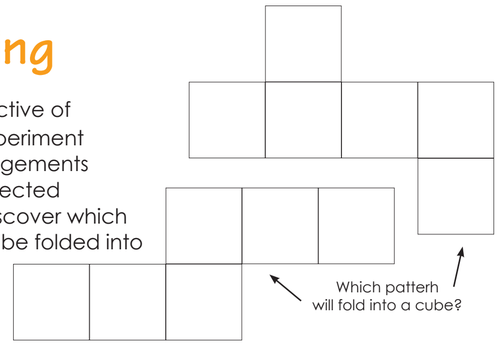
IPRO 330

Raise interest for math

- every child, every school

Cube Folding



OBJECTIVE: The objective of this project is to experiment with different arrangements of six squares connected together and to discover which arrangements can be folded into a cube and which arrangements cannot.

CONCEPT: The underlying goal is to have the kids discover the types of symmetry present in this system, like rotational symmetry and reflection symmetry, and to use the properties of symmetry to explain why certain patterns work and others do not without having to physically fold the squares. As such, this is almost purely mathematical in nature.

DIFFICULTY: ★☆☆☆☆
This is a fun and easy to do project that can be expanded to be more difficult by trying the same approach with shapes that have more sides than a cube.

PROCEDURE: Make up a few different arrangements of cubes, like the ones at this table, and try folding them into a cube shape. Try to make both shapes that will make a cube and shapes that will not, and then attempt to propose rules that will tell what kinds of other arrangements will or will not work based on your observations of the arrangements you tested.

ANALYSIS: Use the rules you have created from testing a few arrangements and apply them to all the other possible arrangements. Use the concepts of various types of symmetry to explain why certain arrangements can be considered together as the same sort of arrangement, which will vastly cut down on the total number of arrangements that need to be considered.

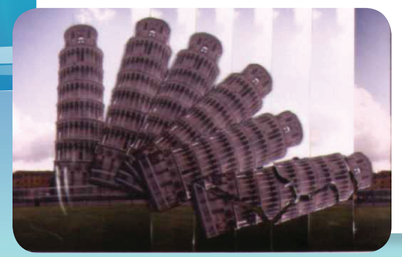
Tower of Pisa

OBJECTIVE: To demonstrate center of mass location on a stable equilibrium, and to determine how this affects whether an object remains standing or falls over.

CONCEPT: This is a physics project which stresses the concept of every object having a center of mass, that is, that every object can be treated as a singular point that acts as if it contained the entire mass of the object. Using this knowledge, the student can determine at what angle a tower of their construction will finally topple over by using this center of mass concept, along with a little experimentation.

DIFFICULTY: ★★☆☆☆ Constructing a suitable tower and precisely testing angles is somewhat difficult, but really just requires diligence in the setup of the experiment.

PROCEDURE: Build a tower on a level base (bonus points for making a scale model of the Leaning tower of Pisa) and then add more and more weight to one side of the tower by gluing something like cardboard to the side. Each time, check the angle of the leaning tower relative to the ground and record it in a table.



ANALYSIS: Using the recorded table of added weight versus tilt, make a graph with added weight as the horizontal axis and angle of tilt as the vertical axis. At what point will the tower cease leaning and actually fall over? That is for you to find out!

M&Ms Packing

OBJECTIVE: To determine how efficient a structured system of putting M&Ms in a box compared to just randomly pouring the candy into the box.

CONCEPT: This project is fairly mathematical in nature, and the main concepts involved are the arrangement of objects in a lattice versus the random arrangement that comes from random filling.

DIFFICULTY: ★★★☆☆
Understanding how the M&Ms will behave when randomly poured in and the geometry behind it means that this project is somewhat more difficult than the others listed on this board.

PROCEDURE: First determine the volume of a single M&M by seeing how much water it displaces in a measuring vial. Then fill a box with an ordered arrangement of M&Ms until you cannot fit any more in. After this, dump the box out but keep all the M&Ms separate from any others. Using these same M&Ms, start randomly pouring until you cannot fit anymore in the box, and note the difference in the number of M&Ms you could fit in randomly versus the number you fit in with the ordered arrangement.

