LEARNING TECHNOLOGY THROUGH COLLABORATION: D&T UNIT FOR BOYS AND GIRLS IN DIFFERENT INDIAN SOCIO-CULTURAL CONTEXTS

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ABSTRACT

Despite global trends, India has lagged in introducing a formal technology education curriculum for schools in the general stream. Recently, the apex national body in school education (NCERT) added 'Technology' to Science and prepared S&T books for middle and high school. These books have been criticized for their presentation of technology as applied science and for their non-inclusive nature.

*This paper reports on systematic efforts made to develop culturally appropriate **D**esign and **T**echnology (D&T) units that focus on "collaborative learning". The paper presents details of development and trials of a unit on puppet making and staging a puppet-show which was tried out with middle school students in differing socio-cultural contexts (two Marathi and one English medium school, in urban and rural areas). The analyses of trials in the three clusters indicate the potential of D&T units to serve as collaborative learning situations for the multicultural contexts of Indian classrooms.*

INTRODUCTION

Technology is an integral part of all societies and is both shaped by society and shapes society. In its many forms, it is entwined within the fabric of human existence (MacKenzie and Wajcman, 1985). The word technology is used to represent things, actions, processes, methods, systems and is also symbolic of progress in various spheres. Realizing the all pervasiveness of technology and its symbolic nature, many countries worldwide have introduced technology education in their school curriculum. Technology education as a part of the school curriculum has different goals and trajectories. These depend upon the country's concerns, which may be economic, political, social or epistemological considerations (Layton, 1993).

One of the proclaimed (but unmet) goals of technology education is providing students with team-work skills (Dyrenfurth, 1996). According to Rogoff (1997) in any classroom, teachers and students comprise a community of learners in which knowledge is shared and co-constructed. The importance of collaboration in technology tasks cannot be undermined. Hennessey and Murphy (1999) state that "collaboration is an important aspect of problem solving which enhances learning (including planning) by making thinking more explicit and accessible and enabling pupils to construct joint understanding of tasks and solutions." Collaborative learning is not only about collaborating to learn, but also learning to collaborate (Collazos, Guerrero, Pino and Ochoa, 2002) and for this reason attempts are made to assess participants' progress in terms of the quality of the learning process and not just the outcome.

Collaboration, like technology is a slippery concept. Not all groups are necessarily collaborative, and some groups collaborate much better than others. Beneficial effects of collaboration on technology learning have been enumerated by Rowell (2002) and skills needed for collaboration have to be recognised and nurtured from childhood. Ridley (1998) argues that we come together in groups and conform to the norms of those groups, out of a human need for reciprocity, i.e. collaborating and sharing with others.

The gendering of society in general and school education in particular has important implications for women's role in knowledge and technology production (Wajcman, 1991). Gender also influences the processes involved in collaborations and the transition from observing to doing a task. Even perceptions of teamwork may differ not only between boys and girls, but also between same and mixed sex peers. Studies have shown that sex differences influence group-work and that satisfactory social relations among members of a team enhance group efficiency (Wood and Rhodes, 1992).

Indian Context

The apex text-book producing body in India, National Council of Education Research and Training (NCERT), in recognition of the importance of science and technology in society, has recently (from the year 2000 onwards) introduced Science and Technology books from upper primary to secondary school levels. These books have technology as an 'add-on' to science and have been titled 'Science and Technology'. This approach to teaching technology does not take into account the broader goals of technology education and portrays technology as applied science. This integration of technology with science could have negative consequences for meeting specific learning objectives (Ramadas, 2003).

In addition to technology being portrayed as applied science, another problem that plagues technology education is its nature of being exclusive rather than inclusive. In the Indian context, many policies are laid down by the Government to ensure equity and gender balance in education. One of the major curricular concerns highlighted by the National Curricular Framework (NCERT, 2000) is to provide education for a cohesive society so that equality of opportunity and access to quality education to various groups including girls, learners with special needs and learners from disadvantaged groups is ensured. Technology education has an advantage in that all groups have the capability to visualise and redesign their environment. A well-planned design and technology (D&T) curriculum, especially in mixed ability and multicultural classrooms, can be an inclusive endeavour for the children of the rich as well as the dispossessed, for those in the indigenous or the modern mould, for girls and boys.

