The Rocket Project

Multiple Intelligences versus Project-Based Approach

Students are challenged with the question, "Does changing the number of fins on a rocket affect the maximum altitude it can attain?" Students construct and launch rockets, collect and analyze data, and develop an ad campaign to market the rockets. This lesson integrates digital editing software and TI-83 calculators. Learning strategies include problem-based projects and multiple intelligences.

Multiple Intelligence Approach

I like to use this approach if I have poorly motivated students, because it often provides a "hook" to get a kid interested in a topic. A student who hates math but is great with poetry loves the fact that he can use his love of language in a science project. The kid who struggles with writing and math but is great with her hands can be successful in building and flying the rockets, and be part of a team that actually investigates and solves a problem.

Students who are not planning to be science majors don't always need to learn every aspect of a topic. As long as they learn core concepts and can demonstrate high order thought, they should be rewarded. The multiple intelligences (MI) approach enables kids to do just that.

One drawback of this approach is that not all students do each task. During this project, some students may not learn to digitize video, or run a "t" test on data, or us the SpaceCad program. If the goal of the instructor is to have the students learn to do all of these skills, then the Project Approach should be used.

Student Page for the Rocket Project

In our discussions about rockets, you have learned that the fins are used to stabilize the rocket and keep it on course. But adding fins also increases drag on the rocket.

Is it better to have more fins and better stability in the rocket, or should you have fewer fins with less drag? That is the question that you need to explore.

Using the Viking Rockets given to you by the instructor, you need to determine the following:

> Does increasing the number of fins cause a significant change in the altitude a rocket can attain?

The class needs to divide into two groups of 12 students each. Each group is responsible for finding the answer to the above question and using that answer to develop an ad campaign to sell rockets to a fictitious company.

Each group will be responsible for building and flying the rockets, statistically analyzing the results, and developing a commercial for selling the rockets, including digital video, graphs and charts, and music.

Project Details

Your group needs to divide up into six groups of two students. Each group should do one of the projects below. Try to divide yourselves up so that each student can work on the aspect of the project that he or she would enjoy. Remember, you can't always get your first choice, so try to stay flexible!

Group 1 - Flight Team

This team is in charge of building and flying the model rockets. The team will construct rockets with different numbers of fins, keeping all other conditions the same. The team will also be in charge of helping to launch and recover rockets during the collection of data.

Group 2 - Flight Analysis Team

This team measures the height attained by the rockets using the altiscopes and trigonometry. Once data is obtained, this team will run statistical analysis on the flight data, attempting to see if there is a significant change in altitude due to changing the number of fins. This information should be gathered and then placed in a Word document, which should clearly show the answer to the project question in both words and graphical format.

Group 3 - Design/Prediction Team

This team will use the SpaceCad software program to predict the height of rockets and demonstrate drag possibilities. The team will also use the digital cameras to document the building and flying of the model rockets.

Group 4 - Commercial Development Team

This team will use Video Wave III to produce a digital video commercial (approximately one minute long). This commercial will attempt to persuade a fictitious rocket company to buy a particular type of rocket, based on the data and graphs collected and produced by other members of the team. The commercial must use digital video, still pictures, moving text, and music clips.

Group 5 - Music Team

This team will write a rap or song to be used in the commercial and then record it. This team is also responsible for obtaining and recording any other background music used in the commercial.

Group 6 - Public Relations Team

This team will be in charge of developing, administering, and analyzing a survey of students to determine its effectiveness.

Rubric for Rocket Projects

The following rubric will be used to evaluate your final project. You should use this as a guide during project development, so that all parts of the final project will relate to this rubric.

