

The SARAS mela: sunshine, rainfall, energy



2015
CfL

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Introduction

One assembly in late August 2014, five teachers walked into the assembly hall with heavy backpacks, trampled through the student body and collapsed exhaustedly in front of us. 'Let's have a cup of tea,' said one. 'Where's the chocolate we packed?' said another. 'Oh-oh,' said a third, 'we don't have enough water. Better look around for some.' Someone discovered a source of fresh water but it was too deep to get the water out, so the five teachers proceeded to construct a pump out of whatever they could find around them and in their bags. Fortunately they found everything they needed right around them (there was a particularly well-stocked shed right nearby, and one of the teacher's capacious pockets provided items as exotic as a staple gun). Within literally minutes, they had constructed a simple pump, lowered into the deep water source and lo and behold, water came gushing out of the top of the pump and flooded the assembly hall! With all of us still watching, the five teachers opened their bars of chocolate, drank their tea and discussed a possible theme for this year's CFL mela: solve-it, do-it-yourself, fix-it, things to do with water and energy...

This document captures some of the flavour of the work done during the mela terms at CFL in 2015. It is by no means an exhaustive document; capturing the details, the fun and the relational networks of the projects are quite impossible on the printed page. Nevertheless, we hope the reader will get some feel of the endeavour and its possibilities for learning.

The SARAS mela was conceptualized as being a mela that dealt with issues of water and energy, rain and sun, and how these are used on our campus. It was a very different mela, right from the process and preparation to the presentation (no songs, dances or theatre). One obvious difference was that the results of all our hard work, good or bad, are made out of brick, PVC and copper, and are here to stay with us for a long time!

This mela definitely pushed many of us out of our comfort zones. It demanded that we first begin by understanding issues that confront us on a daily basis. For example, where does our water come from, how do we put it to use and how do we reuse it once we have contaminated it? We looked at similar issues related to electricity and our consumption of it. We then came up with several small-scale ideas to conserve and reduce our dependence on unsustainable sources of water and energy. We had to cost each design and see how feasible it was. And finally, we had to execute some of our plans, but with a difference: doing it mostly ourselves, relying on our own limited skills and abilities. All this meant many emotional and physical challenges for teachers and students, and that is old hat for CFL!

As educators, we at CFL are constantly exploring different dimensions to living and learning and how to engage with our children in these. Starting from basic reading and writing skills, working with abstract ideas and concepts, learning to think clearly, acquiring aesthetic sensibilities, allowing our imaginations to run free, working with the land, working with our hands, taking care of our bodies and of course the most challenging, discovering what it means to be a compassionate human being: the list is long. Yet, this mela exposed even more unexplored facets to learning, which we perhaps do not engage with in schools. As we all recognise, education is driven by a society which values certain skills over others. A software engineer earns much more than a skilled mason. Even most alternative schools find it difficult to get students to solve practical problems faced on a daily basis, such as water use and re-use, electricity use and waste management. To some extent this is understandable; the challenge of using resources intelligently has hardly been solved by mankind at all! Yet educational institutions offer unique opportunities to explore many of these issues, and to get students involved in understanding and executing the solutions themselves.

This is the opportunity to think about a given problem, come up with a design to solve the problem, figure out the various things needed to implement the design, and then finally go ahead and convert the intellectual solution into a concrete one. In actually executing the solution, one encounters a variety of issues. A solution on paper looks fine, but it is only during implementation that all the difficulties become apparent! You have to understand how materials behave, how to work with tools, and what kind of stamina it takes to complete a project you have taken on. Then there is the intelligence demanded in using tools skilfully and effectively. If you watch a skilled worker, like a cobbler or a painter, you will surely notice this. The tools they use seem to be an extension of their mind and body. The right way to hold a tool, the most effortless and efficient handling of it, the dexterity with which many tasks are done simultaneously, all seem to come together seamlessly and effortlessly. The intuitive and accumulated understanding of material is apparent; the understanding of how materials interact with each other, what is possible and what is not, and how to get the best out of a given medium.

There is great satisfaction, and great frustration, in doing work of this nature. We might have to wait hours for the 'expert' to come and bail us out, or discover that we have the wrong soldering wire and the right store is 50 km away, or that the pipes just don't fit! Yet, many of us found that we were inexplicably looking forward to each session of mela work. It could well have been the endorphins generated because of all the physical work involved, or the sheer joy of making steady progress towards a worthy goal. It is also very fulfilling when a team of students and teachers work well together in a spirit of friendship, good humour and cooperation. The greatest payoff is that we get to see the results of our hard work right away and enjoy a sense of accomplishment in seeing a process through from beginning stages to completion. Every time we harvest rainwater, use our grey water or turn on the LED lights we made, we can look back with quiet satisfaction!



The SARAS mela in detail: what we did

Junior school students: water use around campus

The young ones got a feel for estimating water use, where the school water comes from and how it flows around campus. They experimented with various toy models of water-lifting devices and eventually planned and helped implement a rain water harvesting system for the junior school building.

