Each November, teams of elementary students invade Savannah Gym on the campus of IU Northwest. Teams of 10 to 12 members, parents, coaches, and spectators bring their buckets of LEGO®s, project work, MINDSTORM® robot and afternoon snacks. This article tells the story of the FIRST® LEGO® League programs in northwest Indiana and how this LEGO® program has benefitted students in our region.

Serving six counties in northwest Indiana with over 24 K-12 school corporations, IU Northwest’s School of Education (SOE) has a focus on teaching students in the urban, general, and special education genres. Our teacher preparation programs include partnerships with many of the local schools for student teachers, professional development, and research collaboration. Out of these relationships, the SOE faculty is keenly aware of the struggles teachers encounter to meet and pass state mandated testing and engage their students in meaningful and effective learning.

Research on effective differentiated learning has been an ongoing study for decades. Each emphasize the importance of valuing education as “a matter of ‘life and death,’ both for society and for the [students]” (Haberman, 1991, p. 294). Successful schools will emphasize student centered environments with positive cultures that value learning more than teaching (Cleveland, www.millenniumlearningconcepts.org). Paulo Freire supports problem-posing education to authentically engage students in creatively reflecting and acting on a real-world obstacle. Students engaged in inquiry and creative transformations of the problem posed creates critical thinkers and stimulates their actions upon reality (Freire, 1991, pages 64-65).

However, a student centered environment and a real-world obstacle do not in themselves create engaged students. Teacher education programs pursue and evaluate those qualities that must be developed and established in the learning environment for effective learning to occur. A caring teacher who serves as a role model for the students and insists upon successful behaviors within the school promotes students achievement. Support systems also include teaching positive self-talk, learning to plan and set goals, and how to access information and connections to additional resources for problem-solving (Payne, 1991). Effective teachers can maintain control in their learning environment by establishing relationships of trust and engage their students in meaningful and applicable problem solving activities.

Martin Haberman (1991) describes a good teaching approach to include the following:
• **Involve students with issues they regard as vital.** Pose problems that are viewed as obstacle from the “normal” school routine. Teachers can use these messy problems that seem to resist a solution as an opportunity for learning and living.

• **Help students to see major concepts, big ideas, and general principles and make these key concepts meaningful and relevant.** “A fundamental goal of education is to instill in students the ability to use various and competing ways of understanding the universe.” (Haberman, 1991, page 293)

• **Allow students to be involved in planning their actions for learning.** Students can learn to make informed choices by actually making choices in their topics for study, what resources are needed, how they will present their findings.

• **Involve students in applying the ideals of fairness, equity, or justice to their world.** Students contemplate our environment, war, human relationships, and health care. Work with students to build their character in developing their principles for life, comparing their ideals with reality, and defend their ideals publicly.

• **Students are actively involved.** Students learn from participating in experiments, acting, and constructing.

• **Students are directly involved in a real-life experience.** Expose students to first-hand experience with field trips and interactions with resource people, visiting various job sites and observing life experiences in their community.

• **Students are actively involved in heterogeneous groups.** Students learn from a variety of groupings: cultural, intellectual, urban, and special needs. Divergent questioning strategies, multiple assignments in the same class, activities that allow for alternative responses and solutions all contribute to successful learning environment.

• **Allow students to think about an idea in a way that questions common sense or a widely accepted assumption that relates new ideas to ones learned previously, or that applies an idea to the problems of living.** “Students are taught to compare, analyze, synthesize, evaluate, generalize, and specify in the process of developing thinking skills. The effort to educate thoughtful people should be guided by school activities that involve thought. The acquisition of information – even of skills – without the ability to think is an insufficient foundation for later life.” (Haberman, 1991, page 294)

• **Involve students in redoing, polishing, or perfecting their work.** The successful completion of anything worthwhile rarely occurs in a single trial. Students learn important opportunities to excel when given the opportunity to review their own work.

• **Involve students with the technology of information access.** Computer literacy is critical to living in the 21st century. Students must learn to create, receive, collect, and share data, text, images, and sounds on a multitude of topics.
• Allow students time to reflect on their own lives and how they have come to believe and feel as they do. Teachers must include an opportunity for students to draw out of their home lives by eliciting responses to their environments and experiences.

