NASA

TECHRISE STUDENT CHALLENGE

Step 4: Plan Your **High-Altitude Balloon** Experiment

Design Flight Experiments

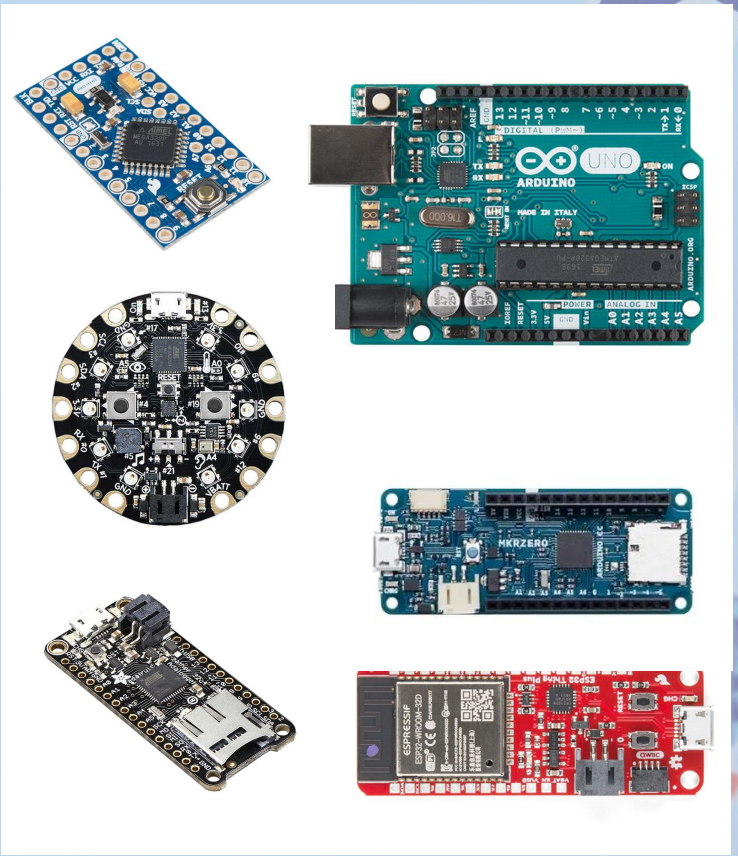
Make an Experiment Design

Now that you've thought about your experiment idea(s), it's time to plan out how you would build it and make it work. There won't be a person on the TechRise flight to control your experiment, so you will need to use a microcontroller for automation.

First, we will learn about microcontrollers.
Then, we will explore different hardware components/sensors.
Lastly, you will develop an experiment design that explains **HOW** your proposed experiment idea could function during flight.

What is a Microcontroller?

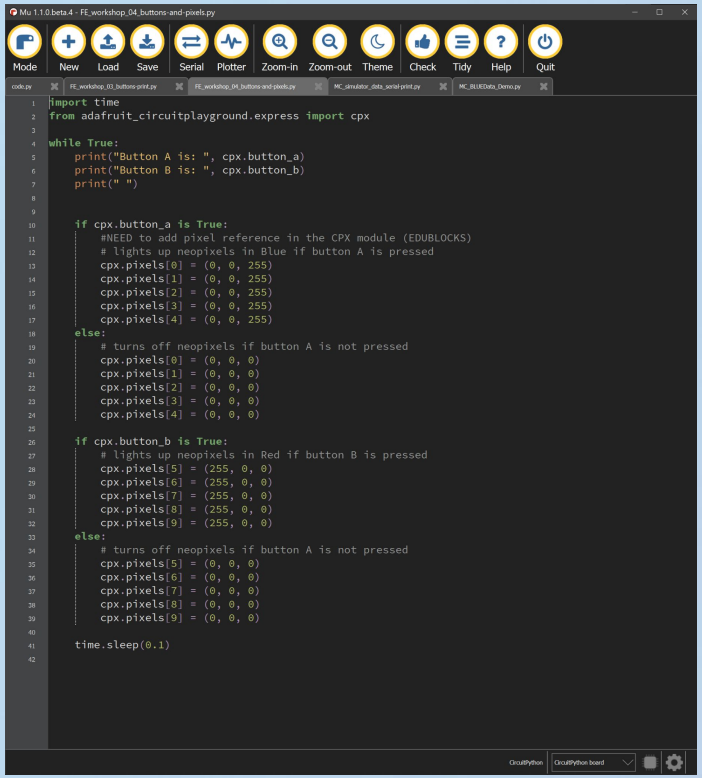
- A microcontroller is the “brain” of an experiment used to automate simple tasks by receiving data (input) and sending data (output).
- For example, a microcontroller could be programmed to receive data (input) from a temperature sensor and then tell a fan (output) to turn on if the temperature goes above 80 degrees F.
- Because microcontrollers can be programmed to automate specific tasks, scientists and engineers use them to remotely record data, control motors/pumps, or take images … whether in a lab, on a high-altitude balloon, or on Mars!



