GO VERT

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CITY AS LAB

ABSTRACT

Air, one of the primary sources of life on Earth is undoubtedly in horrendous state. According to national geographic channel, "Generally any substance that people introduce into the atmosphere that has damaging effects on living things and the environment is considered as air pollution."☐Ubiquitous human activities such as mining, construction, transportation, industrial work, agriculture etc. causes of air pollution. However, natural processes such as volcanic eruptions and wildfires may also pollute the air.☐Depending on the level of exposure and the type of pollutant inhaled, air pollution has serious effects on human health. Air pollutants can be eliminated either by air purifiers or by plants, depending on their form i.e. gaseous form (as toxic gases) or, solid form (as particulate matter suspended in the air / PM10 and PM2.5).☐☐In order to develop a substitute for these expensive machines, we started testing the efficiency of plants. Hence our research question is, "***Air, the prime cause of life on Earth is now getting polluted. This also has adverse effects on our health. The aim of this project is to test the efficiency of plants over air purifiers in our immediate surroundings that is our school campus.***"

INTRODUCTION

"Air, the prime cause of life on Earth is now getting polluted. This also has adverse effects on our health. The aim of this project is to test the efficiency of plants over air purifiers in our immediate surroundings that is our school campus."□GO VERT is a French word which means "Go Green" and as we want to help purify air, we stand green.□Sooner or later, we will have to recognize that the Earth has rights, too, to live in a safer environment, to be able to breathe.□Pollution has always concerned us, in fact, it concerns everyone. It is a global challenge, as evidence shows that adverse effects still exist

even at relatively low air pollutant concentrations.□Seeing little children wear masks to school every day and being restricted to play in the garden because of the rising level of pollution, we were devastated at the condition of air we were surviving on.□This was thus, the driving force that led us to develop a solution for the same.□To improve the air quality we always end up buying an AIR PURIFIER thinking that it is the best way to curb air pollution, but we often unsee the fact that there is a substitute to them - PLANTS.□We believe that vertical vegetation is the best and the most efficient way to reintroduce nature in today's world. □Besides this, having green walls in our city will not just help us fight pollution, but it will also add aesthetics and beauty to the environment. □As we know that, air purifiers are costly machines which cannot be bought by everyone suffering from this issue, plants can surely be an aid to them. □Also, practicing vertical gardening on a large - scale can help in reducing the temperature.□Thus, keeping this in mind, we designed our research problem, as mentioned above.□

METHODOLOGY

Research work:

Our first step was to search about the air quality index (AQI). The AQI is an index for reporting daily air quality. It tells you how clean or polluted your air is, and what associated health effects might be a

concern for you. The AQI focuses on health effects you may experience within a few hours or days after breathing polluted air.

Air Quality Index (AQI) Values	Levels of Health Concern	Colors
When the AQI is in this range:	...air quality conditions are:	...as symbolized by this color:
0-50	Good	Green
51-100	Moderate	Yellow
101-150	Unhealthy for Sensitive Groups	Orange
151 to 200	Unhealthy	Red
201 to 300	Very Unhealthy	Purple
301 to 500	Hazardous	Maroon

Fig. 1

Each category in Fig. 1 corresponds to a different level of health concern. The six levels of health concern and what they mean are:

- "Good" AQI is 0 to 50. Air quality is considered satisfactory, and air pollution poses little or no risk.
- "Moderate" AQI is 51 to 100. Air quality is acceptable; however, for some pollutants there may be a moderate health concern for a very small number of people. For example, people who are unusually sensitive to ozone may experience respiratory symptoms.
- "Unhealthy for Sensitive Groups" AQI is 101 to 150. Although general public is not likely to be affected at this AQI range, people with lung disease, older adults and children are at a greater risk from exposure to ozone, whereas persons with heart and lung disease, older adults and children are at greater risk from the presence of particles in the air.

