Using Design and Technology Task to Foster Learning Through the 'Joy of Making' Among Students of Class VII

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Abstract: *Indian education system is yet to introduce design and technology subject in the curriculum. Design and technology courses in schools bring about a holistic development of students. This paper discusses the planning, development and implementation of a workshop based on tenets of design and technology. 19 students belonging to class VIIth (12 boys and 7 girls) participated in the workshop. The students were presented a realistic technical challenge in which they had to in groups design and produce an artifact which could move on water keeping in perspective the design brief presented to them. This paper discusses the planning and the actual model made by student groups. Barlex and Rutland (2004) framework is used to discuss the design decisions made by the students. This paper provides some implications for teacher professional development programs in terms of preparing teachers for using design and technology based interventions in classrooms.*

Key words: *design, technology, design and technology, artefact*

Introduction

While many countries across the world (England, USA, Australia, New Zealand, Japan etc) have incorporated design and technology subject in their school curricula, Indian school curriculum has still not done so. Mahatma Gandhi's Basic Education, which was craft centered education, led the Education Commission (1966) to introduce the concept of Socially Useful and Productive work (SUPW) in school curricula. Yet, in the years that followed SUPW has lost its meaning and relevance. Design is understood sadly as something that only designers can and are supposed to do, while technology is limited to those in relevant professional courses.

Understanding 'design', 'technology' and 'design and technology'

The most common understanding about the word design is to devise, draw, plan, propose, invent or sketch (Mitcham, 2001).According to Ara, F (2013), design is a discipline, a

process and a product. It is a discipline because it explores the relationships between the user, the product as well as the context in which the product is used. It is a process because it involves intentional and iterative problem solving that converts ideas into systems or products. It is also a product as it is an outcome, which could be a sketch, a model, a specification or a shape of the product**.** Literature review *(*Cross, 1995, Dorst and Cross, 2001*)* from human cognition point of view acknowledges that design as a basic ability can be developed amongst people. Technology in the broad sense refers to the human activity that transforms the natural environment to make it fit better with human needs.

McCraken (2000) describes the relationship between design and technology as follows: As a human soul is to the body, design is to technology. It is important to understand the interdependence and complementary nature of technology and design like the inseparable relationship between body and soul, technology is incomplete without design. Design cannot be fully appreciated without an understanding of technology. If technology is to be fully understood, then the concept of design needs to be understood (pg 87).

Design and technology as a teaching strategy

According to Davies (1996) children and designers showed similar thought processes as well as approaches to the design process. He gave an example of how both children as well as designers use play method to explore the design world and use drawings as visual notes. According to Papert(1993), people always learn better, while constructing anything be it a sand castle on the beach or a theory in physics. Therefore it is of crucial importance that opportunities for hands-on activities are provided to school students.

According to Stables (1997), design and technology courses in schools should have the aim of bringing about a holistic development of students and enable them 'to design what they make and to make what they design'. According to Ritchie and Hamson (1996), this making of products helps students understand better and clarify related concepts, and generate further ideas. A hall mark feature of design and technology (Dand T) education is that students not only design but make too, thereby involving processes like designing, building, testing and refining followed by further testing.

Method of the study

This paper discusses the planning, development and implementation of a 3 day workshop for VIIth std students following a course in design and Technology at Homi Bhabha Centre for Science Education.

About the Students

19 students belonging to class VIIth (12 boys and 7 girls) from different English medium schools of Mumbai district were selected.

Details of the workshop

Students worked in groups as learning is better if it takes place within a social context where there is peer interaction as well as interaction with adults and others in the social environment. This study attempted to do the same by providing students an opportunity to work in groups. Lottery method was employed while making the groups to eliminate the possibility of any sort of selection bias. The groups were asked to think of a name for their groups. The groups came up with the following names

1. Triple Tornado (3 boys)

2. Science Brain (2 girls and one boy)

3. PDA rocks (2 girls and one boy)

4. Chanakya(3 boys)

5. Scientific researchers (3 boys and I girl)

6. 3 Stars (2 girls and one boy)

Data Collection and Analysis:

A worksheet related to buoyancy was given in initial phase which provided data regarding their ideas about floating/sinking concept. Observations were carried out as students worked in groups. Each stage like planning (making of sketches), experimenting (buoyancy), designing and actual working were observed by the researchers and notes were made including the informal discussion that took place within the groups as well as with the researchers. Feedback forms given to the students at the end of the workshop which had items

related to the planning of the artifact, problems faced, previous experiences (including knowledge of science topics) that contributed, the modifications in future designs and the learning that happened. The data was qualitatively analyzed.

