AC 2008-510: ASSESSING THE OUTCOMES OF TWO SUMMER CAMPS AT NKU

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Assessing the Outcomes of 2007 NKU Engineering Camps

Abstract

This paper compares and contrasts the outcomes of two, one-week-long summer engineering camps conducted with mostly similar components but for two different groups of pre-college students. One group consisted of mostly male students whereas only female students constituted the second group. The outcomes of the camps were assessed to evaluate the accomplishment of the objectives of the engineering camp project which was supported by the Center for Integrative Natural Science and Mathematics (CINSAM) at Northern Kentucky University. The results of the assessments will be used to modify the program in order to maximize its efficiency in terms of the program's educational contents, its target audiences, and its outreach impacts.

Introduction

Interest is growing in the reorientation of educational programs to make them more outcome-based and results-oriented [1-4]. Outreach programs, as parts of recruitment efforts of educational institutions, are especially appropriate for outcome assessment. The results of such assessment allow evaluation of the accomplishment of the objectives and provide for fine tuning of outreach activities leading to the improvement of the quality of the educational programs.

Assessment tools used to evaluate the accomplishment of the outcomes of conventional educational programs that include class and laboratory activities may not be directly applicable to outreach programs which are not degree-based. A modification of such tools may be helpful in the evaluation of outreach programs such as summer camps intended for high school students. This is even more critical in the light of the fact that some programs such as engineering summer camps can be broad-based with a multifaceted agenda that includes exposure to science and engineering topics, hands-on activities in those fields, tours of firms and manufacturing plants and information-sharing sessions. The assessment process is even more intricate for collaborative camps in which the participants receive their training by instructors from several competitive programs including the physical sciences, pre-engineering, and engineering technology.

Recruitment efforts targeting different types of audiences may require appropriately tailored schemes that maximize their efficiency. The need for customization may become necessary for recruitment efforts intended for programs less populated by the target

audience. An engineering camp for female high schools students is an example of efforts to increase the enrollment of women in engineering programs. It is interesting to investigate the differences between the results of two similar engineering camps offered to two different groups of students, namely male and female.

This paper presents the results of assessment of the outcomes of two engineering camps offered to mostly-male and only-female student groups. These summer week-long student camps were funded by the Center for Integrative Natural Science and Mathematics (CINSAM) at Northern Kentucky University. CINSAM is a Commonwealth of Kentucky designated and supported center whose mission is to improve the teaching, learning, understanding, and utilization of scientific and mathematics information at grade levels K – 16.

The assessment tools, analysis methods, and evaluation procedures are discussed. Improvements are determined based on the results of the assessment of the outcome.

Engineering Summer Camp Objectives

- To help realize goals and objectives set in the Northern Kentucky's *Vision 2015* (a community developed strategic plan for society, business and industry, and edition P – 20 in Northern Kentucky)
- To increase the enrollment of female undergraduates in Physics, Pre-engineering, and Engineering Technology Programs at Northern Kentucky University (NKU)
- To establish ties between NKU and local high schools
- To raise public awareness about the most recent developments in the educational programs at NKU in the fields of micro-, nano-technology and biomimicking
- To disseminate scientific knowledge and technical expertise among women and provide better educational opportunities for them.

Student Learning Outcomes

Students who participated in this program were expected to be able to:

- describe the mechanical and manufacturing engineering technology program's courses, laboratories, types of training, and job opportunities
- describe nanotechnology, microelectromechanical systems, biomimetics, robotic construction using biologically inspired materials, project management
- make basic drawings, make biomimicked materials, and characterize them using optical and electron microscopy
- make a more informed decision about their choice of college

Cross Links between Among the Program Objectives, *Vision 2015,* and NKU Strategic Agenda

Cross links were established between the objectives/outcomes of the summer camps and North Kentucky *Vision 2015*: "Shaping the Future in terms of education excellence

where Northern Kentucky is expected to exceed national education performance standard at every level." Cross links were also made with the Northern Kentucky University Agenda in terms of "aggressive recruitment and retention strategies" as set forth in the "strategic priorities" described under "Strengthening the Curriculum" heading. A similar cross link was established with the action item:" "Enhance Student Recruitment and Retention" in terms of "to develop a more comprehensive and competitive plan for the recruitment of minorities and other under-served populations."

Planned Activities

Two engineering camps were planned for Summer 2007 at Northern Kentucky University in the month of July with tours, lectures, and laboratory activities spread over a period of five days. These were supported earnings from endowments held by the Center for Integrative Natural Science and Mathematics that were created for this kind of outreach activity. The camps were jointly designed by the authors of this paper and a variety of other physical science faculty members along with input from high school physics and chemistry teachers. Table 1 presents the daily activity for the camps with minor differences between the two camps. The first engineering camp was offered to all students but was filled mainly with male students (11 male and two female students attended). The second camp was offered to female students and was populated with 12 females. One difference between the two camps was a visit to the Toyota Motor Manufacturing and Engineering Plant where two models of cares are manufactured at the plant in Georgetown Kentucky for male students which were replaced by a visit to Ford Motor Company transmission manufacturing plant in Sharonville Ohio for the females. Another difference was an additional physics session for female students that replaced one electronic circuit session presented to male students.

