Using Pictures and Interviews to Elicit Indian Students' Understanding of Technology

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Abstract

This paper reports on a survey aimed to elicit students' understanding of technology. The survey was carried out with over 200 students of Grade 6 (11-14 years old) from schools in and around Mumbai, India. Two questionnaires: 'technology-as-objects' and 'technology-as-activities' were administered followed by interviews on a sub-sample. Analysis indicates that objects and activities related to communication and transport, especially modern gadgets used in urban areas were often considered technological. Objects presented along with humans were perceived more related to technology than objects alone. Most interviewed students had consistent reasons for associating objects and activities with technology. They believed that technology has existed in the recent past, has evolved and is ubiquitous now. Scientists and researchers were credited with creation of technology while others were mere users. The utilitarian and human-made nature of technological artefacts and its role in speeding work were emphasised as reasons for associating objects and activities with technology.

Introduction

Technology is embedded in culture and is reflected in a spectrum of artefacts and processes. The term is used variously to convey the modification of environment, design, and the social, cognitive, affective and material interactions involved in the process (Natarajan, 2004). It conjures up multiple meanings and images in differing contexts. The lay understanding of the word 'technology' is mostly associated with 'hi-tech' artefacts such as, computers, satellites, nuclear technology etc. (Rennie & Jarvis, 1995; de Klerk Wolters, 1989)

In schools where technology education is presented formally as a school subject, the curricula present technology as a problem solving activity that focuses on skills of investigation, designing, planning, evaluating and making or as STS – the science, technology and society approaches that focus on creating awareness of technology and emphasise its historical, social and philosophical dimensions (Kimbell et al, 1996). With these multiple approaches and views on technology, students and teachers may have difficulty in reconciling the lay views of technology with those presented by curricula. Besides, teachers need to know students' conceptions in order to provide suitable learning environments (Driver et a1, 1994).

Gender and experiences in school and at home (MacKenzie & Wajcman, 1999) as well as interactions with technological artefacts influence attitudes of individuals towards technology (Volk et al, 2003). To explore these aspects, there have been numerous PATT (Pupil's Attitude Towards Technology) studies conducted across the globe (Bame et al; 1993, Correard, 2001).

A few efforts have been made in India at learning students' ideas about technology (Rajput et al, 1990; Bhattacharya, 2004). But there is a need for more in-depth studies. Indian schools do not have formal technology education and hence student's ideas of technology are more likely to be influenced by factors other than school. This survey served as a precursor and input to the research and development of design and technology (D&T) units at the Homi Bhabha Centre for Science Education, Mumbai for introducing technology education at the middle school in India (Choksi et al, 2006; Khunyakari et al, 2007). We aimed to see how ideas about technology among Indian students from urban and rural areas, from different media (languages) of learning and girls and boys compared with those of students from other parts of the world.

Methodology

The survey questionnaires inspired by the PATT instrument aimed at measuring students' attitudes towards technology. While attitude is a complex psychological concept having interrelated components of affect, behavior and cognition indicative of underlying belief or value (Shrigley et al, 1988), in this paper we have aimed at knowing the overall concept that students have of technology.

For our study we developed 2 pictorial questionnaires for use with Grade 6 (11-14 years) students. In both the questionnaires, students were given written and verbal instruction to circle the pictures that they felt had something to do with technology. One questionnaire focused on *technology-as-objects (TAO)* and the other on *technology-as-activities (TAA)*. The questionnaires were initially prepared in English and later translated to Marathi (vernacular language of the State of Maharashtra) for use in Marathi medium schools.

The responses to the questionnaires suggested some patterns in students' conceptions of technology. Interviews of some students followed the questionnaires and were aimed at a detailed exploration of the reasons for associating objects and activities to technology. The questions focused on aspects covered in the questionnaires, such as, users/creators of technology, temporal aspects of technology, locales of technology, gender and technology, what is 'not technology', and words, objects and activities associated with technology.

Technology-as-objects (TAO): This questionnaire consisted of 30 pictures of objects associated with ten categories: sports, agriculture, school, music, household, workplace, transport, communication, warfare and natural objects. Our selection of categories and the pictures in the categories was guided by the fact that our sample would have rural and urban students as well as girls and boys. In an earlier study involving students' drawings of 'image of science/technology' we found that students often drew images of science or technology as related to communication, transport and warfare, in locations outside the classroom (Mehrotra et al, 2003). To focus on locations we included categories such as, school, household and workplace. For the rural context we included agriculture. Sports and music were included for their familiarity in both school and outside school contexts.