Planning for the workshop:

In the preparatory phase of this workshop, the foremost step was to first think of an artifact or anything in which principles of design and technology could be employed. The artifact could be concrete, abstract, aesthetic, functional or just an idea. We played with several ideas like making a multi-purpose uniform or a chair, designing a study area amongst several others. We structured our ideas on the basis of our experience that children get very fascinated by objects that move or rotate or show any other kind of mechanism which changes either their position or brings about any kind of change in them. A kind of thrill and excitement is experienced when one sees the object made by them actually showing some kind of technology. This is what can be attributed as the *'joy of making'*. We wanted to give the students the joy of making and also derive immense satisfaction on seeing the artefact actually perform the designated function. After much deliberation we narrowed on the idea of making a ' boat'. Again here we debated that if we beforehand tell the students to make a boat then they all will make a similar kind. So we decided to modify and use the word **'toy'** instead of boat.

The Design Brief

Next task was to make a design brief for which we took some expert help.

Design Brief Given To Students

You have to make a water toy and sell it to your friends in a stall in monsoon fair. Design your toy so that :

- Toy should float
- It should move at least 50 cm
- It should be made of easily available or waste material
- It should be attractive
- Size about 15 cm
- No battery cells only mechanical parts

On the basis of the design brief we anticipated some learning objectives that would be achieved by students during the course of the workshop.

Learning Objectives:

Students would learn to:

- Use the concept of brainstorming to generate ideas
- Use the scientific method of selecting the most feasible idea.
- Visualize the actual design in terms of possibility and imagination
- Use previous knowledge about concepts like floating and sinking when deciding about the materials of the toy
- Develop the selected ideas into planned designs keeping the constraints in mind

Workshop plan

Day1: Planning and drawing the design.

Day 2: Making the model and testing it

Day 3: Modifying the model, testing it and giving feedback.

The preliminary task (Day 1)

For the first day we decided to explore their ideas about buoyancy and floating and other physics principles involved. To each group 19 objects were given. The groups had to analyze each object, discuss and generate a hypothesis regarding whether it would sink or float in water. Once their predictions were complete they had to now test the objects by putting them in water and again mark their observations.

Observations regarding the task done by the groups

	Predict		**Observation**	
Item	**Sink**	**Float**	**Sink**	**Float**
Wooden block	1	5		6
Aluminium foil	1	5		6
Stone	6		6	
Rubber ball	5	1	1	5

Item	Sink	Float	Sink	Float
Eraser	6		6	
Candle	2	4		6
Plastic cup		6		6
Pins	6		6	
Straw		6		6
Iron nails	6		6	
Cardboard pieces		6		6
Crushed aluminium foil	3	3		6
Plastic lid	1	5		6
Pingpong ball		6		6
Marble	6		6	
Thermocole piece		6		6
Cotton ball	4	2	6	
Sponge	3	3		6
Ice cream stick	1	4		5

Making the design of the artifact on the paper (Day 1)

In this stage the students first designed on paper their toy. Though we had asked the students to use scale and draw the artifact in actual proportions of measurement yet none of the groups actually did it. We asked students to put measurements across their sketches and draw more realistically keeping the calculations in place. Based on the artifact they proposed to make, we asked them for a list of the material they would require, keeping in mind one of the conditions of the design brief of using commonly available low cost resources.

Actual making and working of the artifact (Day 2 and 3)

The next day the material was provided to the students and they started working on their respective models. Given below is a summary of each group's performance.

Group 1: 3 stars

This group was the first one to come up with the design on paper and suggest the use of a balloon as means to propel the toy forward. The group decided that their toy would be a boat.

Sketch: Showed a shape that looked like a flat vessel having elevated walls and being narrow at one end. A balloon was in the central inside part and tied to a straw which was coming out through a hole. The straw at one end was shown as means of filling air in the balloon. The drawing had an interesting feature in terms of the arrows that were put to show the difference in the direction of air and boat movement. Measurements were given in the drawing as 15 cm ie the bottom was given as 15cm.

