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LEGO Engineering for Girls

A Summary of Observations

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The purpose of the LEGO Engineering Symposium 2009 was to gather educators from around the world with experience teaching with LEGO robotic toolsets to focus on how these in particular could foster and support a diverse learning environment for girls. Eighty-five participants gathered in Medford, Massachusetts, for two days to present and learn from fellow-educators. Following is an informal compilation of the knowledge shared in development labs and group discussions during the conference.

Gender Differences

Activities that appeal to girls tend to also appeal to boys. It's not about gender – it's about having a variety of approaches. The gender behaviors noted below are generalizations, not absolutes. Some kids learn the "other way."

- Recognize gender differences, but don't reinforce stereotypes.
- Guys solve problems in isolation. Girls solve problems as a series of relationships.
- Girls are interested in social issues, such as helping people, animals, society, and the environment.
- Competition arises naturally even when not intended. Competitions generally attract males, generally because competitions have a clear cut winner. In a girls-only environment, distractions are removed and girls are more competitive.
- Girls sometimes do not have confidence. Robotics is something that girls need to warm up to. Girls like to be better informed, they have the perception that boys already know how to work with tools and therefore will be better than them.
- Girls are more attracted initially to a collaborative feel.
- Girls like themes that they can relate to their everyday life.
- LEGO in the name can be a plus but also a negative. Boys pre-think "I am good with LEGO" and girls do not.
- Guys are competitive. They tend to start building before planning. Girls prefer to plan the work before building. They are more likely to write about it in advance.
- Girls like rules. They expect to follow rules and have others do so.
- There are strategies you apply to girls as a group as opposed to girls individually. Don't think 'boys' and 'girls' but think what the individual needs. Be open to the group and to the individual relative to their experience.
- Teach to different learning styles.
- Girls are more likely to like worksheets.
- Girls might not have as much experience building with LEGO bricks. Allow activities that provide experience. For those who are intimidated they need their own space and time.
- Get more girls involved in JFLL where design is more important.
- Girls require more affirmation/praise.

Recruitment

The teacher/mentor plays a very important role in making girls feel they are welcome and that their input is useful.

- Recruit kids. It's important to invite them in. This gives them a better chance of becoming engaged.
- Provide role models to be guest instructors. Peer teachers are a strong recruiting tool.
- Provide more categories which mean more opportunities to reach more students. Students then have an opportunity to specialize.
- Market where girls are going and create activities that interest and engage them.
- Getting girls together is a confidence builder.

Activity Ideas

Framing questions and challenges for different audiences is important. The goal is to make all activities relevant and engaging to the participants. Following are several activity ideas that were generated during the development labs or discussed in group sessions.

Story Telling

Broaden the landscape to include the whole story, not just moving machines.

- Having a story to start with gives a starting point for learners who are stumped when it comes to building.
- Find a powerful idea to connect to students.
- Let kids make up the stories. They have great imaginations.
- Have students write the story and then use the LEGO sets to illustrate it.
- Share the story before you start so everybody has the background.
- Use storyboards.
- Character education would be a good approach. Focus on the character.
- Have students create models around the Aesop fables. Be aware of the cultural context of the fables.
- Incorporate literature/history/culture.
- Use social studies themes.

- Start with a story then have each group's project be a piece of the larger story.
- Two approaches: read the story first and then build; build and then make up the story. Have students comment on the various approaches.
- WeDo is more conducive for stories. Students can quickly implement ideas, there are not too many pieces making it easily manageable, and it is easier to take care of kits/pieces.

Constraints

- Set basic constraints that leave creativity wide open.
- Keep it simple by limiting the available pieces for less advanced learners, i.e. use one motor and one sensor to create something that moves 3 feet.
- Use the story as a limiting factor/building constraint.

Projects

- Girls are consumers. They should design products for consumers to use.
- Let students help set goals for an activity. It gets buy-in from the students.
- Let students design their own learning. LEGO models are generally boy-centric. Instead of building a car that uses gear ratios, ask students to build a model of something that demonstrates gear ratios.
- Make challenges instead of competitions. Framing and wording
- Add music. Get the robot to dance to music.
- Build a base model from instructions and then allow creativity from the add-ons.
- Create open-ended activities with multiple parameters set by teachers and students.

Themes

- Include the arts when creating themes. It's all about art and engineering.
- Animals and travel.
- Make a machine that simulates a natural disaster. Release a bunch of marbles to simulate results of an earthquake or landslide.
- Search and rescue. Develop a river rescue mission where all participants build the robot model but create their own marble holder.
- Design a parade float that has to do multiple things. Allow students to create line-following robots but with design and dress-up elements.

- Create robotics in the home. Dishwashers, alarm systems, etc. Create a vacuum cleaner for the home. As a test students could attach a magic marker to see how many tiles or the area that is actually covered.
- A lawn mowing competition has a real-world aspect with several different categories: detection of height gauge, safety shut down, obstacle course, obstacle detection, area covered, cutting speed, seeding/planting. Students can choose which competition their robot will be a part of. There can be winners of each category as well as an overall winner. Discuss whether one super mower could be created. Kids can define their own parameters.
- Careers. What tools are used in careers that are of interest to the students? What can be done to create these tools with robots?
- As a collaborative project, design a relay race where one robot will trigger another. Robots cannot trigger the next vehicle the same way. They must use a different sensor to do so. Teams build a vehicle of their choice and there must be collaboration between teams as to who us going to use each sensor. This idea was given to the Competitions group by Sandra Googan, who had done something similar in a conference she attended.
- Reverse engineering – give a completed set have them disassemble fully – store for a month and try to re-assemble – How close to the original did they get.
- Create a competition where you limit the pieces and students create an attachment to hold a marker. Students would then write a program to draw a flower with the goal being to draw the prettiest flower.
- Battle of the pets. Build a dog with the goal that whichever dog is the most obedient wins.
- NXT Acceleration: trying to find a way to make a two wheeled vehicle that can accelerate.
- Hold a robotic dance competition.
- Tape a magic marker onto the model and make it an art project. Use a marker to build the seismograph markings on a piece of paper.
- WeDo Broadway. Build a mechanism to lift a curtain. Design a set. Use SAM and a camera to create a for stop animation show. This is not just about one thing but the whole picture. It is all inclusive.
- Use WeDo for collaborative story telling. Students take turns writing a “line” in the program beginning with a receive message block and ending with a send message block.