Ongoing research is being pursued by IU Northwest’s SOE Urban Teacher Education Program (UTEP) to provide the best practices resulting in the greatest gains in academic success for our urban youth. These studies seek the most effective curriculum, community involvement, adult interactions, class rules and more to define the optimum environment. From UTEP, guidelines are gleaned for defining the parameters of a successful after school urban program. A comparison of these conditions (mentioned earlier by Haberman, Cleveland, Freire, and Payne) with an after school program currently growing in northwest Indiana reveals many similarities. For the past four years, IU Northwest has sponsored the qualifying tournament for the FIRST® LEGO® League. This event has grown from 8 teams with approximately 120 participants to 34 teams with over 1,000 students, parents, and coaches. Schools in northwest Indiana with students in grades 3 through 6 can build an after school FIRST® LEGO® League program to actively engage students in the exploration of STEM related academics (science, technology, engineering, and mathematics). The parallel between best practices for educating our urban youth and the story of FIRST® LEGO® League is shared below.

Successful after-school programs for urban youth were created from passion, a vision, and survive the test of time. These programs don’t just “happen” they are created with intent and key components. When urban youth are actively teaching and learning from each other, there is communication and cooperation (Emdin, 2010). The kinds of experiences recommended by research on positive youth development includes: clear expectations, opportunities for skill building, youth decision-making and responsibility, mentorship, scheduled use of after-school time, and integration of family, school, and community. A partnership between the nonprofit organization called FIRST® and The LEGO® Group has created a powerful program that helps students discover the fun in science and technology while building self-confidence, knowledge, and valuable employment and life skills. Schools in Northwestern Indiana collaborate with faculty and students at IUN each fall to host a tournament in the fall.

In 1989, the Segway Inventor, Dean Kamen of Bedford created the nonprofit organization called FIRST® (For Inspiration and Recognition of Science and Technology) for the celebration and excitement of science and technology. In 1955, Kamen introduced a science and technology challenge to grade level students using LEGO® bricks. The FIRST® LEGO® League (FLL®) was started in 1998 with 200 teams and today, there are over 17,100 FIRST® LEGO® League teams in 56 countries. Kamen’s challenge has been expanded to 55 countries around the world. While FIRST® has four levels of competition for all students in grades K through high school, it is the FLL® that is creating growing attention in northwest Indiana.

• Involve students with issues they regard as vital.

Every September, FLL® releases a Challenge, which is based on a real-world scientific topic. Every FLL® Challenge reflects an important real-world issue as a way to show students how science and technology can contribute to solving problems. Each season in northwest Indiana, these FLL® teams are learning how to make a difference in their urban community by applying what they have learned through the FLL® experience in the real world. Each Challenge has two parts: the Robot Game and the Project. The challenge kit contains a 5’ by 8’ robot table mat plus over 1,100 LEGO® parts including the LEGO® MINDSTORM® set and additional motors, sensors, gears, and an exclusive collection of LEGO® elements required to build the mission models. Students must use the manipulatives in their challenge kit to build a robot in response to the annual challenge proposed by FIRST®.

- **Help students to see major concepts, big ideas, and general principles.**

Each annual challenge includes a project for teams to explore an actual problem that today’s scientists and engineers are trying to solve, develop an innovative solution to that problem by creating something that doesn’t exist or building upon something that does, and share their findings with the community and tournament judges. Themes from 2008 to 2010 have included: Power Puzzle, Climate Connections, Smart Moves, and Body Forward. The 2011 theme is Food Factor, with challenge and project specifications to be released in September. Next fall teams will be working to discover new ways of keeping our food safe, brainstorming ways to prevent food contamination from exposure to insects and creatures, explore ways to prevent unsanitary preparation and storage to combat contaminates.