ANALYSIS: Compare the two ways of filling the box with candy and determine why one is more efficient than the other. Using this knowledge, you can show that one way is better than the other, at least for M&Ms.

Coin Game

OBJECTIVE: To analyze a simple game and determine if it is fair for both players.

CONCEPT: " Unfair" games are games in which one player has an advantage over the other given a certain strategy. Students should attempt to determine if the game is unfair and if it is, what the winning strategy is.

DIFFICULTY: ★★☆☆☆
Easy to Hard depending on the student's math ability.

PROCEDURE: Play a couple games to get a feel for the dynamics. See if the number of coins or value of the coins affects who the winner is. Attempt to come up with a winning strategy. Develop a computer program to quickly run trials and determine if the strategy consistently works.

Balloons

OBJECTIVE - To determine the effect of a change in temperature on the shape of a balloon, and to explain why this occurs.

CONCEPT - Thermal Expansion is the name of the game here. The student will learn about how, as gases heat up, they expand, and as they cool they contract. This will cause a noticeable difference in the shape and" fullness feeling" of the balloon.

DIFFICULTY - ★☆☆☆☆
This one is simple, and seeing the results of the experiment is very neat indeed.

PROCEDURE - Fill up an even number of balloons, and measure them all, then leave half in the same room you inflated them in and put the other half in the freezer. After a short while, maybe a half hour to an hour, take out the balloons in the freezer and observe the differences from the balloons you left alone.

ANALYSIS - Using measured values of the circumferences of the balloons and the changes between the room temperature balloons and the frozen balloons, you can figure out the pressure changes as a function of the temperature changes.

MATH
PHYSICS
CHEMISTRY
BIOLOGY
AND MORE!

IPRO 330

Science Fair Extravaganza

Problem

- American students in middle schools and high schools regularly score **worse** than other nations on standardized tests.
- One instance of this is that students from Chicago Public Schools regularly struggle to complete science fair projects successfully.

Objectives

- Combat mathematical and scientific apathy among Chicago Public Schools (CPS) students.
- Provide students with the ideas and materials to excel in their science fair.
- Encourage students to enjoy math and science through science fair success.
- CPS students may also consider a future career in math or science.

How did it go?

- We split into three subteams focused on creating projects, improving presentation skills, and making a website.
- We obtained **feedback** from Chicago Public Schools officials to see that our ideas were appropriate.
  - Feedback was offered on the quality of the site, as well as its content
  - Some of the content was questioned ethically and practically
  - Changes have been made, and will continue to be made
- **Communication** was the key, both within our team and between our team and CPS:
  - Meetings outside of class, including a CPS chairs meeting during spring break.
  - Digital communication via the internet allowed transport of ideas.
  - Information was constantly updated on the team's website.

iGROUPS

Google Groups BETA

> "Mathematics is the Queen of the Sciences." - Carl Friedrich Gauss

Who are we?

- We are a group of students of math and different engineering disciplines
- We are committed to make a difference in how high school students perceive math through science fair projects.

PROJECT TEAM
Shayne Hill (AMATH)
Jane Chaonan Ji (AMATH)
Kajetan Sikorski (AMATH)
Kevin Yokley (AMATH)

PRESENTATION TEAM
Thomas Holt (CAE)
Chad Meyer (PHYSICS)
Anthony Parrillo (AMATH)
Pradeep Shenoy (ECE)

WEBSITE TEAM
Jonathan Beagley (AMATH)
Brian Dunne (ECE)
Michael McCourt (AMATH)

FACULTY ADVISORS
Prof. Gregory Fasshauer (AMATH)
Prof. Michael Pelsmajer (AMATH)

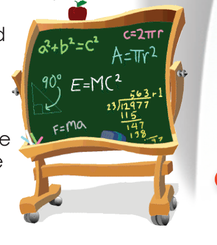
http://www.iit.edu/~ipro330s07/

OUR WEBSITE - an invaluable resource for completing a science fair project.

