

Developing a Research Team for the R&D Challenge

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Developing a Research Team for the R&D Challenge

Participating in the National Research and Design Challenge is an excellent way to introduce new students to robotics. As the coach of a robotics program I endeavor to get the Botball team members to enter the R&D Challenge each year. Most of the veteran members of the team are more interested in working on building and programming skills than writing research papers, so this year I came up with a plan to develop a research team specifically designed to participate in the R&D Challenge.

The research team consisted of other students at our school who worked on their own research papers for credit in their language arts or science classes. I made arrangements with several teachers at our site to allow the students to write a research paper on the R&D Challenge as part of their regular classroom assignments. This worked well in the 7th grade classes where research writing is one of the project standards. Several high school grades also have similar state standards on expository writing. The R&D Challenge also fits into many state science standards. In order to get the teachers to buy in to the idea, I wrote lesson plans for the project. The teachers could then just assign the project to students and hand out the plans as an independent student project. This middle school has a program where students can do independent work if they are proficient in the basic classroom standards for the subject area during a grading period.

How It Works

First I talked with the Botball team members in the fall and explained the idea. They were thrilled that they would be able to work with other students on the R&D Challenge. My students always seem interested in the R&D Challenge subject but not in doing all of the necessary research involved. Procrastination seems to be their motto and they always end up working feverishly the last few weeks before the challenge is due. My role is usually delegated to chastising them for waiting so long and threatening them with expulsion from the program.

The Research Team would write papers on the R&D Challenge subject and then turned copies into the Botball team. The Botball team members did some basic research on the R&D Challenge subject to get an overview and then they choose the top papers and worked with those students to develop the R&D Challenge website.

In order to get students to participate, the Botball team members wrote an invitation to the students to invite them to join the robotics program by participating in the R&D Challenge. (See Student Invitation , #1 in the Sample Documents) Any student participating would be part of the school Botball Team and could come to the regional tournament. Interested students would also be invited to become part of the design and programming teams if they were interested. The invitations were given to the language arts and science teachers who had agreed to be a part of the project. They distributed them to the appropriate students in their classes and set deadlines for the papers to be finished for the grading period.

The project work fairly well this year, but I plan to implement it sooner and get the teachers on board earlier. I plan to revise the lesson plans to fit other grade levels and curriculum areas. I hope that the Research Team will become an ongoing source of new students interested in the robotics program at our school. I want to implement it in the 5th and 6th grades to get younger students interested in becoming a part of the Botball program.

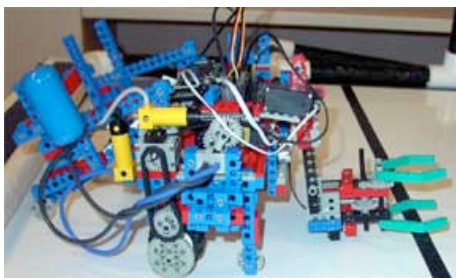
Sample Documents

1. Student Invitation

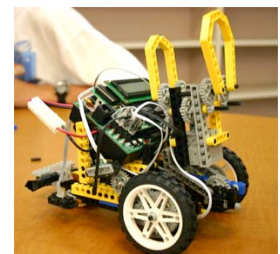
Students,

The JGMS Botball Robotics teams are participating in the National Research and Design Challenge sponsored by the KISS Institute for Practical Robotics. The project involves creating a website highlighting research on a robotics topic. This year's topic is Lunar Robots; specifically, the discovery of water on the lunar surface.

In order to complete the project, each Botball team is looking for students to become part of their research team. Groups of students will participate by doing an independent research project based on the national challenge. The two top projects will be chosen to represent the teams in the contest and work with the team members developing the website. Research team members will be invited to join the building team at the state and national tournaments. Also if you are interested you may want to join the design and programming teams next year.



Robotics is an exciting field of study and the project should be educational and fun for everyone involved.



The JGMS Botball Team

2. Lesson Plans - 2006 Research and Design Challenge

2.1 Student Assignment: (Students may work independently or in small groups)

Write a research paper and design a website.

Requirements:

Six pages of single spaced text; One inch margins; 12 point font (Times); Bibliography

2.2 The Challenge:

One possible mission to the lunar surface could involve a search for water/ice in the Aiken basin on the moon.