Components	Exemplary	Acceptable	Needs Improvement
Communication	Clear, insightful	Generally clear, logical	Unclear, poor idea progression
	Extensive use of topic-specific vocabulary	Appropriate topic-specific vocabulary	Lack of topic-specific vocabulary
	Few Errors	Some Errors	Many Errors
Research	Numerous appropriate resources	Adequate appropriate resources	Few or inappropriate resources
	Wide variety	Some variety	Lack of variety
	Reliability well-documented	Reliability somewhat well-documented	Reliability not documented
Problem Solving	Detailed description of problem	General description of problem	Vague description of problem
	Abundant evidence of Higher-Order Thinking Skills (HOTS)	Demonstrates HOTS (analysis, synthesis, prediction)	Little evidence of HOTS
	Draws insightful conclusions	Draws appropriate conclusions	Draws inappropriate conclusions
Presentation	Clearly focused, richly developed	Generally focused and developed	Lacks focus and coherence
	Creative, engaging	Engaging	Does not engage the audience
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Constructa-Vision

Teaching is a lot like building a house. Most of us generally know what we want the house to look like in the end, but we often need to sit down with several plans of finished houses in order to identify the specific house design we will want in the Finished Project.

Just like contractors, we need to have Blueprints drawn up that identify specifications for how to proceed.

Then the actual Site Work is done, which includes foundational work and temporary structures. And of course, during the course of construction, site inspectors check to see if the work is done correctly.

Check out the lesson to see how the Challenging Question unit to the right was put together using Constructa-Vision.

Challenging Question
Does changing the number of fins on a rocket affect the maximum altitude it can attain?

Time Frame
Single Block: 10-12 days
Double Block: 5-7 days

Finished Project

What will our science students "look like" after this unit? We hope they will be able to do the following:

1. Run a Students "t" Test on data sets to determine statistical significance of changing variables.
2. Build and fly model rockets.
3. Analyze flight trajectories and altitudes using trigonometry and calculate drag coefficients of rockets.
4. Properly use digital video editing to develop an ad to sell a product.
5. Identify audience "hot buttons" in order to communicate effectively in the development of ads.

How does this project relate to the Ohio Science Benchmarks?

Physical Science: Benchmarks 9-10

D. Explain the movement of objects by applying Newton's three laws of motion.

E. Demonstrate that energy can be considered to be either kinetic (motion) or potential (stored).

Science and Technology: Benchmarks 9-10

A. Explain the ways in which the processes of technological design respond to the needs of society.

B. Explain that science and technology are interdependent; each drives the other.

Science Inquiry: Benchmarks 9-10

A. Participate in and apply the processes of scientific investigation to create models and to design, conduct, evaluate and communicate the results of these investigations.

Scientific Ways of Knowing: Benchmarks 9-10

B. Explain how scientific inquiry is guided by knowledge, observations, ideas, and questions.

D. Recognize that scientific literacy is part of being a knowledgeable citizen.

Blueprints

Looking at a model home may help you choose the type of finished house you would like. But in order for the house to actually be built, the contractors must use a set of blueprints, which lay out the specific plans for the house.

In the same way, teachers planning a unit around a challenging question or problem need to lay out blueprints — specific plans for getting to their finished product!

Teachers need to define the Core Content or Concepts that students will be expected to master once the project is complete. What is it that you are trying to teach? Content-driven projects can be used to teach rigorous concepts in new and exciting ways. On the other hand, you should closely analyze a project that has no important underlying concept before doing it!

Teachers need to specifically define and design the Actual Project/Task itself. What is it specifically that the students be doing? How many days will the entire project take? What types of artifacts will be produced to show understanding? What resources will be needed?

Finally, what types of Learning Strategies will be used? Will students discover or construct principles during their project? Will cooperative or collaborative strategies be used? How will data be analyzed and displayed? Does research support these methods?

Core Concepts

A goal of a good teacher is to be sure that students learn core concepts — those practical concepts that will be important in the lives of all students. It is important for teachers planning lessons using technology not to forget that technology can be used to enhance content learning and make it more practical for everyday life.

Below is a list of basic objectives and content for this project.

By the end of this project, students should be able to do the following:

Content

1. Demonstrate the use of protractors and the tangent function to find height attained by rockets.
2. Discover statistical significance between data sets using the Students "t" Test.
3. Find ideal final velocities of model rockets and calculate drag coefficients based on actual testing of rockets.
4. Build and fly model rockets.

Thinking/Problem-Solving Skills

1. Analyze unknown data samples, looking for statistical significance of data.
2. Use drag coefficients to predict heights of rocket flights.
3. Identify target audience and write ads to communicate effectively with that audience.
4. Manipulate a variable and then see the effect on a dependent variable.