Background and Rationale

A project was initiated at the Homi Bhabha Centre for Science Education (HBCSE) in the year 2002-2003 that involved the development and trials of D&T units for Indian middle school students. Three units were undertaken in the trials: making a bag, making a working model of a windmill and making a puppet and putting up a puppet show. All the units were designed within the frame of collaborative learning, wherein groups of students shared a goal and were held together with a common sense of purpose. To achieve their goals and solve problems set to them in real world contexts, students worked as teams, employed common practices, used the same tools and expressed themselves in a common language. The units were selected on the basis of increasing order of complexity of tasks and intra and inter group collaboration.

The *bag-making* unit viewed technology as a product (artefact) and could be done by an individual, though a group was involved in the process. The *windmill* unit required students to make a working model of a windmill to lift weights and test it. This activity was more complex, having many sub-parts and needing more mental and physical work. The third unit on *puppet making and putting up a puppet show* was based on a systems approach of technology. Each group had to make a puppet and all the puppets made by them were needed to put up the show, so a second level of collaboration (with the entire cluster collaborating) was introduced.

This paper focuses on puppetry, which besides being one of the most ancient forms of entertainment in the world, is also part of the cultural heritage of India (Kamat, 2000). It is an art form that unites craftsmanship and design with drama and marionettes (Contractor, 1984). As a pedagogic device when employed in the classroom, it can help in the development of imagination and creative thinking of students (Singh, 2004).

METHODOLOGY

The overall approach in all the units was a modified form of design-make-appraise approach suggested by Kimbell (1994). The modified approach is presented in a model put forward by Choksi, Chunawala and Natarajan (personal communication, September, 2005). Table 1 presents details of steps undertaken in the process of conducting the trials.

Table 1

Steps in process of conducting the trials

Steps	Elaboration of activities
Day 1 *Investigation & Motivation*	Introduction of various kinds of puppets by researchers. Students wrote one story per group, selected a story with 6 characters, selected a character from this story to make a puppet, made a character sketch (drew +wrote).
Day 2 *Designing & Communicating*	Students were given information about human body joints, their movement, symmetry and proportions. They made technical drawings, procedural maps, decided the materials, and the quantity needed for making the puppet. They also made paper cut outs of the puppets.
Day 3 *Making*	Cloth cut-outs were made by the students. They practiced sewing on scraps, made informed choices about the assembly, such as, how the head, hands and feet are attached to the torso. They later decorated the puppets.
Day 4 *Designing the show*	The entire cluster came together to design the show. They were now split into various teams- the music, dialogue writing, stage setting, props creation and lights management team.
Day 5 *Staging the show & Evaluation*	Students made a stage, rehearsed and put up the show for an audience. They evaluated their own puppet as well as the puppets of other groups and communicated the process to other groups.

In each trial of the D&T unit, students worked together for about 15 hours in 5 sessions. The unit was tried with around 20-25 students of Grade 6 (11-14 years of age) in three clusters. We ensured that the number of boys and girls participating in the trials were about the same. The three clusters were: English medium students from an urban school (a school run by the Atomic Energy Education Society), Marathi medium students from an urban school, and a government-run residential Marathi medium school for tribal students *(ashramshala)* located at a distance of about 60 kilometers from the city of Mumbai. In each cluster, students were asked to form groups of around 3-4 students each, with 2 groups of girls, 2 of boys and 2 mixed groups. Video and audio records were maintained during the trials of the unit.

The puppetry unit had interdisciplinary components that integrated topics from various subjects of the curriculum, such as, information about human body joints and movements, body symmetry and proportions (biology), speech, dialogue writing and character description (languages), gestures and dress of people from different regions (social studies), measurements (mathematics), cutting, sewing, decorating (vocational / craft), music (arts), costing (economics) and materials (science), etc.

