

Improving the Aerospace Engineering Summer Camps – Student Surveys

Adeel Khalid¹

Abstract – Student feedback is used to improve the aerospace Engineering Summer Camps at Southern Polytechnic State University. These camps have been offered for the past four years. Every summer, three or four similar week long day camps are offered for middle and high school students. These camps provide hands-on experience to the students. The idea is to get them interested in aerospace engineering early in their lives. In this research, results of the student feedback are presented. Majority of the students indicate that their primary reason for attending the camp is to either learn about aerospace engineering and gain confidence in the field or obtain experience. Many of the students indicated in the pre-camp survey that they were not sure about their interest level in aerospace engineering, whereas the post camp survey showed that most of the students indicate that participation in the summer camp encouraged them to pursue a career in aerospace engineering. Similar results are presented and suggestions for further improvements are explored.

Keywords: Summer Camp, Aerospace Engineering, Middle and High School, Active Learning

INTRODUCTION

Aerospace Engineering summer camps are held every year at Southern Polytechnic State University. These camps are designed for middle and high school students. These camps have been offered every year since the summer of 2010. Over the years, the camp activities have been improved. The week long day camp includes balsa plane competitions, rocket design build fly competitions, flight simulations, unmanned aircraft system operations, and paper plane design build fly competitions, amongst other activities. For the purpose of this research, student feedback is collected for improving the camps. Students are surveyed before the camp and again after the camp. Their reasons for attending the camp and their level of interest are explored using a pre-camp survey. Information about their previous experience with aerospace is collected through an anonymous survey. The survey also reveals their level of prior knowledge about the subject. Their expectations from the camp are also collected in the survey. In the post-camp survey, students are asked whether participation in the camp helped them understand different aspects of the field of aerospace engineering. Students also give opinions about their interests and excitement level about aerospace engineering after attending the camp. The results are compared and inferences are drawn. The results also help improve the camp design for future years.

Most engineering summer programs for middle or high school levels administered at the college-level have the common purpose of exciting middle and high school students about engineering and serving as a means to attract talented students into their programs [1]. Based on the student demands and feedback, often the activities are designed more for fun than for educational purposes, and the appropriate age level is not always considered. Amongst several others, one of the goals of this camp was to find a balance between these competing priorities. Since these camps have been offered at Southern Polytechnic State University for several years, the staff and students workers have gathered information from experience to maximize the probability of success. The camp structure and activities are intended to address the following fundamental questions:

- Are these camps sufficiently interesting and instructive to maintain the attention of middle and high school students, from diverse backgrounds, without either boring or overwhelming them?

¹ Southern Polytechnic State University, 1100 South Marietta Parkway, SE, Marietta, GA. 30060, akhalid2@spsu.edu

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- Are these camps effective in communicating the fundamentals of Aerospace engineering to middle and high school students?

These questions are used as guidelines for improvements of the camp structure. All ideas and potential activities are assessed based on these guidelines. Hands-on, experimental, operational, observational and exploratory techniques can be taught and enjoyed by students of all ages [2].

THE CAMP PROGRAM

The week long summer camp starts with early morning registration and sign up. Students are given camp T-shirts and are asked to wear the same T-shirts every day of the camp. Every day activities include a few lectures mixed with hands on experimentation and several projects and competitions. In addition to the middle and high school groups, students are further divided into smaller groups of 2-3 students. They participate in all activities as groups. Camp instructions include introduction to flight, history of flight, Bernoulli's principle, parts of airplanes, types of airfoils, airplane controls and motions, types of engines, flight planning, rocket engineering, space, and astronomy among several other topics. Camp activities include but are not limited to balsa plane competitions including range, endurance and accuracy competitions, radio control rover races, boomerang competitions, radio control helicopter and fixed wing flight demonstrations, use of telescope, computer aided design (CAD), rocket design build fly competitions, paper plane design build fly range, endurance, and accuracy competitions, and student presentations. Students are also given a chance to visit various laboratories of the engineering building. Experimentation and demonstrations are done in the wind tunnel laboratory, automation and robotics laboratory, aerial robotics student competition room and flight simulation laboratory. To keep the students engaged and interested, they are given points for all activities. They compete for the top three positions in each activity. On the last day of the camp, a conclusion ceremony is conducted where all the parents are invited to attend. The overall best students are awarded with trophies, medals, and certificates. All the camp details for students and parents are posted on the camp website [3]. Several camp activities are shown in Figure 1. The camp activities are done at several locations throughout the campus including a large theater room where most of the activities are held, computer and simulation laboratory, automation laboratory, wind tunnel laboratory and the baseball field. The large theater room is essential because several functional and static aerospace related models can be placed there for lectures, discussions and engaged learning. Hands-on activities are evenly dispersed throughout the weeklong camp. Students are encouraged to get creative and build new models from balsa wood. From the principles of flight, they learn how to modify their airplanes for best endurance, range and accuracy flights. The astronomy event includes looking at the solar spots, focusing light to collect energy and basics of telescopes.