Technology Skills

1. Use digital editing software to develop ads marketing a product.
2. Use TI-83 graphing calculators to find statistically significant differences in data sets.

Actual Project/Task

Students will be divided into teams of three or four based on their choice or a multiple intelligences assessment test. They will do the following tasks based on their particular strengths:

1. Build rockets with different numbers or arrangement of fins, fly the rockets, and calculate their heights and final velocities. (Kinesthetic)
2. Compare each group of rockets using the Students "t" Test to determine if there is a statistically significant difference in the rocket altitudes. (Logical-Mathematical)
3. Graphically illustrate and present results of testing. (Spatial)
4. Develop an ad campaign to sell rockets to a company, using digital video editing as a medium. (Linguistic)
5. Compose songs or raps to use in the ad campaign. (Music)
6. Develop a student survey which investigates the appeal of the ads developed by the team. (Interpersonal)
7. Present ads to a panel of experts (marketing class or business class).

The principle task of the students is to vary the fins on model rocket, fly them, analyze the results, and use those results to develop an ad campaign, selling the rockets to a prospective company.

Learning Strategies

Good teachers make it a point to vary their strategies so that all students are able to learn effectively in their classes.

Below is a list of some of the strategies used in this project to help students learn.

Multiple Intelligences - The overall strategy for this project is to provide several types of activities in a common project that allows students with differing strengths to succeed. The project includes the following:

1. **Bodily/Kinesthetic** - Students will build and fly model rockets with varying numbers of fins.
2. **Logical/Mathematical** - Students will measure heights of rockets using tangent functions and then statistically analyze rockets for significant differences in flights.
3. **Spatial** - Use graphics program to analyze turbulence around rocket fins and graphically illustrate test results.
4. **Linguistic** - Develop an ad for sales campaign to sell rockets to a company.
5. **Musical** - Compose a song or rap for ad campaign to sell rockets.
6. **Interpersonal** - Develop and use survey with students to test ad appeal for campaign.

Site Work

Foundation

Most lessons have some basic skills that are required before you are able to begin. These are sometimes called "foundational" or "prerequisite" skills. As in the building of a house, ensuring an adequate foundation is very important in learning.

Scaffolding

You just can't build a structure without introducing some temporary structures — temporary roads, scaffolding, or false walls. In a similar way, most complex tasks in learning require some type of leading activities or temporary bridges that enable students to go from what they know to what they need to know.

Inspection

A house has several inspections along the way, as well as a final inspection after it is completed. Those initial inspections don't cause the whole project to stop &151; they ensure that each step is done correctly. If an electrical circuit fails inspection, the electrician is recalled and the problem is corrected. If the initial inspections are done well, the rigorous final inspection usually goes without a hitch. In fact, that is the goal!

Learning needs to involve "along the way" inspections (formative evaluations) that ensure correctness as well as a final (summative) evaluation that is rigorous, yet is one which students are well prepared.

Foundation

The following skills need to be in place in order for students to be successful on this project.

TI-83 Graphing Calculator and the Students "t" Test Function

1. Students should have some experience in graphing data sets using the TI-83 graphing calculators and storing data sets in lists.
2. Students should be able to from the TI-83 graphing calculator and paste them into documents using Graph Link software and hardware.

Math

1. Students should have a basic understanding of algebra and solving for an unknown in an equation.
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1. Students should be comfortable in an icon-based computer environment and be able to locate and open files.
2. Students should be comfortable using a browser and search engine to locate information on the Internet.
3. Students should be able to cut information from one document and paste into another.
4. Students should be able to graph data from a spreadsheet and change types of graphs.

Scaffolding

The following activities will prepare students for the Rocket commercial project:

1. **TI-83 Graphing Calculator/CBL (Calculator-Based Lab)** — Students will be given several sets of sample data on which they will run the Students "t" Test, looking for statistical differences in data at the .05, .01, and .001 levels of confidence.
2. **Video Editing** — Students will learn to use digital cameras to take stills and AVI/MPEG clips, which can be imported into a digital video editing program.
3. **Tangent Functions** — Students will use the tan function and protractors to find the height of a tree and a building.