PROJECT TEAM

math & science fair projects bank

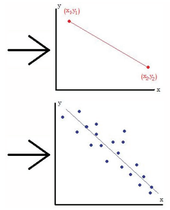
- **GOAL**
  Write up creative and detailed project ideas including: objectives, concepts, procedure, materials, analysis, pictures, etc.
- Determine an appropriate definition of a math-centric project.
- **ORGANIZATION**
  Every member in the IPRO team contributed to project ideas, independently or through group brainstorming.
- The project subteam organized itself in an efficient "parallel" arrangement, each member works project ideas into a detailed project individually.
- A detailed project is then reviewed before its release to assure accuracy and consistency.
- **RESULTS**
  The project team came up with about a dozen different, math-centric projects in about eight weeks.
- Projects cover different fields of science and range from easy problems that an average freshman student could handle, to challenging problems that involve more advanced mathematics knowledge, but still fully manageable with our hints and tutorials!
- Each of the projects was completed by the team to produce pictures and ensure feasible results.



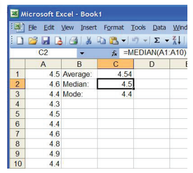
PRESENTATION TEAM

guides, tips, and techniques

- **DATA ANALYSIS**
  We have developed a comprehensive introduction to Excel for students who have had little or no exposure to this powerful software. Included are a number of guides to doing the basic things that most science fair projects will need.



- We have provided an introduction to the statistics that are important in a science fair experiment. Not only do we include an introduction to the mathematics behind this important analysis too, we also give practical guides for how to implement them in a science fair context.



- Included among these is a step-by-step guide for computing the best fit line of a set of data. This is an extremely important bit of knowledge for science fair projects, as a quantitative analysis is important.
- **SCIENTIFIC WRITING**
  The research paper is an important aspect of every science fair project. We have therefore developed a set of guides to help guide a student in preparing a research paper.
- We discuss how to find, evaluate, and cite quality sources for the research portion of their paper. With the nearly unlimited supply of sources on the internet, we found it important to help students decide what was good and useful for their paper.
- We provide a guide for all sections of the final report. Each part is designed to help the student better understand their project, and the scientific method they followed.

WEBSITE TEAM

making it available to everyone, everywhere

- Charged with creating an aesthetically pleasing website to display the information from the other teams so the CPS students are interested in the science fair.

- **PRESENTATION**
  The display board is the first thing that a judge would see in a science fair project. In this vein, we include guides for making a quality display board to present the experiment to judges.
- The placement and look of the main title will catch the eye of someone possibly interested in the project.
- The overall layout of the display board is important, because it summarizes your research, and helps someone see, quickly, what it is you did, and concluded.
- We even discuss aesthetics, because a poorly made board can be quite distracting to a judge, and can detract from an otherwise well done project.
- A comprehensive video guide on how to present your project verbally is also included. The way you should dress is discussed, as well as the sorts of things you should say to a judge.

EXPERIMENT
ANALYSIS
PRESENTATION

Achievements

- We created newer, more interesting and math-focused projects for high school students throughout Chicago Public Schools.
- We developed some presentation techniques ranging from presenting the data that the student found to presenting their findings orally to presenting their findings in written form on the board and in the form of a research paper.
- We also created a website that not only portrays all the work that we accomplished over the semester, but also contains invaluable resources for students working on their science fair projects.
- Our IPRO now has contacts with CPS teachers and administrators which will prove valuable in coming semesters.

Future goals

- This IPRO will be continued next semester with another group of students, and some current members of the team will continue to participate actively.
- Future members of IPRO 330 will expand and improve on already posted projects and presentation guides, as well as add projects of their own.
- The website will also need to be expanded and improved upon with increased content, and more interactive programs, based on further research and feedback from current Chicago Public Schools students and teachers.