

Best Practices of Technology Integration

Title: Lego Robot Competition:

A Competition Designed by High School Students
For
Middle School Students and 5th Graders

Submitted by:

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Subject Area: Science

Intended Grade Level:

9th through 12th graders design the Lego Dacta Competition for
Middle school technology and 5th Grade Enrichment Classes

Description:

Interested Harrison High School Science and Technology students form a club whose purpose is to design a “Lego Robot Competition” for the middle school technology classes and 5th grade enrichment classes. The competition uses the Lego Dacta Control System that is controlled through tethers by laptop computers.

The high school students and high school teacher visit all interested schools, (middle school and elementary), as an orientation to introduce the “Lego Robot Competition”, demonstrate the program and interface the laptops with the Lego robot. The High School team also creates the competition, organizes the media coverage, and conducts the day long competition.

This paper outlines for lead high school teacher(s) the steps involved in organizing from start to finish a “Lego Robot Competition”.

Narrative:

Educational Research shows that students learn best, remember longer, and are more involved in projects that have a greater value than just to be graded by a teacher. Part of the 5th grade enrichment and middle school technology curriculum in Farmington Public Schools involves the use of Lego Technic to teach about gears, gear ratios, belts, and motors. The competition is created in order to give the middle school students an

application of their learning and to increase interest in science and technology at an earlier age.

Currently, the competition is designed by volunteer 9th through 12th grade science and technology students. When the technology wing of our building is completed, the responsibility for the competition will be assumed as part of a newly established technology class. The middle school students are part of a technology class and spend time after school once a week to perfect their skills. The first year of the competition was a joint effort with TRW Automotive Firm as part of the F.I.R.S.T. Competition.

Farmington Public Schools has eight Student Learning Outcomes. They are collaborative team member, effective communicator, healthy individual, knowledgeable thinker, life-long learner, quality producer, responsible citizen, and thoughtful problem solver. The high school students who develop the “Lego Robot Competition” demonstrate proficiency in each of these outcomes.

One feature of the competition for the middle school students and 5th graders is that they do not know the task expected of them until they arrive the morning of the competition. They must problem solve, use prior knowledge, and apply their creative abilities throughout the day.

The excitement and energy generated by the students and teachers, both middle school and high school, during the process and especially on competition day, is phenomenal. It is hard to describe the intensity and fun experienced by the entire group as they learn new computer skills and apply classroom knowledge. The high school students love the role of mentor and are unbelievably nurturing and supportive to the younger students

Curriculum Benchmarks:

ML.SCI.I.1.HS.4 Diagnose possible reasons for failures of mechanical or electronic systems. (Key concepts: Documentation of systems, such as diagrams, owner manuals, trouble-shooting guides. Procedures for identifying malfunctioning components or connections. Real-world contexts: Mechanical systems, such as bicycles, small appliances; electronic systems, such as videocassette recorders, stereo systems, computers.)

ML.SCI.I.1.HS.5 Assemble mechanical or electronic systems using appropriate tools and instructions. (Key concepts: Documentation of systems, such as diagrams, owner manuals, assembly instructions. Tools: Screwdrivers, pliers, hammers. Real-world contexts: Mechanical systems, such as bicycles, prepackaged furniture; electronic systems, such as videocassette recorders, stereo systems, computers.)

ML.SCI.I.1.HS.9 Reconstruct previously learned knowledge. (Key concepts: Appropriate scientific contexts—See Using Scientific Knowledge. Real-world contexts: See Using Scientific Knowledge.)

Total Amount of Time for the Unit:

This project is viewed from two points: the middle school student preparation time and the high school student preparation time.

The high school science/technology club (called Robohawks) or technology class planning the competition needs three months, working only a few hours each month. The Robohawks organize the competition working at lunch and after school on an “as needed” basis

The time requirement this year was eight lunch meetings (30 minutes each), four after school meetings (one to two hours each), and the competition day (five hours). Students have various homework tasks to complete before the next meeting.

The middle school students work on the Lego Robot building project as part of a simple machines unit. They spend approximately one month of class time. Some teams work after school once a week during the open lab times in the technology shop.

Materials/Hardware/Software:

Each middle school team needs:

One laptop computer and extension cord with surge protection

One complete Lego Dacta Control System (970976) that contains a motor, sensors, Lego pieces, instruction books, computer interface, program disks, and connector cables.

