A Female-Only Camp for STEM Disciplines

Dr. Muhittin Yilmaz, Texas A&M University-Kingsville (TAMUK)

Dr. Muhittin Yilmaz received a B.S. in Electrical and Electronics Engineering from Gazi University at Ankara, Turkey, and the M.Sc. and Ph.D. degrees in Electrical Engineering from Pennsylvania State University at University Park. He has been an assistant professor with the Electrical Engineering and Computer Science Department, Texas A&M University-Kingsville (TAMUK) since 2007. His research interests include robust and control system optimization, model identification and validation, robotics, computer architecture, electric drives, and power electronics. He also conducts research on engineering education concepts and STEM outreach camps. Dr. Yilmaz is a member of the Eta Kappa Nu Electrical Engineering Honor Society, IEEE and ASEE.

Prof. Nuri Yilmazer, Texas A&M University, Kingsville

Nuri Yilmazer received the B.S. in electrical and electronics engineering from Cukurova University at Adana, Turkey in 1996, and M.S. and Ph.D. degrees in electrical and computer engineering from University of Florida and Syracuse University in 2000 and 2006, respectively. He worked as a post-doctoral research associate in the Computational Electromagnetics Laboratory at Syracuse University from 2006 to 2007. He is currently working as an assistant professor in Electrical Engineering and Computer Science department at Texas A&M University at Kingsville. His current research interests include adaptive array processing, signal processing, and smart antennas.

Mr. Eusebio Cuellar Torres, Texas A&M University-Kingsville

Torres earned his B.S. in Secondary Education from Texas A&M University in 1978, and then earned his M.S. in Occupational Training and his M.S. in Educational Administration Development both from Texas A&M University at Corpus Christi in 1992 and 1995, respectively. Torres was the principal at Banquete Jr. High from 2001 to 2010. Then he was a recruiter in the College of Nursing at Texas A&M University at Corpus Christi from 2010 to 2012. Torres is currently an outreach coordinator with the College of Engineering at Texas A&M University at Kingsville.

Ms. Tamara Denise Guillen, Texas A&M University-Kingsville

A Female-Only Camp for STEM Disciplines

Introduction:

Science, Technology, Engineering, and Mathematics (STEM) field student recruitment demands a need for active interventions to maintain U.S. global scientific and technological leadership[1]. Undergraduate level U.S. student characteristics have indicated lower enrollment numbers[2] in STEM related programs, up to 16% drop for engineering and engineering technology disciplines for the 1986-2006 period[3] in spite of projected engineering discipline job growth rate of above 10%[4] in the near future, and pre-college student unwillingness for science and mathematics courses[5]. Underrepresented groups including females, Hispanics and African-Americans have extended the STEM enrollment gap due to their tendency to pursue social sciences and to attend programs at two-year institutions[6] and declining engineering, mathematics and computer science enrollment numbers for the 2002-2012 period[7] for women who also indicate disproportionately low engineering enrollment at the graduate level[7]. Although interest development on mathematics and science is targeted to attract females to engineering[8], lack of knowledge on engineering disciplines and associated career opportunities has also been observed to partially explain female underrepresentation in engineering fields[9]. The current trend in apparent female student shortage of STEM interest can partially be mitigated by utilizing outreach activities in early stages.

High school students are the major recipients[10] of most K-12 engineering outreach camps that are proven effective to attract as well as to expose students to science and engineering disciplines[11,12]. A number of STEM camps focused on specific student clusters such as middle school female students in a day camp[13], grade-level[14] or specific minority groups[11,12] with broad engineering subject exposures. Other camps focused on specific subjects such as robotics[15] or required a camp fee[16] or minimum grade-point-average (GPA) for camp admission eligibility[17]. In addition to these camps with a broad exposure to various engineering fields, research opportunities for high school students have been utilized in engineering outreach, including camps focusing on research course templates for high school students[18], one semester hour college credit for a summer camp research experience[19], specific subject research experiences such as robotics[20] for a one-week period and biology for a six-week period[21], or eight-week research experience for participants with GPA requirements[22]. Due to the underrepresentation of female students in STEM disciplines, a number of organizations including Institute for Mathematics and Computer Science (IMACS), National Girls Collaborative Project (NGCP)[23] that is serving 38 states and Girls, Math&Science Partnership[24] that connects all stakeholders for female educational needs focus on activities to attract and retain young girls in STEM fields[25]. The IMACS organization study[25] indicates that STEM excitements for girls at early grade levels via related programs generate favorable outcomes and adult STEM-minded female mentors are effective role models. A diversified STEM camp in a university environment with almost no eligibility requirements can also contribute to the solution of the lack of female Hispanic population in STEM fields.