Data logging goals

Participants want to do these things with data logging:

- Integrate several subjects

- Math and science applications
- Make math interesting
- Utilize sensors
- Gain new uses/perspectives
- Learn what data logging is
- Integrate into wider science curriculum – general science
- Bridge pre-engineering at middle school with engineering at high school
- Cross-curricular activities
- Pre-service teachers are often not math and science (expand general teacher user base)
- Making data logging personally relevant, personal, meaningful

Data logging activities

- Heart rate monitor
- Detect the nosiest area in the classroom
- Measure proximity to an object (vehicle)
- Measure distance between lines (vehicle)

Classroom management

Creating a building environment in the classroom can be intimidating for the teacher. Classrooms become a laboratory where students employ the process of chaos learning. This approach takes longer than traditional teaching and oftentimes there is not one right answer. Following are ideas to ease the process for teachers and students.

- Set kids up for success. Provide an initial experience that is successful so they are motivated to explore further.
- Set different goals for first time. Allow students to experiment before giving them activities to do. Determine appropriate goals for first time users.
- Use building examples and tutorials to help kids learn about how to use pieces.
- The concept of play is greatly underestimated. Get their hands on the product and let them explore. This will help to build confidence.

- WeDo is a good entry point for teachers who are afraid of the NXT (confidence builder). WeDo groups should not include more than 2-3 children.
- Assign the same task for boys and girls but split groups depending on age or experience of students. Grouping students together is not necessarily treating them unequally.
- Keep challenges open, but have a direction.
- Make competitions more about the whole solution vs. tweaking technical aspects.
- Teachers should speak to their students' intelligence. Model to students the way they are expected to speak. Instill confidence in them.
- Encourage reflection. Forget about right and wrong – look at the iterative process.
- Evaluate not just the final machine; include a portfolio aspect, with photos, a presentation, etc.
- Use exhibitions – kids need time to show off what they've done before moving on.
- A prize at the end is a motivator for girls as well as boys.
- Have lots of space for building
- Consider holding class in the art room
- Provide large desks or tables or allow students to work on the floor.
- Put tablecloths on the tables. It keeps bricks from bouncing.
- LEGO League has multiple categories which translate to multiple winners. It is up to the teacher or mentor to focus students. Oftentimes too much of the focus is on the robot.

Failure

Provide students enough time to complete a task but make sure they know that failure is okay. Kids should be prepared to fail but also coached on how to learn from failure so they use that knowledge to continue.

- Failure can be motivating.
- Big learnings follow big failures.
- There is an important aspect to learning from failing and girls need to be comfortable with failing.
- Reflection helps the fragmented elements come together.

General observations about participants

In addition to listening to what the participants were saying, the interaction between the groups was noted. Men and women demonstrated behaviors that were similar to the observations they were making about gender differences in learning. Below are some comments made by observers in the development labs.

- Women started the activity discussion with storytelling or real-world connection. They were concerned with function over form, but did little building. They were more open to sharing and wanted to create consensus. They wanted to identify the reason for using the robot – why should it be created. Their discussion also centered on helper robots.
- The women in the NXT groups did no building. The men helped them with it. The women in the WeDo group did not come up with a design or an end goal. They played around with the bricks for awhile and then talked the rest of the time. Each of the groups were more interested in the brainstorming aspect rather than the hands-on aspect.
- In the end the women abandoned designing their own and built the top WeDo model.
- Men assigned roles then worked independently with little interaction. Their stories were developed after the robot was created, which was opposite of the women. Most of the men groups created vehicles.
- Men built robots to do cool things, then figured out a story that could explain it. Women did the opposite. They considered a common societal or classroom issue and built a robot to figure it out. The idea of creating a story around a robotic design was novel to the men-only groups. They had to be guided/reminded to make their activities more appealing to diverse groups.
- The women groups wanted to tell me about their issues, their robot, and their solutions. They wanted to share. The men groups were less interested in sharing and didn't seem to think it was a necessary component for the activity.
- One woman struggled to grasp basic robotics principles. She had zero experience before the symposium. She fully understood how to do it after a few minutes, but she couldn't make the connection and answer the "why". I wonder if many girls unfamiliar with LEGO, technical scenarios, or gaming might be just going through the motions.
- None of the women groups made moving robots. One had an idea for one, but assigned a man to build it so they could focus on the story and programming.

Suggestions for product improvements

- A single top card in the MINDSTORMS set would be better.
- Include a temperature probe in the set.

- The sound sensor is low-tech and limited in what it can do.
- Make the WeDo motor transparent so kids can see what is going on inside.
- The WeDo software is not intuitive for adults but may be more so for children.
- The FIRST competition lacks the collaborative facet. It would be great for teams to learn from others and what they have done.
- NXT requires one musical note at a time. The RCX allowed more than one note at a time which was much better.