Each category had pictures that focused on aspects of 'time' or tradition/modernity. For example, in the transport category, there were pictures of bullock-cart, and airplane, while in the warfare category there were pictures of bow and arrow, tank and gun. Additionally, we had a category that could be termed 'natural objects' or 'no technology' (flower, sun) as we were interested in knowing how students would deal with this category of objects. The *TAO* sub-part was used in our earlier work with Grade 8 students and a reliability score 0.9 (alpha-coefficient) had been established (Khunyakari et al, 2003).

Technology-as-activities (TAA): This questionnaire depicted activities related to categories in the *TAO* questionnaire. Most pictures showed humans involved in an activity and there were a few pictures without humans (waterfall). Two alternate forms (A and B) were developed, with 24 pictures each. Both forms had some activities being done by males and some by females. If an activity in form A was shown as being done by a male then in the alternate form it was depicted as being done by a female. Students were asked to write "T", if they thought that a picture was related to technology, and "N", if they thought that the picture was not related to technology. This questionnaire was aimed at eliciting students' ideas about technology in activities and gender stereotypes, if any. Test-retest reliability for *TAA* was 0.76.

Sample

The *TAO* questionnaire was administered to 343 students studying in Grade 6 from 8 schools in and around Mumbai, India. The details of the sample are given in Table 1. The two forms of the *TAA* questionnaires were administered to 201 students of Grade 6 in 4 of the schools with an interval of 5 days. On an average, students took 20-25 minutes to complete each questionnaire. *Interviews* were conducted with some students, who had already responded to the questionnaires from both the rural and urban settings. Care was taken to have an equal representation of boys and girls. Responses of the students were audio-recorded and detailed notes were also taken.

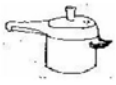
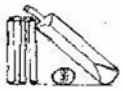
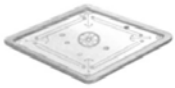
Table 1: Sample composition

Technology-as-objects (TAO)	**Urban**	**Rural**	**Total**
Girls	88	73	161
Boys	126	56	182
Total	214	129	343
Technology-as-activities (TAA)			
Girls	65	49	114
Boys	60	27	87
Total	125	76	201
Interviews			
Girls	5	5	10
Boys	6	2	8
Total	11	7	18

Results

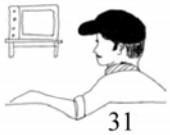
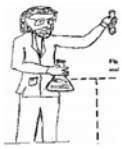
Technology-as-objects*:* In response to the *TAO* questionnaire we observed that all pictures in all categories were related by some students to technology. There was no picture that was not related to technology by any student. Table 2 presents the objects within each category and the percentage of students stating the objects were related to technology.

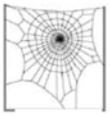
Table 2: Percentage of students relating objects to technology

Category	Percentage			
Communication	 89	 84		
Transport	 87	 83	 61	 27
Workplace	 59	 70	 55	 79
School	 55	 31	 64	
Household	 73	 36	 55	 24
Warfare	 65	 49	 29	
Music	 35	 33	 43	
Natural objects	 23	 42		
Sports	 29	 35	 26	
Agriculture	 23	 40		

Technology-as-activities: Table 3 presents students' responses to the two alternate forms of the *TAA* questionnaires. The table shows the percentage of students associating pictures in Form A and B with technology. For each category the pictures from the alternate forms have been presented in Table 3.

Table 3: Percentage of students relating an activity to technology

Category	Percentage
Communication	 81  81  93  96  31  31
Warfare	 69  66  78  64
Transport	 69  56  61  65
Workplace	 96  88
Household	 62  68  51  53  51  64
Agricultural	57   63

Music	 46	 46	 30	 32
Sports	 76	 68	 56	 65
	27 	 33		
School		29  24	53 	 55
Natural	 54-63	 22	 19	 50-53
Neutral		 48-51		

Analysis

The responses to the questionnaires are complemented by the results from the interview and these are discussed below. The questions in the interviews served as a framework for our analysis.

Objects, activities and words associated with technology

The responses of the students to the *TAO* and *TAA* questionnaires indicate that some objects and activities were more often associated with technology than others. More students related objects and activities in the categories of *communication, transport* and *workplace* to technology. In addition in the activity questionnaire, the *warfare* category was considered related to technology by large number of students. Less proportion of students considered *agriculture*, *sports* and *music* as technological. It is interesting that in an agricultural economy like India, only a minority of students considered agricultural objects (plough, bullock-cart) as technological. This aspect is discussed further in later questions on traditional/modern and rural-urban differences.