- "Unhealthy" AQI is 151 to 200. Everyone may begin to experience some adverse health effects, and members of the sensitive groups may experience more serious effects.
- "Very Unhealthy" AQI is 201 to 300. This would trigger a health alert signifying that everyone may experience more serious health effects.
- "Hazardous" AQI greater than 300. This would trigger a health warnings of emergency conditions. The entire population is more likely to be affected.
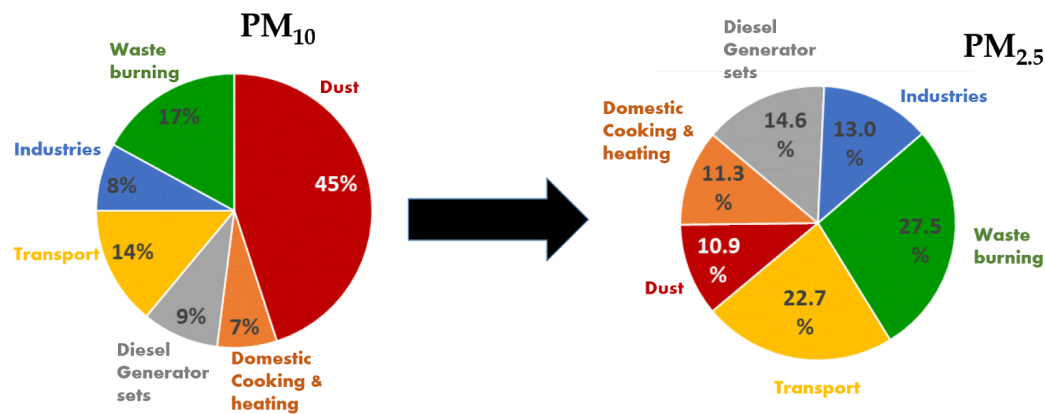

Fig. 2

The above picture (Fig. 2) shows the various sources of pollutants.

Our second step was to do intensive research about the types of pollutants present in our surroundings (especially indoors) and finding out plants that can help eliminate those particles. Air pollution can be defined as the presence of toxic chemicals or compounds in the air, at levels that pose a health risk. These chemicals or compounds are called pollutants which can be classified into 2 types that are **PARTICULATE MATTER** (pm 2.5 and pm10) and **TOXIC GASES.**

Toxic gases are those gases that can be poisonous or cause health effects. Particulate matter is the sum of all solid and liquid particles suspended in air, many of which are hazardous. These particulate matters are soot, dust, ash, fine particles, coarse particles. The main source of particulate matter is burning fuels, meaning anything from

diesel and gasoline to wood and leaves. Construction sites, roadwork, factories, and quarries are other sources of particulate matter. Toxic gases present around us are Nitrogen Oxide, Carbon Monoxide, Xylene, SO2, Ozone, Benzene, Formaldehyde, Toluene, Trichloroethylene. □Both Particulate matter and plants have harmful effects on our health.□Particulate matter cause coughing, shortness of breath, irritation of the

respiratory tract, hoarseness and wheezing, lung dysfunctions, chronic bronchitis, cancer, especially lung cancer.
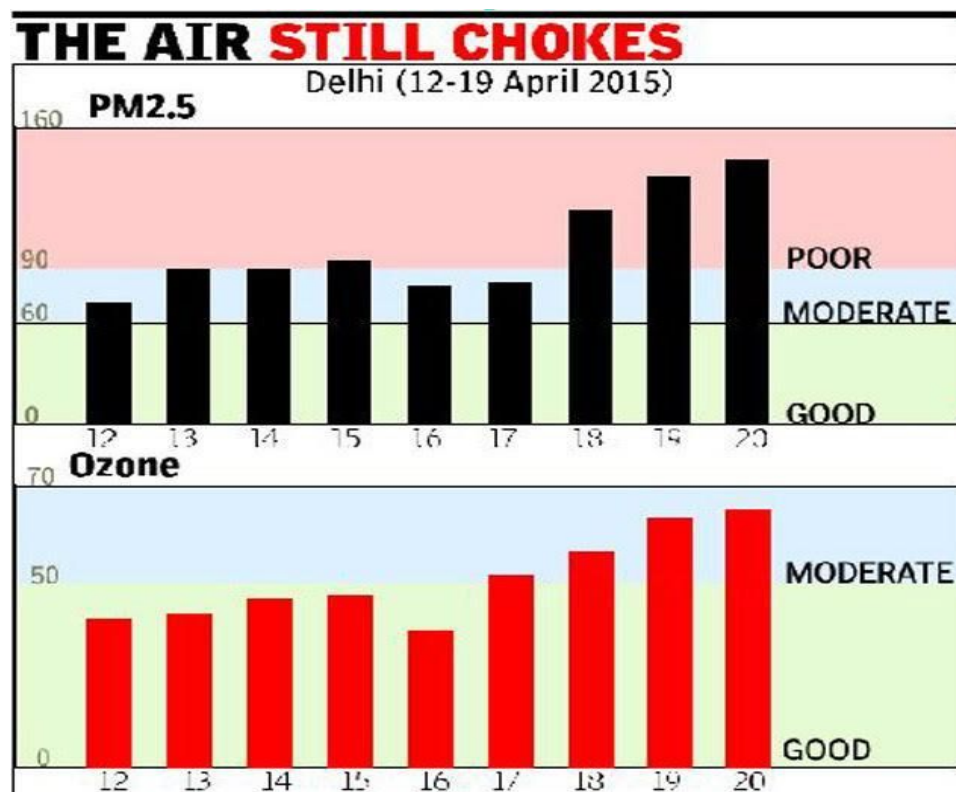