How can very small children, between the ages of seven and eight, get a feel of the complexity of the issues surrounding water use (in a practical everyday sense) as well as the beauty and delight inherent in the subject/in this aspect of the natural world?

Rather than facing abstract information immediately, the students learnt to get an intuitive feel for water in daily life. Through playing with bottles, mugs and buckets, they got a sense of what constitutes a litre, and how many litres of water we use for a bath, for example, or even how much water our hostels consume in a day.

In the same spirit of practical understanding, the students studied the main water tank in the school, examining the way the pipes entered and left the tank and linking these to pipe connections elsewhere on campus. Understanding the way water is pumped, stored and distributed across the campus is quite complex, but they got a feel of how this is done by learning about the piping system across the school.

Notes from a teacher's diary:

One activity the children did was to sketch the design of the water-tank and the tap system that exists in and around the junior school toilet. The children drew two sketches of the same building from two different perspectives. They were later asked to describe and explain how the entire system works.

The theories and explanations that they came up with describing the source and flow of water were very interesting. Here are a few:

In one student's theory the water to the tank is provided by a well that is dug below the toilet. The water is pumped to store in the tank above which later flows through the taps when they are turned on. There was only one pipe that ran through the surface of the tank and in the child's opinion every pipe had a partition to allow flow of water in opposite directions.

They saw a pipe that was connected to the tank from the garden. In their opinion it was connected to the tap that provided water to the garden.

We had more such interesting theories about the working of the plumbing system in the junior school.

The children later were given a simple science experiment. They were given a bucket of water and a transparent pipe that is not more than a meter long and asked to make the water flow through the pipe.

It was fascinating to see their brains work. They tried different ways of keeping the bucket at a different height, squeezing the water into the pipes using their hands etc. One group tried to emulate the spiral pump experiment that was conducted by the entire school on the day the mela inauguration.

Slowly they made connections between milk shakes and straws and found a way of sucking the water from the bucket. They also understood the different heights at which the pipe and bucket needs to be placed for this technique to work. The spark of discovery in their eyes was a sight to see.

Students sketched the design of the water tank and tap system in the junior school. They played with the tap in their garden, looking at how it is built and how it actually works. These were leisurely activities,

One design task the Bilvas (eight year olds) undertook was to understand and build a water sprinkler. They watched a teacher demonstrate a straw centrifugal pump. The students then built their own models, varying the diameter of the straw, the height of the stick from its pivot and the distance between the bend and the centre of the pump.



The Bilvas also began a rain water harvesting project in the junior school. The group explored how we get water in school through a borewell, and how the water reaches all the buildings. They had a discussion with the adults on rain water harvesting and questioned why we are trying to use rain water. The Palasha (eleven year olds) and Aksha (twelve year olds) group explained these key factors to the Bilvas:

- Rainfall and area of roof
- First flush
- Filter
- Storage tank
- Slopes and gradient

The group decided to collect water from half the roof area of the junior school and that the water would be used without filtering for the toilet near the junior school. The students did a water audit of the amount of water used in the junior school toilet in order to decide the size of the tank for the rain water system. Each student made an individual plan of the system.

The group measured and calculated the area of the roof, both the concrete and tiled parts, measured the lengths of pipe needed to get the water to the toilet and also decided and cleared a place to keep the storage tank. The group met to discuss the first flush concept. The students came up with ideas of what we could do to maintain the system: sweeping the roof regularly and keeping it clean, putting a *jaali* to a pipe to collect the leaves, a valve system to separate the dirty water.

The students enjoyed carrying brick, sand, soil and using spades and trowels to make the base for the plastic storage tank that eventually (with adult assistance and planning) collected the water.



The very youngest ones worked on a papier-mache model of the sun, around four feet in diameter. The metal frame was covered with chicken mesh before their work began. Many happy hours were spent splashing red, orange, pink and yellow paint on large sheets of paper, tearing these into strips, gumming one side and slapping onto chicken mesh. The resulting brilliant sun was suspended on mela day from a tree, and at the proportionally correct distance, a proportionally sized earth and moon were suspended...it turned out that the sun was near our dining area and the earth-moon were near the assembly hall!

Another activity they worked on was to paint tiles in bright colours and lay them out in the sharp sun to see which colours absorbed more heat. Visitors were invited to guess which tile would be the hotter and then to test it out by the empirical method of laying their hands on the tile.



Younger middle schoolers: water flow and usage on campus

For about twelve weeks (in the second term), for three hours a week, the Tamalas and Ashwathas (nine and ten year-olds respectively) studied the way water moves around the campus and is used in buildings in school.

The class walked around the campus, understanding how water flows from the main tank (situated at the highest point of the land) to all the other buildings. They were particularly struck by how the water can 'climb' up the pipe of a building without being pumped, because the original source of the water is at a still higher point!