Natural objects and *activities in nature* were considered technological by a larger percentage of students than even objects in the category of agriculture and sports. When we probed this in the interviews, one reason given by students for considering natural objects or activities to be technological was that they had read about these objects and activities in their science books. A student reasoned that *'Anything that has life and grows and respires is technology',* while another student related sun to technology using a knowledge-laden argument; *'It uses hydrogen and produces heat and light'.*

Not all objects within a category elicited similar responses. For example, fewer students (27%) considered a bullock-cart (transport category), to be technological as compared to an airplane (87%). In the interviews, students were shown their earlier responses on questionnaire and were asked to support their answers. Some of the reasons for considering an object to be technology related were; it is human-made, is used for speeding and easing activities, is composed of simple and/or complex machines and tools, and is useful. Some responses suggested that some components of an object could 'have' technology while other may not 'have' *('Tube-light has technology only if the switch is on').*

During the interviews, students were asked to write words that came to their mind when the word 'technology' was mentioned. Objects such as *gun, electronic items, vehicles, computers,* were most often listed. Other commonly associated words were school subjects *(science)* activities *(driving)* and knowledge or research related words *(inventions, knowledge of complex machine, discovery)*, as well as professions *(doctor, engineer),* and famous personalities (*Homi Bhabha, Alexander Graham Bell*).

Activities like *working on computer*, *talking on phone* and a *scientist in laboratory* were related to technology by most students. On the other hand, activities perceived as more dependent on skills than equipment, like *wrestling* (male picture 33%, female picture 27%), *teaching* (male picture 24%, female picture 29%) and *dancing* (male picture 30%, female picture 32%) were considered as technological least often. An exception was 'yoga' which was associated with technology by over half the students.

The activities in which, humans were shown actively involved *(working on a computer)* were considered technological by more students than those in which humans were passive *(watching TV).* Students' response patterns differed between an object shown alone and an object as part of an activity. In general it was observed that when objects and humans were shown together, more students related it to technology than when the objects were shown by themselves: *sitar* – a musical instrument – as object (35%) versus *playing a sitar* (46%); bow and arrow as object (29%) and archery as an activity (>60%) and plough as object (40%) and as an implement in farming (~60%). This reiterates that the use of human skill in association with an object increases its perception as being related to technology. In this context, it was interesting to note that teaching activity using objects (~29%) was associated to technology by almost the same number of students as the object blackboard (31%).

People who use/ create technology

Most students said that all people use technology *('we all use some or the other technology like phone').* A few students stated that children or those staying at home do not use technology. This is consistent with household objects being related to technology only by half the students in the survey.

Regarding who creates technology, most students believed that scientists and researchers working in laboratories or special centers created technology as they *'engaged in experiments'*. About 90% of the students surveyed related the laboratory activity to technology. Only two students stated that their teachers could create technology. Very few students thought that human beings other than scientists and researchers could create technology, even if they had knowledge. One student articulated that God created technology.

Is technology something new (modern) or old?

Objects like bullock-cart, plough and wood-stove were considered technological less often as compared to their more modern counterparts (plane, tractor and cooking range). In the interviews, we probed aspects related to traditional and recent objects: the temporality of technology. All the students interviewed thought that technology involved something new and that it came into existence in the recent past, rather than in ancient times. Some students stated that technology began before or after some specific event: 'discovery' of light / fire /steam engine/ life/ electricity/Indian Independence. One student said that *'science was discovered before technology'* and other students specified in years when technology came to being, example: 'B.C.', '100 years', '1000000 years'.

A gradation in technology level was also seen; some students stated that in ancient times there was less technology as compared to now. The ideas of progress (evolution) were exemplified by a boy's response about various objects: *('Airplane, we can fly and it has developed over age. Earlier we used to walk barefoot. Pressure cooker is related to technology, as it is a new way of cooking. Earlier we used open vessels. Flower does not have technology because from the starting it is like this. This is no new thing.')*

Is technology found more in urban or in rural areas?

Gradation of technology was mentioned with respect to locales too. All interviewees believed that technology existed more in urban areas. Some of them even had a clear idea about gradations in various places, such as, highest amount of technology in cities, followed by districts (towns) and lastly in villages. The reasons for such answers were that towns have more transport and communication facilities, factories, laboratories and regular power (electricity) supply.

