The 4-H Tech Wizards Program: Engaging Underserved Youth in Science, Technology, Engineering, & Mathematics

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ABSTRACT

The 4-H Tech Wizards Program is a national program funded through the Office of Juvenile Justice and Delinquency Prevention whose mission is to engage youth from economically depressed areas in robotics and STEM related activities while providing a strong small group mentoring environment. In Wisconsin, the program reaches over 100 youth in four counties: Kenosha, Racine, Crawford and Milwaukee. Youth ages 8-17 are paired with adult mentors who are trained in aspects of positive youth development and evidence-based standards. This paper describes the Wisconsin 4-H Tech Wizards Program which includes a robotic competition based on robots such as the LEGO NXT Mindstorm Robots.

This paper will discuss the implications of this program in terms of positive youth development and the engagement of economically disadvantaged groups in informal STEM programs including the strategies for recruiting and retaining mentors and youth in the program. The authors will review the implementation strategies and funding requirements, while discussing the plan to expand the mentoring model into Tribal Communities of northern Wisconsin. The results of evaluations concerning STEM skills gained through the program and the importance of the frequent mentoring component will also be shared.

STEM, Conference Proceedings, K-12 Outreach, Hands-On Learning

INTRODUCTION

Since March 2011, outreach work has begun in economically disadvantaged communities to develop community based partnerships to engage more youth and adults in this program. Youth recruitment was started by identifying community-based organizations (such as community centers, public and private schools, and other youth development organizations) in socio-economically depressed geographic areas of Southeastern and Western Wisconsin. The locations were identified by the United States Department of Justice’s SMART System. The SMART System is a Geographic Information System (GIS) based management system. The system scores at-risk communities by geographical regions based on factors such as crime rates, poverty, single parent households, unemployment rates, etc.
These factors provide a way to identify emerging local issues early and enable agencies to match appropriate resources to meet local needs. Communities are ranked with a Community Disadvantage Index (CDI) score (on a scale of 1 to 10). A CDI score of 10 is the highest at-risk score that a community can receive. These communities have high resource needs while a CDI score of 1 represents more affluent communities with minimal risk factors. Organizations and youth participating in this program are located in a community that scored between ranges of a 7 CDI score to a 10 CDI score. To serve youth, STEM professionals from local businesses and students from college/universities were strategically approached to volunteer as mentors.

4-H TECHWIZARDS PROGRAM

The model of the 4-H Techwizards program is replicated by a program developed by Oregon State University which has received a National 4-H Program of Distinction Award. 4-H Techwizards is an afterschool, small-group mentoring program for vulnerable and marginalized youth who tend to be underrepresented in STEM fields. The program uses youth interest in science and emerging technologies to help engage them in learning and to encourage them to apply their learning to their STEM academic instruction and future life paths. Professionals specializing in emerging technologies (filmmaking, GIS/GPS, photography, robotics, and website development) connect with youth in a group mentoring setting. Youth are in cohorts of ten to twelve, with three to five mentors per group (Mereclas-Cuevas, 2011). In 2011, Wisconsin 4-H and partnering counties decided to focus on one type of technology subject, Robotics.

The mentors work with youth enrolled in a local 4-H robotics club or group. Mentors received training from UW-Extension staff to improve their work to support youth mentees. Trainings are based on the topics to improve their knowledge and skills with teaching STEM education: introduction to 4-H club model, computer programming/building for robotics platforms including LEGO® Education NXT Mindstorm and VEX Cortex Kits, experiential learning models through the National 4-H Junk Drawer Robotics Curriculum, and orientation to FIRST LEGO® League. The robotics platform trainings included VEX Easy CV4 Cortex software and LEGO®® NXT 1.0, 1.1, 2.0, and G software. (Note: These robotic model kits were purchased from LEGO® Education and VEX Educational Robotics Systems.) Additional trainings are conducted to help volunteers understand how to successfully work with youth including mentor-mentee relationships and youth protection on child abuse and neglect.

The current model of the program employs certain practices to keep youth mentees engaged in the program throughout the entire year. Summer Day Camps were held in local neighborhoods throughout the counties served. These day camps were approximately 2-3 days in length. Staff recruited organizations such as schools and youth development groups that have a year-round program calendar and an established relationship with the families of their clientele. Program staff developed a competition for 4-H Techwizards youth at the County Fair during the summer. A few teams participated in FIRST® LEGO® League competitions in November 2011. Some 4-H teams found the robotics challenges and science presentations to fulfill the wishes of youth to expand their study of STEM beyond robotics.

In addition, program staff (Jolene Arnold and Pam Kelly) designed robotics competitions featuring the LEGO®® NXT Mindstorm that required youth to design and build a robot to accomplish a challenge and conduct a science experiment as a team. A partnership occurred
with Case International Harvesters who hosted the event for three counties at their training facilities. The entire planning was approximately three-months to finalize the challenges (robotics and teamwork) challenge. 4-H Teams from the three Southeastern Wisconsin Metro Counties were transported to attend the event in Racine.