The students also got a sense of water usage in the junior hostel, Inchara. They discussed ideas on how to save water: brush with *neem* twigs, use outdoor toilets. One experiment they tried was to just keep one mug in a sink each morning and to see whether they could brush their teeth using just that one mug of water. They also tried simple changes in usage habits, such as using leftover water in buckets, and also consuming less bath water.

The group worked on understanding grey water and black water in the hostel. They understood that grey water could be filtered and used to water the surrounding plants. They drew plans for filters, out of their own understanding. These plans had to be practical and affordable!



Water pumps and solar cookers

The same group worked on model water pumps and experimented with two models of solar cookers.

In working on pumps, the idea was to understand the principles behind how the pumps worked and to appreciate the sheer human ingenuity in creating these mechanisms.

For example, the students worked on an inertia pump. The children were given a bucket of water, a pipe 30 inches long and were asked to make a pump. The children thought of ways to use the pipe as a pump and had multiple chances to experiment with their ideas and see if they work. There were a few who covered the top end of the pipe with their palm, put it into the water, and then lifted the pipe to see what happens. Nothing happened! A few others put the pipe into the water, covered the top end, then lifted it and saw a little water gush out. There were also children who dipped it horizontally into the water and wondered why nothing exciting was happening! Amidst those who believed in hands-on experience were a couple of theorists who sat on the rock and narrated their theories on water and pumps!

After the children spent considerable time trying out various possibilities with the materials given, the adult read aloud the instruction on how to make the pump. The Tamalas and Ashwathas then took turns again

to see how the pipe can work as a pump and were thrilled to see water squirting from the top of the pipe! The Theorists preferred not to get wet!

The students felt that we were doing this kind of mela because the issue of water usage and conservation is an important one. Water should be saved because there are many in the world who struggle to get water for basic needs. They also felt we were doing this work to get ourselves to think about this question seriously and to raise “awareness” of the issue. We are “destroying nature”: polluting the waters and building dams, and we need to figure out different ways of getting what we want.

Some students felt that since water is “always” there, and water molecules never get destroyed, we need not really worry about this problem. This led to an interesting discussion in the mela group!

The students also experimented with cooking in a solar cooker.

This mela is different from our regular classes because we do a lot of hand work and physical work which we don't normally do. We are also doing things and building things for the school, to help the school. We resisted writing work and learning something which we already knew (like about the flow of water around school). The pumps were enjoyable and we looked forward to working on them.



Notes from a teacher's diary:

We tried cooking rice in the solar cooker. The whole group met in the kitchen, measured a cup of rice, washed and put it into the black container with water. We set up the solar cooker at around 9.30 am. The children went in pairs after every hour to change the angle of the mirror and focus light into the solar cooker. The rice was overcooked when we opened the cooker at around 1.30 pm!

Middle and high school: grey water treatment and rain-water harvesting

Older middle schoolers and high school students made grey water proposals and planned and executed localised rain water harvesting projects. They worked on scale drawings, estimating materials and costs, writing proposals, digging and laying foundations, doing brick masonry and plumbing. Some of these children also worked on water testing.

We're doing all this work to save rain water and to use it more than we are using it now. It is another source we can use. We are also doing this to get the experience of this kind of work and to learn about conservation.

I don't really understand why this is conserving water. If the rainwater goes into the ground, it will collect in the ground and we can dig a borewell later.

It was time consuming work and you had to think through each and every step. You had to think from different angles and predict if something would go wrong. If we measured something, we had to measure it many many times to make sure it was correct.

My attention would wear off quite quickly. After I had learnt the basic pattern in building the wall, I would doze off. But when I was actually doing it myself, I would make mistakes and I had to correct that quickly. Working with the masons was interesting. But sometime we had to just get sand or something, and that was quite boring. And there wasn't always work for everyone.

In the initial phase of exploring the problem of water usage, this mixed age group (roughly 12-15 years old) took up two thought experiments. They focussed on three buildings, Aria (the middle school hostel), the chemistry lab and the kitchen, and they came up with plans for grey water usage and rainwater harvesting in these buildings.

Grey water

The students made plans for where the grey water should go: the garden, for example, or the fruit orchards lower down in our land. In making the plans, the students had to consider factors such as the volume of grey and black water generated by the building in question. They did this by recording data every time they used water in the building. The group also had to consider cost. They made detailed estimates for the proposals, such as for the length of piping required. By actually tracing the paths of (potential) water flow on the ground, they came up with some realistic plans.



Notes from a teacher's diary: Jan 9

Measuring first flush volume required for the chemistry lab. Students also determined the turbidity of the water collected from the down pipe. They re-measured the area where the tank would be placed and the amount of piping required to connect the tank to the sinks.

Rain water

The basic idea behind the rain water project was to estimate the amount of water various roofs in campus would actually generate, and to try to store that amount. This involved several challenges: estimating the volume, conceptualising and costing the piping, and deciding on the location of the plastic water tanks that would eventually store the water. Of course, the actual construction and execution had to take place as well, which brought its own challenges!

