Planning a science project

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Based on IRIS handbook and presentation, by Narayan Iyer, IRIS SRC

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What is “research-based”?

Usually

- We don’t know the answer before starting out…..
- Formulate hypotheses, make observations/ do experiments to test our hypotheses.
- No fixed end-point, can modify path of depending on what is done, and upon making interesting observations
- Novelty (i.e. not done before, not patented etc) is essential!

Engineering projects

May be prototype or implementation of known concepts

Select your topic

- Choose a topic that interests you - you'll have a lot more fun (and probably learn more)
- Check all the resources around you.
  - For eg. - If you are doing a project on Eucalyptus leaves, ensure that you have the Eucalyptus tree in the surrounding region where you live
- Literature survey helps define questions
  - Books
  - Wikipedia
  - www.scholar.google.com, www.scirus.com or www.pubmed.gov

Hypothesis and rough plan

- Hypothesis: a tentative theory that can be proved or disproved through further investigation and analysis.
  - Usually one hypothesis for each question you have.
  - You must do at least one experiment to test each hypothesis.

- Plan should include
  - The purpose of your experiment
  - The variable or the things that you are going to change during the experiment
  - Parameters which remain constant during the experiment
  - Positive and negative controls
  - Number of replicates, kind of analysis
  - Timetable

Data analysis and interpretation

- Carry out experiment and record data
  - Raw data in ink
  - There is no ‘wrong’ answer
  - Record observations that are not ‘planned’ (i.e. power outage, accidental jolt to table etc)
- Carry out planned data analysis
- Discuss data, analysis and conclusions
- Follow-up experiments if necessary
- Cost feasibility if relevant
- Report writing

How do I start?

- Choose a topic that will interests & challenge you
- Don’t be afraid to try something new – you will learn a lot in your journey
- Idea need not be complicated – simple idea succeeds
- Do background research – makes you realise the vast amount of research work undertaken
- Data suggests that good Mentoring by Teacher/Parent/Guide lead to higher quality
- If teachers see a potential in any student they can “assign” the students
- Problems are Opportunity

*Some contents taken from sciencebuddies.com

Common tips

Helpful hints

- Use available resources fully – *anyone* can be a guide
- Maintain a log book – record of the thought process, and original data is a must!
- Starting off with a hypothesis and proving it is incorrect is also good science
- Control experiments are often forgotten
- Appropriate measurements
- Solid conclusions – repeatability, practicality, knowledge of limitations of data

2009 winners

- Botany
  - Investigation Of Anti – Microbial Properties Of Ervatamia coronaria Flowers
  - Investigations On Growth Stimulating Activity Of Datura stramonium & Embelia ribes In Crop Plants
- Chemistry
  - Approach For Carbonaceous Nano Material Synthesis From Soil Sources And It's Application
- Maths
  - An Improved Tool For 'n‘-Secting an Angle
- Physics
  - A Study on the Reflection Of Electromagnetic Waves From two Reflection Type Diffraction Gratings
- Team-Engineering
  - Climbing chair
  - Design Of A Low - Cost Single - Shot Hypodermic Syringe
- Team- Environmental Sci
  - Eco Friendly Particle Board Made From Agricultural Waste Using Natural Binder Derived From Spoiled Garlic

Some other finalists/ awardees

- Physics-08 Squeezing The Cotton Cloth : Drying Faster Or Does it Harm the Cloth?
- Physics-03 (Team) (Jr) The Best Oil For Lamp
- Engg-10 (Jr) Mechanical Water Level Controller System