The robotics challenge was adapted from a challenge from the Wisconsin 4-H Robotics Rally 2011 Staff Implementation packet using low cost materials for building the robotics challenge. For example, poster board was used for the playing surface and outlined play boundaries with electrical tape. Team building was the second challenge adapted from two lessons from Junk Drawer Robotics Curriculums. In one lesson, youth built a paperclip car and tested the friction of the car’s wheels. In the second lesson, youth designed and tested a trebuchet catapult (University of Nebraska, 2011). For the teamwork challenge, youth respond to questions based on the team’s ability to solve a mechanical science design problem. The competition provides newer sites with a context for practicing robotics programming and design as a team.

Strategies used by program staff to recruit and sustain adult volunteer mentors. Program staff established a partnership with institutions of higher learning to recruit college or university students majoring in STEM professions. The program’s on-campus partnerships include service-learning offices and student organizations with an engineering and science focus. Local STEM businesses endorsed the program by donating financial support and promoting the volunteer opportunity with their employees. Companies who support the program in Wisconsin currently include CASE IH, 3M, and Time Warner Cable. Trainings currently are being conducted with adult volunteers on 4-H Robotics Mechanical Science Curriculum, the LEGO® NXT® Mindstorm robotics platform program software, and VEX® Robotics Systems kits/software.

**METHODOLOGY**

Currently, an evaluation is being conducted with adult mentors, parents/guardians, and youth mentees. The evaluation is in the form of a questionnaire which was distributed in May 2012. Evaluation results from each county will be combined with surveys from other counties after all questionnaires are received in mid-June 2012.

Adult mentors are surveyed regarding the development of the mentee/mentor relationship, professional growth of mentors, their motivation of volunteering, and their opinion of the program’s implementation. The program’s implementation relies strongly on three factors including volunteer training on the role of a mentor and robotics programming/planning, access to curriculum and other resources, and support provided by the Wisconsin 4-H Youth Development program staff.

Youth mentees are asked how their confidence has grown in their social skills, robotics building/programming abilities, self-esteem, and use of technology as a result of their participation in the 4-H Techwizards program. Youth are also asked to establish goals for their involvement in the program, identify their future job or career preferences as adults, and their definition of teamwork. Youth data is collected using a Likert Scale. This data will be disaggregated by the mentees’ demographic information. To further evaluate the program’s effect on youth, guardians and parents are asked to identify their perspective of the mentor/program’s influence on their children’s self-confidence, higher education goals, excitement about science, and attendance at school. This survey formats questions in the
form of a Likert Scale and Open Ended questions.

In January 2012, the first collection of data from youth mentees was collected from a questionnaire given at the 2012 4-H Techwizards Robotics Rally Competition held at Case IH Training Center in Racine, Wisconsin. The findings from this event are reported in the next section and Table 1.

**FINDINGS**

Approximately, 38 4-H Tech Wizards Youth from Kenosha, Milwaukee, and Racine Counties participated in this event. Youth competitors are between the ages of 8 and 15. There were 40% male, 34% female, and 26% of youth who did not answer this question present. Youth identified themselves in the following ethnic and racial groups: 16% Hispanic, 5% American Indian or Alaska Native, 13% Black or African American, 13% Mixed Race, and 37% White. 32% of youth did not select an answer to identify their ethnicity or race.

Youth had positive feedback in regards to the competition’s design and execution. 84% of survey participants indicated the robot challenge’s level of difficulty was “about right” for their current skill level. 84% of participants also said the information and registration packet had enough information to help teams prepare for this competition. Youth were divided on the amount of time needed to prepare for the competition as 55% of participants felt they had “enough time” and 39% of respondents needed more time to prepare. The charts indicated youths’ responds to statements about changes in the mentees’ level of confidence with engineering design and technology. In addition, youth reported changes in their interest to further study STEM and robotics, and the growth of their confidence to work as a team member.