The current female-only Girls in Engineering, Manufacturing and Science (GEMS) camp was developed by Texas A&M University-Kingsville (TAMUK), a Hispanic serving institution with 65% Hispanic student population, to expose the camp participants to a variety of STEM subjects. The camp targeted female Hispanic students in an underserved region of Texas, a state with a

significant underserved minority Hispanic student population[26], by providing hands-on STEM exposure in university laboratories with close faculty-student interactions and eliminated many similar camp restrictions such as a camp fee or grade-level eligibility, except the one based on the participant age that was imposed by the sponsoring agency, to reach out potentially promising female students both in urban and rural areas. This paper describes a STEM summer camp for middle and high school female students and evaluates the camp effectiveness. The camp surveys imply that the hands-on camps with major supporting educational components may have a significant impact on student perspectives of STEM fields and associated career choices.

The GEMS Camp:

This day-camp goal was to attract and retain female middle and high school students to all STEM fields. The GEMS camp provided a week-long intensive hands-on learning experience on various STEM subjects for teams of three or four female students under close faculty and graduate assistant supervision in the TAMUK laboratories. The camp participants were divided into eight teams and were rotated throughout the week to attend different STEM subjects. The camp took place on the TAMUK campus during July 16-20, 2012, and included 27 female students, with 25 students of Hispanic background, from a number of regional school districts, and provided a stipend to each participant to cover their camp-related expenses such as daily commuting and university housing for a number of student-parent pairs. The camp was sponsored by Texas Workforce Commission and TAMUK university offices. The GEMS camp also maintained a website, http://www.engineer.tamuk.edu/gems/index.html, for timely communications on the application process, STEM subject descriptions, tentative schedule and camp execution steps. The major parts of the camp were a) the recruitment and enrollment process, b) STEM subjects, c) the camp schedule, d) STEM presentations, e) notebook/poster preparation and competition, f) a field trip, and g) supporting educational camp components.

Recruitment and Enrollment: The camp advertisement used traditional and online sources, upon finalizing the program contract with the sponsoring agency in April 2012. Extensive recruitment activities included camp flyer and email notice distribution to parents, school officials, and Educational Service Centers (Regions 1 and 2), local school presentations, customized descriptions of camp details to parents/students/school officials via emails and phone calls, and camp flyer distribution to a foster care facility, Circle of Care in Corpus Christi, Texas. After the floating window of application period, all applications were evaluated by the camp leadership team and a total of 27 eligible middle and high school students were identified based on the camp selection criteria, as shown in Table 1. Due to the sponsoring agency age requirement, the eligibility criterion only required each prospective participant to be a Texas student between 14-21 years of age during the camp period. The prospective participants were also expected to continue in their schools during the following academic year. The camp website was heavily utilized during the recruitment and application process for public announcements with broader impacts. The application and consent forms contained all required data fields for the sponsoring agency reporting purposes and for a superior camp execution and satisfaction level such as a participant grade status. Interested students submitted a hard copy of the application package including the application forms, her transcript, her school attendance record, and her educational goal statement. The school district support on camp participant documentation was very instrumental for the faster and smoother camp admission process.

