

CAMP GEMS (A success story)

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Abstract

Girls in Engineering, Math, and Science (GEMS) is a 4-day, 3-night residential summer camp for girls entering the 7th or 8th grades. The camp was begun in 1996 at Ohio Northern University and has been held each summer for seven years. Its objectives have not changed over the years. These objectives have been for the campers to discover the fun of math and science, to develop critical thinking skills, to reduce math and science anxiety, to look at career options that use math and science, to provide an introduction to the profession of engineering, and to provide positive female role models.

The camp is limited to 48 girls, 6 groups of 8. The camp is multidisciplinary with university faculty from the areas of civil, computer, electrical, and mechanical engineering, physics, biology, chemistry, technology and math all taking part as instructors for the many workshops. Because of our strong Pharmacy College, a pharmacy workshop has also been added. Each of the days is full, starting with their first workshop at 8 am, immediately after breakfast, and usually ending at 10 pm with recreation or speakers in the evenings. Each workshop typically runs 1 hour, but some are scheduled for one and one-half hours. Activities range from a bridge design competition to making bubble gum. The camp culminates with an awards banquet on Friday evening when the parents come to pick the girls up.

An integral part of the advertising and recruitment process has been the American Association of University Women branches across the state. The cost of the camp, which is \$225, is covered for some of the girls by sponsorships provided by AAUW branches. There are normally two counselors per 8-person group who spend all day with the campers and even sleep in the residence halls with their group. These counselors are recruited from the female students on campus who are majoring in the areas of science, math, engineering, or pharmacy.

Surveys have been distributed to the parents of the first four years' graduates of the camp – who have since graduated from high school. There was about a 44% response from these surveys. Results from these surveys on how Camp GEMS affected the girls' decisions about high school courses and college majors are discussed in the paper.

Introduction

Ohio Northern University (ONU) is a 3275 student, private, United Methodist affiliated, liberal arts university. The university is known for its solid educational programs and offers undergraduate majors in the Colleges of Arts and Sciences, Business Administration,

Engineering and Pharmacy (which graduates students with a Pharm D degree) and graduate programs in Law and Education.

Historically, female enrollment in the ONU College of Engineering has remained steady at about 14% of the college. In an effort to increase the number of females considering engineering as their chosen field, ONU Professor, Dr. Lee Grismore, shared his vision of a summer camp for girls related to engineering and mathematics with others within the college and outside of it. The idea of a summer camp had been discussed in the electrical engineering department and the college for several years. Studies by the American Association of University Women¹ (AAUW), Girls, Inc.² and others indicated that opportunities were needed to help middle school age girls overcome math and science anxiety. AAUW is an organization founded in 1881 that promotes education and equity for all women and girls, lifelong education, and positive societal changes.³ Girls Inc. is a national nonprofit organization dedicated to inspiring all girls to be strong, smart, and bold.²

The idea was, if the girls enjoyed math- and science-related activities, perhaps they would continue to take math and science courses at the high school level and beyond. This seemed especially important since research showed that taking Algebra I and Geometry early in high school was a major predictor of a student's continuing to college.⁴ In mid-1995, members of the ONU Engineering Advisory Board became actively involved and helped to create a basic model for the program.

In November 1995, Dr. Lee Grismore and a group of ONU female engineering students met with AAUW representatives in Lima and presented their outline for a camp along with data supporting the creation of the camp. The goal was to operate the camp in late summer of 1996. Similar programs at Denison University in Ohio (an AAUW/Ohio camp called Be Wise), Girls Inc. (SMART Programs²) and ONU's own 4-H Space Camp were investigated. AAUW branches in Ohio worked closely with ONU and were happy to share their experiences from the Denison camp and others like it.