If a dependent variable changes due to changing an independent invariable, how much of that change could be by chance alone?

Do your students know what "statistical significance" means?

Inspection

Have your students presented you with enough information and artifacts to prove they understand?

Formative (nongraded) Assessments

1. **Tangent Functions** — Students must find the height of a tree and a building using the tangent function and a protractor. This must be done before continuing on to fly the rockets.
2. **Correct Use of Technology** — Students must paste two screens from the TI-83 graphing calculator into a Word document, illustrating the "t" test results and data in list format.
3. **Prototype Construction** — Student rockets must pass inspections for fin, recovery systems and engine mounts before flight.
4. **Digital Video Editing** — Students working on video editing must periodically demonstrate us of movies, slides, moving text, and music background to the instructor.
5. **Ideal Velocity Calculations** — Students must calculate ideal velocity and approximate Gs of force for the rocket before actual flight and check math with instructor.

Summative Assessment

1. Each student will calculate drag coefficients based on an ideal velocities and actual calculated velocities and submit calculations to instructor.
2. Logical/Mathematical team will present Word document with statistical analysis answering project question, taken from TI-83.
3. Spatial team will present data from design program demonstrating turbulence around fins.
4. Musical/Linguistic team will present a video commercial that will attempt to sell a particular fin style to a prospective buyer of rockets.
5. Interpersonal team will survey students to determine commercial appeal.

#2-4 will be presented in class to several experts (teachers or parents) as one team presentation. Total presentation is to be evaluated using the technology rubric.

Rubric for Roject Projects

Components	Exemplary	Acceptable	Needs Improvement
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	Few Errors	Some Errors	Many Errors
Research	Numerous appropriate resources	Adequate appropriate resources	Few or inappropriate resources
	Wide variety	Some variety	Lack of variety
	Reliability well-documented	Reliability somewhat well-documented	Reliability not documented
Problem Solving	Detailed description of problem	General description of problem	Vague description of problem
	Abundant evidence of Higher-Order Thinking Skills (HOTS)	Demonstrates HOTS (analysis, synthesis, prediction)	Little evidence of HOTS
	Draws insightful conclusions	Draws appropriate conclusions	Draws inappropriate conclusions
Presentation	Clearly focused, richly developed	Generally focused and developed	Lacks focus and coherence
	Creative, engaging	Engaging	Does not engage the audience
	Abundant supporting evidence	Adequate supporting evidence	Little or no supporting evidence

Are you helping students by making sure they know the target you want them to hit?

Are you giving helpful feedback on how they are doing before you take grades?

Project-Based Approach

I use this approach when I want all students to learn all of the tasks involved in the project. If all students need to do statistical analysis of data, digitize video, and build and fly model rockets, then using this approach is desirable. Working in small groups of three forces each student to do all the activities while having the help of other students provides enough variety in learning styles that each group is able to adequately perform the tasks.

This approach is especially good near the end of a course as a check to see if students really have mastered techniques taught throughout the course. Rather than being a beginning learning experience, it can serve as a check of what has already been learned.

A drawback of this approach is that students may need more time to do this project. Because each group must perform all of the tasks, groups cannot work on different tasks at the same time. However, the teacher may not require as much detail or as exacting standards, which may help cut down on the time.

Student Page for the Rocket Project

In our discussions about rockets, you have learned that the fins are used to stabilize the rocket and keep it on course. But adding fins also increases drag on the rocket.

Is it better to have more fins and better stability in the rocket, or should you have fewer fins with less drag? That is the question that you need to explore.

Using the Viking Rockets given to you by the instructor, you need to determine the following:

> Does increasing the number of fins cause a significant change in the altitude a rocket can attain?

The class needs to divide into teams of three students. Each team is responsible for finding the answer to the above question and then using answer to develop an ad campaign to sell rockets to a fictitious company.

Each team will be responsible for building and flying the rockets, statistically analyzing the results, and developing a commercial for selling the rockets, including digital video, graphs and charts, and music.

Project Details

Each team needs to do ALL of the following tasks and then put together a presentation that is a compilation of these separate items. Check the Rubric for Rocket Project link for details on how your final project will be evaluated.