What is a Microcontroller?

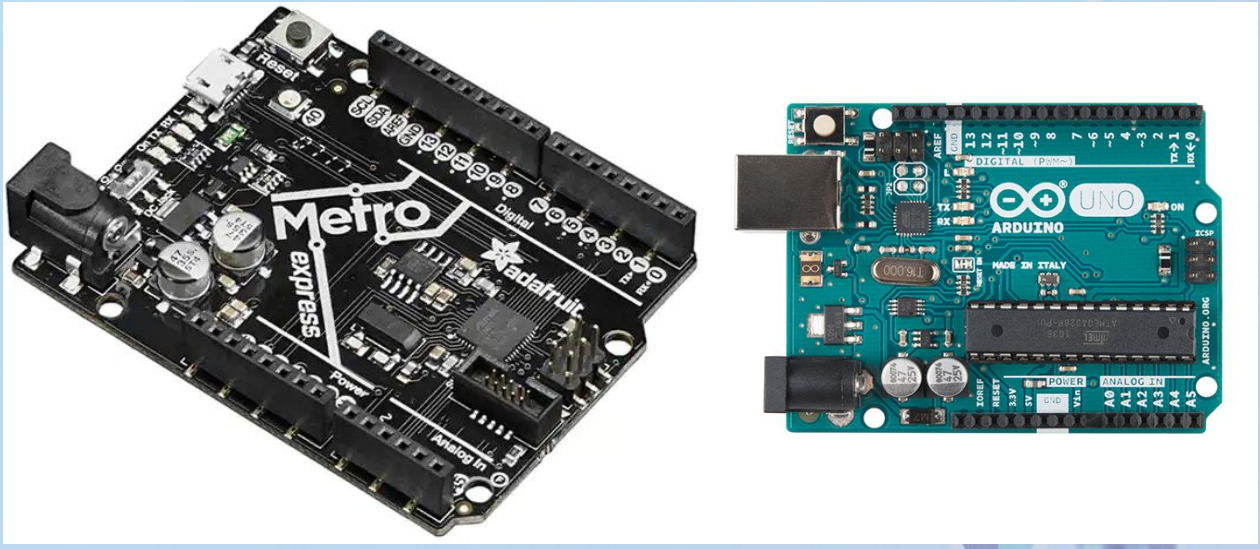
- You can think of a microcontroller like a mini computer. They perform repetitive functions and can be programmed to interact with components (e.g., motors, sensors) to make your experiment work.

- You DO NOT need to include code in your proposal, nor do you need to know how to code to submit a NASA TechRise proposal, but rest assured that you will learn to code a microcontroller if selected as a winner!



Which Microcontroller Should I Use?

TechRise winners will be provided a microcontroller, such as the Metro M4, as part of their introductory learning kit. This microcontroller can be programmed in Circuit Python or Arduino IDE. You are welcome to use this microcontroller in your final experiment or choose your own. If you decide to use your own microcontroller, please select one that can operate within the 9V, 1.5A power constraint during flight.