The following equation is used to calculate the percentages reported in the findings section. The number of each response rating on Table 1 (excellent, very good, good, fair, or poor) is divided by the total number of responses (38). The sum is multiplied by 100 to provide an accurate percentage of each response.

| Table 1: Changes In the Youths’ Level Of Confidence with Engineering Design and Use of Technology/Robotics Kit Including Changes In Youth’s Interest In STEM and Robotics & Confidence in Teamwork

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University of Wisconsin-Stout  July 16-17, 2012
### NOW After the Robotics Rally, I would rate my knowledge or skills:

<table>
<thead>
<tr>
<th>Ability</th>
<th>Excellent</th>
<th>Very Good</th>
<th>Good</th>
<th>Fair</th>
<th>Poor</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Ability to program a robot</td>
<td>12</td>
<td>13</td>
<td>8</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>2. Ability to design and build</td>
<td>16</td>
<td>7</td>
<td>12</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>3. Comfort level using a computer</td>
<td>20</td>
<td>8</td>
<td>8</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>4. Ability to view a robotic challenge</td>
<td>14</td>
<td>9</td>
<td>10</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>6. I want to participate in future Robotics Rallies</td>
<td>29</td>
<td>7</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>8. I can work well in a team</td>
<td>20</td>
<td>17</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>9. I want to take more science and technology classes in school</td>
<td>21</td>
<td>13</td>
<td>4</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>10. I feel I can communicate about robotics to others</td>
<td>17</td>
<td>17</td>
<td>2</td>
<td>2</td>
<td>0</td>
</tr>
</tbody>
</table>

### BEFORE preparing for the Robotics Rally, I would rate my knowledge or skills:

<table>
<thead>
<tr>
<th>Ability</th>
<th>Excellent</th>
<th>Very Good</th>
<th>Good</th>
<th>Fair</th>
<th>Poor</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Ability to program a robot</td>
<td>2</td>
<td>5</td>
<td>14</td>
<td>10</td>
<td>6/1</td>
</tr>
<tr>
<td>2. Ability to design and build</td>
<td>9</td>
<td>3</td>
<td>11</td>
<td>8</td>
<td>6/1</td>
</tr>
<tr>
<td>3. Comfort level using a computer</td>
<td>12</td>
<td>4</td>
<td>11</td>
<td>9</td>
<td>2</td>
</tr>
<tr>
<td>4. Ability to view a robotic challenge</td>
<td>5</td>
<td>7</td>
<td>11</td>
<td>11</td>
<td>4</td>
</tr>
<tr>
<td>6. I want to participate in future Robotics Rallies</td>
<td>8</td>
<td>11</td>
<td>15</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>8. I can work well in a team</td>
<td>7</td>
<td>18</td>
<td>10</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>9. I want to take more science and technology classes in school</td>
<td>9</td>
<td>11</td>
<td>13</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>10. I feel I can communicate about robotics to others</td>
<td>8</td>
<td>10</td>
<td>11</td>
<td>7</td>
<td>0</td>
</tr>
</tbody>
</table>

### SUMMARY

So far, the findings of this event’s evaluation indicate that the 4-H Techwizards Robotics Rally has built up youths’ interest in STEM and robotics educational programs as well as a growth in their confidence to work as members of a team. After the Robotics Rally, 93% of youth strongly agreed or agreed that they have a higher interest in science/technology education, increased their comfort in discussing robotics with other people, improved their ability to work on a team, and a desire to participate in future robotics rallies. Prior to the event, only 45% of youth strongly agreed or agreed to these same statements.

In addition, the Robotics Rally indicated a positive change in the youths’ confidence with engineering design and their use of technology. Before the event, 69% of youth rated their knowledge of robotics programming and designing, problem solving skills, and increased or expanded their ability to use a computer as between good to poor. After the rally, 68% of
youth ranked their knowledge and skills of these same competencies between excellent to very good.

More progress will be reported after the Robotics Rally evaluations are compared with data gathered at the conclusion of the year-long program in mid-June 2012.

Note: These findings are the result 2 to 3 months’ of work as teams prepared for this event with their mentors.

In addition, another survey is currently being administered with adult mentors, youth leadership, youth mentees, and parents/guardians of youth mentees. The survey covers the methods to develop a mentor/mentee relationship, youth’s self-concept, and the development knowledge/skill sets of the robotics-engineering program. Below is some early data results from the adult mentor and youth mentee surveys. Please note that these results are subject to change when all surveys are complied.

Table 2: Preliminary Results of the Mentor Survey

<table>
<thead>
<tr>
<th>Adult Mentor Perspectives On The Program</th>
<th>(Quotes From 4-H Techwizard Mentors)</th>
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</thead>
<tbody>
<tr>
<td>Strengths of the Program</td>
<td>“I have gained experiences with leading youth.”</td>
</tr>
<tr>
<td></td>
<td>“The most helpful thing about the program is the mentor training.”</td>
</tr>
<tr>
<td></td>
<td>I learned “how to interact with mentees and how to be aware of children who may be experiencing negativity in their homes.”</td>
</tr>
<tr>
<td>Ways to Improve the Program</td>
<td>Volunteers should receive “more training on the [robotics] subject.”</td>
</tr>
<tr>
<td></td>
<td>Volunteers should be able to “interact with kids [in the program] outside of robotics.”</td>
</tr>
</tbody>
</table>

Table 3: Preliminary Results of Youth/Mentee Survey

<table>
<thead>
<tr>
<th>Feelings Youth Report About Themselves</th>
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Response Rate | Response Statement
--- | ---
88% | Youth strongly or slightly agreed that they feel very proud of themselves.
71% | Youth strongly or slightly agreed that they feel useful.
100% | Youth strongly or slightly agreed that they were important as other people in society.