National Geographic video “The Great Pyramid, Extraordinary Secrets of the Great Pyramid Unveiled” A&E Home Video, 1995 (cat. # AAE-12305)

The high school club or class needs:

One laptop per four people and extension cords with surge protection

One complete Lego Dacta Control System per four people

Wood, paint, cardboard, and other miscellaneous items to build a playing field (exact specifications are determined by the rules of the game)

White painter hats to be decorated with Lego parts (we want to look spiffy)

A bag of spare parts for each middle school team (it includes such things as tape, long sticks, cardboard, brads, rubber bands, spoons, spools, etc.

InFocus projector or LCD panel to view the scoring

Video cameras attached to TV monitors to facilitate spectator viewing

Large poster board and markers to grid the order of the play-off rounds

Certificates and prizes for the winners

A trophy (designed by high school students made of Lego pieces) with the winning team’s name and year engraved. (Modeled after the Stanley Cup Trophy concept)

Teacher Preparation:

The high school teacher or teacher team calls a lunch meeting for any interest Robohawks, using the morning announcements. The team is assembled in one or two thirty minute lunch periods. The teacher or teacher team spends two to four hours learning to program and build Lego Dacta. The Control system is expensive (approximately \$500 each). Most of our equipment was purchased with grant money.

Prerequisite Student Skills:

The high school students learn to build and program the Lego Dacta Control System Robots and teach the middle school/5th grade students to do the same. Students may use stand-alone computers for practice, but the competition uses only laptop

computers. The middle school/5th grade students are ready for the competition if they can build and program the four sample robots following the instructions that are supplied with the kit. The actual rules of the game are revealed on competition day.

Procedures:

Steps in organizing the competition are as follows. The first week of school check the district calendar and select a date for the competition. Reserve the cafeteria by filling out the maintenance forms. This year our competition was Saturday, December 5, 1998. Solicit other high school teachers to help.

The first year of the competition, the high school teacher calls and/or visits individually each interested middle school technology teacher and explains the competition. The personal touch is critical. Follow the visit and/or phone call by e-mail and inter school mail describing the competition in written form. Communication between the middle school teachers and the high school teacher/coordinator must be on going and timely.

In October, the high school technology class (or robot club) meets to plan the sequence of events. Students brainstorm the form of the competition. Two main committees form. One committee is responsible for the writing and publishing the rule book, designing and building the playing field, learning the Lego computer program, and building practice robots to play on the field. This group has mock competitions with each other in order to refine the rules and check the engineering of their playing field. This group also organizes and assembles a spare parts kit for each middle school team.

The other committee is more involved in public relations. They solicit food and other donations from the community for competition day. In addition, they also contact the news media, write press releases, practice using the video equipment to tape the event, learn to edit video, and designate a photographer. They decorate the cafeteria, make signs, set up and organize the competition arena, purchase prizes, prepare the trophy, print out certificates, decide on other types of awards, coordinate the “uniforms” of the high school students, and fund raise.

At some point during the three month time period, both high school and middle school science students view a National Geographic Video detailing the building of a small robot mini-cam (5” by 6” by 4” approximately). Its job was to travel up an eight inch square tunnel in the Great Pyramid. Students research uses of other small robots and share their information with the rest of the group. The National Geographic article, “Robot Revolution” (July 1997) is an excellent reference. The article includes cockroach biorobots! Medical robots are usually discovered on the web. Students need to know how their robot building skills may be used in the future.

The middle school/5th grade students submit a completed competition application by November 13. The application includes team member names, parent or teacher in charge, team name, and team logo. (Attachment B)

Each committee has a student chairperson who is in charge of the subcommittees in their group and oversees the completion of the work. Both committees have the responsibility of visiting the middle schools to provide assistance and training.

The day before the competition, the high school students set up the cafeteria. There is a work area for each team, a registration desk, the competition arena and the eating area.

The day of the competition the middle school/5th grade students and parents/teachers arrive at 9:00 am. They assemble in the competition area to have the game explained to them. The teams have from 9:15 am to 1:00 am to build their robot, practice on the playing fields, and eat lunch. High school students help middle school/5th grade students problem solve when necessary. The idea is to have fun as you work and enjoy the day. “Adult” help calms and soothes jittery and nervous competitors.

This year the game required the students to build a robot that could push balls up inclines or through a hole in the center of the playing field. Each side of the playing field started with 6 balls of various sizes and composition. The goal is to get rid of all the balls on your side (low score wins). Each round is five minutes long and refereed by high school students. Last year’s game was played like soccer, with robots pushing balls through their goal (high score wins). The game requires two players from each team with two teams competing against each other at the same time. One human player has a limited number of interactions with the robot during the game and one-player types in commands on the laptop to move the robot. The teams make “hot buttons” to facilitate the changes in movement of the robot faster.