Sample Experiment Design

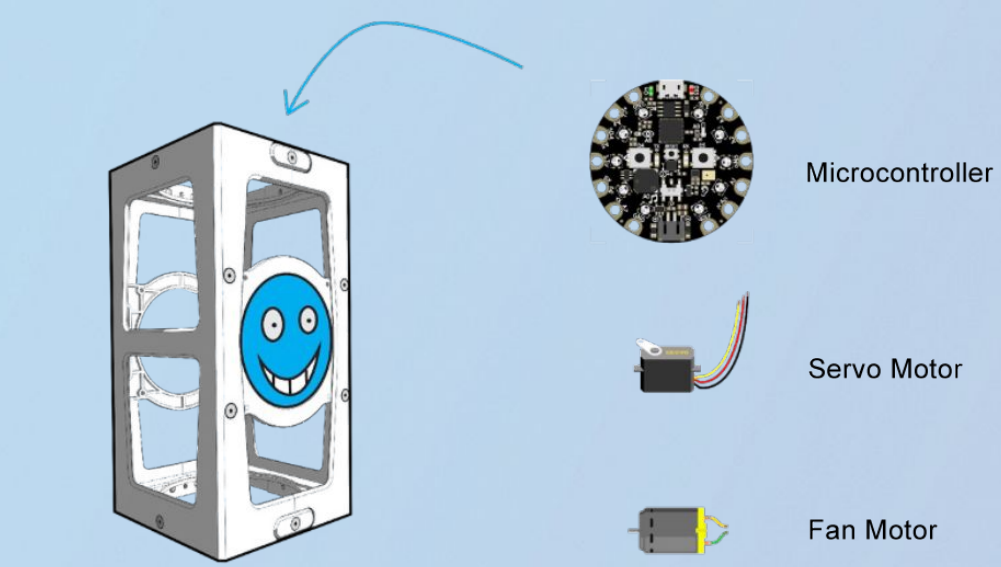
- Now, let's look at a sample experiment and explore how to develop a design for your proposal.

- Watch this sample TechRise experiment that was designed last year for a rocket flight.

Sample Experiment Design - Identify Components

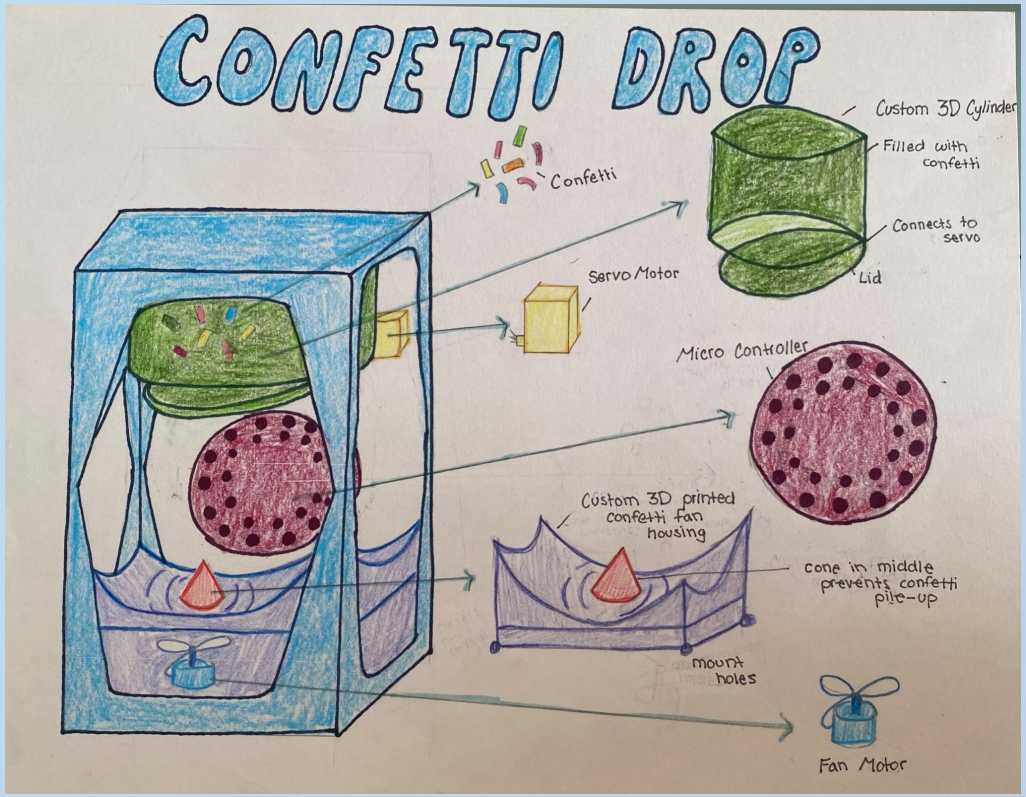
The experiment you just watched used three main components:

- A microcontroller that was programmed to release the confetti at a specific time
- A servo motor to release confetti
- A fan motor to blow the confetti