Fig. 3□The above picture (Fig. 3) shows the change in PM2.5 and Ozone levels in Delhi.

The Toxic gases and their effects on health are listed below:□1. **Benzene**- It increases the risk of cancer and other illnesses, and is also a notorious cause of bone marrow failure. Substantial quantities of epidemiologic, clinical, and laboratory data link benzene to aplastic anemia, acute leukemia, bone marrow abnormalities, and cardiovascular disease□2. **Trichloroethylene**- it damages the nervous system resulting in general anesthesia. Its high blood solubility results in a less desirable slower induction of anesthesia. Higher

concentrations result in tachypnea. Many types of cardiac arrhythmias can occur and are exacerbated by adrenaline. 3. **Ozone**- Ozone layer depletion increases the amount of UVB that reaches the Earth's surface. Laboratory and epidemiological studies demonstrate that UVB causes non-melanoma skin cancer and plays a major role in malignant melanoma development. In addition, UVB has been linked to the development of cataracts, a clouding of the eye's lens. 4. **Carbon Monoxide**- Breathing CO can cause a headache, dizziness, vomiting, and nausea. If CO levels are high enough, you may become unconscious or die. Exposure to moderate and high levels of CO over long periods of time has also been linked with increased risk of heart disease. People who survive severe CO poisoning may suffer long-term health problems. 5. **Toluene**- A serious health concern is that toluene may have an effect on your nervous system (brain and nerves). Nervous system effects can be temporary, such as headaches, dizziness, or unconsciousness. However, effects such as incoordination, cognitive impairment, and vision and hearing loss may become permanent with repeated exposure, especially at concentrations associated with intentional solvent abuse. High levels of toluene exposure during pregnancy, such as those associated with solvent abuse, may lead to retardation of mental abilities and growth in children. Other health effects of potential concern may include immune, kidney, liver, and reproductive effects. 6. **Formaldehyde**- The EPA has classified formaldehyde as a "probable human carcinogen." National Cancer Institute researchers have concluded that, based on data from studies in people and from lab research, exposure to formaldehyde may cause leukemia, particularly myeloid leukemia, in humans. 7. **Nitrogen Oxide**- It increases respiratory problems. Nitrogen dioxide inflames the lining of the lungs, and it can reduce immunity to lung infections. This can cause problems such as wheezing, coughing, colds, flu, and bronchitis. It also worsens asthma. 8. **Xylene**- Inhaling xylene vapor is depression of the central nervous system, with symptoms such as a headache, dizziness, nausea, and vomiting. 9. **SO2**- It irritates the nose, throat, and airways to cause coughing, wheezing, shortness of breath, or a tight feeling around the chest. The effects of sulfur dioxide are felt very quickly and most people would feel the worst symptoms in 10 or 15 minutes after breathing it in.

The diagram (Fig.4) below shows the effects of toxic gases on human health.
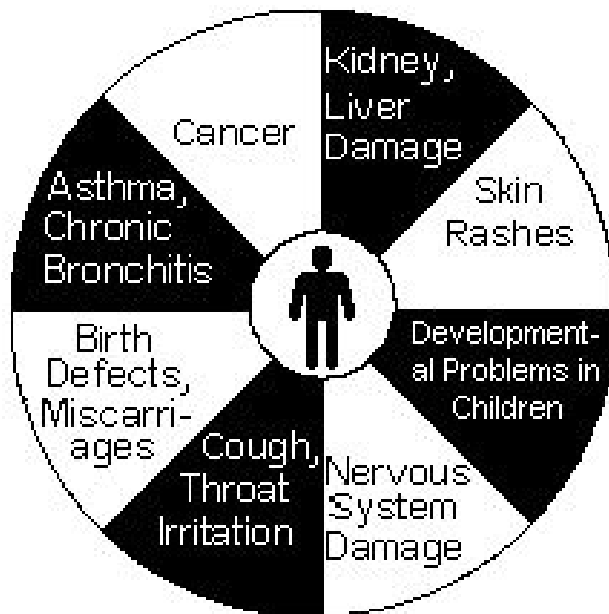
Fig. 4