Student Assignments:

1. Describe the environment the robots will have to work in to accomplish this mission. Where in the basin would you look? (25% of points for challenge, about 2 pages)
2. Describe some of the key difference between the robots for this lunar mission and the MER (Spirit and Opportunity) robots that are currently exploring Mars. Why can't we use MER robots for this mission? (10%, 1 page or less)
3. Design a robot to try and find water in the Aiken Basin. (40%, at least 3 pages)
Describe the following:
 - a. What the robot will look like
 - b. How it will move
 - c. How it will navigate/be controlled
 - d. How it will be powered
 - e. How it will try and find water
 - f. Other items you think are important
4. Include a bibliography (10%, doesn't count in the 6 pages)

Webpage Design 15% The website should contain the six pages of typed text from your research paper plus the pictures and student drawings/diagrams. Include the bibliography in the website. If your references are to websites, you should include the URL. Other sources may also be used (e.g., books and journals) however a complete bibliographic citation for the source must be included in your bibliography. Hint: look at the bibliographies of your sources to find possible other sources as reference. http://www.botball.org/about_botball/research_design.html

2.3 BACKGROUND INFORMATION:

http://www.botball.org/about_botball/research_design.html

Since humankind first looked up and gazed upon the moon and stars we have wondered what might be out there. In the 1950's, NASA brought us one step closer to the wonders of space when

they sent the first men into orbit around the Earth. Then, in 1969, Neil Armstrong took another huge step for space exploration with the first moonwalk.

NASA has recently announced that change is on the horizon and that "NASA is plotting a new course into the cosmos. The Vision for Space Exploration calls for a return to the moon, followed by journeys of discovery to Mars and beyond."

http://www.nasa.gov/vision/space/features/apollo11_35th.html

This time, the astronauts will probably not be alone. "If NASA wants to build a Moon base or put human footprints on Mars, its astronauts are going to need a lot of help from robots."

http://www.nature.com/news/2004/040426/pf/428888a_pf.html

Prominent roboticists predict that robots in the future are going to need to be robust, focused on whole-system design, mission competent and represent a virtual presence for humans back on Earth. http://www.traclabs.com/~korten/publications/isairas_space_robotics.pdf

Development of autonomous navigation and robot collaboration will also be crucial to the success, or failure, of robots involved in lunar and planetary exploration. "The coming decades offer a rich, exciting landscape of opportunities for space exploration and discovery. Within this landscape, new and breakthrough technologies are being developed that will change the way we explore our solar system and beyond."

http://technology.jpl.nasa.gov/state_of_technology/

2.4 Procedure for Students:

1. Brainstorm questions for assignments #1 and #2. Come up with enough questions to fully answer the challenge. Remember to cover where, what, when, why and how.
2. Divide up questions for assignments #1 and #2 for research. Complete the research, write solutions for the questions, and present your findings to the group.
3. Work on assignment #3, the robot design. Do background research first.

Robot Design Questions:

What did the lunar rovers from the past look like? How did they work? Power? Navigation?
What was their mission on the moon? Were they robots?

How do the atmosphere, climate conditions, and gravity effect the operation on robots on the moon? What kinds of power supply would work on the moon?

What tasks will the lunar robots have to accomplish in order to find and collect water on the moon? How far will it have to travel to find the water? How will it extract the water? Where will it collect the water?

Brainstorm solutions for a-e. Everyone should develop their own robot design, draw pictures/diagrams, and write solutions for a-e.

2.5 Procedure for Teachers:

Large Class Group (30 to 40 students): Divide the class into groups of 4 students. Each group will complete the entire project. Each student is responsible for 1 1/2 pages of typed text.

Small Group (a Botball team, 4 to 10 students): Divide into 2 groups

1. Brainstorm questions for #1 and #2 (See sample questions in section 3.) Teacher can decide to show the sample questions to the students or let them come up with their own independently.)
2. Divide up questions for #1 and #2 between the students for research. Have students complete research, write solutions for questions, and present their findings to the group. (Teacher can decide whether to give the students the sample websites' page to get them started.)
3. Work on #3, the robot design. Have the students do background research and brainstorm solutions for a-e. (See questions for robot design) Have each student develop their own robot, draw pictures/diagrams and write solutions for a-e.

2.6 Research Record (See sample research record on the next page)

Use a word processor like Microsoft Word to keep a record of all of the internet sites that you visit. Just copy and paste the URL from the website into a document next to the question. Copy and paste the title of the article or site after the URL along with the name of the author if it is on the site. The URLs in a Word document will be active and you can click on them to return to the site when you need more information. You can use these in your bibliography also.

Tip: Be careful about using URLs that come from search engines like Google. Make sure that you are actually on the website and not still in the search engine. Don't use URLs in your bibliography that are just search engine data like

www.google.com/search?hl=en&q&er&ed+b3/en?=23+water+on+the+moon/%223pdf/

Type in specific information from the article that will help answer your assigned question.

Remember: *Use your own words. Don't copy and paste from the article.*

Also, copy and paste the images into your Research Record. Afterwards, double click on them, choose layout, square, and click OK. Now you can resize the image. Make it small and move it to the correct URL. (Word sometimes moves the picture to somewhere else in the document).