Figure 1a: Camp classroom



Figure 1b: Students building balsa airplanes

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Figure 1c: Balsa plane Accuracy Competition



Figure 1d: Astronomy event



Figure 1e: Foot race



Figure 1f: Student finishing up a model rocket



Figure 1g: Hands on activities – building rocket



Figure 1h: Setting up rockets for spot landing competition



Figure 1i: Flight Simulation activity



Figure 1j: Motion based flight simulations



Figure 1k: Computer Aided Design Competition



Figure 1l: Wind Tunnel Laboratory demonstration

To keep students active, some physical exercises and foot races are included in the camp activities.

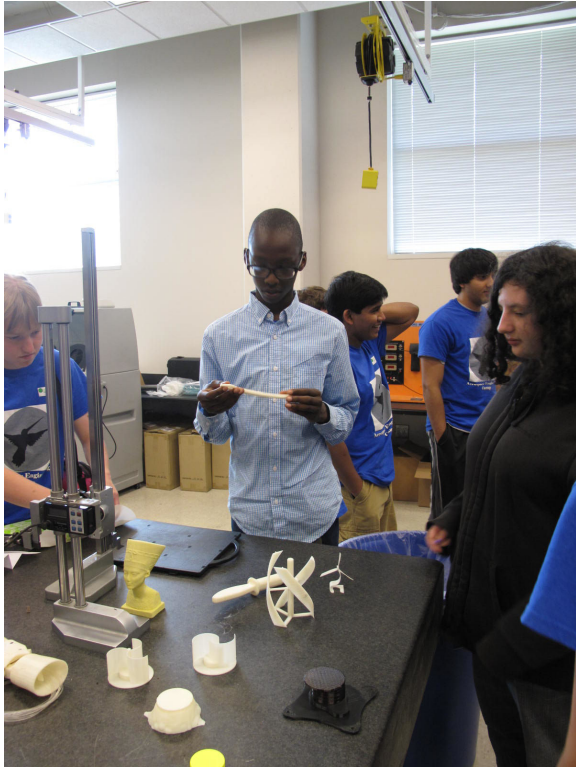


Figure 1m: 3D printing laboratory



Figure 1n: Boomerang Competition



Figure 1o: Model Aircraft Operations



Figure 1p: Prize Distribution Ceremony

CAMP SURVEY

Students are asked to fill out surveys at the beginning and end of the camps based on carefully designed survey forms [4]. These surveys are designed to gather their level of interest in the camp and analyze whether the camp got them excited about the engineering in general and aerospace in particular. Both surveys are anonymous. Both qualitative and quantitative feedback is received from these surveys. All students are encouraged to take the survey both before and after the camp.

Pre-Camp Survey

In the pre-camp survey, students are asked about their main reason for attending the camp, their level of interest in aerospace engineering, their past experiences and their expectations from the camp. This data helps understand whether the students attended the camp out of their own interest or were sent by their parents. The level of involvement and interest of students can be very different depending on their reason for attending the camp. The challenge for the camp organizers is to excite all students at the same time and keep them engaged while keeping the material simple and not turning away the more advanced students. The pre-camp survey is shown in Figure 2.