The seeding matches start at 1:00 p.m. and spectators are welcome at that time. Middle school teams carry their laptop, robot, and Lego interface to the competition arena. We have two competition playing fields. While one match is being played, the other team is setting up. The scores of each team are viewed on a big screen and is calculated automatically a pre-designed spreadsheet. The competition proceeds to the elimination tournaments. An awards presentation follows the competition. Numerous awards are given such as the overall winner of the competition, most creative robot, best team spirit, and play of the day.

This year, the local newspaper ran an article complete with pictures about the competition.

This lesson submission does not include the middle school lesson plans using gears, pulleys, and motors. If this lesson wins, the middle school teacher will submit details of how the technology class accomplishes getting the students ready for the competition.

Attached items:

- A: Second Game Rule Book
- B: Registration Form
- C: Invitation Letter
- D: Competition Information
- E: First Game Rule Book
- F: Award template
- G. Photographs

Assessment and Evaluation:

Evaluation is taken care of during the awards presentation. Every participant receives a certificate of participation. Every team is given some award, (even if we have to make one up on the spot. One middle school had technical problems with their robot, but never gave up. They received the “Most Persistent Team” Award. The winning team displays the trophy for one year in the trophy display case of their school.

The National Science Education Standards for Content Standard E states this narrative concerning science and technology, p 191.

“The tasks should promote different ways to tackle the problems so that different design solutions can be implemented by different students. Successful completion of design problems requires that the students meet criteria while addressing conflicting constraints. Where constructions are involved, these might draw on technical skills and understandings developed within the science program, technical and craft skills developed in other school work, or require development of new skills.”

The completion of the “Lego Robot Competition” fulfills National Content Standard E.

The other members of the teacher team at Harrison High School are Cristina Broz, Steve Dail, Alisha Hill, Roy Lewis, and Cherylinn Golden.

Attachment A: Second Game Rule Book

Harrison High School



Second Annual Lego Dacta Competition
Saturday, December 5, 1998

Harrison High School
Welcome!

We, the teachers and students of Harrison High School would like to welcome you to the Second Annual Lego Dacta Competition. This day should prove to be an exciting opportunity for our 5th graders and our middle school students from around the district to share ideas and actually compete with their minds. We hope that you are eager to begin and that today will be a fun and enjoyable experience. Good luck and let the games begin!

Schedule

9:00 - 9:30 AM	Registration and Introduction
9:30 - 11:00 AM	Robot Design and Build
11:00 - 12:30 PM	Robot Practice Rounds
11:30 - 12:30 PM	Lunch
12:40 - 1:50 PM	Seeding Matches
2:00 - 2:45 PM	Single Elimination Tournament
3:00	Awards

Goal

The goal of the competition is to build a robot using the parts contained in the Lego Dacta Kit and the Spare Parts Kit. This robot will compete against another team's robot in a spirited competition where the robots try to score points by placing as many balls as possible on the opponent's side of the field.

The playing field consists of a 3' x 4' pen divided in half. Two ramps and a wall divide it. In the middle of the wall there is an opening in which one toy car will be placed at the beginning of each match. This car will count as a point for whichever robot knocks it onto the other team's side. Play begins with the robot placed in its respective starting box. Using the computer controller and a human player the robots proceed to knock, roll, or push the balls and the cars on to their opponent's side of the playing field. Each round will last 5 minutes.

Robot Rules

The completely assembled robot (excluding cables) must fit inside a rectangle whose dimensions are 5.5" x 8".

The robot may be made only of parts contained in the Lego Dacta Kit and the Spare Parts Kit. No other Lego Parts or materials may be used.

The materials in the Spare Parts Kit may be used to build a part of the robot that will allow it to perform other tasks or move more effectively. No part of the robot should be designed to destroy or dismantle an opponent's robot. No parts, whether from the Lego Dacta Kit or from the Spare Parts Kit may be permanently fastened. The tape and Velcro provided in the Spare Parts Kit is the only adhesive that may be used.

Human Player/Robot Controller Rules

The Human Player and Robot Controller are the only persons allowed to interact with the robot in the immediate playing field area. All other team members are asked to watch and cheer for their teams so as to allow space for the players to work.

Good manners and sportsmanship are a must. Always shake your opponents' hands and congratulate them graciously.

The Robot Controller must stay seated at all times and may only operate the Computer Control System.

The Human Player is responsible for guiding the controller cables in such a way to prevent tangling. The Human Player may not guide or pull the robot with the cables. The referee may use his or her discretion in penalizing a team for using the cables in this manner. Each penalty will cost the team a human interaction card. When there are no human interaction cards left, the penalty will be a point against the team.