Actual model

The group had planned to make the toy with thermocol keeping in mind the floating sinking activity. The design was simple so group finished the task quite early and spends rest time either testing the boat or decorating it with thread and toothpicks. This was the first group to test the boat.

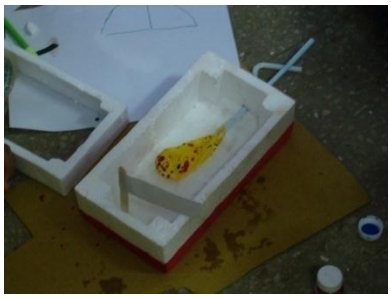

Fig 1: Actual model of 3 stars

Group 2: Scientific Researchers

Sketch: The design made by the group on paper had hardly any connection with the actual model they made. The paper drawing looks like a typical boat. There are no measurements mentioned.

Actual Model

The actual model that this group made was very different from their sketches. One boy came on the second day with an altogether different mode to make the toy with cardboard. His

fellow group members showed resentment towards his idea as it seemed vague and non-functional and asked him how he would prevent the cardboard from getting wet. They made use of propellers of cardboard. The problem with it was that the cardboard got wet and had to be assembled again to make it move.

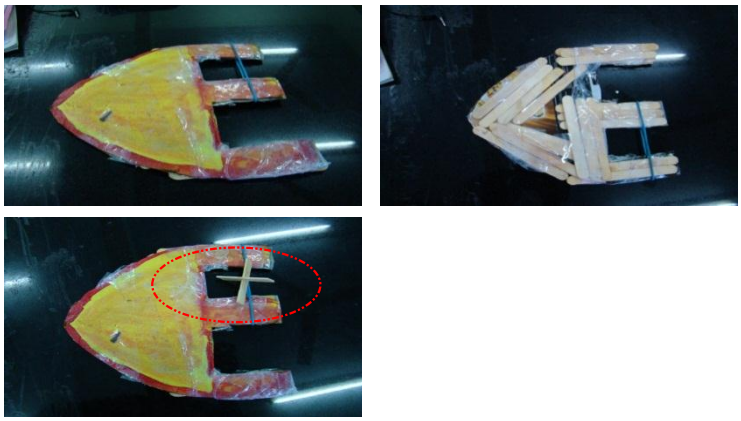

Fig 2: Actual model of scientific researchers

Group 3: Science Brain

This group decided to make a kind of Ant as they called it.

Sketch

The drawing revealed that the group had made a sort of erect figure that represented the head and body made of 3 parts of the hand. The straw was shown as passing through all the balls. The figure was standing on some sort of base.

Actual model: The material they used was rubber balls. The basic design was to drill holes in 4 rubber balls and pass a straw with a balloon attached at one end through it. The group was very confident that the toy would move on water. Though lot of questions were asked regarding the possibility of toy not working or sinking of balls or tilting but the group was adamant on their stand that it will work hence they were given the freedom to make it

Fig 3: Actual model of science brain

Group 4: Chanakya

They had decided to make a design in lines of a similar kind of situation in a popular Hindi film called *Tare zameen pe*.

Sketch

The sketch showed a leaf as the roof supported by vertical wood stick which was standing on a base made of cardboard. There were no measurements provided in the sketch or the mechanism by which their artifact would move.

Actual Model: The boat like thing made by them had cut open tetra pack box as the base. For the wooden sticks ice cream sticks were used and the leaf was put at the top supported by the 4 ice cream sticks. The problem with the design was that the ice cream sticks were not able to support the leaf and the structure looked collapsed. They after testing in water tub discovered that the model does not move plus does not stay steady on water. They then modified the model and removed the leaf. The structure now had a sponge as a base and ice cream sticks now were put like oars.


Fig 4: Actual model of Chanakya

Group 5: PDA Rocks

Sketch: The sketch made by them looked like a boat. It had 2 balloons like structures attached to a pipe like thing. The design had no depiction of any kind of measurements.

Actual Model: The final structure had thermocol as a base as well as supporting walls on 2 sides making an open box like structure. There was a straw running inside with a balloon attached to it at one end. The mechanism was that once air is blown and the balloon is filled

in air the artifact is put in water and air from balloon is released making the artifact go forward in water.