Table 1. The GEMS Camp Student Selection Criteria

	Grade Point Average	**Points** (Max. 50 Points)
Core Subject (Science, Math, English & History) GPA	70-79	20
	80-89	35
	90 +	50
Essay (Follow Directions, Organization, Stated Educational Goals, Syntax)	**Number of Elements**	**Points** (Max. 25 Points)
	4 Elements	up to 25 points
	2-3 Elements	up to 15 points
	1 Element	up to 5 points
School Attendance Record	**Attendance**	**Points** (Max. 25 Points)
	0-3 Absences	up to 25 points
	4-6 Absences	up to 15 points
	7 or more Absences	up to 5 points

STEM Subjects: A total of eight STEM projects, popular to the South Texas students, from electrical, computer, environmental, mechanical, industrial, chemical, and architectural engineering disciplines were developed by the faculty members under implicit lesson plans to expose the students to STEM fields, to promote student enthusiasm for the associated disciplines and to offer valuable insights and maximum hands-on experiences under close faculty-graduate assistant supervision for fundamental engineering concepts in daily life items:

- ***Solar Energy:*** The students explored three important factors in the production of solar power including the light intensity, the angle of exposure of a solar panel to the sunlight, and the resistance load. The teams determined the required size of a solar panel to operate a 100-watt light bulb.
- ***Robotics:*** The students studied the characteristics of the robots, and learned the V+ programming language. Also, the students developed algorithms for the industrial robot to perform specified tasks such as to draw certain shapes or to interact two robot arms.
- ***Introduction to CAD/CAM:*** Computer aided design and manufacturing are heavily used in manufacturing companies. The students learned the basic concepts and tools in CAD/CAM. The participants developed a design project and a manufacturing code.
- ***Biofuels:*** The students learned about biodiesel production via reactions between a vegetable oil and methanol to produce fatty acid methyl esters (FAME). They run the reactions in a new reactor type that contained tiny fibers where the oil and methanol reacted. In addition to chemistry, the students gained knowledge on reactor operations, crude biodiesel product analysis, and the effects of various reaction conditions on biodiesel product quality.
- ***Groundwater Quality:*** The students learned important water quality parameters such as alkalinity, salinity, concentrations of metals, naturally occurring radionuclides and conducted research on groundwater quality, including lab measurements and drinking water standard analysis.
- ***Computer Organization:*** The participants learned the theoretical and practical aspects of computer technologies such as input/output, memory and central processing units and the Bluetooth technology. The student teams led the activities and built a working computer that was verified by an image transfer via the Bluetooth technology.
- ***Discover the Product Recycle:*** The students explored the recycle value of a digital video recorder by disassembling, recording the disassembling time, measuring the mass of each component, and identifying the material of each component. Then, the participants determined the recycle value based on collected data, with a re-design to increase its recycle value.

- ***The Venturi Effect:*** The architectural concept was explained during the introduction. The teams investigated the phenomenon by taking measurements around the College of Engineering building. The teams then used their findings to model a cityspace and experimented with the placement model 'buildings' in windy conditions, created by a fan, and gauged the results.

The Camp Schedule: The five-day camp started at 7:45AM and ended at 5:30PM each day, as shown in Table 2. A booklet including the detailed camp program was prepared and was provided to all camp personnel and participants. The strict adherence to the camp timeline effectively ensured smooth execution of all camp activities. The technical activities focused on relatively short hands-on STEM subject exposures while the STEM projects provided longer, hands-on and detailed subject coverage and offered competitions.