Table 1: List of daily activities carried out during summer camps

Day	9	10:30	10:45	12	1:30	3:30
Monday	Welcome, Agenda	Break	Introduction to Eng and Sciences	Lunch	Robotic Construction	Rapid Prototyping
Tuesday	Tour of Toyota	Break	Toyota	Lunch	CNC Machining	Project Management
Wednesday	Physics	Break	Physics	Lunch	Physics	Physics
Thursday	Electron Microscopy	Break	Casting	Lunch	Tour of KLH and Cardinal	Tour of KLH and Cardinal
Friday	Welding	Break	Project Mgmt	Lunch	Wrap up, Test, Survey	Parent Mixer, Prizes

NB: KLH Engineers, Inc., and Cardinal Engineering, Inc., are local consulting firms, mechanical/electrical engineering and civil engineering, respectively, that provide practicing engineers and active projects for hands-on experiences for these camps.

Assessment Tools

To evaluate the outcomes of the two camps the following assessment tools were used:

- Student surveys at the beginning and at the end of each camp
- Written tests on subjects studied

- Projects completed (Welding, AutoCAD design, Robotic Construction , …)
- Interviews with students
- Interviews with parents
- Outside observers
- Team contest (Project Management)

Results of the Assessments

While qualitative results were obtained from the interviews and observations made by parents, students, and outside observers, quantitative results were extracted from student surveys, written tests and team contests.

Rating of Knowledge or Interest: Students rated their knowledge or interest in the subject areas on a scale of 1 to5. The same questionnaire was given to them at the beginning and at the end of the program. The percentage change in the rating was calculated. Table 2 presents the subject areas and the percentage change in the rating as marked by the students. The percentage change figure was calculated using the ratio of change in rating divided by original rating. (e.g. if original rating was 5 and final rating was 7, the percentage change would be 40%)

Table 2: Percent change in knowledge of Students

Subject	Males	Females
Change in the Interest in NKU	0	15
Knowledge of Rapid Prototyping	69	375
Electrical Circuit	37	48
Robotic Construction	60	105
Arc Welding	81	200
Eng. Materials Selection	42	59
MMET and EET	63	132
Average	50	133

The values in Table 2 clearly show an increase in the level of the knowledge or interest of students in all fields except for males' interest in NKU which remained unchanged at 5 on a scale of 0 to 10. In contrast, the interest of females in NKU rose by 15%. The percentage change in the knowledge of students about Mechanical and Manufacturing Engineering Technology (MMET) and Electrics Engineering Technology (EET) programs of NKU showed a significant increase amounting to 60% for the males and 132% for the females. On average, the percent change in the knowledge/interest of students in various fields rose by 50% for males and 133% for females.

Results of the work of students during various hands-on activities include some of the items presented in Figure 1. It is interesting to note that the best weld was made by one of the females. Casting of an aluminum anvil, milled block of aluminum, and towers made of newspaper are depicted in Figure 1.

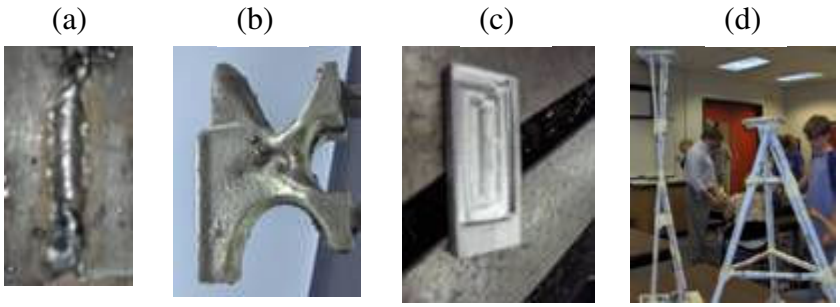

Figure 1: Outcomes of hands on activities by students: (a) Welding, (b) Casting, (c) Milling and (d) Project

The results of the survey on the activities are presented in Table 3. indicate some interesting differences in perceptions of male vs. female high school students toward the technical activities offered. In general, females rated the activities slightly higher than males. In general, females liked Materials Selection and Robotic construction and one of the plant visits more than males. However, they did not rate arc welding as high as males did. Trips to local consulting firms and their project sites were rated highest by both girls and boys.

Table 3: Rating of the Activities on a scale of 1-10

	Boys	Girls
Materials Selection	6.3	6.9
Materials Characterization	6.9	6.8
Robotic Construction	6.6	7.5
Rapid Prototyping	6.6	7.1
Welding	7.5	7.4
CNC Machining	6.9	7.4
Project Management	6.9	7.5
Ford Visit	7.5	7.8
KLH Visit	7.5	8.0
Cardinal Visit	6.2	7.4
Average	6.9	7.4

Results of the surveys on the effect of engineering camps on the selection of a career after high school are listed in Table 4. Both of the groups found the camps helpful in selecting their future career. Moreover, they found that the camps helped choose their next step in pursuing their educational goals. The average rating of the females was slightly higher than that of males. The results of career choice surveys are depicted in Figure 2.