Pre-Camp Survey

Note: This survey is anonymous. Results from this survey will help us improve the camp.

1. My main reason for attending the Aerospace Engineering summer camp at Southern Polytechnic State University (SPSU) is: (Select all that apply)
 - a. Learn about Aerospace Engineering
 - b. Obtain experience
 - c. See what SPSU was like
 - d. Gain confidence in Aerospace field
 - e. Build Resume
 - f. Other _____
2. I am interested in Aerospace Engineering as a career
Strongly Agree Agree Neutral/Not Sure Disagree Strongly Disagree
3. I plan to apply to the Aerospace Engineering department at SPSU or at another institution
Strongly Agree Agree Neutral/Not Sure Disagree Strongly Disagree
4. My previous experiences with Aerospace Engineering:
 - a. _____
 - b. _____
 - c. _____
5. I expect to learn the following from this camp:
 - a. _____
 - b. _____
 - c. _____

Figure 2: Pre-Camp Student Survey

Post-Camp Survey

At the end of the camp, students are asked to take another survey. The intent of this survey is to analyze whether students are still interested in aerospace engineering after having gone through a week long camp filled with hands-on activities. This also helps analyze whether the camp encouraged them to pursue aerospace engineering as a profession. At the end of the survey, students have the option of letting the staff know what they liked and did not like about the camp. Most of the students like the flight simulations the most and want to spend more time in the simulator. Most of the students are less interested in the lectures where the theory behind flight is discussed. These surveys give the organizers plenty of data to work with to help improve the camps over a period of time. Post camp

survey is shown in Figure 2. A summary of the results obtained from the pre and post-camp surveys are discussed in the results and discussions section.



Post-Camp Survey

Note: This survey is anonymous. Results from this survey will help us improve the camp.

1. I am interested in Aerospace Engineering as a career (Circle One)
Strongly Agree Agree Neutral/Not Sure Disagree Strongly Disagree
2. Participation in the Aerospace Engineering summer camp has encouraged me to pursue a career in Aerospace Engineering:
Strongly Agree Agree Neutral/Not Sure Disagree Strongly Disagree
3. Participation in the Aerospace Engineering summer camp has excited me about Aerospace Engineering:
Strongly Agree Agree Neutral/Not Sure Disagree Strongly Disagree
4. Participation in the Aerospace Engineering summer camp has made me nervous about Aerospace Engineering:
Strongly Agree Agree Neutral/Not Sure Disagree Strongly Disagree
5. I plan to apply to the Aerospace Engineering department at SPSU or at another institution
Strongly Agree Agree Neutral/Not Sure Disagree Strongly Disagree
6. My expectations were fulfilled from the Aerospace Engineering summer camp at SPSU
 - a. Yes, surpassed
 - b. Yes
 - c. Mostly
 - d. No
7. I liked this the most about this camp:
8. What can be done to improve the camp?

Figure 3: Post-Camp Student Survey

RESULTS AND DISCUSSION

The data obtained from the camp surveys is summarized for analysis. These data proved to be both revealing and valuable and will help improve the future camps. As shown in Figure 1, overall students had a good impression of the aerospace engineering camp at SPSU. Survey results were obtained using Likert scale. This type of qualitative survey is used to score responses along a range, in this case from strongly agree to strongly disagree. For a few questions, students were allowed to select more than one answer. Students were mainly interested in aerospace engineering with 53% of participants selecting agree or strongly agree. 44% of the participants were not sure or were neutral about their interest level in aerospace engineering before the camp as shown in Figure 4. Most importantly, after the camp was over, 73% of the students indicated that they were encouraged to pursue aerospace engineering. For comparison, 70% of the students either disagreed or strongly disagreed with the statement that participation in the aerospace engineering camp made them nervous. Overwhelming number of students felt that participating in the camp provided encouragement to pursue a career in aerospace engineering or excited about the field. On the flip side, it is also worth noticing that 46% of the students did not plan on apply to the aerospace engineering department for pursuing a degree in college. Since the pool of students that come to the camp is quite diverse, this might be an indication of their overall level of interest in the field. To understand this completely, another question was asked where they could identify the areas of potential improvements. Most of the students indicated that they enjoyed the hands-on activities more than the classroom based lectures or instructions. The lectures typically involve discussions. Students are constantly kept engaged by asking them relevant questions and rewarding the correct answers with candy or other rewards. Students enjoyed the candy questions but wanted to engage more in field activities. Based on this feedback, the camp organizers will cut back on the lectures and introduce more hands-on activities for students in the future camps.