Include a description. **Tip:** You can insert a text box next to the image for the description.

Copy and paste the URL along with the picture if you don't already have it. This way you will know which website goes with each picture.

Create a folder on your computer for pictures to use in your printed project. Make sure to name it appropriately so you can find it later. Download the pictures (same ones you placed in your Research Record) into this folder from each website you visit. To get the highest resolution picture for printing, you should first left click on the picture to open it and then right click on the picture and choose 'Save Picture As'.

Sample Research Record:

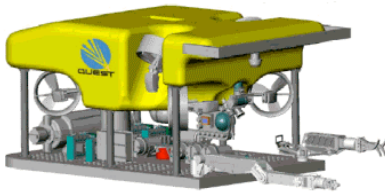
Subject: Aquatic Robotics

Question: What are some current undersea robots in use today?

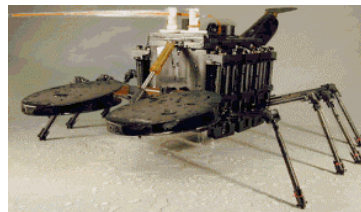
<http://www.leanaboutrobots.com/>

Undersea Robots, Rich Hooper

Using robots under the sea is useful because it is dangerous and difficult for humans to work there. Many companies make robotic systems for use in the ocean environment. Schilling Robotics makes a system that can do welding and maintenance. It has thrusters and two robotic arms that are remote controlled. The Northeastern University Marine Science Center develops biomimetic robots that act like invertebrate animals like a lobster. They even have autonomous behaviors like animals. Oberon is a robot designed by the Australian Centre for Field Robotics at the University of Sydney to explore the Great Barrier Reef using a color camera, two scanning sonars and a depth sensor.



Schilling Robotics'
undersea robot



Biomimetic robot that
imitates a lobster.



Oberon
Exploration robot

2.7 Organization of Paper

Organize the questions for each section. Title each section appropriately. Choose what to include.

Assemble the text into paragraphs. Write an introductory paragraph for the entire report, and one for each of the 3 sections. Write a concluding paragraph for the entire report. Assemble the text, (cut and paste) into one document.

Add appropriate pictures and diagrams. *Pictures should enhance the text.* Caption each picture. Use the picture files from your folder, not from the research record document. Resize the pictures to fit appropriately on the page.

The final document should now be more than 6 pages because it includes not only the text but also all of the pictures and diagrams.

2.8 Website Development

Teachers may have each independent student or group prepare a basic website as part of the project using the procedure below.

Website: Focus on content, not glitz.

Have each group present a summary of their findings focusing on their robot designs. This may be a short presentation, 2-3 minutes or longer depending on class size and time limitations.

Website Design:

Come up with an overall template for the page design.

Decide upon layout – scrolling page or individual linked pages.

Decide upon fonts, colors, background, etc.

Typed text should be standard fonts available to different computer systems.

Turn titles with unusual fonts into graphics and place as pictures on the website page.

Tip: Don't crowd the pages; leave some white space.

Brainstorm ideas for unique features to add to your site like animated gifs, videos, flash, etc. Original student creations are better than canned graphics/gifs downloaded from the internet.

Remember: *Give credit to anything that is not original student work.*

2.9 Possible Questions for Student Assignments

Assignment #1

What is the Aiken Basin? Where is it located? How big is the basin? What is the history behind it?

What are conditions on the moon like? Atmosphere? Gravity? Temperature?

Why do scientists think there might be water on the moon?

How can you determine if water is present?

What technology would be used to discover water? How does it work?

Why is the Aiken Basin a good place to look for water?

Why would scientists choose one section of the basin over another? Where would you look for water in the basin?

Assignment #2

What is the MER project? What is the history behind it?

What are the key features of Spirit and Opportunity? What do they look like? How big are they? How do they work? Power? Navigation?

What tools do the rovers have for exploring Mars?

What features of Spirit and Opportunity would not work on the moon?

What features would a lunar robot need that Spirit and Opportunity don't have?

3. Internet Research:

Use general keywords in large search engines like Google, and then more precise phrases within subject area websites. Example: Searching on the Internet Public Library for 'lunar robots' will turn up the Lunar and Planetary Institute. Searching on that site for 'water on the moon' will find several pdf articles about current research on finding water on the moon.

Try using quotes around your keywords.

When you find a website about your subject look for keywords that will extend your search. For example: a search for 'water on the moon' might lead to a site that mentions the name of a NASA mission to the moon. Run another search using that name as the keyword.

Look for the post dates on websites to see if the information is current.

Possible keywords for research: lunar robots, robots on the moon, earth's moon, water on the moon, lunar rovers, Apollo mission, Aiken basin.

Some sites that might help to find information on the internet.