In the chemistry lab, the students faced some difficulties in placing the tank. They had to find the optimal placement for the tank for optimal pressure. They also had to consider aesthetics; the tank had to be placed at the rear of the building and not right in the front.



It was kind of exciting to do all this work because it was new. We had never done building and other things like this before. Now I know how to build a brick wall and how piping is done. That is exciting. But there is a lot of effort in the work. The mason took a really long time to do the levelling. It takes a lot of patience. We learnt to use tube levels and spirit levels and plumb lines.

In the process of construction, the students learnt how to make a foundation (for the brick structure that supports the overhead tank). They learnt how to mix cement and sand and bind the bricks together. They also figured out how to do the levelling of the bricks: by the water level method and by using a plumb line. They faced many challenges along the way. When digging for the foundation, there were pipes in the way and also lots of frogs!

The kitchen was a natural choice for rain-water harvesting as there would be a large volume of water from the roof. Also, water from the kitchen area could be diverted to several locations around and used for growing plants.

The students estimated the amount of water flowing from the roof using a specific formula. Based on this estimate, they began making proposals (plans and costing) for rain water harvesting from the kitchen. One idea was to do a basic filtering of the rain water and use it for the plate-washing taps and provide a separate borewell connection for a drinking tap in the kitchen. The final plan they adopted was a

modification of the plans they had created earlier: Water from the kitchen roof was to be collected in a 2000 litre plastic tank located on the western side of the kitchen after passing through a first flush system. This was to be piped to the existing plate washing area. Drinking water from the existing bore well tank on the kitchen roof would be piped to a separate drinking water area around the corner (which would also be built by the students). If there was no rainwater, a simple ball valve could be turned to ensure that bore well water was piped to the washing area taps. A non-return valve placed near the output valve of the rainwater tank, would ensure that bore well water did not fill up the rainwater tank.

I enjoyed the documentation work. But sometimes we had to keep measuring things and that got tiring. I enjoyed the planning and thinking about whether it's going to work or not. I didn't enjoy actually going out there and doing the work, hauling sacks and all.



Notes from a teacher's diary:

Oct 31 to Nov 7: Abhin, Agastya, Ishaan. Maya and Rishab are focusing on tackling the tough problem of harvesting water from Aria. They have finished mapping/measuring the terrace and today worked on the design of the collection system. They are confronted with some significant problems. Most pressing is the location of the water tank and how to route the water from the down pipe to the tank. They anticipate working on this for the next two weeks.

Anya, Chirantan, Eduardo, Taarika and Yashoda are working on the feasibility of harvesting water from the Guest House. They have tried to understand the delivery of water to the Guest House from the main tank and how the water is being directed to specific areas (bathrooms, toilets and the kitchen). Furthermore, they are also discussing whether this is a feasible project and, if so, determining the location of the collection tank. They are also determining the use of the excess water, i.e., whether it should recharge the ground or be collected in a separate, larger tank (> 2000 L) that could be used for the drip irrigation system (guava orchard).

Aashutosha, Chanakya, Nayana and Rutu are brainstorming simple designs for the collection of water from the Chemistry Lab roof. The use of this water would be primarily for the Chemistry Lab with any excess possibly filling the Panchayat tank. The current problem they are faced with is understanding the first flush principle and its application to this building.

We realised that this is what other people do for a living: every day they have to do this same thing. This mela was an exposure so we could understand this. Also it's more of figuring out, trial and error. In math we don't figure it out in the same way. Here we had to learn to use something in a real life situation. And there's much more physical work in this.

I was more attentive in this kind of work. There's just a yes or a no most of the time, not a lot of grey stuff. I'm more curious to know how it's done. Different things are happening all the time.

In the process of construction, the students learnt the building techniques that the chemistry lab group learnt. But they also had some additional challenges. For instance, the foundation of the kitchen (against which they were placing drinking water taps) was not waterproof, so they had to cement the foundation and fix that issue.

The planning for the Aria rainwater was essentially the same. The water collected from the roof is to be used mainly for bathing. Finding the correct location of the tank was challenging: the tank had to be moved outdoors, and the piping plan too was modified. In this case, the students did not build a brick foundation, as the space beside Aria did not permit this. Instead, they used a pre-fabricated metal frame to mount the tank on.



Sample teacher report on kitchen rain-water harvesting plans:

Juan Daniel and I continued to look at kitchen rain water. In order to take stock and check measurements taken in a rush last week, we re-measured or finished measuring sections of the roof. Each child did quick sketches of the roof top and pencilled in the dimensions they had measured. They were careful not to take into account sections of the roof which were covered by another overlapping, higher section of roof as rain water would only hit the higher roof section.

Following this, they calculated areas of their sections of roof. Due to the odd shapes, they had to segment each section further and figure out areas of smaller rectangles and then add these up. The teachers checked the calculations along with the children to ensure accuracy.