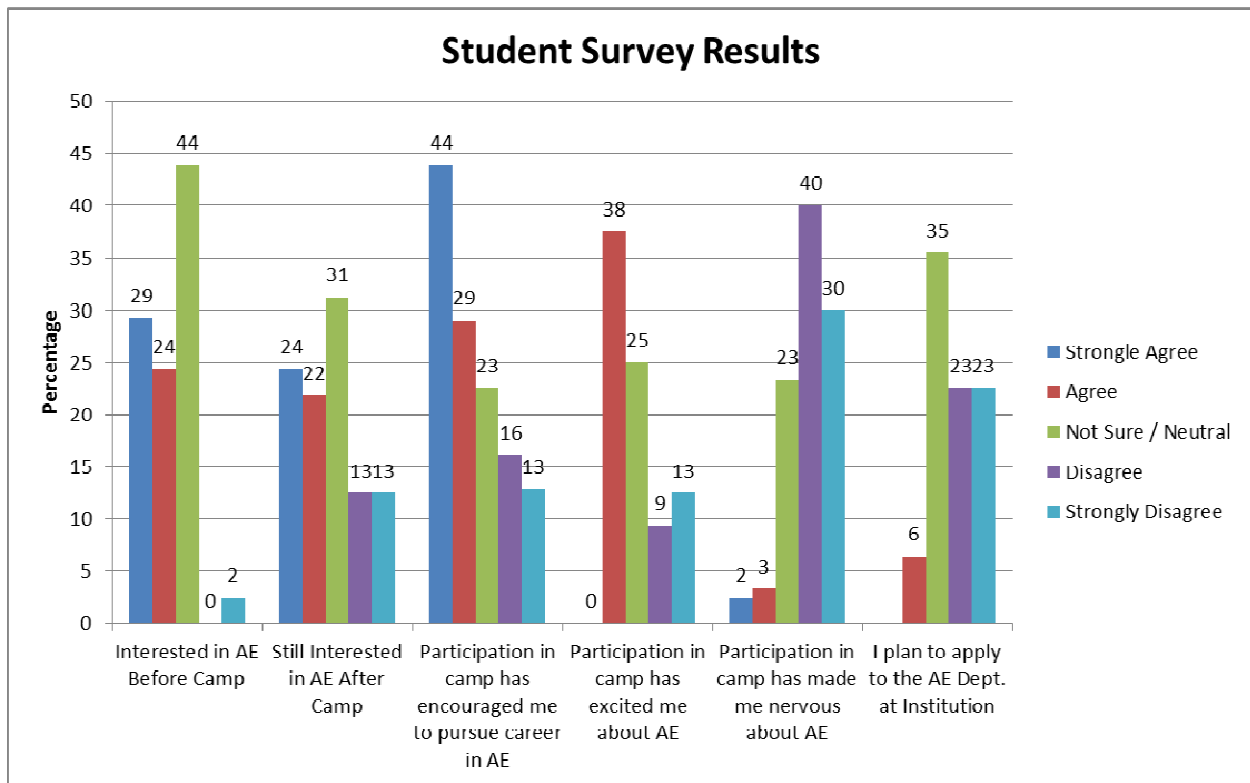


Figure 4: Summary of Student Survey Results

Information related to the reasons students decided to attend the aerospace engineering camps is shown in Figure 5. A large majority of students wanted to become more knowledgeable about aerospace engineering field. It was an open ended question where students listed one or more reasons for deciding to attend the camp. Other popular

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reasons included wanting to gain experience and seeing what SPSU was like. Additional information included in the survey related to favorite and least favorite activities, feedback on each of the projects and competitions, overall experience in the camp, and suggestions for improvements. Providing the students exposure to unique advanced research and teaching laboratories was deemed important in the initial planning of the camp. Needless to say, flying airplanes in the flight simulation laboratory, on both motion based simulator and radio controlled flight simulator were favorites. These activities provided high interactions and hands-on experience. It was important for not only the activities to be interactive but also to have the speaker being energetic and talking on the level of the students.