The Human Player may interact with their team's robot five times during the course of play. He or she must surrender one of the team's playing cards for each human interaction. The number of remaining cards may be used in case of a tie. The only legal interactions allowed are to (a) right a robot that has tipped over, (b) move a robot up to three inches in any one direction, or (c) rotate a robot up to 180 degrees clockwise or counterclockwise. The human player must get permission from the referee before performing any interaction. A human or robot during a human interaction may touch no ball. No other human interactions are allowed.

Scoring

Points are accumulated as your robot pushes balls to the opponent's side of the table. Each ball is worth one point and the toy car is a tiebreaker.

Seeding Matches

The schedule for seeding matches will be posted. Your team is required to be ready to go at your posted time. The match will begin even if your team is not present. There are 8 teams competing and you will play 3 matches against 3 different teams. Your scores will be recorded for each match and the teams will be seeded based on the total of the 12 matches for the day.

Final Competition

The final competition is a single elimination tournament based on the posted chart. Teams will compete until they acquire a loss. The winner will be the final team remaining. All teams are expected to stay and cheer for another team even after they have been eliminated. If your team has been eliminated, then you should consider

"adopting" another team to cheer for.

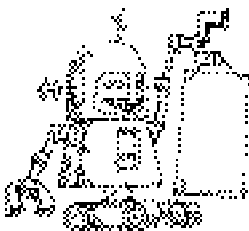
Awards

At the conclusion of the Final Competition, there will be a short recess. This is a good time for the teams to have their photographs taken and for video interviews to be shot. Awards will be given to teams in the following areas:

- Overall Champion
- Most Team Spirit
- Most Team Work
- Play of the Day
- Best Looking Robot
- Best Use of Spare Parts Kit
- Most Creative Team Name
- Most Creative Team Logo

Spare Parts Kit

Description	<u>Quantity</u>
Portion Cup	2
Velcro Fastener	2
Clear Tape	1
Scissors	1
Rubber Bands	6
Paper Clips	12
Plastic Film Container	1
Drinking Straws	3
Ruler	1
Plastic Spoons	2
Wooden Craft Sticks	4
Wooden Skewers	4
Index Card	1
String	1 meter



ATTACHMENT B: Registration form
Harrison High School RoboHawk
LEGO Dacta Competition
Application

Please Print.

School Name _____

Teacher _____

Team Grade Level _____

Team Name _____

The team decides on a team name. Example: Lego Lions

Team Logo *Draw the design on a separate piece of paper.*

TEAM MEMBERS (2 – 4 Students per team)

Parent or Teacher in Charge _____

This person must be with the team all day on Saturday, December 5, 1998.

Phone Number _____

Address _____

City _____ Zip _____

Please return this form to Mrs. Tomlinson at Harrison High School by November 13th by inner school mail or by fax at 489-3514.

ATTACHMENT C: Invitation letter

Memorandum

To: Technology Teachers
 Science Teachers
 Math Teachers

From: RoboHawk Central

Joyce Tomlinson
Cristina Broz

Date: September 23, 1998

Subject: LEGO Dacta Robot Competition

The RoboHawk team here at Harrison wants to interest our young students in technology and science as well as provide a service to Farmington Public Schools. This year the competition will be held at Harrison High School on Saturday, December 5, 1998. This is our second annual competition and teams that competed last year can attest to the fun and challenge involved. In the words of one of our LEGO 5th graders, "This is way cool!"

If you are interested, please contact Joyce Tomlinson at Harrison High School at (248) 489-3499 or by email for an application.

ATTACHMENT D:

Lego Dacta Robot Competition Information

Dear Team member:

We hope your teams are working well and are ready for the competition!!

Competition Day: Saturday, December 5, 1998

Please be at Harrison High School by 8:50 am. Park (or be dropped off) in the lower lot by the gym and auditorium entrance. Proceed up the stairs to the cafeteria on the second floor.

At 9:00 am in the cafeteria, the robot task will be explained. By 9:30, your team will be moved to your assigned work area to construct your robot.

Between 11:30 and 12:30, a sandwich buffet will be available for students and chaperones.

At 1:00 pm, all teams will meet back in the cafeteria and the competition will begin. Parents and friends are welcome at this time.

The awards and prizes will be given to the teams at the conclusion of the competition. We estimate the day will be concluded by 3:30 p.m.

What to bring: Your complete Lego Dacta set, including computer interface, all connector cables, motor, light, sound, angle sensor, light sensor, paper and pencil. If you do not have your own laptop, a laptop computer will be provided. Also bring your extra dual speed motor and cords from last year (if you have them).

Chaperone: Each team (or school) needs to have an adult at Harrison the entire time. This person can be a teacher or parent. The chaperone is responsible for transportation arrangements (pick up and departure) and for supervising the students during the day.