Phase 1 - Building/Flying Phase

Your team must build and fly model rockets. The team will need to construct rockets with different fin numbers, keeping all other conditions the same. You will launch and recover rockets, collecting altitude and velocity data during the flights.

Phase 2 - Design/Prediction

Your team will use the SpaceCad software program to predict the height of the rockets and demonstrate drag possibilities. You will also use the digital cameras to document the building and flying of the model rockets.

Phase 3 - Flight Analysis

Your team needs to measure the heights attained by the rockets using the altiscopes and trigonometry. Once data is obtained, your team will run statistical analysis on the flight data, attempting to see if there is a significant change in altitude due to changing the number of fins. This information should be gathered and then placed in a Word document, which should clearly show the answer to the project question in both words and graphical format.

Phase 4 - Commercial Development

During this phase, your team will use Video Wave III to produce a digital video commercial (approximately one minute long). This commercial will attempt to persuade a fictitious rocket company to buy a particular type of rocket, based on the data and graphs collected and produced during the first three phases of this project. The commercial must use digital video, still pictures, moving text, and music clips.

Phase 5 - Music

Your team will be expected to write a rap or song to be used in the commercial and then record it. You are also responsible for any other background music used in the commercial.

Phase 6 - Public Relations

In order to determine the effectiveness of your commercial, your team will need to develop, administer, and analyze a survey of students.

Rubric for Rocket Projects

The following rubric will be used to evaluate your final project. You should use this as a guide during all phases of project development, so that all parts of the final project will relate to this rubric.

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Challenging Question

Does changing the number of fins on a rocket affect the maximum altitude it can attain?

Time Frame

Single Block: 11-13 days

Double Block: 6-8 days

Finished Project

What will our science students "look like" after this unit? We hope they will be able to do the following:

1. Run a Students "t" Test on data sets to determine statistical significance of changing variables.
2. Build and fly model rockets.
3. Analyze flight trajectories and altitudes using trigonometry and calculate drag coefficients of rockets.
4. Properly use digital video editing to develop an ad to sell a product.
5. Identify audience "hot buttons" in order to communicate effectively in the development of ads.

How does this project relate to the Ohio Science Benchmarks?

Physical Science: Benchmarks 9-10

D. Explain the movement of objects by applying Newton's three laws of motion.

E. Demonstrate that energy can be considered to be either kinetic (motion) or potential (stored).

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A. Explain the ways in which the processes of technological design respond to the needs of society.

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2. Discover statistical significance between data sets using the Students "t" Test.
3. Find ideal final velocities of model rockets and calculate drag coefficients based on actual testing of rockets.
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Thinking/Problem-Solving Skills

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2. Use drag coefficients to predict heights of rocket flights.
3. Identify target audience and write ads to communicate effectively with that audience.
4. Manipulate a variable and then see the effect on a dependent variable.

Technology Skills

1. Use digital editing software to develop ads marketing a product.
2. Use TI-83 graphing calculators to find statistically significant differences in data sets.

Actual Project/Task

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	Extensive use of topic-specific vocabulary	Appropriate topic-specific vocabulary	Lack of topic-specific vocabulary
	Few Errors	Some Errors	Many Errors
Research	Numerous appropriate resources	Adequate appropriate resources	Few or inappropriate resources
	Wide variety	Some variety	Lack of variety
	Reliability well-documented	Reliability somewhat well-documented	Reliability not documented
Problem Solving	Detailed description of problem	General description of problem	Vague description of problem
	Abundant evidence of Higher-Order Thinking Skills (HOTS)	Demonstrates HOTS (analysis, synthesis, prediction)	Little evidence of HOTS
	Draws insightful conclusions	Draws appropriate conclusions	Draws inappropriate conclusions
Presentation	Clearly focused, richly developed	Generally focused and developed	Lacks focus and coherence
	Creative, engaging	Engaging	Does not engage the audience
	Abundant supporting evidence	Adequate supporting evidence	Little or no supporting evidence

Are you helping students by making sure they know the target you want them to hit?

Are you giving helpful feedback on how they are doing before you take grades?