

Introducing Engineering to Elementary and Middle School Teachers Through Hands-on Experiences

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Dr. Stacy Wilson from the Department of Engineering at Western Kentucky University and Dr. Kathleen Matthew from the Department of Teacher Education at Western Kentucky University have collaborated for three years on a project to further the science content knowledge and pedagogical skills of elementary and middle school teachers and counselors. This project has four basic strands covering four outcomes and four goals

- a) a mentoring program using successful women in executive positions in science/engineering careers,
- b) an intense summer workshop focusing on science/engineering and gender equity,
- c) a LEGO robot extravaganza to promote critical thinking and creative thinking in teachers and their students, and
- d) dissemination/replication of the project information.

The summer workshop has been held for the past two years. During the week-long workshop, the teachers learn about gender equity and how to deal with their classrooms in an equitable manner. Also, the teachers learn about the types of engineering and are provided with hands-on low cost engineering activities to take back to their classrooms. This year the teachers were given LEGO Mindstorm sets and instructed on their use. The teachers are required to coach a team of students on building a LEGO robot and to bring the team to compete in the Kentucky Robotic Championships in November. A requirement of the competition is that each team has two females and the students must write a report on the process they went through to complete their LEGO robot.

The paper will describe the teacher workshop and robotic competition.

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In 1972, Title IX stated that “No person in the United States shall, on the basis of sex, be excluded from participating in, be denied the benefits of, or be subject to discrimination under any education program or activity receiving federal financial assistance.” Great strides have been made in women’s rights since 1972 but in many areas of science, mathematics, engineering, and technology, women continue to be under represented. Even though females achieve higher grades, are pictured in science books, and have had career opportunities in science and math, the research continues to indicate that women are under represented in several science arenas including the engineering field.

Women are subject to subtle socializing barriers and negative messages which lower self-esteem, career aspirations, and rates of participation in science, mathematics, engineering, and technology [1]. Teachers can make a difference when they are made aware of subtle gender equitable mannerisms and career advising which will encourage females to achieve and succeed in areas that have been typically dominated by males.

Simply getting more females into the “pool” of engineers will not automatically take care of the gender inequity in engineering. Teachers must take an active role in lowering three major barriers:

- 1) inequitable treatment of females in classes,
- 2) lack of self-confidence, and
- 3) lack of successful mentors.

Breaking down barriers and broadening boundaries for female students can be achieved through education, mentoring, and focusing on female empowerment.

At Western Kentucky University (WKU), faculty from the Department of Engineering and the Department of Elementary Education have collaborated for three years on a project to further the science content knowledge and pedagogical skills of elementary and middle school teachers and counselors. This project has four basic strands covering four outcomes and four goals:

- 1) a mentoring program using successful women in executive positions in science/engineering careers,
- 2) an intense summer workshop focusing on science/engineering and gender equity,
- 3) a LEGO robot extravaganza to promote critical thinking and creative thinking in teachers and their students, and
- 4) dissemination/replication of the project information.

This paper will discuss educating elementary and middle school teachers about engineering and providing hands-on opportunities to their students.

Summer Teacher Workshop

There is a need for teachers in Kentucky School Districts and Universities to communicate their curricular needs to each other through professional sharing of information, ideas, methods, and content knowledge. This goal was accomplished by inviting teachers and counselors to attend various engineering and gender equity

activities, including the Gender Related Equity Activities to Teach Science (GREAT Science) workshop at Western Kentucky University where they learned and shared specific science content knowledge and methodology skills.

In an unpublished study conducted by K. Matthew, it was found that Kentucky elementary teachers lack content knowledge in science and feel anxiety when faced with teaching it. The professional development provided in the GREAT Science workshop used activities to teach science content and science methodology. Communication between Teachers and University personnel had the potential of increasing students knowledge in science and increasing female and minority representation in the sciences.

For the past two summers, teacher workshops have been held on the campus of Western Kentucky University. The workshops were hosted by the Department of Engineering and the Department of Elementary Education. The first workshop was sponsored by the National Science Foundation through the Women Engineers * Changing Attitudes Now grant. The second workshop was sponsored by an Eisenhower GREAT Science grant. Each workshop was one week long. The first workshop included elementary, middle, and high school teachers. It was determined that the difference in age related activities made it too difficult to accommodate such a wide diversity of teachers. Therefore, the second workshop focused on elementary and middle school teachers. All teachers in the state of Kentucky are required to earn a Master's degree or an equivalent. Teachers were offered a stipend or graduate credit for involvement in the program

Part of the workshop focused on gender equity and equipped the teachers with skills to confront gender equity issues in the classroom. The gender equity topics discussed included:

- Defining, discussing, and describing what gender equity looks like,
- Providing positive female role models in science, math, and technology,
- Using the web to find and identify sites that have biographies of female success stories,
- Spotting gender bias in the classroom and changing your teaching to avoid it,
- Encouraging female participation in science, math, and technology at individual schools,
- Planning for change and its impact on individuals in the school setting, and
- Identifying individual barriers that may discourage female participation.