Team name and logo: Teams need to give themselves a name. (The Harrison High School team is called *RoboHawks*)

The teams may also design a logo. The logo is not required. Teams may want to dress in the same color T-shirts or wear the same type of hats. Try to dress in a way that makes you look like a team.

Questions? Call (3499), fax (3415) or e-mail Broz or Tomlinson.

TRW / Harrison High School



dacta[®]

ATTACHMENT E: First rule book

First Annual Lego Dacta Competition
Saturday, April 25th, 1998
TRW Automotive– Farmington Hills, Michigan

Welcome!

We, the teachers and students of Harrison High School and the engineers of TRW-Automotive would like to welcome you to the First Annual Lego Dacta Competition. This day should prove to be an exciting opportunity for our 5th graders and our middle school students from around the district to share ideas and actually compete with their minds. We hope that you are eager to begin and that today will be a fun and enjoyable experience. Good luck and let the games begin!

Schedule

9:00 – 9:30 AM	Registration and Introduction
9:30 – 11:00 AM	Robot Design and Build
11:00 – 12:50 PM	Robot Practice Rounds
11:30 – 12:30 PM	Lunch
1:00 – 1:50 PM	Seeding Matches
2:00 – 3:00 PM	Double Elimination Tournament
3:15 – 3:30 PM	Awards

Goal

The goal of the competition is to build a robot using the parts contained in the Lego Dacta Kit and the Spare Parts Kit. This robot will compete against another team's robot in a spirited competition where the robots try to score points by placing as many balls as possible in their goal in five minutes.

The playing field consists of a 3' x 4' pen similar to a foosball table with a goal cut out at each end. Play begins with the robot placed in its respective starting box. Using the computer controller and a human player the robots proceed to knock, roll, or push the balls in to their goals to gain points.

Robot Rules

1. The completely assembled robot (excluding cables) must fit inside a box whose dimensions are $8\frac{1}{4}$ " x $5\frac{3}{4}$ " x $4\frac{1}{4}$ ".
2. The robot may be made only of parts contained in the Lego Dacta Kit and the Spare Parts Kit. No other Lego Parts or materials may be used.
3. The materials in the Spare Parts Kit may be used to build a part of the robot that will allow it to perform other tasks or move more effectively. No part of the robot should be designed to destroy or dismantle an opponent's robot.
4. No parts, whether from the Lego Dacta Kit or from the Spare Parts Kit may be permanently fastened. The tape provided in the Spare Parts Kit is the only adhesive that may be used.

Human Player/Robot Controller Rules

1. The Human Player and Robot Controller are the only persons allowed to interact with the robot in the immediate playing field area. All other team members are asked to watch and cheer for their teams so as to allow space for the players to work.
2. Good manners and sportsmanship are a must. Always shake your opponents' hands and congratulate them graciously.
3. The Robot Controller must stay seated at all times and may only operate the Computer Control System.
4. The Human Player is responsible for guiding the controller cables in such a way to prevent tangling. The Human Player may not guide or pull the robot with the cables. The referee may use his or her discretion in penalizing a team for using the cables in this manner.
5. The Human Player may interact with their team's robot five times during the course of play. The only legal interactions allowed are to (a) right a robot that has tipped over, (b) move a robot up to six inches in any one direction, or (c) rotate a robot up to 180 degrees clockwise or counterclockwise. No ball may be touched by a human or robot during a human interaction. No other human interactions are allowed.

Scoring

Points are accumulated as your robot places balls in your goal. The number of balls and the point values for the balls are given in the following table.

Ball	Number	Points
Plastic Egg	4	5
Foam Ball	2	1
Pink Golf Ball	3	3
Lattice Ball	2	4
Yellow Wiffle Ball	3	1
Eye Ball	1	2
Ping Pong Ball	2	1

Seeding Matches

The schedule for seeding matches will be posted. Your team is required to be ready to go at your posted time. The match will begin even if your team is not present. There are six teams competing and you will play three matches against three different teams. Your score based on the above chart will be recorded for each match and the teams will be seeded based on the total of the three matches for the day.

Final Competition

The final competition is a double elimination tournament based on the posted chart. Teams will compete until they acquire two losses. The winner will be the final team remaining. All teams are expected to stay and cheer for another team even after they have been eliminated.

Awards

At the conclusion of the Final Competition, there will be a short recess. This is a good time for the teams to have their photographs taken and for video interviews to be shot. Awards will be given to teams in the following areas:

- Overall Champion
- First Seed
- Best Looking Robot
- Best Use of Spare Parts Kit
- Team Spirit

[View a student certificate and pictures of the event](#)