Youth’s Feelings: Science, 4-H Techwizards Program, and the Program’s Mentors

Response Rate | Response Statement
--- | ---
76% | Youth strongly or slightly agreed that they have skills that will be useful in a job one day.
100% | Youth strongly or slightly agreed that the content learned in school is useful in their futures.
76% | Youth strongly or slightly agreed that the mentor understands them.
47% | Youth strongly or slightly disagreed that the mentor’s expectations of them were too high.

The following equation is used to calculate the percentages reported in the summary section. The number of each response rating on Tables 2 and 3 (strongly agree, slightly agree, neutral, slightly disagree, or strongly disagree) is divided by the total number of responses. The sum is multiplied by 100 to provide the percentage of each response. Sometimes, two ratings were added to showcase the total number of responses whom agreed or disagreed.

These findings indicate that the mentor resources and trainings provided by our offices are well-received by children in the program who feel supported by their mentor’s relationship. Mentors prefer to have more one-on-one interactions with the students, and feel that they could provide a more enriching experience by receiving more subject area and instructional methods trainings on robotics platforms and robotics education.

**FUTURE WORK/RESEARCH**

Once the year-round survey data from all audiences is collected, a larger body of research will be established to evaluate the accomplishments and shortcomings in the first-year of implementation. This data and the youth/mentor’s demographic data for the year-round program will be added to the paper’s findings and summary in mid-June 2012. As of today’s publication date, our organization is still compiling data which will be presented at the ASQ STEM Agenda Conference in July 2012 with the final findings. The program will officially conclude as the end of the 2011-2012 school year in June. These recommendations will be used to strengthen the program’s ability to provide positive development experiences for youth and professional development opportunities for adults during the program’s implementation for the 2012-2013 School Year.

In 2012, program staff will introduce robotics platforms such as VEX® Robotics Systems and Seaperch® kits that are appropriate to retain upper middle school and high school students in the program. Older youth (7th grade and older) perceive these two robotics kits to
be more advanced while they feel that LEGO® NXT Mindstorms are “toys” for younger children.

ACKNOWLEDGMENTS

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This program is conducted in partnership with the United State Department of Agriculture and the University of Wisconsin-Extension: Wisconsin 4-H Youth Development along with UW-Extension staff and volunteers from following Wisconsin counties: Crawford, Kenosha, Milwaukee, and Racine. A special thanks to the 4-H Youth Development Educators John de Montmollin (Kenosha County), Amy Mitchell (Crawford County), and Tracy Strother (Racine County) for their leadership in this program.

Special thanks to the following local businesses and institutions of higher learning that have supported the program’s growth in a variety of ways: CASE International Harvesters Agriculture, Gateway Technical College, 3M (Minnesota, Mining, and Manufacturing Company), Time Warner Cable’s Connect A Million Minds Campaign, Safe Alternatives for Youth Foundation, and the University of Wisconsin-Milwaukee’s Service Learning Institute.

REFERENCES


AUTHORS’ INFORMATION
Joanna Skluzacek, Ph. D. leadership’s includes her providing primary leadership for the following 4-H Youth Development programs: 4-H Project Lead the Way Coordinator, statewide leadership for STEM (Science, Technology, Engineering and Mathematics) projects, and National & Regional SET Liaison. She is also the Primary Investigator for the Wisconsin 4-H Techwizards Mentoring Program Grant. Contact her at joanna.skluzacek@ces.uwex.edu

Michelle Gonzalez’s role is to provide primary leadership for the 4-H Community Club program and oversight for financial and volunteer management. She serves as the co-chair of the Wisconsin 4-H Robotics Committee. She also works collaboratively with community partners to implement the 4-H Techwizards (Robotics) Program and Innovative Pre-College STEM program with youth in Milwaukee County. Contact her at michelle.gonzalez@ces.uwex.edu

Jolene Arnold oversees recruitment and training of robotics Mentors from the local community businesses, schools, and universities. She works collaboratively with Pam Kelly in designing, planning, and organizing the off-season competitions such as the 2012 Wisconsin 4-H Techwizard Robotics Rally. Contact her at jolene.arnold@ces.uwex.edu

Pam Kelly oversees recruitment and training of robotics Mentors from the local community businesses, schools, and universities. She works collaboratively with Jolene Arnold in designing, planning, and organizing off-season competitions such as the 2012 Wisconsin 4-H Techwizard Robotics Rally Contact her at Pam.Kelly@goracine.org