- **Involve students in applying the ideals of fairness, equity, or justice to their world.**

In 2009, the Smart Moves Challenge examined everything from how vehicles to viruses move within their community and worked to present improved transportation systems with greater safety. The Robot Game required teams to consider their robot as a sensor-equipped vehicle which could gain access to places and things, while avoiding or surviving impacts, all within a test environment. Students were required to program their robot to avoid causing or diving into traffic jams, consider the need for traffic signals, if their vehicle was involved in a collision how would they keep their passengers safe or modify their robot to avoid getting stuck or damaged and consider the number of vehicles on the road today, reduce or eliminate their need for travel. Students must work quickly to accomplish each of these missions in 2 minutes and 30 seconds using only a programmable LEGO® robot.

- **Students are directly involved in a real-life experience.**

Engineering and medicine were combined in the 2010 challenge which encouraged each team to improve our quality of life. The Body Forward Challenge required students to explore the cutting-edge world of Biomedical Engineering to discover innovative ways to repair injuries, overcome...
genetic predispositions, and maximize the body’s potential, with the intended purpose of leading happier and healthier lives.

Communication and cooperation are the keys to a successful solution and winning competitions. Students learn to speak informatively, to share their thinking and present their findings to the whole group. Students also learn to listen to the arguments and ideas of others. The students work in groups and take ownership of the entire learning process. The camaraderie is fun and respectful as the members learn from one another and make conjectures about their findings. (Mueller, Maher, 2009)

CORE VALUES AND GRACIOUS PROFESSIONALISM®

FLL® Core Values and Challenges parallel the behaviors necessary to encourage students to think like scientists and engineers by engaging them in playful and meaningful learning through a fun, creative, hands-on learning experience by challenging them to solve real-world problems using robotics and projects. Gracious Professionalism®[MDM1] is a part of the ethos of FIRST®. It was originally coined by Dr. Woodie Flowers, FIRST® National Advisor and Pappalardo, Professor Emeritus of Mechanical Engineering, Massachusetts Institute of Technology.

FIRST® could not accomplish these lofty goals without a solid base of team behaviors. FLL® Core Values are the cornerstone of the FLL® program and emphasize friendly sportsmanship, learning, and community involvement. By embracing the Core Values, participants learn that friendly competition and mutual gain are not separate goals, and that helping one another is the groundwork of teamwork.

- **Relationship of trust and Core Values**

Students working together in the FLL® program are introduced to an atmosphere of Professionalism® towards their team members and Coaches. Students are encouraged to produce high-quality work, emphasize the value of others, and respect for individuals and the community. Gracious professionals learn and compete with enthusiasm, but treat one another with respect and kindness. It is the responsibility of the FLL® team coaches to model these core values and guide their teams to work as gracious professionals, blending research, competition, and respect.

- **Allow students to be involved in planning their actions for learning.**

FLL® elementary school teams typically meet 2 hours each school day and middle school teams might meet for 3 hours each school day evening. Teams are restricted by FIRST® to include a maximum of 10 students. Teams diligently work before school, during the school recess time or after school for 8 solid weeks to prepare for the qualifying tournament. The work is a compilation of students programming an autonomous robot (using LEGO® MINDSTORMS® technologies) to score points on a thematic mat and create an innovative solution to a problem as part of their research project. In northwest Indiana, teams gather at Indiana University Northwest to compete regionally with the

- **Students are actively involved.**

Project judges are looking for a research problem that is clearly and concisely explained with multiple research citations and possibly an interview or correspondence with a professional in the field of study. Solutions proposed by these students should include substantial data to support their innovation with each of the team members able to share a complete understanding of the problem, its technical terms, and their solution. Judges will frequently ask about the time management of the team work and collaboration of the team.

In 2008 the FLL® Challenge was Climate Connections. Students were motivated to explore the challenge with urban solutions such as how to remove the water from our downtown communities, interstate and neighborhood. LEGO® town models were constructed with underground water pipes and pumps to remove the flood water. Students also invested their time in visiting city government offices and sewage water facilities to explore the possibilities of their solutions and share their innovations. Guided by their imaginations and adult Coaches, children discover exciting career possibilities and learn to make positive contributions to society. Coaches volunteer their time in working with the FLL® teams. If your school has a FLL® team, and you know students who would like to join, consider coaching or sponsoring a team. One can add to society and enjoy the satisfaction of knowing one has acted with integrity and sensitivity.