Since the inception of Camp GEMS, additional research has been done over the years to determine how the camp fits into the many offerings available to young people. Ohio Northern University is located in a rural county where 80.6% of the residents are high school graduates but only 11.4% of the population has a Bachelor's degree or higher⁶. Exposing middle school age students in this area to a college campus is beneficial as many of their parents did not attend college. Additionally, helping these students and their families learn about technical career alternatives has also become important as the number of jobs in the agricultural and manufacturing fields has declined⁶. A search of the ASEE K-12 Science and Math Education website⁷ and others like it allows a comparison of our camp to others being offered in various parts of the country. For example, a similar camp offered at the University of Illinois at Urbana-Champaign called G.A.M.E.S. Camp⁸ (Girls' Adventures in Mathematics, Engineering and Science) is designed for 7th and 8th grade girls. It is similar to Camp GEMS in that it is designed to interest young women in the fields of engineering and science. Like Camp GEMS, campers are involved in demonstrations and hands-on activities related to engineering. Unlike Camp GEMS, it focuses on one particular area within engineering, structures, and it also includes a week-long project component. Other camps that are similar to Camp GEMS include the Science

Technology & Engineering Preview (STEPS) program at the University of Wisconsin – Stout⁹ which is supported by the Society of Manufacturing Engineers and is replicated at other locations in Wisconsin, Michigan and Minnesota and the Girls Researching Our World (GROW) program at Kansas State University¹⁰. Again, these programs emphasize hands-on activities related to careers in engineering and science with the goal of increasing the number of women entering these fields.

The first Camp GEMS was structured as a 3-day, 2-night residential camp in August, 1996, with a goal of 30 campers. Topics and projects at the camp promoted majors in engineering and other technical areas. Twenty-six campers came the first year and experienced activities in the areas of civil engineering, mechanical engineering, electrical engineering, chemistry, mathematics and physics. Additionally, the girls built their own circuit boards and hot air balloons, went stargazing and interacted with industry through activities moderated by professional women. Ten ONU female students acted as counselors for the camp and alumni and faculty assisted with class sessions and industry interaction.

Since that time, Camp GEMS has been held each summer with enrollment varying between 30-48 campers each year. Additionally, the length of camp was increased to accommodate additional activities in technical areas and to address the desires of the faculty, campers and their parents. The camp is structured such that campers are divided into 6 groups with up to 8 campers and 2 counselors in each group. These groups follow the GEMS theme, having names such as Amethyst, Emerald, Garnet, Ruby, Sapphire and Turquoise. These groups attend individual “classes” together during the day and are housed near one another in 2-person rooms in ONU residence halls. All campers and counselors are housed in the same residence hall and the majority of activities take place on campus. Specific objectives for the campers include the following:

- To discover that doing mathematics and science is fun
- To develop critical thinking skills
- To reduce mathematics and science anxiety
- To expand mathematics and science career expectations and options
- To provide an introduction to the profession of engineering
- To provide positive career role models

Participants

To attend camp, girls must be entering either the 7th or 8th grade in the fall following the completion of Camp GEMS. Campers are given the opportunity to meet other girls, usually from Ohio or surrounding states and gain self-confidence through hands-on activities and experiments. They associate with camp counselors who are students at ONU majoring in engineering, pharmacy, math or the sciences. These mentors help the girls assess their own values, set goals, and give them first-hand knowledge of career opportunities. The camp is for all girls, not just those with high academic excellence and/or involved in enrichment programs. The camp especially wishes to attract the average, college-bound girl who may or may not pursue math and science classes without a “gentle push” from this kind of activity.

The majority of campers come from rural communities in Ohio but a few are from larger metropolitan areas such as Columbus or Cincinnati. Campers are recruited in several ways. In January each year, direct mailings are made to over 400 junior high/middle schools in the state of Ohio that are within a two-hour drive of Ada with additional mailings made to AAUW branches in Ohio. Math and science teachers and AAUW members are excellent recruiters for the camp and help to identify girls who would benefit from the experience. AAUW branches often sponsor (monetarily) campers to further encourage their participation. Advertisement for the camp additionally includes mailings to past campers and their families, news articles pertaining to the camp released to local newspapers and radio stations, interviews on local television stations regarding the camp and talks at schools and/or to community groups who have requested information on the camp. Recruitment continues until the camp maximum (48 girls) is reached. Currently, about half of the girls are sponsored (partially or in whole) by some outside source. AAUW branches in the state of Ohio are our primary source of support but companies, school districts, charitable organizations and private citizens also assist campers in attending each year.