Fig 5: Actual model of PDA rocks

Group 6: Triple Tornado

Sketch: The sketch made by the group actually was not well defined. It neither was clear nor had any dimensions.

Actual Model: The arrangement had ice cream sticks arranged in vertical and horizontal rows with straws on either side. However from the design it is not clear as to how the artifact would move forward. They later modified the design. The mechanism was that as air if filled in the balloon and the structure is kept on water due to air release the artifact would be propelled forward.

Fig 6: Actual Model made by triple tornado

4. Framework adopted for analyzing the activity of designing and making

The study used Barlex and Rutland (2004) framework for design decisions for analyzing the types of design decisions students made.

1. Conceptual decisions requiring students to think about the overall purpose of the design that is what is the sort of the product and what it does. In this study, students were very clear about what purpose their toy would be for. Some groups like the groups who made an 'ant' like toy however could not make a very clear conceptual decision. Students came up with varied type of designs some of which were too complex to be created or too ambitious or too complicated.

Students did not reflect on whether the design on paper was clear, did it actually meet the constraints imposed, ease of making and using it. They were very excited to make it rather than focus on designing and planning for it first. Students made sketches on paper without any specifications of measurements though they were told to. Later when asked to use measurements they randomly put some numbers without doing calculations regarding how the measurements affected the model and the proportions of various parts of their model. Most of them had already conceptualized in their minds what kind of toy they would be making and were very confident regarding these mental images. They did not probably think measurements were crucial. Even when they gave measurements, their actual models did not follow the measurement criteria they had pre decided. A refinement in their sketches was needed.

2. Technical decisions require the students to consider "how the product will work" and the nature of the components and materials required to achieve this. Students did not understand how the principles of science would work in their artifacts. There was no explanation provided by them during the course of designing and even while demonstrating but through trials and watching the performance of the other groups they understood simple mechanism oh how air in a balloon when released results in propulsion or basic concept of floating and buoyancy or force. The design on paper did not indicate how the toy would move. Trial and errors method was sought for refinement of designs.

3. Aesthetic decision regarding the students to thinks ways in which their product would appeal to the senses. Initially the groups especially the girls in the groups were quite keen on beautifying the product. They used some kinds of additional decorations on their toys but later they realized that it was posing as hindrance to the actual working of the 'toy' as buoyancy of their ' toy' was getting affected. However groups did indulge in painting and coloring the 'toy' and trying their level best to make it look attractive. Later though they

concentrated only on the working mechanism without paying much attention to how it looked but rather on how it worked.

4. Constructional decisions regarding how to make the production. Only some of the designs on the paper reflected that students were mentally able to visualize the images of the products they wanted to make. None of the designs depicted the back view or side view. It was only the front view. Students told about the material they would need to make the toy on basis of the floating sinking experiment. To some extent this experiment did contributed a lot in making of the artifact. Apart from learning about buoyancy, the exposure to the objects during the floating / sinking experiment did influence the lists of items students wanted for their artifact. They mentioned every day easily available material like thermocol, straws, tertapacks, balloons, tapes, cardboard pieces etc.

5. Marketing decisions requiring students to consider who the product is for, what is its cost, where it will be sold? Students did not market the product well. They only talked of low cost material and ease of making rather than the technological aspects.

Conclusion

Indian education system still has a long way to go in terms of giving priority to including design and technology Education. The detachment of school lessons from real life issues makes students learn the content for only evaluative purposes as they do not see the relevance otherwise. Design being interdisciplinary can help to integrate knowledge, skills and values across several disciplines like arts, science, mathematics and humanities so that a holistic perspective is generated. As seen from this study, designing activities do influence the learning of science concepts (Roth, 2001). Through the exercise of making the artefact move on water, students did come to realize important concepts like propulsion, force, streamlining, buoyancy though there was no direct attempt made by the facilitators to teach them these concepts. There was lot of peer learning that occurred. Creativity potential is abundant in students as seen in this study and education has to exploit it. This study provides some implications for teacher professional development programs. It is crucial to include design and technology education in teacher tool box. Teacher training courses can include small workshops, short terms courses or even projects on design.

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