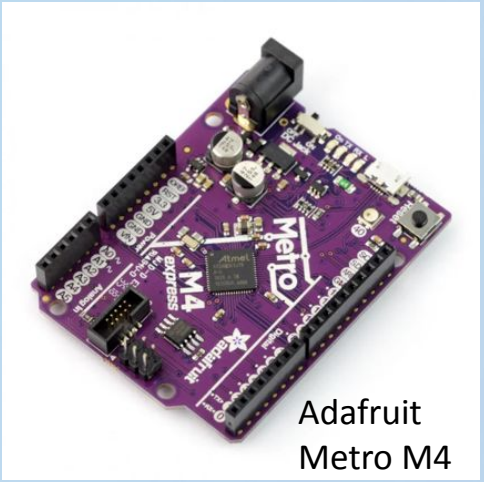
Sample Experiment Design - Draw how it will work

The sketch to the right shows a sample diagram of how the experiment is designed to work. Teams are encouraged to include a sketch or diagram of their proposed experiment in the HOW section of their proposal.

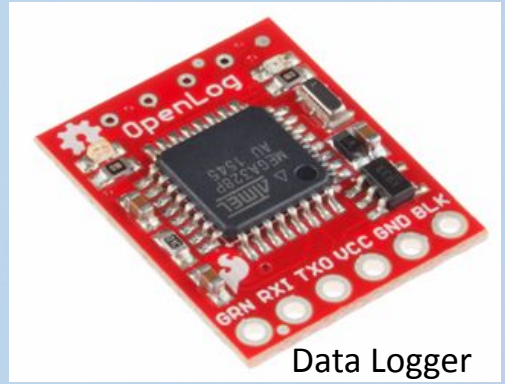


Explore Components: What will your experiment need?

In the following slides, we will review types of components that can be used with a microcontroller to build an experiment. As we review these different components, start thinking about what you may need to build your experiment idea.



Adafruit Metro M4



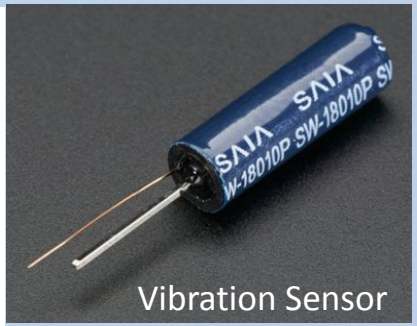
Data Logger


DC Motor in Servo Body


Solenoid

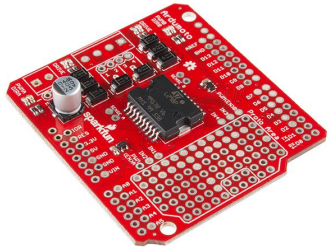

Submersible Pump

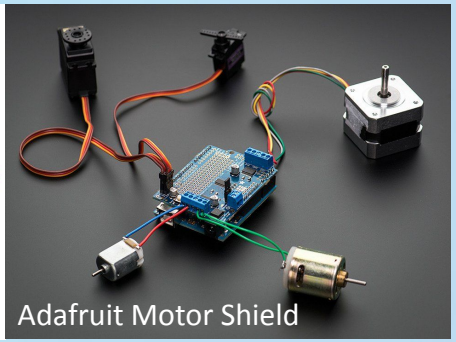

Dash Cam

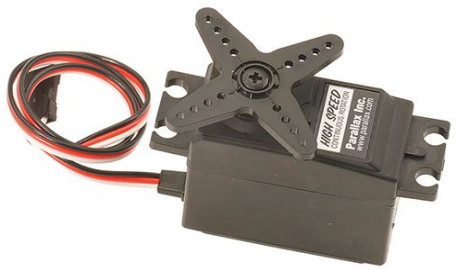

Vibration Sensor

Motion

Do you need something to move, open, close, or spin in your experiment? What about actuating something to start in flight? Explore the motion components on the worksheet like motors, servos, solenoids, and pumps.