Counselors and faculty are recruited approximately 6-9 months prior to the start of camp. Both counselors and faculty volunteer their time to assist with camp. Payment for counselors is in the form of a token gift and all expenses paid during the week (i.e. expenses for supplies, t-shirts, food, lodging, etc.) while faculty receive a gift (i.e. dinner for two at a local fine-dining establishment) and reimbursement for all supplies.

Counselors are female students who are studying engineering, pharmacy, mathematics or the sciences at ONU. A letter containing information about Camp GEMS and a counselor application is sent to each female in the above-mentioned majors during the ONU winter quarter. After a sufficient amount of counselors are identified (usually 10-12 counselors for 48 campers), meeting dates and training takes place during the spring academic quarter. Counselors are responsible for their group of campers and for ensuring that all campers attend all activities.

Activities

Activities include hands-on activities in engineering, mathematics and science. In general, ten ONU faculty and several staff members assist with the operation of the camp as classroom activities include sessions in civil, electrical and mechanical engineering, biology, mathematics, technology, chemistry, physics and pharmacy. Additionally, two projects are typically completed. One of the projects is a soldering project where the campers complete a circuit board design with LED "blinking" lights. The other project varies but generally involves building an item either in the machine shop or classroom as part of a competition.

Each day of camp is slightly different. Campers arrive on a Tuesday afternoon and stay until Friday evening. Tuesday is used as a day to get acquainted with those involved in the camp and to complete some small projects. On this day, each 8-camper group completes a banner, which identifies their group. Prior to completing their banner, each group must create a plan for their banner that is then shared with their counselors and "approved". This is similar to gaining approval from a supervisor for completing a project at work in a certain manner. If changes have to be made to the plan during the process of creating the banner, the group must create a change order and attach it to their plan. The banners are displayed on the last evening of the camp for

parents and friends to view with one group winning a prize for how well they followed their plan and another for capturing their group's "personality" the best. Table 1 shows a typical overall schedule for one group of campers.

Table 1.
Typical Schedule for One Group of Campers

<i>6:00 pm</i>	Tuesday Registration, Find Room, Unpack	<i>8:00 am</i>	Thursday Breakfast
<i>7:00 pm</i>	Opening Remarks, Group Photographs	<i>8:45 am</i>	Mechanical Engineering
<i>8:00 pm</i>	Evening Activities	<i>10:00 am</i>	Math
<i>11:00 pm</i>	Lights Out	<i>11:15 am</i>	Physics
		<i>12:15 pm</i>	Picnic Lunch
	Wednesday	<i>1:15 pm</i>	Games
<i>8:00 am</i>	Breakfast	<i>3:30 pm</i>	Motivational Speaker
<i>8:45 am</i>	Chemistry	<i>5:00 pm</i>	Dinner
<i>10:00 am</i>	Civil Engineering	<i>6:00 pm</i>	Evening Activities
<i>11:15 am</i>	Electrical Engineering	<i>11:00 pm</i>	Lights Out
<i>12:15 pm</i>	Lunch		Friday
<i>1:15 pm</i>	Pharmacy	<i>8:00 am</i>	Breakfast
<i>2:30 pm</i>	Technology	<i>8:45 am</i>	Soldering
<i>3:45 pm</i>	Machine Shop Project	<i>10:30 am</i>	Biology
<i>4:45 pm</i>	Dinner	<i>12:15 pm</i>	Lunch
<i>6:00 pm</i>	Evening Activities	<i>1:30 pm</i>	Afternoon Activity
<i>11:00 pm</i>	Lights Out	<i>3:00 pm</i>	Evaluations and Wrap-up
		<i>4:00 pm</i>	Pack and Prepare for Banquet
		<i>5:30 pm</i>	Banquet
		<i>7:00 pm</i>	Leave Campus

The evening activities shown in Table 1 allow the campers to interact with one another and get to know their counselors and other role models. These activities might include a trip to the local swimming pool, bowling at the on-campus bowling alley, participating in get-acquainted games, star-gazing with an astronomer, eating pizza while watching a movie, interacting with women from various technical professions, or just hanging out in the residence hall. Additionally, each year, a motivational speaker comes to camp and talks with all campers about self-esteem and goal setting during a lively, interactive session.

