	25(4), 15(3)=19
Entertainment	0(0), 4(1)=2	0(0),0
Communication	0(0), 0(0)	0(0), 0
Warfare + Environment	0(0), 15(4)=10	25(4), 15(3)=19
Medicine	13(2), 0=5	0(0), 0
Environment + Entertainment	0(0), 0	6(1), 0=3
Warfare + Unemployment	13(2), 0=5	6(1), 0=3
Household	0(0), 0	0(0), 5(1)=3
Maintenance/ Repairs	7(1), 0=2	0(0), 0
Unemployment + Environment	0(0), 12(3)=7	0(0), 10(2)=6

(Warfare+ Environment) + Agriculture	0(0),8(2)=5	0(0), 0
Communication + Environment	0(0), 0	0(0), 5(1)=3
(Warfare+ Environment) + Communication	0(0), 4(1)=2	0(0), 5(1)=3
Warfare + Communication	0(0), 0	0(0), 5(1)=3
Population	0(0) ,0	0(0), 5(1)=3
Communication + Agriculture	0(0), 0	0(0), 0
Communication + Environment + Unemployment	0(0), 0	0(0), 0
Consequences		
Positive	20(3), 4(1)=10	0(0), 0
Negative	67(10), 96(25)=85	75(12), 100(20)=89
Not Attempted	13(2), 0=49	25(4), 0=11
Benefits of Technology		
Number listed		
Above 4	0(0), 0	6(1), 10(2)=8
4	13(2), 13(4)=15	25(4), 20(4)=22
3	13(2), 27(7)=22	6(1), 30(6)=19
2	40(6), 35(9)=37	50(8), 5(1)=25
1	20(3), 23(6)=22	13(2), 30(6)=22
Not Attempted	13(2), 0=5	0(0), (1)=3
Area		
Education	20(3), 7(2)=12	6(1), 5(1)=6
Warfare	0(0), 0	0(0), 0
Household	13(2), 4(1)=7	6(1), 20(4)=14
Environment	0(0), 4(1)=2	6(1), 0=3
Entertainment/Luxury	7(1), 12(3)=10	13(2), 5(1)=8
Communication/Transport…	20(3), 35(9)=29	13(2), 20(4)=17
Medicine	7(1) ,0=2	13(2), 0=6
Communication+ Transport+ Medicine.	7(1), 12(3)=10	6(1) , 0=3
Entertainment+ Luxury+ Communication	7(1), 4(1)=5	13(2), 5(1)=8
Progress	0(0),8(2)=5	13(2), 15(3)=14
Speed	0(0), 4(1)=2	6(1), 20(4)=14
Progress+ Speed	0(0), 0	0(0), 5(1)=3
Communication+Trans+Hhold	0(0), 4(1)=2	0(0), 5(1)=3
Communication+Trans+Education	0(0),8(2)=5	0(0), 0
Consequences		
Positive	93(14), 100(26)=98	100(16), 100(20)=100

Negative	7(1), 0(0)=3	0(0)
Has technology benefited you in any way in making your poster?		
Yes	67(10), 81(21)=76	56(9), 70(14)=64
No	33(5), 15(5)=24	44(7), 30(6)=36
Number listed		
Above 4	7(1) , 0=3	0(0), 0
4	0(0), 4(1)=3	0(0), 5(1)=3
3	0(0), 12(3)=7	0(0), 0
2	20(3), 15(4)=17	6(1), 10(2)=8
1	33(5), 2 3(6)=27	6(1), 15(3)=11
Not Attempted	0(0), 46(12)=29	0(0), 70(14)=39
Technology as aid in drawing poster		
Stationery	27(4), 38(10)=34	6(1), 10(2)=8
Irrelevant	27(4), 19(5)=22	25(4), 30(6)=28
Could not explain	7(1), 15(4)=12	13(2), 0=6
Technology Equipment	7(1), 12(3)=10	0(0), 5(1)=3
Not Attempted	33(5), 15(4)=22	56(9), 55(11)=56

Note: Figures in brackets indicate number of students

Questionnaire in English

Poster Competition

Name:_____
School: _____
Standard:_____

Poster Theme: _____

1. Did you enjoy making the poster? (Tick one)

☐ Very much ☐ Somewhat ☐ Unsure ☐ Not much ☐ Not at all

2. Write a catchy title/slogan for your poster.
   _____

3. If you were given more time, what would you add to your poster?
   _____

   _____

4. Your poster shows which time period? (Tick one)

   Ancient time ☐ Present time ☐
   Near Future ☐ Distant future ☐

5. List a few uses of technology that have been harmful.
   _____ _____

   _____ _____

6. List a few benefits of technology.
   _____ _____

   _____ _____

7. Has technology helped you in any way in making the poster? (Tick one)
   Yes/ No
   If yes, list a few pints to explain how.
   _____

   _____

पोस्टर स्पर्धा– प्रश्नावली(मराठी)

नाव: _____

शाळा: _____

इयत्ता: _____

पोस्टरचा विषय: _____

१. हे पोस्टर बनविताना तुम्हाला मजा आली का ? (खालीलपैकी एकावर खूण करा.)

☐ खूप जास्त ☐ थोडी फार ☐ सांगता येत नाही

☐ जास्त नाही ☐ अजिबात नाही

२. तुमच्या पोस्टरसाठी आकर्षक । उचित शीर्षक लिहा.

_____

३. जर तुम्हाला जास्त वेळ दिला असता, तर तुम्ही तुमच्या पोस्टरमध्ये अजून काय काढलं असतं?

_____

_____

४. तुमच्या पोस्टरमध्ये कोणता काळ दाखविला आहे? (खालीलपैकी एकावर खूण करा.)

☐ प्राचीन काळ ☐ वर्तमान काळ ☐ भविष्य काळ ☐ दूरचा भविष्यकाळ

५. तंत्रज्ञानाचे अपायकारक ठरणारे असे काही उपयोग सांगा.

_____ _____

_____ _____

६. तंत्रज्ञानाचे काही फायदे सांगा.

_____ _____

_____ _____

७. तुमचे पोस्टर बनविण्यासाठी तंत्रज्ञानाची मदत झाली का? (खालीलपैकी एकावर खूण करा.)

हो । नाही.

जर हो, तर कशी मदत झाली ते लिहा.

_____

_____

_____