Sparkfun Motor Shield


Adafruit Motor Shield


Angular servo


DC motor

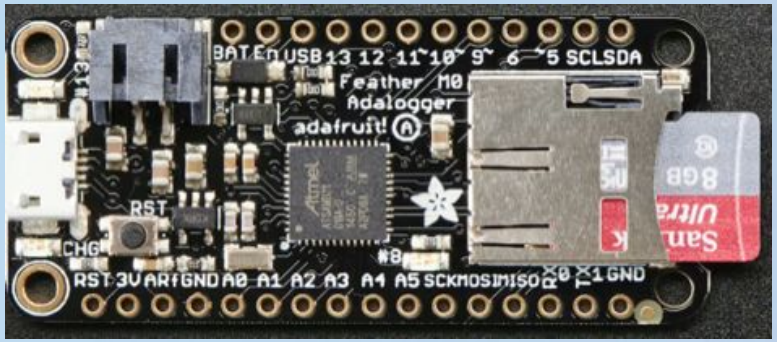

Solenoid


DC motor with gearbox


Submersible pump

Data Capture

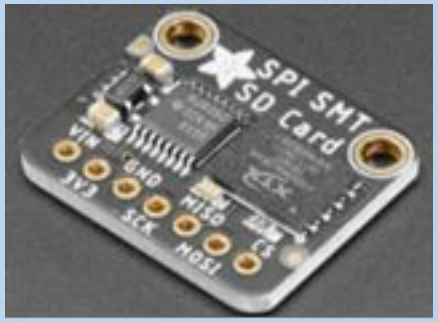
Do you need to record sensor data in your experiment? Like recording temperature and pressure data or saving GPS coordinates or camera images? Explore the data capture components on the worksheet like data loggers, microSD cards, and more.



Adafruit Feather M0 Adalogger

Data Logger

MicroSD Breakout Board



Adafruit SPI Flash SD Card - XTSD 512 MB

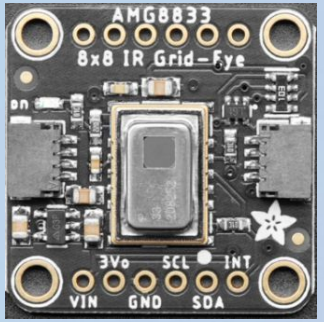
Imaging & Cameras

The stratosphere has quite a view! What kind of cameras should be onboard your experiment? Cameras like the dash cam and mini spy cam can take images of your experiment or pictures of the ground below. But, you can use other cameras to see the invisible world around your experiment, like infrared thermal imaging cameras. Check out the worksheet to explore possible cameras.


Dash Cam

Adafruit IR Thermal Camera Breakout


Mini Spy Camera



IR Thermal Camera Breakout

Environmental Sensors

Sensors are small but mighty devices that gather data and can tell you about the surrounding environment during flight. If your experiment aims to understand more about air quality, temperature, humidity, aerosols, greenhouse gases, or other environmental factors, you should browse these sensors on the explore components worksheet.

Low Concentration Ozone Gas Sensor

Air Quality VOC and CO2 Sensor

Methane Sensor

Temperature, Humidity, Pressure and Gas Sensor

Air Quality Breakout Sensor

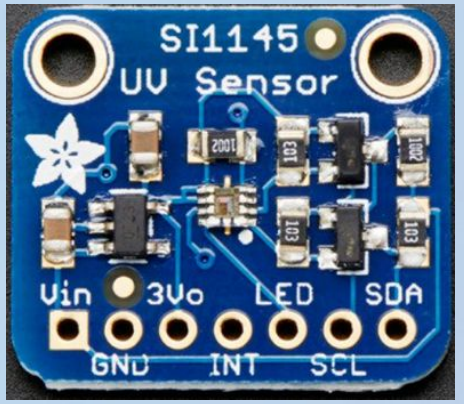
Precision Barometric Pressure and Altimeter

Particulate Matter Sensor

Light Sensors

Does your experiment need to measure light? Different intensities of light? Different wavelengths of light? Check out the light sensors section of the worksheet to explore which ones may be useful for your experiment.