The wide variety of activities and the qualifications of the instructors have been two of the strengths of this camp. Departments that participate include Civil Engineering, Mechanical Engineering, Electrical and Computer Engineering, Physics, Chemistry, Technology, Math, Biology, and the ONU College of Pharmacy. A full-time college professor who develops their own hands-on activity leads each department's session. Each professor has one or two counselors (mentors) to help answer questions as the activity progresses, but he/she is always

there to direct the activity to its final conclusion. Each session, which lasts from 1 hour to 1 ½ hours, is a combination of instruction and hands-on activity. Enough theory and background information are given to make sure the girls understand the “why” behind what they are doing. In the case of the suspension bridge building, a 12-minute video was shown from the PBS “Building Big” series to give some history of suspension bridges as well as a “low-tech” understanding of how one works. However, in all cases, instruction (lecture time) is limited so that the majority of time is spent actually accomplishing a task. With most activities there is a final product that each camper takes home as a souvenir. Campers also gain experience with group projects using equipment such as a milling machine supervised by the College of Engineering shop technician.

In the middle of camp, on Thursday, an all-camp picnic is held where campers, counselors, faculty, staff and sometimes AAUW members interact. After the picnic and games, female professionals meet with the campers to share insight and advice on their area of expertise. For example, an electrical engineer describes how night vision goggles work and the campers try them out in a darkened room, an architect discusses aspects related to the design of a building and has the campers design a structure, a civil engineer teaches the basics of asphalt using the concept of no-bake cookies and a computer scientist enlists the campers help in writing a program to exit a room (and getting some somewhat hilarious results from the resulting commands that are written). Other major activities that have been incorporated when available have been activities facilitated by volunteers from the Center of Science and Industry (COSI) in Toledo, OH and activities incorporating engineers and supplies from NASA Glenn Research Center in Cleveland, OH and American Electric Power, Columbus, OH.

Typically, by the camp’s third day, faculty notice a loss of energy in some of the girls due to the combination of lack of sleep (each night, as the counselors will attest, is like a giant slumber party) and the fast pace of each day’s activities. Therefore, faculty find that a group that was very energized on the first day is a group that may need some special attention during each activity on the last day to keep them stimulated. Each group of girls, even though they usually have not known any member of their group before the camp, takes on a personality of its own and professors quickly discover what technique is needed to keep a particular group on track.

The camp ends on Friday evening with a closing banquet. Campers are asked to dress up and their families are invited to attend. Each camper receives a certificate of completion during the evening and various awards are presented for activities completed during camp. Banners are displayed for families to view and a video or PowerPoint presentation is given chronicling the events of the past week.

Evolution of the Program

Over the years, not only has the week’s schedule changed but the specific activities of each topic area have changed and evolved as well. These changes were predicated by hopes for continuous improvement in the camp (based upon campers evaluations completed at the end of each camp), but also because of the inclusion of repeat campers and our desire to make the experience unique for each camp they attended. For example, in the session on civil engineering, projects have ranged from floating boats in open channels to determine velocity of flow, observing how

suspension bridges work by building them with straws, string, and masking tape, building stepping stones using concrete mix made by the campers, and having a bridge design competition using the West Point design software.

Another change that had to be made over the years was to “spread out” the class sessions so they were not all back-to-back. This eliminated some exhaustion on the part of campers and faculty who found it difficult to stay focused for six to eight hours at a time on “technical” topics. By incorporating some group or all-camp activities in-between classes, the monotony of the days is broken up.

After the first year, it was determined that the counselors needed time for themselves sometime during camp. So after the first year, the concept of evening counselors was introduced. These evening counselors come to campus at dinnertime and take over from the full-time counselors for a few hours each evening. During those 3-4 hours, the full-time counselors are free to do whatever they want (usually sleeping is high on the priority list!) while the campers are occupied with their evening counselor monitored nighttime activities.