The group of nine children then reconvened and discussed how we would go about calculating the total volume of rainwater potential for the kitchen roof. Soon enough one or two of the children said that we need to take into account the total rainfall in this region. We arrived at the formula of multiplying roof top surface area by annual rainfall. We also figured we needed to take into account a coefficient for different roof types. The children had measured areas of not only the cement roof, but also the fibreglass sections and the tiled roofs of some of the dining areas which runoff into the central fibreglass covered corridor! I told them the coefficients to use: Cement and Tiled roof: 0.75 and Fibreglass: 0.85.

They guessed correctly that this runoff coefficient was used to account for losses due to evaporation or absorption.

So the formula was : rooftop area (m^2) * annual rainfall (m) * coefficient.

I also explained to them, using two books as props, that usually the rooftop area is projected against a flat surface. This is because the steeper the slope of the roof, the less area available to collect rain. However Srini had told us that the coefficient for this was between 0.9 and 1.0 so Juan and I explained to the children that we would ignore this slope as it was so close to 1.0. Further, as Juan said, sometimes rain falls at an angle so this would compensate.

Finally we added volumes of sections of the roof, converting cubic metres to litres and arrived at the following:

Concrete area of kitchen roof: 103,400 Litres

Fibreglass outside door: 10,000 Litres

Tiles (part of totorum, half of aquarium, whole of compendium): 31,260 Litres

Fibreglass corridor: 5,710 Litres

With just 10 minutes left we discussed the question of what to do with this rainwater, what we would need to consider if we wanted to collect, store and use it. The children came up with ideas such as: maintenance, cost (labour, materials and construction), storage, usage. Further, how big is any tank that needs to hold more than one lakh litres of water?

Their homework was to call or visit two shops to find out prices of good quality 4-inch PVC pipes, elbows and the cost per litre of different brands of plastic tanks.



Project:

Charcoal and pebble filter

Juan Daniel, a new friend of the school visiting from Mexico, shared his know-how about homemade water filters. We used materials available around school, or bought locally. Here's how we did it, under his guidance:

Ingredients:

- * one bucket with lid (minimum volume ~50 litres) or other sturdy plastic container with lid.
- * PVC pipe (2.5-3 inch diameter) : two pieces each about 1.5 feet long.
- * small stones to fill half the volume of the container.
- * charcoal to fill half the volume of the container.
- * mosquito mesh: two pieces, one for top and one for bottom of container.

Method:

1. Cut a hole in lid and fit one piece of PVC pipe snugly.
2. Cut a hole in the bottom side of the container and fit the other PVC pipe snugly.
3. Place one piece of mesh inside and at bottom of the container ensuring it covers the PVC pipe hole.
4. Layer the small stones and charcoal alternately, beginning with the stones at the bottom, until you reach the top of the container. There should be about 6 inches space between top layer and lid.
5. Place the other piece of mesh just under lid and secure lid tightly (mesh may stick out and this is okay).
6. To test, pour a bucket of water with a little soil, leaf litter etc through top of filter and collect water which come out the other end. Remember that input water shouldn't be very dirty because if this is the case, it means your rooftop needs a sweep!

Variation: a layer of sand could be placed above the first layer of stones to remove more particles and perhaps reduce any charcoal powder residue in the output water.



Senior school: grey water treatment and LED lighting

Our oldest students rebuilt the kitchen grey water treatment system brick by brick, and one gravel load at a time. They also spent one intensive week learning from scratch how to assemble an LED light. They assembled printed circuit boards, fixed LEDs on a heat sink, and finally mounted all components to make a ready-to-use lighting fixture. They have made nearly 200 LED lights.



The kitchen grey water system:

The CFL kitchen uses about 2000 litres of water a day in preparing food for the community. For some years, we have been keen to treat this water—which contains oils, soaps and other chemicals—and use the treated grey water to water our vegetable garden.