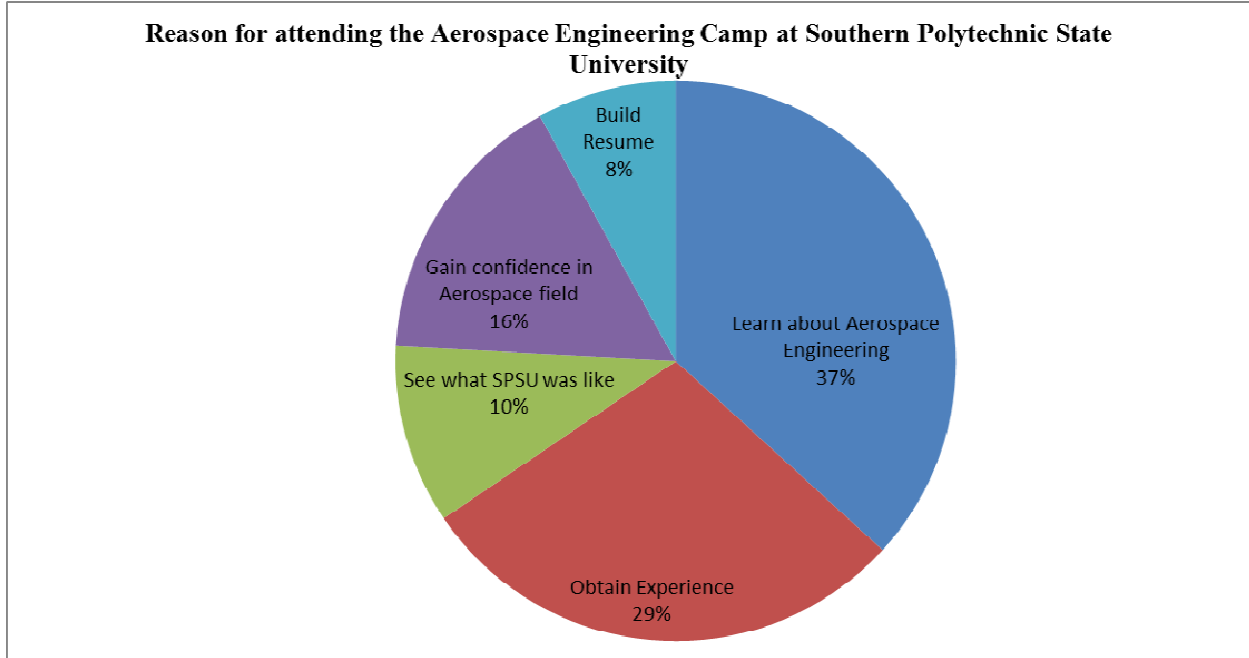


Figure 5: Student responses for reasons for attending the aerospace engineering camp