Evaluation of Program – Short Term

At the end of each camp, counselors and campers each complete an evaluation of the camp. This evaluation gives important feedback on the content of the “class” sessions and the overall satisfaction with activities that occurred during camp. The campers also give feedback on the length and difficulty of the “classes” and make comments on what they liked the most and least. Additionally, campers are asked about their plans to take math and science courses in school, whether they had ever attended a math/science camp previously and how they heard about Camp GEMS. All of this information is then used to improve the following year’s camp and to tailor or revise the camp’s advertising.

Satisfaction over the “class” sessions and camp activities is typically very high (usually above a 2.2 on a scale of 1.0 to 3.0 with 3.0 being “outstanding”). Campers tend to enjoy the sessions that offer hands-on activities and/or items they can take with them more than those that are primarily passive. The popularity of other camp activities varies with the camp and sometimes with the weather (i.e. like time at the pool, the picnic or activities in the dorm – which is not air-conditioned). Several years’ data has shown that the length of sessions (primarily 1 hour) is just right and that the difficulty of each session’s activities is at the right level.

Evaluation of Program – Long Term

Additional questionnaires were sent to the parents of campers who should have finished high school to determine what path they chose through high school and beyond. The first mailing in December 2001 to parents of campers who had attended GEMS in 1996 and 1997, netted a return of 41% (24/58). Parents were enthusiastic for the camp and its activities. They noted that the exposure to a college campus, the counselors and the message that science and math are “ok for girls too” were important aspects of the camp to their daughters. Of the respondents, ten campers had graduated from high school, ten campers were high school seniors and four campers were high school juniors. Over 80% of those responding took courses in physics, chemistry and

advanced mathematics. The exception in the math sequence seems to be calculus, which not all schools offer, with only 50% taking this course. Additionally, seventeen of the twenty-four respondents noted that their daughter had entered a math- or science-related field in college such as math-statistics, medicine, botany, engineering physics, network technician, architecture or engineering (chemical and mechanical were noted). Six parents indicated that their daughter's choices in high school courses and career path might have been different if their daughter had not attended Camp GEMS.

Table 2.
Survey of 1996 – 1999 Camp GEMS Participants
Courses taken (or planning to take) in High School (56 Responses)

Course Name	Number of Campers Completing
Physics	40
Chemistry	49
Algebra	49
Geometry	51
Trigonometry or Advanced Algebra	48
Pre-Calculus	43
Calculus	27

A second mailing in November 2003 to the parents of campers who had attended in 1998 and 1999 also received a fairly good rate of return at 45% (32/71). Of the respondents, six campers had graduated from high school, sixteen campers were high school seniors and ten campers were high school juniors. About 65% of these respondents took physics, 88% took chemistry and more than 84% took upper level math classes (except for calculus which was about 46%). Additionally, fifteen of the thirty-two respondents noted that their daughter had entered a math- or science-related field in college such as environmental science, nursing, pre-med, veterinarian or mechanical engineering. Twelve parents indicated that their daughter's choices in high school courses and career path might have been different if their daughter had not attended Camp GEMS. Table 2 summarizes the results of the two mailings completed for campers who had attended in 1996-1999.

Conclusion

The percentage of campers taking each high school math and science course is indicated in Table 3 along with national data from the U.S. Department of Education. This data indicates that the girls who attended camp from 1996 to 1999 completed or are completing courses in high school math and science at a higher rate than the national. The only course less than 50% is calculus and it is still much better than the national average. One reason for the lower calculus value may be due to the fact that the majority of Camp GEMS campers come from small, rural schools that often do not have the resources to offer calculus to their students. Additionally, these schools are often isolated from colleges and universities, which could afford students the opportunity to take calculus in the state's post-secondary option.

Although data at this point is limited, Camp GEMS is a success. It helps girls see that math and science can be fun, interesting and worthwhile – even when 31% of their 5th through 9th grade friends “think science is dumb”.⁵

Table 3.
Percentage of Female High School Graduates
Taking Math and Science Courses in High School

Course Name	% Nationally (1994) ⁵	% GEMS Campers
Physics	22	71
Chemistry	59	88
Algebra	68	88
Geometry	72	91
Trigonometry or Advanced Algebra	62	86
Pre-Calculus	18	77
Calculus	9.1	48

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