Table 2. The GEMS Camp Schedule

Time	Monday	Time	Tuesday and Wednesday	Time	Thursday	Time	Friday
7:45 AM	Registration	7:45 AM	Check in	7:45 AM	Check in	7:45 AM	Check in
8:00 AM	Orientation, lab safety training Campus tours for parents	8:00 AM	Notebook/poster preparation Campus tours for available parents	8:00 AM	Notebook/poster preparation Campus tours for available parents	8:00 AM	Evaluation of Thursday's activities
9:20 AM	Break	8:50 AM	Break	8:50 AM	Break	8:10 AM	Field Trip
		9:10 AM	Department presentations	9:10 AM	Department presentations		
9:40 AM	Technical Activities	9:40 AM	Technical Activities	9:40 AM	Technical Activities		
11:45 AM	Lunch, Guest speaker	11:45 AM	Lunch, Guest speaker	11:30 AM	Lunch, Guest speaker	Noon	Lunch with parents, Guest speaker
1 PM	STEM Projects	1 PM	STEM Projects	12:45 PM	STEM Projects	1:30 PM	Group poster presentations, notebook judging
2:30 PM	Break	2:30 PM	Break	2:15 PM	Break	2:50 PM	University presentations to students and parents
2:50 PM	STEM Projects (continued)	2:50 PM	STEM Projects (continued)	2:35 PM	STEM Projects (continued)		
4:20 PM	Break	4:20 PM	Break	4:05 PM	Break	4:00 PM	Student Program Evaluation
4:35 PM	STEM Project Competition	4:35 PM	STEM Project Competition	4:20 PM	STEM Project Competition	4:30 PM	Awards and Closing ceremony
5:20 PM	Daily evaluation	5:20 PM	Daily evaluation	5:05 PM	Poster preparation and submission		
5:30 PM	Dismiss	5:30 PM	Dismiss	5:45 PM	Dismiss		

The *Orientation* provided all camp essentials such as the main camp policies, STEM subject camp outcome expectations, documentation and competition materials and a short speech by the Dean of Engineering, and introduced the camp personnel. The participants were trained on important laboratory safety issues and precautions during the *Lab safety training,* a prerequisite to conduct STEM activities in the university laboratories. Available camp student parents were provided a campus tour highlighting the major educational offices and physical facilities such as

computer labs and research offices. The participant teams conducted their *Technical Activities* and *STEM Projects* both inside the laboratories and outside the Engineering building with advanced technical gadgets and instruments under close faculty-graduate assistant supervision. Although the faculty-graduate assistants were present during the sessions, the student teams led the activities after the initial introduction of each subject. The *STEM Project Competitions* took place to verify the student conceptual understanding of each STEM project in the laboratory environment and were evaluated by the project faculty and graduate assistants based on the predefined judging criteria. The *Lunch, Guest Speaker* sessions provided food in mostly university dining facilities and STEM-related presentations. The *Notebook/poster preparation* and *Group poster presentations, notebook judging* sessions focused on documentation and team performances.

The camp included a number of supporting sessions to ensure smooth execution and to enhance camp outcome achievements. The *Registration* and *Check-in* of the camp participants by the camp secretary was done in the morning and the camp chaperones guided the teams to reach their upcoming activity locations. The *Break* sessions gathered all participants together in a hall with light refreshments and a student resting opportunity. Each camp participant completed a written *Daily evaluation* to provide instant feedback on the camp learning experiences and activities. Timely adjustments, if needed, were made promptly to ensure the expected camp outcomes. During the *Departmental presentations*, six representatives from various STEM departments introduced their programs to the camp participants in ten-minute interactive sessions by focusing on the nature, admission and scholarship opportunities, and career perspectives of their respective disciplines, followed by a short questions/answers session. The *University presentations to students and parents* focused on supporting educational components, i.e., housing, financial aid, and admission process. The participants completed the written and anonymous *Student Program Evaluation* that contained the questions to identify the camp impact and outcomes. The *Awards and Closing ceremony* provided recognitions for the first, second, and third place teams and educational awards presented by the Dean of Frank H. Dotterweich College of Engineering. High school representatives such as counselors, principals, and science teachers, all industry professional speakers, project poster judges and student parents were invited to the lunch on the final day of the camp for informal discussions on engineering and science careers and to all afternoon activities. Based on the sponsoring agency requirement, the student parents paid their own lunch.