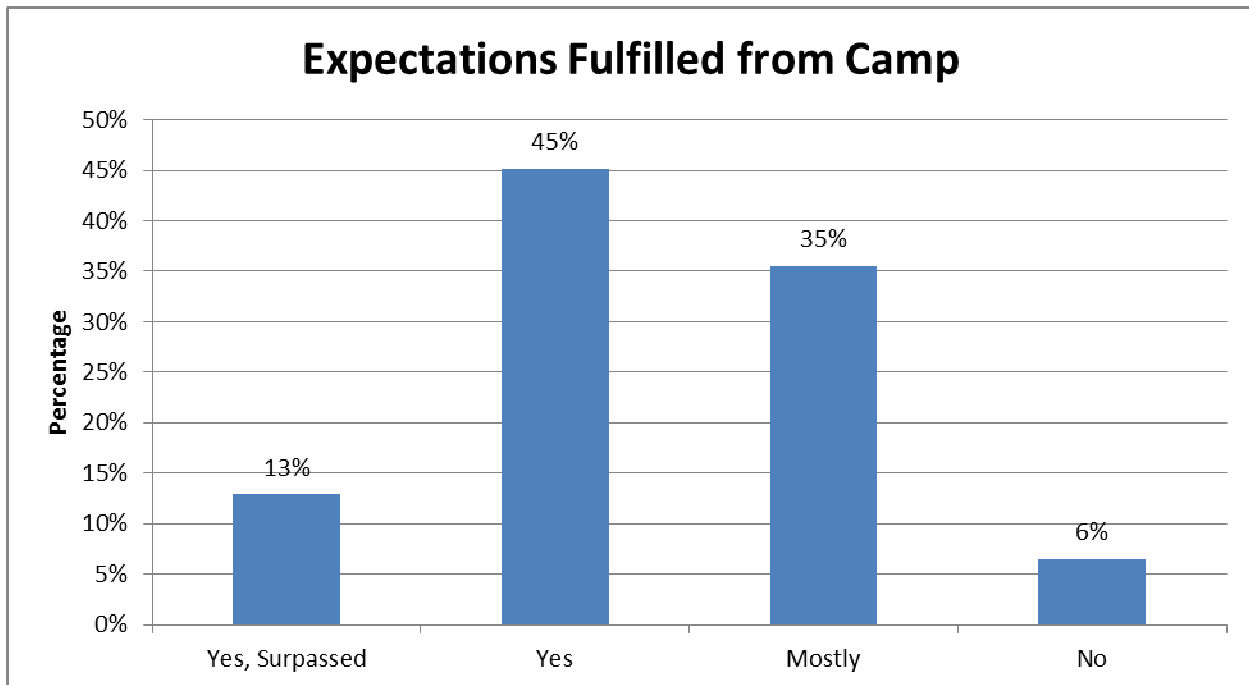


Figure 6: Student responses for the level of fulfilment of their expectations from the camp

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Students were unanimously in the approval of the hands-on projects. Having the opportunity to be creative was also a positive experience for camp participants. Students even suggested projects that involved problem solving or goal attainment and asked for more involved challenges. In addition, the students wanted more competition. There was a certain level of competitiveness built into the camp but this area can be further improved. Students also enjoyed working in teams. This was encouraging since teamwork has become an important part of the engineering education of college-level students and the engineering profession. Overall, students responded positively about their experience with the aerospace engineering camp. Survey responses indicated that over 90% of the students felt that the camp fulfilled or exceeded their expectations as shown in Figure 6. For those who were not satisfied with their experience with the camp, new ideas are being considered for future camps including pre-screening students, including more hands-on activities, field trips, and a visit to a local airport and the Lockheed Martin Marietta facility. It is expected that these activities will make the camp experience more positive for all campers.

CONCLUSIONS

Overall the camp organizers are pleased with the outcome of the aerospace engineering camps held at Southern Polytechnic State University. Through student surveys, valuable lessons are learned regarding what worked well and what needs further improvements. The primary purpose of the camp is to introduce middle and high school students to aerospace engineering and motivate them to pursue the field in college. Although a large majority of students enjoyed the camp experience and wanted to come back, there were valuable feedbacks that will help improve the future camps. The metric used to measure the success of these camps will be to track the progress of the students who have graduated from these camps and see how many of them actually pursue engineering when they enter college.

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Adeel Khalid

Dr. Adeel Khalid is an Assistant Professor of Systems and Mechanical Engineering at Southern Polytechnic State University (SPSU) in Marietta, Georgia. Dr. Khalid received his Ph.D. in Aerospace Engineering from Georgia Institute of Technology. He holds Master of Science degrees in the discipline of Mechanical Engineering from Michigan State University, and Industrial, Systems, and Aerospace Engineering from Georgia Institute of Technology.