Table 4: Effect of camp on career selection

	Males	Females
Helped select career	7.1	7.8
Helped select next step	6.2	7.2
Increased interest in NKU	5.5	6.0
Average	6.3	7.0

Testing students about materials they were taught returned average scores of 83% correct for the males and 81 % correct for the females. Scores ranged from 70-100% correct for both groups. The test was comprised of questions on the classes and laboratory exercises completed during the week.

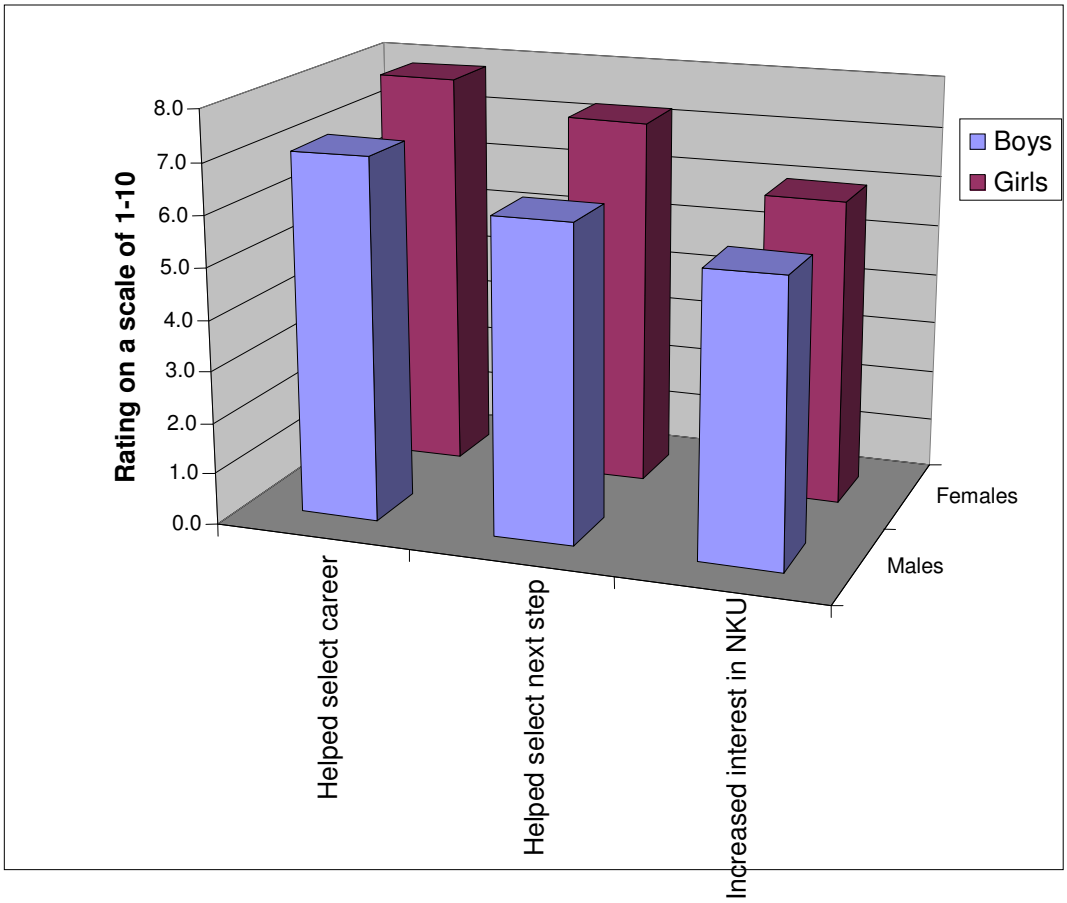

Figure 2: Depiction of the results of surveys on career selection

Discussion of Results

The results clearly show a significant difference between the males and the females when it comes to their perception of their knowledge or interest in subjects listed in Table 2. It is apparent that the females responded more strongly in expressing the increase in their knowledge or interest (nearly 2.5 times that of the males). This may indicate less exposure of females to engineering concepts or practices throughout their high school education. It is interesting to see that a construction site visit was found to be interesting (rated 7.1/10) to females while males expressed less interest (6.2/10) in that visit.

Overall assessment of students

Almost all students who attended the camps indicated their satisfaction with the quality of the activities offered. While a few indicated no change was necessary in the camp

program, most asked for a reduction in the lectures and an increase in the number of hands-on activities. Students' favorite activities included industry visits (especially to Toyota and KLH), welding, project management, and robotic construction.

Summary and Conclusions

Two engineering summer camps for mainly males and females were conducted at Northern Kentucky University. Based on the analysis of the outcomes of the two camps the following conclusions were made:

1. Both camps achieved the outcomes specified as evidenced by various assessment tools including pre- and post- camp activity surveys, tests, internal and external observations, and student contests.
2. Females seemed to show greater response in terms of the increase in their knowledge and awareness of the engineering programs, engineering concepts, hands on training, and plant visits
3. Both groups of students showed an increased level of interest in pursuing a career in engineering related fields.

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