STEM Presentations: Due to the female-only camp, female speakers from professional engineering fields and from academics were targeted to establish potential role models for the camp participants. During luncheons, the camp participants engaged in fruitful STEM related discussions with the speakers from TAMUK undergraduate/graduate students (5), two of whom were former TAMUK STEM Summer Program participants, a high school science teacher, a superintendent, and civil, environmental and electrical professional engineers. The main theme of the discussions and short question/answer sessions was to present STEM career insights, development opportunities and basic expectations in academic settings. A female Assistant Dean of Frank H. Dotterweich College of Engineering addressed the participants, parents, middle and high school officials, and other attendees during the keynote speech on the final day of the camp and emphasized exciting potential and rewarding nature of STEM fields. Furthermore, Electrical and Computer Science, Mechanical and Industrial, Civil and

Architectural, Chemical and Natural Gas, Environmental, and Industrial Technology departments of TAMUK orally presented their respective departments for basic scholarly requirements, STEM career opportunities and college life academic as well as financial readiness. Informal discussions among the participants and camp personnel also contributed the STEM perspectives of the students.

Notebook/Poster Preparation and Competition: The camp daily engineering project and technical activity documentation on STEM subject procedures, designs, results, and discussions was achieved via team notebooks for timely team progress. The participants received basic documentation training on scientific notebooks and poster concepts as well as all scoring guidelines, in sessions led by the dedicated camp faculty member, and prepared a poster presentation, focusing on the four engineering project content and outcomes while reinforcing teamwork, communication and writing skills. The final day of the camp provided both notebook and poster documentations to all audience members such that a large number of parents and young children were able to examine all camp materials. The notebook judging was done by the camp faculty and graduate assistants while the students attending the field trip. The team poster presentations were judged by the qualified external faculty members and students on the final day of the camp when many STEM professionals, teachers, parents and other children were present. The poster presentation judging focused on subject introduction, project description and organization, and effective presentation delivery. The notebook judging criteria focused on documented understanding of the eight STEM subjects, documentations for introduction, execution, analysis and overall organization components. Although the notebook and poster presentation competitions were announced at the beginning of the camp, the weights of each competition in the final team scores were not disclosed to ensure best team preparations for both competitions. Extensive subject discussions between the teams and the judges were very effective to score the posters and respective team subject comprehensions. The combination of notebook and poster scores was used to rank the three best teams who were also acknowledged and presented educational prizes such as scientific calculators during the award ceremony.

Field Trip: A field trip to the Celanese-Bishop Chemical Plant, Bishop, Texas, took place on July 20, 2012. The camp students were given a facility tour and industrial control room experiences, in addition to extensive interactions with professional engineers and valuable STEM-related discussions. The participants were able to explore and observe different engineering career options in real life environments. In addition, the field trip offered the camp participants to envision potential STEM careers by breaking potentially restrictive perspectives.

Supporting Educational Camp Components: The GEMS camp included a number of important supporting components for a successful execution. The participant parents were provided a campus tour by the TAMUK admission staff members, during which major institutional offices, educational and physical development facilities were introduced to alleviate potential parental anxiety for their children development options. Although the parental campus tours were planned on each day, it was observed that majority of parents were only available on the first day of the camp. TAMUK admission, financial aid, and housing office presentations on the final day of the camp proved to be very effective to prepare the students, parents, and guardians for the college life by offering STEM career perspectives, available scholarship opportunities and eligibility requirements, campus housing options and essential university

application information. The campus tours and university admission, financial aid, and housing presentations were geared towards parents such that they continue encouraging their children STEM interests. Based on the sponsoring agency requirement, all camp personnel were required to go through a Background verification process with satisfactory results. The camp personnel, led by the camp director, maintained relevant verification documentations for all faculty, graduate assistant, camp chaperones and assistants. As part of the newly issued Texas A&M University System regulation, all camp personnel were also required to successfully complete the 'Child Protection Training', available online with proper access privileges. The background verifications and required online training progress were monitored at the camp director level to ensure prospective participant safety and regulatory compliance requirements, resulting in time-exhaustive efforts due to the involvement of large number of people during the camp. In addition to the camp director, the camp secretary and student chaperones as well as assistants were proven to be very essential to implement a successful outreach program that typically required extensive paperwork and communications with all camp constituents. The camp secretary was very instrumental for early recruitment activities and arrangements for all camp activities, especially for the field trip, luncheons, STEM speakers, and university as well as departmental presentations. The chaperones and camp assistants were important to shadow the participants at all times and to prepare camp execution materials such as poster printing and visual documents for the last day of the camp. The required TAMUK university student affairs camp related preparations such as a detailed application, food service certification, and student insurance were handled by the camp director with assistance from the camp personnel. A GEMS camp T-shirt was designed and distributed to all camp students and personnel to increase the camp spirit.