Gender and technology

The *TAA* questionnaire had 19 activities being done by males or females. Significant differences (paired t-test) were found for 5 activities: archery (male picture- 64%, female picture-78%), pulling rickshaw (male picture- 56%, female picture- 69%), scientist (male picture- 88%, female picture- 96%); playing hockey (male picture- 68%, female picture- 76%) and wrestling (male picture- 33%, female picture- 27%). Of these activities, the activity when depicted by a female was considered technological by more students then when depicted by a male, except for wrestling.

To the question, 'Who uses more technology – boys or girls?' most students (9/15) said that both used technology equally. Two boys said that boys used more technology while two girls stated that girls used more technology. Regarding the use of technology by their parents, most students said that both parents used technology, but related their mother's use of technology to the household while their father's use extended both at work and at home. Only one student specifically said that his mother did not use technology because *'she stayed at home'*.

In contrast to the above responses, when asked, 'If there is a space shuttle on which only one person could go then who should be sent – a boy or a girl?' most students (13) gave non-egalitarian answers. Three girls and 7 boys said that a boy should be sent and gave several reasons: *'it needs courage, which only boys have', 'till now most astronauts have been boys', 'boys can act faster if there is in any trouble', 'boys are able to do difficult work', 'have better observational powers'.* Three girls who were of the opinion that a girl should be sent, reasoned that *'girls should be given a chance to go to space'*.

What do you think is 'not technology'?

In response to the questionnaires, several objects and activities were not related to technology by a majority of students: especially in the categories agriculture, sports and teaching. Several reasons were given for not relating some activity/object to technology, such as: '*not human-made'* – a natural phenomenon, '*it grows on its own like trees'* or '*it does not move -like a clock without battery', 'it does not involve tools', or' is not related to science'*. Students' answers to the question 'What is not technology?' focused on natural phenomena such as *'stone', 'blowing winds, sun rays falling on earth', 'walking' 'nature and living organisms'*, absence of electricity *'when you switch off light'*, or something not related to science *'weaving, dancing, etc'* or mechanical objects, example *'objects on which no action has been done'*.

Conclusions and Implications

From a preliminary analysis of the study, which aims to understand students' ideas about technology through pictures and interviews, it appears that Indian middle school students have associated technology mostly with objects and activities depicting modern appliances used for speeding work and easing life, usually seen in the urban areas. The product-oriented view of technology is consistent with earlier studies (Raat & de Vries, 1986; de Klerk Wolters, 1989 and Rennie & Jarvis, 1995) where students associated products, particularly computers, transport, domestic appliances and modern electronic gadgets with technology.

Students in our sample also associated school subjects, research, discoveries and inventions with technology. This idea may be due to the fact that technology is introduced in Indian schools as application of science. Students viewed technology as a human endeavor and credited scientists/ researchers for technological inventions but considered most other humans as mere users of technology. Indian students thought that technology essentially had an evolving nature, was present in the ancient periods in limited ways and is now used by everyone. They also thought that there was more technology in urban than in rural areas.

Students gave consistent reasons for associating a particular object or an activity to technology. These were mostly to do with the benefits derived from using technological artifacts such as having to use less physical strength, doing work faster, being made by humans and being dynamic. Students who related technology to natural categories stated that plants, waterfall, thunder and lightening had motion and life and therefore were related to technology and also they had studied these in their science books. Reasons for considering something as 'not technology' were; it did not have a machine, was not related to science, or was something found in nature.

This survey indicates that objects when presented along with humans tend to be associated with technology more often than humans presented in an activity without equipment, or when objects are presented alone. This finding is in contrast with de Klerk Wolters (1989) and Rennie & Jarvis (1995) studies where pupil's drawing on technology were mostly without humans indicating that humans are not an essential element of technology.

According to Mammes (2004), the interest of girls in dealing with technology can be encouraged through interventions that reduce gender differences in experiences about technology. Gender biases surfaced in the survey, in the following ways. Pictures showing women involved in activities were considered by more students as technological, than the same activities by men (playing hockey, a working scientist). Perhaps women in these roles as well as the activities were unfamiliar to students. Considering an activity technological differs from considering it suitable for a person and therefore, most students said that a boy more than a girl should be selected for space travel.

The results from this study can be used for planning technology education curriculum in India and can help teachers/ planners equip themselves with the ideas that children hold of technology. Our findings suggest that Indian students' ideas of technology though varied, lacked depth. Their view of technology was rooted in science either as its applications or as its object of study. There is a need to introduce the study of technology at the school level as a subject with distinct knowledge and skill requirements. Teachers and educators need to be conversant with the multiple perspectives of technology so that in their classrooms they may be able to make appropriate linkages of technology with science and society as well as with other school subjects.

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