FRAMEWORK FOR ANALYSIS

Working together in a group is something that has been encouraged in technology tasks, not merely for completing a project with pre-determined goals but also for learning to work and operate as a team. Collaboration goes beyond mere working in groups, to working together to synthesize the knowledge, and other advantages brought to the situation by each group member into a product that is truly a group effort (Roschelle, 1992). We used collaborative learning framework to analyze the activities in our trials. Frameworks for analysis of collaboration have been given by various researchers. Borden and Perkins (1999) have suggested a collaboration checklist that includes *leadership, planning, decision making, conflicts, conflict resolution, capacity building, communication, connectedness, customs, political climate, rules, resources and catalysts.*

However, most of these studies were done in the context of internet/computer use. Jeong and Chi (1999) in their work in an educational context, proposed several factors, such as, cognitive conflicts, partner expertise, and amount of verbalization that are responsible for improving learning in collaboration. By its very nature, D&T is a social and collaborative endeavour with various components and these components needs to be reflected in D&T education. Of the various components of collaboration, communication is an important element. According to Bucciarelli (1994) in any technological activity, 'despite differences among individual interpretations and constructions and among object worlds, participants do communicate, negotiate, and compromise; in short they design.' Communication not only through verbal discourse but also nonverbally through sharing of technical (physical) tools, drawings, writings, gestures also mediates interactions in collaborative technology tasks (Dillenbourg, Baker, Blaye, and O'Malley, 1996).

Another aspect of collaboration is 'group dynamics' or the types of interaction which take place within groups. Group dynamics includes the roles taken by various members of the group, the relations between them, and the environment that is maintained in the group. Rowell (2002) has analyzed group interactions in terms of establishing roles (e.g. manager-assistant) and identities (participatory contributions, tutoring, imaging and planning, manipulating, testing, mediated participation, etc).

Besides the dynamics of the group, conflicts can also affect the overall learning environment of the classroom. Conflicts exist whenever incompatible activities occur (Deutsch, 1973) and have been classified in various ways. School conflicts have been categorized by Johnson and Johnson (1995) as controversy, conceptual conflict, conflict of interests and developmental conflict. Jones et al. (2000) found that conflicts do occur within interacting groups over sharing of resources in classrooms. They found a gender-related pattern in tool sharing and how students in dyads relate to each other and the materials.

Another aspect of collaboration is peer review; a system during which students review the written and oral work of other students and make suggestions for improvement. Peer review benefits students' learning in terms of developing their written skills, critical thinking, collaboration and professional responsibility (Kern, Saraiva, and Pacheco, 2003). It can also be a kind of peer tutoring which helps students to realise their errors and rectify them in order to improve their designs. The observation parameters for collaboration in our study were group dynamics, conflict, resource sharing, communication, and peer review.

ELEMENTS OF COLLABORATION OBSERVED

Observations of the various groups and members in the groups were made during the trials of the puppetry unit for each of the clusters. Besides, field notes and video tapes, the students' own writings on various occasions were a source of data. In the sections that follow, comparisons across the three clusters are made with respect to various elements of collaboration. For each of the clusters, specific differences between mixed sex and single sex groups will be highlighted. In the interactions of the group members within and across groups, observations were made with respect to: a) roles played by different members of a group, b) conflicts and conflict resolution, c) sharing of resources d) communication and e) peer review

a) Roles played by different members of a group: We observed from the video records that different members adopted different roles within the groups (as leader, worker, communicator, writer/artist, mediator- within and across groups, critic). This informal role-adoption was evident through repeated patterns of behaviour or comments made by the individuals. While no leader was formally appointed, we observed that in most of the groups some member assumed the position of a leader. Usually, this 'leader' tended to be either an academically bright student or a physically well-built student. The leader generally gave ideas or was the first to initiate some line of thought and action. Other roles, such as worker, writer, artist and communicator, were often take up by members in a team who possessed some specific skills, like, a good hand at drawing or composing poems, decorating or good public speaking skills. The mediator helped resolve conflicts and maintained the cohesion of the group. This mediation could also be in interactions with other groups.

Browne and Ross (1991) in their work with students in primary school suggested that the roles that children volunteer for, or are forced to take, often depend upon gender. Children tend to have 'territories' in which their confidence and assertiveness varies. They are more confident in 'their' own rather than in 'other's' domain. We observed that girls participated more actively in all girls' groups, while in mixed groups girls were more comfortable taking roles subordinate to boys. Parkin (1991) reports that girls when unable to participate in the activity of choice, accepted the next best choice without any resentment. For example, in a mixed group (tribal cluster), a girl was given

the task of cleaning away the mess after the cloth and paper cutting. In another mixed group (Urban Marathi medium cluster) boys took over the stitching activity (even though they found it difficult) and the girls were involved in stuffing the puppets.