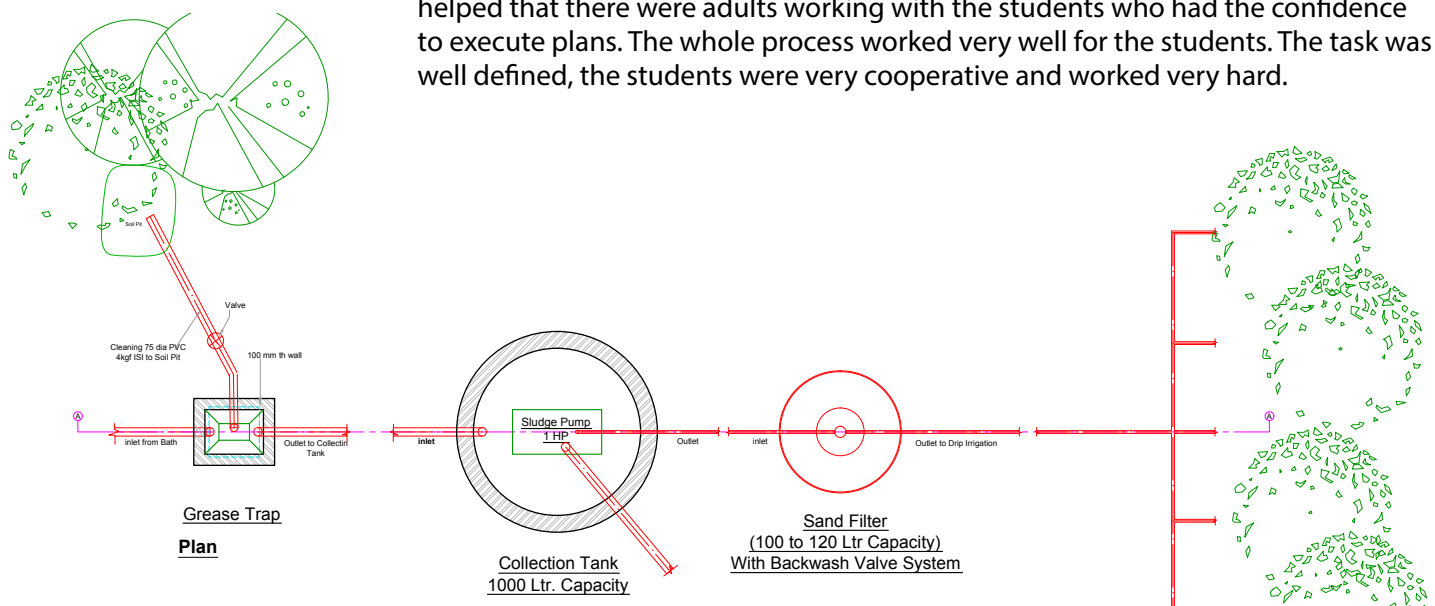
The basic plan was to let the heavier chemicals settle in a soak pit and then treat the remaining water in a reed bed in which the plant roots break down the larger molecules into simpler ones, safe to use in vegetable gardens.

(We already had a pre-existing system that had some problems. The seniors used the foundation of this older system on which to construct the new system).

The idea was to get a do-able project for the seniors, and the grey water worked well in this regard. We had a concrete plan with the help

of the Hunnarshala team (Tejas Kotak and his friends) from Gujarat, who came on site and identified the problems with our old systems (both rainwater harvesting and grey water use) and fixed them from a design point of view. We thank the Hunnarshala group for their invaluable assistance.

The students used the flooring of the old reed bed on which to build the new system. The suggestion was to use conventional cement to construct the tank. This was because both students and masons needed to be familiar with the processes and we didn't want to introduce anything exotic, such as ferro-cements. It also helped that there were adults working with the students who had the confidence to execute plans. The whole process worked very well for the students. The task was well defined, the students were very cooperative and worked very hard.





The tasks for each day were clear: weeding the bed, or moving sand, or sieving. Organising material was relatively straightforward. It was also an advantage that many of the group already knew bricklaying (from an earlier project) and could teach others.

The research that the students did was to find out how the reed-bed worked.

The students also learnt many skills during this process. In the daily mechanical work, they internalised many aspects of hand-eye coordination and the use of tools. Working for three to four hours continuously over several days itself achieved this result! Watching something being made from beginning to end and knowing that it was useful was very interesting and important. They had to learn the skills of using tools, how to carry large loads without hurting themselves and how to dig trenches. They also learnt significant masonry skills: mixing cement, laying bricks, how to use a plumb line and spirit level, cutting pipes, understanding how valves work, just to list a few. In terms of soft skills: all students have the theoretical understanding of how a reed bed works. They got the confidence that this kind of problem can be solved.



Notes from a teacher's diary:

Week 2

1. We briefly talked about the issues with estimating water use and waste from the kitchen.
2. We dismantled the inlet pipes to the reed bed
3. We started work in the reed bed by removing canna plants.

Week 3

We continued work with the Mallikas and Champakas (senior school students) of clearing up the grey water treatment plant. We spent the whole time moving gravel and jelly out of the reed bed.

We also managed to get a better estimate of the amount of grey water that is generated by monitoring and measuring how much water is used from the overhead kitchen tank. We estimate that we use about 2000-2500 litres per day.

We also discussed phyto-remediation and the roles that reeds and plants play in filtration. We need to understand this better.

More arduous and smelly(!)work with the Mallikas and Champakas of clearing up the grey water treatment plant this week. Two less participants - one with a broken arm and the other recovering from dengue. We spent the whole time moving gravel and jelly out of the reed bed. We also had to remove a papaya tree that decided to grow in the middle of the treatment tank!

The LED project:

As dusk falls and our campus becomes dark, we notice many small creatures moving around: bats, owls, the loris on the top of the tree in the honge grove, middle schoolers getting from the kitchen to their study areas. In order to light our paths safely and also not to intrude upon the nocturnal lives of the animals on campus, we conceptualised a lighting plan (based on LED lights and solar power) that would work well for all concerned.