Besides doing online research we also collected data from the botanical chemist, Dr. Disha Sharma (Scientist), Dr. Nitish Dogra (Founding Convenor, GFF). We even contacted Khetify, a startup based on vegetation to understand the framework models regarding the green walls. After research, we began with the designing of green walls. However, since we had to design greens walls indoors, we also had to be wary of insects and bugs. Therefore, we decided to add another element to our project which is that of insect-repelling plants.

Following are the plants that were used for the experiment :

1. Aloe Vera
2. Basil
3. Snake plant
4. Spider plant
5. Lemon grass
6. Peace Lily
7. Ajwain

Below are the reasons for choosing the plants mentioned above:

- **Spider Plant** - It eliminates formaldehyde and xylene. It is non - toxic to animals and kids. It also absorbs NOx.
- **Aloe Vera** - It absorbs formaldehyde, benzene and, carbon monoxide.
- **Snake Plant** - It absorbs formaldehyde, nitrogen oxide, benzene, xylene, and carbon dioxide. It releases oxygen during the night.
- **Peace Lily** - Peace Lily was the most efficient at removing airborne Volatile Organic Compounds, including formaldehyde, trichloroethylene, and benzene.
- **Lemongrass** - It's used as a medicine- helps when having flu. Because of the strong lemon scent, the mosquitoes don't come near it.
- **Basil** - Basil contains very heavy oil and is useful in keeping small gnats and flies out. It has a strong smell and is also the king of herbs.
- **Ajwain** - The smell of ajwain is very strong which helps the mosquitoes stay away.

After choosing the plants we worked on the framework designs. We came up with 3 sets of frames which included the following materials. While working on the same, we tried to refrain ourselves from using any amount of plastic.

1. Bamboo
2. Sacks
3. Wiremesh
4. Cocojute

- ❖ Even though we built all the three frames to check their feasibility, we finalized the **bamboo framework** for our experiment, which looks **aesthetically good**, consumes less space and is easy to go with drip irrigation system. We chose bamboo for the frames for it is an **eco - friendly, sturdy** material and just like other plants, it too helps in eliminating harmful gases from the air. In fact, it absorbs Carbon dioxide

and **releases oxygen** into the atmosphere 3 to times higher than many other trees.

- ❖ The drip irrigation system we are using in our project is different from other systems as we are not using any motors or electricity to run it. Instead, it purely works on the **PRINCIPLES of GRAVITY** only.

- ❖ We decided to use the bamboo frame because it could hang easily on the wall while the others couldn't and it was **easier to manage.**

Here are some pictures which display our work:

A short clip of our journey :

https://animoto.com/play/lCQDDWBmiRMKe95o8tA0HQ

WHERE WE GOT OUR RESOURCES FROM?

We went to Sikanderpur to buy bamboo and, to a nursery to select the plants. ☐We cut the bamboo first and put 4 plants with soil in each one. We drilled holes on each stalk to loop them all with a common rope so that it could be hung on the wall. After hanging the bamboo frames on the wall, we did a couple of experiments to check the working of the drip irrigation system for plants and finally succeeded in doing so. We used a small tank, pipes, taps, and valves. Our school carpenter Bhaiya helped us in making the bamboo frames and gardener Bhaiyya helped in planting the saplings.

THE EXPERIMENT:

In order to collect the necessary data, we decided to have **3 specimen rooms** [of the same size (25 x 25) each, with the same activity, and location to measure the levels of PM and TOXIC GASES in all of them:

- In the first room we did not have air purifiers or plants.
- In the second room we only had an air purifier to keep a check on its efficiency.
- In the third room we had implemented both, plants and air purifiers.

After the identification of our specimen rooms, we designed the green walls in the first room with 70 plants in total.☐☐Since we wanted our project to be cost-effective, we worked on the drip irrigation system, which works without any electricity or motors. Instead, our drip irrigation system is purely based on the principle of gravity.