- **Involve students with the technology of information access.**

Teams are judged in three areas: Robot Design, Project, and Teamwork. An excellent robot design will include an innovative, creative and unique design. The robot might use manipulators or sensors in an unusual or unexpected way with strategies that coordinate with the missions. The computer program, written by the team members is logically organized, efficient, dependable, and each of the team members can describe the missions and reference the computer program. FLL® judges look for strong evidence that team members are solely responsible of the knowledge of robot construction and programming shows through understanding of underlying design, science, and technology; the building and programming must be solely accomplished by the team members. Overall, judges are looking for a robot with a stable base, easy to assemble, robust, unique, with a creative design whose complete construction is elegant and complete.

- **Allow students time to reflect on their own lives and how they have come to believe and feel as they do.**
Team work judges are looking for a balance of responsibility across all team participants. As a collaborative group, they learn to build on their own and their team mates prior knowledge and previous experiences. Team members are asked for concrete examples of time management, respect for their peers, and an increased awareness of their school and community issues (and impact on their lives), and examples of how they helped each other. Teams are expected to have brainstormed multiple potential solutions and with respectful management skills to whittle these ideas down to their teams favorite and most innovative solution to the challenge problem. Each team member is expected to speak with the judges and enthusiastically show how they worked together and included each other. They are asked about new skills acquired, their interest in the subject areas, and a clear understanding of the FLL® experience.

Like any other organized “sport,” teams also create a team identity. You might recognize some of these 2010 team names from northwest Indiana: the Somatix, the SkeleKids, the LEGO® Wizard, the Bot Squad, and the Block Busters of Munster; and additions from Hammond included the Frank-o-Bots, Scott Bots, Hess Hawks, Mac Arthur Mustangs, Nutz-n-Boltz, Engineering Eagles, Robotic Panthers, and the HAST LEGO® Team. Teams sport matching t-shirts, banners to mark their “pit” location in the gymnasium and some provide sweet treats or tokens for their spectators. During the robot table competition, each of the team member’s semi-circles their side of the table to cheer and guide their team mates on to winning strategies. Teams display banners, have motivating cheers and offer “hi-fives” accolades for their best efforts in the competition.

**Early Participants Are Now Giving Back**

In 1999, in northwest Indiana, the School City of Hammond (SCH) made it a goal to have at least one FIRST® team in each of their schools. This was accomplished in six years (from 1999 to 2001) and students who have benefitted from the programs are now returning to their FIRST® FLL® teams to give back to the program. Breanna Farmer, currently a high school FTC® (FIRST® Tech Challenge) coach and teacher, makes frequent visits to her elementary school after school to mentor the FLL® team students. Sarah Mich, a graduate from the SCH whose FTC® team went to the National Championship, is now an elementary teacher in Lafayette and a FLL® coach for students in her class. Columbia, Indiana’s Nathan Babbit is also a teacher and graduate from SCH is giving back to his community as a FLL® coach.

- **Involve students in redoing, polishing, or perfecting their work.**

The culmination of all the hard work for many teams is the participation in an FLL® qualifying event which is similar to a high energy sporting event. Referees monitor and score the Robot Game, judges review team presentations. An FLL® tournament is a pumped-up environment with music and excitement that celebrates the work the students have done throughout the season. In the 2010 regional qualifying team at IU Northwest, 9 teams were awarded the top awards and trophies in Project Design,
Robot Design, and Teamwork. The coaches of these teams include: Joe Markovich (Somatix team of Munster), Dale Wiersbe (NXT Generation Christians of St. John), Anthony Kenning (SkeleKids of Munster), Ryan Eckart (O’Bannon Bots of Hammond), Sarah Michna (Lafayette Shamrocks of Hammond), Silvia McDanieli (Eggers E-bots of Hammond), Keith Hall (Exploding Pie of Hobart), Mr. Doolin (Eye Tech of South Bend), Dwayne R. DeYoung (G-Bots of Hammond).