<http://www.ipl.org> The Internet Public Library - Example search: Go to Science and Tech under Subject Collections; Astronomy; search for "robots on the moon"
Also, check out the newspapers and magazines sections for current information.

<http://dictionary.com> Encyclopedia, dictionary, thesaurus - Use general keywords.

Astronomy pictures:

<http://nix.ksc.nasa.gov/home> - NASA Image Exchange

<http://antwarp.gsfc.nasa.gov/apod/astropix.html> - Astronomy Picture of the Day

**The Botball team came up with some research to get the students started.
Some Websites that might help in your research:**

http://www.universetoday.com/am/publish/printer_water_on_moon.html

Is There Water on the Moon

<http://www.firstscience.com/site/articles/prospecting.asp>

Prospecting for Lunar Water

http://www.space.com/scienceastronomy/moon_ice_0301112.html

Water on the Moon? Scientists Await Definitive Answer

http://nssdc.gsfc.nasa.gov/planetary/ice/ice_moon.html

Ice on the Moon

<http://whyfiles.org/060moons/ourmoon.html>

Liquid Gold on the Moon

Sample Standards Addressed:

California State Standards for 7th Grade Language Arts

Reading: 2.0 Reading Comprehension (Focus on Informational Materials)

Students read and understand grade-level-appropriate material. They describe and connect the essential ideas, arguments, and perspectives of the text by using their knowledge of text structure, organization, and purpose.

Structural Features of Informational Materials

- 2.1 Understand and analyze the differences in structure and purpose between various categories of informational materials (e.g., textbooks, newspapers, instructional manuals, signs).
- 2.2 Locate information by using a variety of consumer, workplace, and public documents.
- 2.3 Analyze text that uses the cause-and-effect organizational pattern.

Comprehension and Analysis of Grade-Level-Appropriate Text

- 2.5 Understand and explain the use of a simple mechanical device by following technical directions.

Writing

1.0 Writing Strategies

Students write clear, coherent, and focused essays. The writing exhibits students' awareness of the audience and purpose. Essays contain formal introductions, supporting evidence, and conclusions. Students progress through the stages of the writing process as needed.

Organization and Focus

- 1.1 Create an organizational structure that balances all aspects of the composition and uses effective transitions between sentences to unify important ideas.
- 1.2 Support all statements and claims with anecdotes, descriptions, facts and statistics, and specific examples.
- 1.3 Use strategies of note taking, outlining, and summarizing to impose structure on composition drafts.

Research and Technology

- 1.4 Identify topics; ask and evaluate questions; and develop ideas leading to inquiry, investigation, and research.
- 1.5 Give credit for both quoted and paraphrased information in a bibliography by using a consistent and sanctioned format and methodology for citations.
- 1.6 Create documents by using word-processing skills and publishing programs; develop simple databases and spreadsheets to manage information and prepare reports.

Evaluation and Revision

1.7 Revise writing to improve organization and word choice after checking the logic of the ideas and the precision of the vocabulary.

2.0 Writing Applications (Genres and Their Characteristics)

Students write narrative, expository, persuasive, and descriptive texts of at least 500 to 700 words in each genre. The writing demonstrates a command of standard American English and the research, organizational, and drafting strategies outlined in Writing Standard 1.0.

2.3 Write research reports:

- a. Pose relevant and tightly drawn questions about the topic.
- b. Convey clear and accurate perspectives on the subject.
- c. Include evidence compiled through the formal research process (e.g., use of a card catalog, *Reader's Guide to Periodical Literature*, a computer catalog, magazines, newspapers, dictionaries).
- d. Document reference sources by means of footnotes and a bibliography.

2.5 Write summaries of reading materials:

- a. Include the main ideas and most significant details.
- b. Use the student's own words, except for quotations.
- c. Reflect underlying meaning, not just the superficial details.

Listening and Speaking 2.0 Speaking Applications (Genres and Their Characteristics)

Students deliver well-organized formal presentations employing traditional rhetorical strategies (e.g., narration, exposition, persuasion, description). Student speaking demonstrates a command of standard American English and the organizational and delivery strategies outlined in Listening and Speaking Standard 1.0.

2.2 Deliver oral summaries of articles and books:

- a. Include the main ideas of the event or article and the most significant details.
- b. Use the student's own words, except for material quoted from sources.
- c. Convey a comprehensive understanding of sources, not just superficial details.

2.3 Deliver research presentations:

- a. Pose relevant and concise questions about the topic.
- b. Convey clear and accurate perspectives on the subject.
- c. Include evidence generated through the formal research process (e.g., use of a card catalog, *Reader's Guide to Periodical Literature*, computer databases, magazines, newspapers, dictionaries).
- d. Cite reference sources appropriately.