As a team we brainstormed with Michael Mazgaonkar (of Mozda) when he made a visit to our campus. The idea was to work with students aged 14 and above on this project.

Michael and his colleagues (Vishven, Eshwar, Jayanti, Virsingh and Koojan) came to CFL and trained a group of students in assembling LED lights for our campus. A very enjoyable ten days was spent in February hosting and learning a great deal from this formidable team! We thank them for their hard work, commitment and patience, all of which touched our students.

There were two aspects we took on: interior and exterior lighting, for both of which the teachers did extensive background work in which the students were not involved.

For the exterior lighting, we tried to design aesthetic fixtures to house the lights and we had to take the cost of this into account. The entire project was quite complex because we had to consider several factors: the location of each light, what kind of circuit, what kind of wiring, the nature of the mounting, how to join one wire to another. We designed the route, and made an estimate of how many lights to use and a chart of each building. We learnt these things on the ground, and without the help of the Mozda team, none of this would have been possible!

The students were involved in the assembly of the lights. They worked intensively for up to eight hours a day for more than a week, assembling the circuits for LED lights. The printed circuit board was designed by the Mozda team keeping the students in mind. Since they could concretely identify the outcome of the work, they were emotionally very involved with it.

We couldn't get into understanding the theoretical aspects very much. But as an outcome, the students can maintain the lighting system. They can identify problems with it and how to fix them.

The students learned many hard skills during this project, most of which we list below: soldering, recognising parts, recognising polarity, how components work (resistors, capacitors, switches), stripping a wire, connecting it to a plug, testing using a multimeter, using tools (screwdriver, cutter), connecting components together, opening fixtures, measuring wires, understanding connectors, understanding the different kinds of bulbs, understanding electrical plans, conducting power audits.



How was the mela designed as a learning opportunity? A meta-view of the mela and the kinds of learning that took place



Students had to understand the nature of the problem. For example, those who were trying to understand rain water harvesting had to get a feel for how much rain water can be harvested from a flat surface area. They needed to understand whether the rain water could be used directly or whether it needed filtering. For this, they needed to understand the following concepts: annual rainfall in a given area, distribution of rainfall over the seasons, run-off coefficients and so on. They had to come up with a way of harvesting the rain water and storing it. Costing was also an important aspect of the planning, as well as assessing the practicality of the various designs.

Actually executing the plan meant making lists of the materials needed, procuring the material and making sure the resource people with the technical know-how were available for consultation. The skills involved in executing the project included masonry (cement mixing, brick laying, using a plumb line, constructing perpendicular walls), optimising the layout and position of tanks, reading and understanding a design, understanding slopes and how water flows. For plumbing, the students had to understand the various components of a plumbing system. They had to acquire the skills of sawing pipes and attaching them and gluing fixtures. Of course there was a lot of labour involved in digging trenches, sieving sand and jelly, moving heavy materials and so on.

For the grey water reed bed system that the seniors worked on, most of the above skills were necessary. They had to understand the design. (The reed bed is basically a sand and gravel filter and is sized depending on the volume of grey water