The gender equity material proved to be very informative and useful for the participants. Comments from the teachers were very positive concerning the gender equity aspect of the workshop. Many were surprised to find that they did not always practice gender equity in the classroom.

The second component of the workshop was an introduction to engineering and providing hands-on engineering experiences which the teachers could take back to the classroom. The engineering content included:

- Engineering as a profession
- Types of engineering
- Preparing students to study engineering
- Understanding electrical circuits and components including series and parallel circuits, motors, light emitting diodes (LED), and resistors

- Tour of the WKU engineering labs and demonstration of the Institute of Electrical and Electronics Engineering student robot
 - Tour of local industry and meeting engineers working in industry
 - Seminar with a female engineer from local industry
 - Hands-on projects for the classroom which included: a motorized fan constructed from a toiled paper tube, a flashlight also constructed from a toiled paper tube, a motorized car made with popsicle sticks, a LED traffic signal, and a LED trivia game.
- The engineering component of the workshop informed the teachers about engineering and provided them with activities to promote interest in engineering in the classroom. The teachers were very enthusiastic about the hands-on activities and have used the faculty as resources to bring these activities into their classroom.

The second workshop content was modified to reinforce the engineering content. Each teacher was provided a LEGO Mindstorm that is a set used to build LEGO robots. These LEGO kits contain a small processor, software to program the processor, wheels, motors, sensors, and many LEGOs. The teachers were instructed in the building of LEGO robots and using the software. The teachers had a miniature competition on the last day of the workshop. Each teacher that attended the workshop committed to bringing a team of students to the LEGO competition that will be discussed below.

Kentucky Bluegrass Robotic Championships

The Department of Engineering sponsors a high school robot competition each fall to promote hands-on opportunities for students before entering college. This competition is affiliated with BEST (Boosting Engineering, Science, and Technology) Robotics [2]. This competition typically includes ten to sixteen schools with four to twenty students on each team and is designed to simulate a real world business and engineering environment. The game is limited to a six week period (in the fall) to simulate a product time-to-market constraint. Each team of students must design and build a machine on their own. Also, each team is given an identical box of odd parts, fasteners, materials, and a radio controller for motors.

This year a new component was added to the Kentucky Bluegrass Robotic Championships: a LEGO division for elementary and middle school children. The goal of this competition is to provide hands-on opportunities for young students to apply engineering design principles. Teachers were given an opportunity to learn to use the LEGO sets during the summer engineering/gender equity workshop. The teams gathered on the kickoff day for the high school competition to learn the rules and see the game demonstrated.

Each LEGO team had to complete an obstacle course which simulated the campus of Western Kentucky University. The robots had to avoid pedestrians, climb a hill, avoid cars, and ditches. Each robot had to be constructed entirely from the LEGO Mindstorm kit. No extra LEGOS could be used in construction and no bonding element such as glue could be used in construction. Each team was required to have at least two female students on the team. Since this was a youth oriented contest, the teachers were instructed to serve as a guide only. They were not to machine parts, detail design, nor force their will on the youth.

In addition to the robot competition, a written competition was held for the students. The following criteria were given to the students to include in the written portion:

1. A general explanation of how your robot was assembled.
2. Problems you encountered and how you overcame them.
3. Discuss your trial runs and the modifications you made.
4. Describe the problem solving skills your team used.
5. Explain how your team was formed and how teamwork was used to complete the robot and this paper.
6. Describe the help your mentor provided to the team.
7. Describe how your teacher helped you with this project.
8. Explain why your robot is the best and deserves to win.

The paper winners were determined by:

1. Clarity of the paper
2. Knowledge of content
3. Mechanics (spelling, punctuation, grammar, etc)
4. Overall composition

The LEGO robot competition was a tremendous success and will continue to be an important outreach effort of the Department of Engineering and the Department of Elementary Education.

Conclusion

The GREAT Science workshop and LEGO robot competition were highly successful. These efforts provide teachers and students with opportunities to solve hands-on engineering problems. An important component of these efforts is the collaboration of faculty in these two programs. Many other engineering opportunities have been provided to teachers and students through this collaborative effort [3]. Enrollment in engineering programs is a growing concern to the engineering community. It is vitally important that engineers and engineering faculty reach out to educators and engage them and their students in engineering experiences.

Bibliography

[1] Sadker, M. & D. (1994). *Failing at Fairness: How America's Schools Cheat Girls*. New York: Charles Scribner's Sons.

[2] BEST Robotics, Inc. www.bestinc.org

[3] Wilson, Stacy and Kathleen Matthew. "Developing and Implementing a Women in Engineering Program at Western Kentucky University," 12th International Conference on Women Engineers and Scientists, Ottawa, Canada, July 2002