**University Student Involvement**

Volunteers are a necessary and important ingredient to sponsor a successful tournament. The qualifying tournament held at IU Northwest included more than 60 volunteers, the majority of them university students. The College of Arts and Sciences requires their physics students to serve as robot table game and project judges. The School of Education pulls from the Math Methods courses and uses both elementary and high school pre-service teachers to also service as robot game table setters, table queuing, teamwork and project judges, timers and a DJ. Many of the tournaments have project judging in the morning and robot table game competition in the afternoon, which makes for a very full, all day long event.

- **Students are actively involved in heterogeneous groups.**

At IU Northwest, the project judging and robot table game competitions all occur in the afternoon. Teams arrive on campus at noon for set-up in their assigned “pit” locations around the walls in the Savannah gymnasium. The opening ceremony is at 1:00 and all judging and competition begins at 1:15. Every 6 minutes a new team is competing in one of 6 locations on the 3 tables in the middle of the gymnasium. Project judging occurs every 8 minutes. Teams are judged once for their project and teamwork and compete three times at the robot game tables. All during the robot game table competition (and during practice at their own home site), music is played to distract the teams from outside noises. At IU Northwest, we have been fortunate to have the donated services of Ray Liskey of Trans Audio fill our room with fun dance music like the Twist, Electric Slide, Casper Slide, and Cotton Eyed Joe.

Amanda Czyszczon of Lake Central Schools served as the Head Technical Judge, Vickie Jarecki served as the Head Teamwork Judge, and Jim Wozniewski served as the Head Referee. Each of these professionals worked with the student volunteers to train them on the importance of staying on time, correct table set-up for the table competition, and how to use the score sheets for judging. Lin Wozniewski and Dana Dodson co-direct the tournament. Tournament sponsors include: IU Northwest’s College of Arts and Sciences plus the School of Education and Jim’s Repair Service. Approximately 1000 people participated in the 2010 FLL® qualifying tournament at IU Northwest, team members, coaches, volunteers, and spectators.

- **Allow students to think about an idea in a way that questions common sense or a widely accepted assumption that relates new ideas to ones learned previously, or that applies an idea to
the problems of living.

What FLL® teams accomplish is nothing short of amazing. The skills, fun, and excitement these students learn and exemplify will last a life time. Independent studies from Brandies University show that the program provides: increased interest in and understanding of science and technology, improved attitudes towards education, and improved life and workplace-related skills. The STEM (science, technology, engineering, and mathematics) principles are naturally imbedded within the robotics program. Teams learn life and employment skills which will benefit them no matter which career path they choose. Nationally, thousands of students have found their own niches in science and technology with the help of FIRST®.

Students’ team work takes them into the community and into a world where science and technology are valued and celebrated. Successful urban educators engage all their students in learning activities, involve their students in planning what they will be doing, directly involve their student in real-life experiences, give them access to technology, encourage them to reflect on their own lives and goals for their future, and involve them in polishing and perfecting their work. (Haberman, 1991).

IU Northwest looks forward to continuing its participation with area FLL® teams. The parallels between the best practices for educating our urban youth and the FIRST® LEGO® League after school program are benefitting the interests in our youth to explore science, technology, engineering and mathematics. The problem posing challenges presented annually by FIRST® supports Paulo Freire’s challenge to authentically engage students in real-world obstacles. The role of the coach in facilitating the learning environment creates a growing relationship with the team members where graduates of the program return to encourage the new team members. Martin Haberman’s description of best practices for good teaching was bulleted through-out the article. All students who are members of an after school FLL® team are actively involved in a real-life, vital problem which demands multidimensional tasks and engagement with the community and technology. Each coach models and supports the team’s actions to develop and grow into thinking problem solvers.

Serving as a project judge, one university student majoring in education, was amazed with the quality of research, project work and presentation skills the elementary students displayed. Another student praised the positive and focused behaviors of the young students who packed the gym for hours. An expectation for the quality of work capable from young students and their behaviors was raised beyond their previous expectations. FIRST® LEGO® League models the best practice for teaching our urban youth, which makes LEGO®’s beneficial to the learning environment.

References


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