DATA CALIBRATION:

Now, the biggest challenge in parallel with us was how do we actually monitor the ppm concentration in the specimen rooms? Since the AQI machines which were available in the market did not monitor the gases we wanted to keep a track on (these included gases and particles which had a direct impact on our health like CO, pm 2.5, pm 10, etc.) and they were exorbitantly expensive in the market and no device was able to give us live data. So, we decided to build our own AQI machine which could be connected to our server and give us live data for all rooms at the same time. For this, we studied what AQI really is, how it is calculated, and its various categories and components, etc. We built 2 sensors (which recorded Carbon Monoxide levels and pm 2.5 concentration) and learned their calibration with the help of IT faculty. We also ensured to get live data from http://aqicn.org/city/india/gurgaon/vikas-sadan-gurgaon on our server to check whether our machines are calibrated correctly or not. This automated the process of data collection where all the readings were stored on the server, on a timely basis.

FINDINGS/RESULTS

Air pollution index

DATE	TIME	ROOM WITH PLANTS		ROOM WITH AIR PURIFIER	
		PM 2.5	PM 10	PM 2.5	PM 10
26/11/18	10:00 AM	130	268	137	270
27/11/18	2:00 PM	164	374	172	389
27/11/18	10:00 AM	168	363	169	391
28/11/18	2:00 PM	94	182	102	187
28/11/18	10:00 AM	202	407	217	410
29/11/18	2:00 PM	119	236	143	296
29/11/18	10:00 AM	197	416	217	509
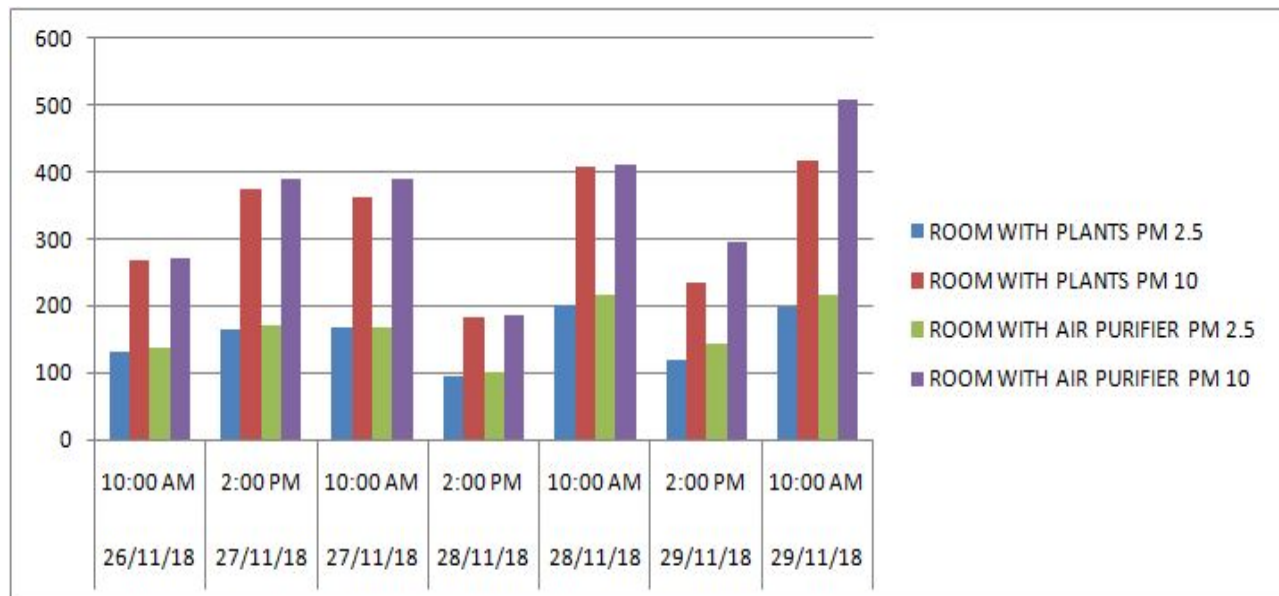
According to the data - there is a significant difference between the concentration of PM2.5, PM10 in a room with plants and without plants (with air purifier). There is a difference in the concentration of the particulate matter on different days and different timings, same days

and different timings☐The room with plants has cleaner air than the room without plants. Hence, we can say that plants are a way to curb air pollution and reintroduce nature in a simpler form!