When all the groups in a cluster had to come together to put up the stage-show, the existing teams dissolved and regrouped in new ways were formed for managing stage setting, music, lights, dialogues and compering. While generally a bonding in the cluster emerged, at times, members from other teams were not welcomed.

b) Conflicts and conflict resolution: Instances of disagreements amongst team members were plenty. Often arguments took place because of unfavorable work distribution or over control of resources or having to comply with a group decision. There were often debates amongst team members on the procedural aspects of the activity. Instances of vociferous arguments were more frequent in all boys' groups than in all girls' groups, and more in English medium cluster and least in Rural Marathi medium cluster.

The ability of an individual to resolve conflicts with peers helps to determine his or her level of acceptance or rejection by the peers and successful completion of a task. The conflicts that occurred within teams or across teams were most of the times settled without the intervention of the researchers. However, one conflict in the English medium cluster took nearly 25-30 minutes to get resolved, wherein it was difficult for students to agree on the common story to be chosen. The role played by availability of resources or need to control these resources in leading to conflict is highlighted in the next section.

c) Sharing of resources: The dynamics of resource usage within groups in different clusters was interesting. Some resources were available in plenty, and others were limited resources. There was sharing as well as attempts to establish control over resources. In some groups, the members who completed their work helped other members and groups, while in other groups, fights broke out over the sharing of small or easily available resources such as needles (unlimited supply) broke out.

In a majority of our observations of the rural Marathi cluster, in mixed sex groups, boys tried to control limited resources like tools (e.g. scissors) and other materials (e.g. beads), and girls were left without them or had little chance to handle them. Studies in secondary schools have also shown that girls rarely engage in playing with tools and equipment, while boys not only have more experiences, but also a perceived expertise with equipment (Jones et al. 2000).

However, the same pattern did not emerge in the urban mixed sex groups where a definite dominance pattern was not evident. It was the perceived-to-be-academically-bright student who often controlled the resources within a team. In our study, we observed that there were conflicts even over abundant resources (such as, thread), besides the crucial role of control of limited resources in leading to conflicts. As a session neared its close, the groups preferred to have all the resources handy and were reluctant to share. Time was also a decisive factor in the resulting conflicts. Perhaps time was a limited resource.

d) Communication: Communication, both oral and written is an essential component of the design and technology curriculum for school level. Golub (1988) has pointed that "collaborative learning has as its feature a structure that allows for student talk: students are supposed to talk with each other….and it is in this talking that much of the

learning occurs." Students in our study were free to express themselves in any language that they felt comfortable. Their exchanges lead to sharing of ideas and transferring skills between the group members. In general we found that students were very articulate during presentations of the stories, character and design of puppet, as well as in the formal communication of evaluations.

We observed that in the English medium cluster, while English was used for formal communication, Hindi was used for informal communication. In the urban Marathi medium cluster, Marathi and Hindi were spoken, and in the rural Marathi cluster, Marathi was used almost exclusively with a few words in Hindi and almost negligible English. There were a lot of commands that were used by the members, especially those who dominated the groups. Boys in all the groups, tended to use more of abusive language and slang, while addressing each other. These were not necessarily aggressive speech patterns. Girls, on the other hand, were softer in their communication. Table 2 gives some examples of differences in communications in the same sex and mixed sex groups.

Table 2

Examples of differences in communication

Girl – Girl pairs	Boy – Girl pairs	Boy – Boy pairs
Tell me one thing, do we insert the hands first? (Use of 'we') {English medium Urban}	*What do you think, he is- a basket ball player?* (a boy commenting about the length of the sleeves on seeing the paper cut-out of the puppet){English medium Urban}	*Hey you! Pass the needle* (Command) {Marathi medium Urban cluster– translated to English}

During collaborative tasks, members do engage in various kinds of explanations. Hausmann, Chi, and Roy (2004) classified such communications as other-directed explaining, co-construction and self-directed explaining. During our trials, we observed that students (often the leaders) in a group tried to explain their ideas to other members of the group for clarification of their own thoughts, explaining (teaching) others or getting opinions (consensus) on their idea.