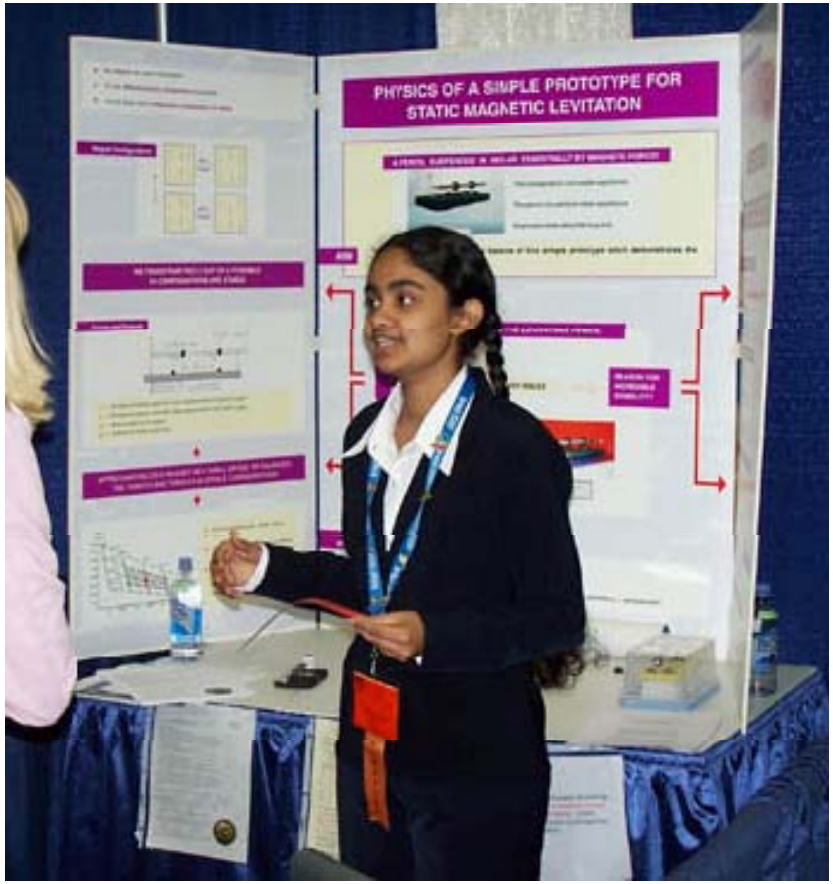
Example 1 : Simplicity

- A winning project does not always require expensive equipment, or a fancy laboratory to work in!

  ISEF 2006: Physics Grand Awards 2nd Prize winning project of Hamsa Padmanabhan

Simple projects: levitating pencil

- What did Hamsa do?
  - Exquisitely detailed analysis of the physics of a simple arrangement of magnets on a pencil, demonstrating the basics of static magnetic levitation
  - All the “experiment” needed was a pencil, some ring magnets, thermocole etc., (but it was followed up with some very rigorous mathematical analysis!)



Example 2 : Engineering Innovation

- Innovative Engineering Design – must work out all the nitty-gritty details and have final working product

  ISEF 2006: Engineering Grand Award winning project of Apurv Mishra

Innovative Engineering Design

- Apurv Mishra, ISEF 2006
- Designed a sensitive device to pick up small movements of the muscles above the eyebrow
- This enables patients who cannot speak, or do not have limbs to communicate
- Made a variation that would enable them to use a computer mouse!
- “Engineering” – not just science – actual prototype fabricated and tested on patients

Specific issues for engineering-type projects

- ENGINEERING design – why this length, why this voltage, why this particular chip used…
- Rigorous testing under field conditions – feasible/practical
- Thorough checking of alternative solutions, prior work
- Cost?

Example 3 : Traditional Knowledge

- “Ancient wisdom” re-analysed
- Traditional Indian medicine (Ayurveda) or cultural references to a lot of natural remedies, procedures etc. which have not been analyzed using a modern “scientific method”

- ISEF projects:
  - Custard apple seed/leaves
  - Coconut flower extract
  - Spices
  - Kusha grass
  - Papaya leaf

Termite resistant grass mats

- Vaishnavi Vishwanathan, ISEF 2007
  - Detailed analysis of termicidal properties of “kusha” grass (desmostachia bipinnata)
  - Analysis of various extraction techniques, attempts at identifying active component, control experiments

Specific issues for TK projects

For “traditional knowledge” projects

- thorough checking of prior work – recently lots of work thanks to new patent regimes
  - Many plants etc. studied comprehensively
- Why does it work? – often a synergistic combination of many factors, isolation of single ingredient can be close to impossible
- Comparison with “alternative” (incl. cost)
- Access to labs – beyond a point, need sophisticated standardized equipment
- Statistics

Example 4 : Local Relevance

- “Appropriate Technology” – typically low-cost solutions using easily available resources to solve local problems
- Might appear “crude” or elementary but these projects are often the most useful ones
- ISEF projects:
  - Foot operated 2-wheeler
  - Artificial limbs
  - Modified wheelchairs
  - Currency identifier

Modified wheelchair

- Mukund Tiwari, ISEF 2006
  - Modified a wheelchair to provide forelimb exercise for cerebral palsy patients
  - A cost effective solution that filled a need in his local environment
  - Used available contacts effectively

Problems that Intel folks see…

- Abstract – Lot of pages; sometimes the message is lost – Express your idea in 250 words
- Not enough data provided, it is not clear if it is a mere idea or some work has been done
- Not enough novelty – bring out your novelty upfront
- Copied material – judges hate it! & reject immediately
- If you have a prototype done – say a working prototype done!
- State your specific reference – don't hide! Don't say referred google or yahoo – state the exact internet site URL
- If you don't have complete data points – don't make any conclusion – state that it is in progress

Resources

- www.ScienceBuddies.org*
- www.ScienceClub.org
- http://www.societyforscience.org/isef/
- YouTube – search for science project videos

*Has Topic selection wizard for project selection

Judging rules

- **POTENTIAL MAXIMUM SCORE CHART**

	Individual	**Team**
1. Creative Ability	30 points	25 points
2a.Scientific Thought /		
2b.Engineering Goals	30 points	25 points
3. Thoroughness	15 points	12 points
4. Skill	15 points	12 points
5. Clarity	10 points	10 points
6. Teamwork	——	16 points
Total Possible Score	100 points	100 points

What is IRIS?