The Camp Evaluations:

The camp surveys and competitions were used to quantify the camp educational outcomes. Each camp student completed the daily evaluations, about the camp performance including most and least meaningful sessions as well as potential improvements, at the end of each day with the immediate management review for potential corrective actions. The comprehensive final camp evaluation was conducted on the last day of the camp to quantify the student camp achievements, prior to the awards ceremony. As the daily surveys indicated successful camp execution and overall student satisfaction, the final camp survey verified the success of the camp to motivate students to engineering disciplines via pre- and post-camp student STEM perspectives due to the camp participation. 27 female camp participant demographics are summarized in Table 3.

Table 3. The GEMS Camp Participant Data

Category		**Number of Students**
Ethnicity	Hispanic	25
	Non-Hispanic	2
Grade Level	Freshman	3
	Sophomore	17
	Junior	3
	Senior	3
Age	Sixteen	5
	Fifteen	3
	Fourteen	19

The final survey results have strongly indicated the camp effectiveness to attract the camp students to STEM fields, as indicated by the illustrative survey data in Table 4, where the student STEM interest, especially in engineering, higher confidence in potential majors, and positively impacted opinions towards engineering are strong indicators of the GEMS camp impact. In addition, the usefulness of the information by the camp STEM speakers was also rated positively as there were 11 'Strongly Agree' and 14 'Agree' ratings. Furthermore, the notebook and poster competition scores demonstrated superior subject comprehension by student teams.

Table 4. The GEMS Camp STEM Outreach Effectiveness

Q: Because of my participation in GEMS, I would like to pursue a degree in:	Engineering	17
	Chemistry	6
	Mathematics	3
Q: My participation in GEMS increased my confidence in my choice of major.	Strongly Agree	10
	Agree	12
	Disagree	2
	Strongly Disagree	2
	No response	1
Q: My participation in the GEMS Summer Camp has changed my opinion towards engineering.	Strongly Agree	14
	Agree	12
	Disagree	0
	Strongly Disagree	1

The institutional benefits of the GEMS camp also indicated favorable results. When students were asked about their college choices before participating in the GEMS camp, there were only 3 students who indicated their educational plans to attend TAMUK. However, due to their GEMS camp participations, 20 students developed plans to attend TAMUK, i.e., a large pre- and post-camp institutional interest percentage improvement strongly implies the performance of the university recruitment efforts. The TAMUK housing, admission, and financial aid presentations were all favorably rated with a total 'Agree' or 'Strongly Agree' ratings of 25, 25, and 26, respectively.

The student status and expectations in underserved regions towards STEM-related fields were also studied in the final survey. Students were almost equally attracted to the GEMS camp due to the educational experience (19), the opportunity for hands-on training/research (19), and the prizes (16). The major obstacles to attend a college were said to be finances (14) and geographical location (7). The camp participants improved their essential skills and student engineering perspectives due to the GEMS camp such that the students favorably verified the improvements on teamwork skills (21), documentation skills (17), presentation skills (15), and writing skills (7). Moreover, the teammates are mentioned to be the most effective to improve the teamwork (19) and presentation (17) skills of the team members. The field trip educational and informative aspects were verified by 24 student ratings of 'Agree' and 'Strongly Agree' while the field trip effectiveness to steer student interest toward and enhanced engineering concepts was rated by a total of 20 'Agree' and 'Strongly Agree' ratings. Open ended survey questions also yielded valuable conclusions:

- The camp participants seem to like the hands-on and fun activities in a team environment with new concepts

- In addition to the local school visits and the camp website, online social networking mediums can reach out broader student population
- Good communication seems to be an important key for successful teams
- All STEM subjects appear to be equally important to attract female students to STEM fields, suggesting the effectiveness of outreach camps with diversified STEM subject exposures
- Robotics was suggested to be the most appealing subject to local students.