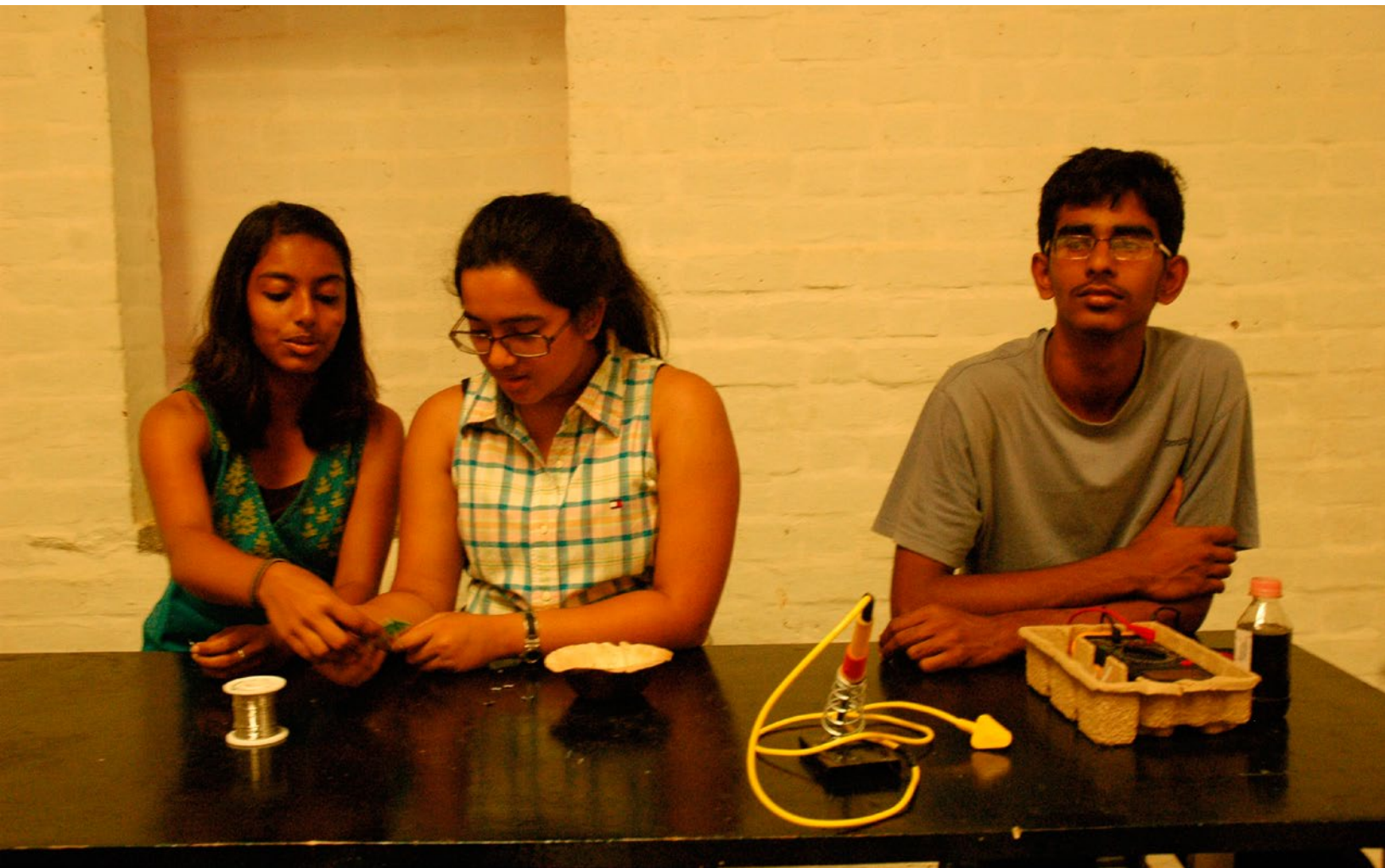
generated). They also had to figure out how a grease trap functions (a grease trap is a small tank that allows heavy particles to settle at the bottom and the grease to float on top. The grease trap is piped to a soak pit that is at a lower level, controlled by a valve. When the valve is opened, both the heavy particles as well as the grease are sucked into the soak pit). The students had to understand how the reed bed works and what the function of the reeds is (the reeds have a matrix of shallow roots that trap heavy particles, including oils. Bacteria present in the roots break the oils down and these become nutrition for the plants. The plants also have the capacity to absorb heavy metals and other minerals).

For the LED lights, students (aged 14-18) learnt about all the components of an LED light. They also learnt how to assemble the components on to a printed circuit board. They then mounted the various parts involved in an LED light onto a lighting fixture and figured out component testing for errors. Soldering skills were very important, as well as the use of instruments such as a multimeter. They learnt about wiring and fixing the lights in their respective locations. Perhaps the biggest question the students worked with was the big picture of looking at campus lighting overall. The effort needed to work together as a team to put together almost 200 lights, working long hours, was tremendous.

Learning outcomes in the mela as a whole

Apart from the hard skills, there were many learning outcomes:

- 1 Understanding the use and re-use of water and grey water
- 2 Understanding how to treat water and the technical difficulties involved
- 3 Becoming aware of how we take basic energy requirements for granted
- 4 Communicating clearly to a large audience what students have understood
- 5 Taking ownership for what was built and maintaining it



This mela is not a one-off experience, as we have not solved all the problems on campus. Other students, as they grow older, will be more involved with the processes of conservation and in maintaining systems. Hopefully, in whatever context we are, we will be able to recognise the basic issues involved and plan accordingly.

All of the above is a reflection of a process of planning and construction. We have had invaluable help from experienced plumbers, engineers, tinkerers and masons, without whom we would not have got this far. However, the students themselves have created most of what we have described above.



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Thanks and acknowledgements:

To pull off a mela of this complexity, we required the help and goodwill of many individuals and organizations. We wish to thank them all.

We would like to thank the Hunnarshala group, especially Tejas Kotak, for invaluable help with the grey water system.

The LED project would not have been possible without the Mozda Parivar. We would like to thank Michael, Vishven, Eshwar, Jayanti and Koojan for their incredible energy, commitment and patience, all of which touched our students deeply.

As with all melas and other school events, we received invaluable support from our parent community. We are lucky that we are able to tap into the specific expertise that they have in order to accomplish our learning goals.

We thank Vijaykanth and the team of workers for their skill and patience in guiding the CFL community on various building aspects of the mela.

We received generous financial help for the mela from many donors in India and around the world. In particular, we thank Wipro Applying Thought in Schools for their continuing support of many learning endeavours at CFL.