- A National Science & Engineering Fair for school students that focuses on “Research Based” projects
- Std 5^{th} – 8^{th} classified as category I
- Std 9^{th} to 12^{th} classified as category II
- Jointly conducted by Intel, CII, DST
- Affiliated to ISEF International Fair

When does it happen?

- It happens yearly during the month of December
- City is chosen by consensus – This time it is in Kolkata (Dec 4th to 6th) – Dec 5th - Public Viewing
- Abstracts are generally due by August 31

How it works?

- IRIS Scientific Review Committee meets on a need basis
- Shortlists the abstracts (pre-screening)
- Students get accept letters
- Students participate in the National Fair
- Judging of projects (Judged from various scientific community - local and out station) followed by deliberation
- Category wise winners and special awards announced
- Out of the selected National winners 6 projects go to ISEF international fair (4 individuals and two team projects)
- Coaching camp for ISEF projects

Subject Categories…

- Subject categories for submission of entries
  - Animal Science/Zoology, Plant Science/Botany, Biochemistry
  - Environmental Science
    - *Example:* Hydroponic Phytofiltration of Arsenic in Drinking Water
  - Physics/Astronomy/Earth Sciences,
  - Chemistry,
    - *Example:*Can lettuce seeds be used as a bioassay for testing toxicity?
  - Mathematics
  - Engineering,
  - Computer Science
    - *Example:* Signature Recognition
  - Behavioral and social science
    - *Example:* The Effects of Colour on Memorization Tasks.•

From examples, it seems that topics are quite loosely defined

India’s Performance at ISEF

Year	Awards (G+S)	Total
2008	4+4	8
2007	2+5	7
2006	4+3	7
2005	1+2	3
2004	7+2	9
2003	4+0	4

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Judging criteria – Creative ability

- **I. Creative Ability (Individual – 30 , Team - 25)**
  - The approach to solving the problem? The analysis of the data? The interpretation of the data?
  - The use of equipment? The construction or design of new equipment?
  - When evaluating projects , it is important to distinguish between gadgeteering and ingenuity.

Judging criteria – Scientific Thought

- **II a. Scientific Thought (Individual - 30 , Team - 25)**
  - Is the problem stated clearly and unambiguously?
  - Was the problem sufficiently limited to allow plausible approach?
  - Was there a procedural plan for obtaining a solution?
  - Are the variables clearly recognized and defined?
  - If controls were necessary , did the student recognize their need and were they correctly used?
  - Are there adequate data to support the conclusions?
  - Does the finalist or team recognize the data's limitations?
  - Does the finalist/team understand the project's ties to related research?
  - Does the finalist/team have an idea of what further research is warranted?
  - Did the finalist/team cite scientific literature , or only popular literature (i.e. , local newspapers Reader's Digest).
- **II b. Engineering Goals (Individual - 30 , Team -25)**
  If it is an scientific literature , or only popular literature (i.e. , local newspapers Reader's Digest).
  - Does the project have a clear objective?
  - Is the objective relevant to the potential user's needs?
  - Is the solution workable? Acceptable to the potential user? Economically feasible?
  - Could the solution be utilized successfully in design or construction of an end product?
  - Is the solution a significant improvement over previous alternatives?
  - Has the solution been tested for performance under the conditions of use?

Judging criteria - Thoroughness

- **III. Thoroughness (Individual - 15 , Team - 12)**
  Was the purpose carried out to completion within the scope of the original intent?
- How completely was the problem covered?
- Are the conclusions based on a single experiment or replication?
- How complete are the project notes?
- Is the finalist/team aware of other approaches or theories?
- How much time did the finalist or team spend on the project?
- Is the finalist/team familiar with scientific literature in the studied field?

Judging criteria - Skill

- **IV. Skill (Individual - 15 , Team - 12)** Does the finalist/team have the required laboratory , computation , observational and design skills to obtain supporting data?
- Where was the project performed? (i.e. , home , school laboratory , university laboratory) Did the student or team receive assistance from parents , teachers , scientists or engineers?
- Was the project completed under adult supervision , or did the student/team work largely alone?
- Where did the equipment come from? Was it built independently by the finalist or team? Was it obtained on loan? Was it part of a laboratory where the finalist or team worked?

Judging criteria - Clarity

- **Clarity (Individual - 10 , Team - 10)** How clearly does the finalist discuss his/her project and explain the purpose , procedure , and conclusions? Watch out for memorized speeches that reflect little understanding of principles.
- Does the written material reflect the finalist's or team understands of the research?
- Are the important phases of the project presented in an orderly manner?
- How clearly is the data and results presented?
- How well does the project display explain the project?
- Was the presentation done in a forthright manner , without tricks or gadgets?
- Did the finalist/team perform all the project work , or did someone help?

Judging criteria - teamwork

- **VI. Teamwork (Team Projects only - 16)** Are the tasks and contributions of each team member clearly outlined?
- Was each team member fully involved with the project , and is each member familiar with all aspects?
- Does the final work reflect the coordinated efforts of all team members?