Student testimonials also indicate the camp effectiveness and satisfaction, including 'Open my eyes to new fields of engineering and showed me the practical use', 'I was interested in Pharmaceutical, but now I am interested in engineering as well. Encouraged me to try different things', 'It inspired me to go to college for engineering. Guest speakers were also inspiring', 'GEMS has been such an amazing experience. It really made me decide on what engineering to go for.', 'It has opened a whole new world for me in the engineering field', and 'GEMS has opened doors to engineering and an opportunity to participate in engineering'.

The GEMS camp execution experience also resulted in valuable conclusions. A partial overlap of the camp award notification and subsequent recruitment efforts with the Texas Assessment of Knowledge and Skills (TAKS) middle and high school exam period proved to be very challenging to reach out local school officials, teachers, counselors and students, mainly due to the middle and high school officials focusing on their own evaluations and delaying the GEMS camp submissions after the TAKS period, instead of guiding students for STEM summer programs. Moreover, many potentially eligible students were observed to have completed their summer plans before the GEMS recruitment efforts were initiated. Outreach camp presentations at local but remotely-located middle and high schools may suggest administrative or project support for personnel travel arrangements. Potential STEM speakers from prominent organizations may also suggest sufficient travel support and very early initiation of solicitations. Potential camp secretaries may need to come from inside members of the institution so that extensive timely paperwork and compliance conditions can be satisfied. A nonparticipating member of a student team causes disruptions and distractions for the other productive team members, suggesting a series of pedagogically appropriate actions to ensure the optimal team educational experience. Arbitrary non-attendance or withdrawals of prospective but committed participants results in very detrimental management and execution effects.

Conclusions:

A STEM outreach camp for middle and high school female students was successfully implemented and its effectiveness was verified by the competitions and daily as well as final surveys. The camps with broad hands-on exposure to various engineering fields in shorter durations and with a number of supporting educational components appear to significantly enhance female student understanding of STEM related perspectives and associated career opportunities.

The GEMS camp model is being utilized for future camps via potential grants from local, state, federal, and industrial institutions. The camp structure, STEM subject scope and depth are under investigation for younger student population who is at their critical stages for STEM-related career decisions.

Acknowledgments:
The GEMS camp was supported by Texas Workforce Commission and Frank H. Dotterweich College of Engineering of TAMUK. All camp personnel including faculty, students, chaperones, assistants, and staff members are acknowledged for their valuable contributions.