DISCUSSION

The research question of the study was, "***Air, the prime cause of life on Earth is now getting polluted. This also has adverse effects on our health. The aim of this project is to test the efficiency of plants over air purifiers in our immediate surroundings that is our school campus.***"☐In order to test the efficiency of plants, we formulated our hypothesis as follows, "***Plants are a more sustainable and efficient way to curb air pollution, though plants and air purifier together make an ideal situation.***"☐According to the data collected, we inferred that there was a 15 - 20% reduction in the concentration of PM2.5 and PM10 in the room with plants versus the one without plants.☐During our research, we found out that plants too have the capacity to eliminate the various toxins present in the air. Different plants have different strategies to do so. In fact, when carbon dioxide (CO_2) builds up in the atmosphere, plants actually thrive, become larger, and are able to soak up more CO_2 due to photosynthesis.☐According to studies, carbon acts like a fertilizer that accelerates plants growth. We also discovered that particulate matter (PM 0.1) can be absorbed by plant stomata and get stored there. Sine PM2.5 and PM10 are bigger in size, they precipitate onto the leaf surface and get washed off in the soil. The rougher and larger the leaf surface is, the more effective air purification gets with plants. Leaves of succulent plants can also trap these toxins, so can the waxy surfaces of plants like aloe vera.☐We believe that because of the above reasons, plants were able to purify the room better than the one with an air purifier. ☐Some of the factors which could have led to possible errors in the study could be the susceptibility to outside air. Since the specimen rooms were activity rooms, the opening, and closing of the door may have caused outside air to rush in and manipulate the readings to some extent. ☐There is no doubt in the fact that plants do us all good. They not only improve the aesthetics but also help in purifying air and they also have various therapeutic and medicinal

uses. ☐Furthermore, large green walls can also act as a sound absorbing solution, which can get us rid of the booming noise levels of the city. ☐Not every household and school and NGO etc. cannot afford to have an air purifier. However, we can surely implement these cost-effective and sustainable green walls to help control the rising pollution levels in our city. ☐Unlike air purifiers, they plants e have used in our research need low maintenance and are completely eco - friendly for we have restricted ourselves from using plastic. ☐Lastly, it is the best way to reintroduce nature in today's world.☐

THE FUN WE HAD

PALAK: "Going to buy the bamboo and plants at the nursery was a really fun experience for me. I had very little knowledge about plants until I started working on this project. Now, I can easily identify any air purifying plant I see. Besides, developing a drip irrigation system which only works on the principle of gravity was also cool. I had never heard of it before. We were introduced to various new concepts from Physics in the procedure."

DISHA: " For me meeting the people who could help us gain insight into the world of plants, pollution and air purifiers was the most interesting part. I have always been a social person and getting to know their opinion was an enriching experience. Besides this, building the frames was an exciting part too. We did almost everything on our own - from buying the plants to arranging them into the frames and setting up the drip irrigation system

CHALLENGES WE FACED:

In the process of collecting data, we encountered quite a lot of problems.

1. Since the plant frames had to be hung on the school walls, we had to seek permission from the authority to do the needful.

2. Keeping in mind the cost - factor, we had to do the prototyping in the most reasonable / economical way possible.

3. In an attempt to keep our project eco - friendly we tried our level best not to use any plastic except for the drip irrigation system.

4. Since there was no air quality monitor available in India which could give us live data of pm 2.5 level and the gaseous pollutants present in air , we had to design our own.

5. We even designed the drip irrigation for plants, thus, learning the physics behind it all.

6. Researching for the various myths associated with the efficiency of air purifiers was quite a task.

7. Similarly, researching and studying about the mechanism through which plants absorb pm 2.5 and how the purify air was a lot of science!

8. Since plants need proper sunlight and adequate amount of water for growth, we had to adjust the frames in a careful / a well positioned thought through manner.

9. We faced a major challenge while collecting our data. Kids used to turn off the system. Sometimes they switched off the air purifier too and thought that the AQI monitors were explosives. This disturbed our analysis, for the process of data collection became erratic.

STUDENT WOULD CHANGE IF THEY HAD DONE THE RESEARCH AGAIN

We would have made the project more cost efficient and tried to better our drip irrigation system.

WHAT WE LEARNT
1. We learnt about different plants
2. We learnt how they help us.
3. Different types of diseases caused by air pollution.
4. What are the components of air pollution
5. How the AQI is calculated.

PALAK MODI, DISHA ZUTSHI, IRA SIDHU, SOUMYA JUNEJA