UV Sensor



UV Sensor

Light Sensor

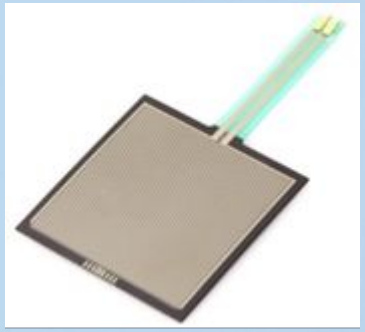
Light Spectrum Analyzer

Proximity, Light, RGB, and Gesture Sensor

Motion and Force Sensors

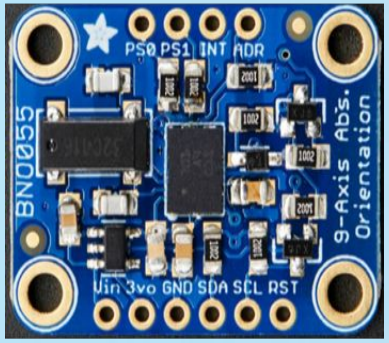
TechRise experiments will be on the move while traveling on the balloon. And, depending on your design, so could parts of your experiment, too! Look at the components worksheet to explore sensors that detect and measure force, motion, and vibration.

Ultrasonic Distance Sensor

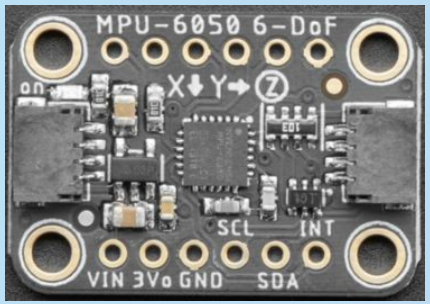


Force Sensitive Sensor

Strain Gauge

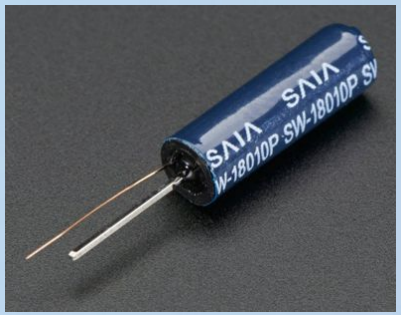


IMU

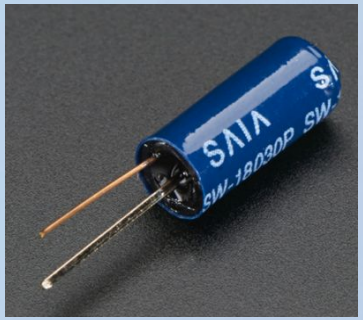


Gyro & Acceleration Sensor

IR Beam Break Set



Fast Vibration Sensor



Slow Vibration Sensor

Radiation and Magnetism

Understanding radiation is important to human health, particularly at high altitudes or in space. If your experiment aims to investigate radiation or magnetism, check out the worksheet to find a sensor that will work for your design.

Geiger Counter

Geiger Counter
Radiation Sensor Kit

Magnetometer

Pocket Geiger
Radiation Sensor

Accelerometer Magnetometer

Water Sensors

Water is vital not only for our planet, but it's essential for space exploration too. If your experiment involves measuring water flow, pH, saturation, or ANYTHING related to water or liquids, you should explore water sensors for your design on the component worksheet.

Water Flow Rate Sensor

pH Sensor

Water Sensor

Soil Moisture Sensor

Total Dissolved Solids Sensor

YOU CHOOSE!

You are NOT required to use the components in the worksheet.

It is merely provided as a starting point. You may propose to use any components that your team needs to bring your experiment idea to life!

Explore Components Design Activity

Now it's time to design your experiment and develop the "HOW" for your proposal!

With your team, use the Explore Components Design Worksheet to explore a list of possible components for your experiment and then create a sketch of your experiment design for the proposal.

Explore Components Design Activity Worksheet

Explore Components Design Worksheet: High-Altitude Balloons

Pick one NASA TechRise experiment idea and plan out a design for it.

Explore Components Design Activity Procedure

1. Now that you've brainstormed experiment ideas and understand the electrical components needed to build an experiment, choose one idea for your group, and plan the experiment's design.
2. Review the hardware component menu (below) and use the following questions as a guide to plan your experiment.

Choose one person in your group to record the answers to the following questions.

1. What is your experiment idea?
2. What data do you want to collect from your experiment?
3. How will you capture data? What will this data tell you?
4. What main components/hardware will you need to build your experiment? Use the hardware component menu below to help plan out the design for your experiment. Keep in mind you are welcome to use other components that you know of in the design and are not limited to only ones that you see in the list.
5. Sketch a drawing or diagram of your experiment plan (optional).

Share Your Ideas With Your Class