Bibliography

1. National Science Board, "Preparing the Next Generation of STEM Innovators: Identifying and Developing Our Nation's Human Capital", 2010, [Online]. Available: http://www.nsf.gov/nsb/publications/2010/nsb1033.pdf , Last Accessed on January 4, 2013.
2. National Science Board, Science and Engineering Indicators 2004. [Online]. Available: http://www.nsf.gov/statistics/seind04/, Last Accesed on January 17, 2012.
3. E.C. Kokkelenberg and E. Sinha, "Who Succeeds in STEM Studies? An Analysis of Binghamton University Undergraduate Students," *Economics of Education Review*, vol. 29, no. 6, pp 935-946, Dec. 2010.
4. A. Dohm and L. Shniper, "Occupational Employment Projections to 2016," *Bureau of Labor Statistics, Monthly Labor Review Online*, vol. 130, no. 11, pp 86-125, Nov. 2007.
5. J. Glenn, et. al, "Before It is Too Late," *A Report to the Nation from the National Commission on Mathematics and Science Teaching for the 21st Century*, Department of Education, 2000.
6. R. Fry. "Recent Changes in the Entry of Hispanic and White Youth into College,'' Pew Hispanic Center, Nov. 2005. [Online]. Available: pewhispanic.org/reports/report.php?ReportID=56, Last Accessed on January 5, 2013.
7. Science and Engineering Indicators 2012, [Online]. Available: http://www.nsf.gov/statistics/seind12/c2/c2h.htm, Last Accessed on January 4, 2013.
8. A. T. Jeffers, A. G. Safferman, S. I. Safferman, "Understanding K-12 Engineering outreach Programs," Journal of Professional Issues in Engineering Education and Practice, pp. 95-108, April 2004.
9. J. Gilley, J. Begolly, "Great Progress, Great Divide: The need for evolution of the recruitment model for women in engineering," 2005 American Society of Engineering Education (ASEE) Annual Conference and Exposition, Portland, OR.
10. D. Chubin, K. Donaldson, B. Olds, L. Fleming. "Educating Generation Net–Can U.S. Engineering Woo and Win the Competition for Talent?," Journal of Engineering Education, 97 (3), July 2008, pp. 245-257.
11. M. Yilmaz, J. Ren, S. L. Custer, J. A. Coleman, "Hands-On Summer Camp to Attract K-12 Students to Engineering Fields", *IEEE Trans. Education*, Special Outreach Issue, vol. 53, 1, Special Outreach Issue, February 2010, pp. 144-151.
12. M. Yilmaz, J. Ren, D Ramirez, S. L. Custer, J. A. Coleman, "An Improved K-12 Outreach Camp for Engineering Disciplines", 2010 American Society of Engineering Education (ASEE) Annual Conference and Exposition, Louisville, KY, USA.
13. S. Burkett, C. Small, C. Rossetti, B. Hill, C. Gattis, "A Day Camp for Middle School Girls to Create STEM Pipeline", 2008 American Society of Engineering Education (ASEE) Annual Conference and Exposition, Pittsburgh, PA.
14. Advancing Hispanic Excellence in Technology, Engineering, Math and Science (AHETEMS) Summer Camp at the University of Texas at Arlington. [Online]. Available: http://www.ahetems.org/pre-college/summer-camps/ahetems-scitech-summer-camp-at-university-of-teas-at-arlington/, Last Accessed on January 18, 2012.
15. R. S. Stansbury, F. Behl, "Inspiring Interest in STEM Trhough Summer Robotics Camp", 2012 American Society of Engineering Education (ASEE) Annual Conference and Exposition, San Antonio, TX, USA.
16. University of Missouri, College of Engineering, High school summer camp, [Online]. Available: http://engineering.missouri.edu/k-12/hs-summer-camp.php, Last Accessed on January 8, 2010.
17. AHETEMS CATALYST Summer Program at Cornell University. [Online]. Available: http://www.ahetems.org/pre-college/summer-camps/catalyst-summer-program-at-cornell-university/, Last Accessed on January 18, 2012.
18. Science Research in the High School. [Online], Available: http://www.albany.edu/scienceresearch/, Last Accessed on janaury 18, 2011.
19. High School Summer Science Research Program. [Online], Available: http://www.baylor.edu/summerscience/, Last Accessed on January 17, 2011.

20. M. Yilmaz, C. Garcia, T. Guillen, D. Ramirez, “A K-12 Advanced Research Camp for Engineering Outreach”, 2011 American Society of Engineering Education (ASEE) Annual Conference and Exposition, Vancouver, Canada.
21. Young Scholars Program. [Online], Available: http://ysp.ucdavis.edu/program-description, Last Accessed on January 17, 2011.
22. High School Summer Research Program. [Online], Available: http://www.seasoasa.ucla.edu/high-school/high-school-summer-research-program, Last Accessed on January 17, 2011.
23. National Girls Collaborative Project, [Online]. Available at http://www.ngcproject.org/about-ngcp, Last Accessed on January 4, 2013.
24. BrainCake, [Online]. Available at http://www.braincake.org/default.aspx, Last Accessed on January 4, 2013.
25. IMACS, “Keeping Talented Girls on the STEM Track”, (2011) [)nline]. Available at http://www.eimacs.com/blog/2011/09/keeping-talented-girls-interested-in-math-science-and-technology/, Last Accessed on January 4, 2013.
26. Advanced Placement Report to the Nation-2007, College Board. [Online], Available: http://www.collegeboard.com/prod_downloads/about/news_info/ap/2007/2007_ap-report-nation.pdf, Last Accessed on January 17, 2011.