Communication frequently involves more than a verbal message and expression of emotions and attitudes is more non-verbal than verbal. Effective communication requires that we understand the role of nonverbal behavior (anything other than utterances) as a dimension of communication competence (Gunawan, 2001). Non-verbal communication can be a part of verbal exchanges when some ideas or skills are being communicated, or they are independent of verbal components. In our trials, we focused on instances of non-verbal communications that were seen in acts of teaching other members, grabbing and trying to gain control over limited resources, ignoring, maintaining eye contact, pushing or shoving, hand gestures for communicating ideas and emotions, such as showing a 'V', indicating victory (successful completion of the task).

e) Peer review: Peer review is an important part of design and technology process as it helps students make value judgments about the worth and quality of their own and

other people's products (Ritchie, 2001). In design and technology, it is essential for students to evaluate the processes as well as their outcomes. This helps to practice and develop skills, such as close observation (investigation), recognizing strengths and weaknesses of a product, testing ideas and communication, which in turn will help in formation and articulation of ideas about design. There were opportunities for evaluation during the D&T unit at various stages; investigation, planning, designing, communication and making. Students gave and received feedback in a healthy and constructive manner. They made attempts at appreciating aspects of products of other groups, and the criticisms were presented respectfully. Groups presented their rebuttal to the criticism and were competent in justifying their positions.

The success in the design and making task was evaluated by the groups themselves, through the use of criteria, such as ease of handling, ease of movements, resemblance to the character, appropriateness of materials used and the economics involved. Students evaluated their own products as well as those made by other groups. Semi-formal evaluation sheets based on the criteria: *functions, aesthetics, materials, economics* and *design* were provided to the students after they had finished putting up the stage show. We observed that all students were reluctant to evaluate their own and others' puppets (one group in English medium and two groups in rural Marathi medium did not rate themselves).

In the self evaluation form, all the groups reported that their own puppets were easy to handle. None of the three clusters had a unanimous choice of any one puppet being the best or the worst. Most often the groups rated themselves better than the other groups. Some groups evaluated themselves lower than others but they were also evaluated low by the other groups. Regarding the economics, students from all three clusters had a limited idea about costing of a commodity. Most of them merely knew the terms profit and loss (taught at school) and somehow contrived to show a profit if they sold their puppets.

CONCLUSIONS

The paper addresses the potential of D&T units to serve as collaborative learning situations for the multicultural contexts of Indian classrooms. The observations of trials conducted in multi-cultural settings indicate that D&T can encourage collaborations and can also be benefited by collaboration. A difficulty faced during the trials was getting students to work in groups to achieve a common goal. Collaboration is something uncommon in the Indian classrooms. In the present study, the D&T unit on puppetry was so designed that it gave students opportunities to investigate, analyze, synthesize, and evaluate ideas collaboratively in teams.

The settings where the units were conducted were informal and provided an environment of active, involved, exploratory learning among students. Working in teams aided students in learning to share their resources (both material and non-material), as well as skills and knowledge. The sharing and the verbal / non-verbal exchanges inevitably helped students to better understand the processes involved in reaching the goal along with developing a perspective of the points of views of others. Collaborative learning allows opportunities for feedback. In our unit, students presented their procedure verbally and through drawings to other groups who questioned them and asked for explanations. The reviews (feedback), led to defense of their design or necessary changes in it. The constructive criticism helped the groups to channelize their efforts in the right direction.

Collaboration is a social process and in order to study aspects of it, we observed processes such as communication, roles played and relations developed between members within and across groups. The occurrence of conflicts among students during the processes involved in the unit versus instances of spontaneous sharing and the peer approval have a bearing both on successful teamwork and completion of a task.

This study is a beginning in the planning, trial and analysis of a D&T unit to be conducted as a form of collaborative learning in multi-cultural contexts in India. The unit on puppetry was a D&T unit planned not only to appeal to grade 6 students of different regions and boys as well as girls, but to engage them in collaborative learning. The unit provided a systems approach to technology, and used a modification of the design - make - appraise model of technology education. The unit was a rich platform for students to collaborate constructively and this aspect of the unit makes it inclusive and appropriate for the Indian context.

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