IAC-16.E1.IP.9x33454
Costa Rica Aerospace Camp 2015: Experiences and Results

Leonora de Lemos[a]*, Andres Mora[b]

[a] *Department of Mechanical Engineering, University of Costa Rica, San Jose, Costa Rica, leonora.delemos@ucr.ac.cr*
[b] Director Technology Projects, *Central American Association of Aeronautics and Space (ACAE), andres.mora@acae-ca.org*
* Corresponding Author

Abstract

The first Costa Rican Aerospace Camp 2015 was an outreach and education activity where participants had active contact with the entire process of constructing and operating sounding rockets. It included lectures on theoretical concepts, simulation, instrumentation, and hands-on construction of the rockets, culminating with their launch. In this paper, we present the lessons learned during the organization, development, and follow-up of over 50 participating students from several technical and socio-economic backgrounds.

A first of its kind in Costa Rica, the camp was organized by the Department of Mechanical Engineering of the University of Costa Rica (UCR) and it was held from July 20th-22nd, 2015 in the campus of the UCR located in the province of Guanacaste. The main objective of the camp was to engage students in the classroom and inspire them to continue their undergraduate studies in the Science, Technology, Engineering and Mathematics (STEM) fields as well as propel them to integrate the growing cluster of aerospace companies in Costa Rica. There were over 90 participants including staff, invited lecturers, organizers, and students.

The camp attracted a large amount of national media coverage since it was the first time senior high school and freshmen university students, both female and male, from all over the country came to work together to, at the end of the camp, launch their sounding rockets with an altimeter as payload. The rockets reach up to 400 meters and after recovery their data was analyzed by the students.

In this paper, we will present the application process the students went through, the teaching methodologies applied during the camp, the data representing the background of the participating students, the outcome of the camp, a follow up on the students and the conclusions we have drawn from this initial experience and how we expect to improve it during the upcoming 2016 edition of the camp.

Keywords: Aerospace Camp, rockets, teaching methodologies

1. Introduction

The first Costa Rican Aerospace Camp 2015 was an outreach and education activity where participants had active contact with the entire process of constructing and operating sounding rockets. It included lectures on theoretical concepts, simulation, instrumentation, and hands-on construction of the rockets, culminating with their launch. In this paper, we present the lessons learned during the organization, development, and follow-up of over 50 participating students from several technical and socio-economic backgrounds.

A first of its kind in Costa Rica, the camp was organized by the Department of Mechanical Engineering of the University of Costa Rica (UCR) and it was held from July 20th-22nd, 2015 in the campus of the UCR located in the province of Guanacaste. The main objective of the camp was to engage students in the classroom and inspire them to continue their undergraduate studies in the Science, Technology, Engineering and Mathematics (STEM) fields as well as propel them to integrate the growing cluster of aerospace companies in Costa Rica. There were over 90 participants including staff, invited lecturers, organizers, and students.

The camp attracted a large amount of national media coverage since it was the first time senior high school and freshmen university students, both female and male, from all over the country came to work together to, at the end of the camp, launch their sounding rockets with an altimeter as payload. The rockets reach up to 400 meters and after recovery their data was analyzed by the students.

In this paper, we will present the application process the students went through, the teaching methodologies applied during the camp, the data representing the background of the participating students, the outcome of the camp, a follow up on the students and the conclusions we have drawn from this initial experience and how we expect to improve it during the upcoming 2016 edition of the camp.

The paper is organized as follows. Section 2 describes the admission process and requirements to

participate. Section 3 describes the profile and background of the admitted students. Section 4 presents the methods used and the activities done during the camp. Section 5 describes the results obtained at the end of the camp and a follow up of some of the students after the camp finished. Section 6 presents the fundraising process and the collaboration established between the UCR and multiple institutions, both public and private and the media exposure the camp had at a national level in Costa Rica. Finally, Section 7 presents the lessons learned and the outlook for the second edition of the camp during the summer of 2016.

2. Admission Process

The organization of the event was handled by three main professors of the department of mechanical engineering of the UCR led by Prof. de Lemos. The idea propelling the camp was to serve as motivational activity for students about to finish their high school and those who were enrolled already in a university regardless of their major being in the STEM fields or not. As such, the students interested in participating in the event had to show a number of qualities: independent but able to work in a team, extremely proactive, creative, have a basic understanding of mathematics and physics, and being able to communicate effectively and to a large audience.

Having this in mind, the organizers defined an admission process consisting in the following set of requirements:

1. Submission of an application form stating general information about the participant and his/her background.
2. Submission of a video with a running time of under 2 minutes describing the participant's merits and interests and why s/he should be selected.
3. Payment of a participating fee covering the participant's logistics once the student was accepted.

With the admission criteria defined, the organizing committee announced the event through different outlets: newspapers, social media, radio and TV.

The admission was announced in February, 2015 and 59 complete applications were submitted by the end of the admission cycle in May, 2015. As shown in Figure 1 out of the 59 applications, 30 were submitted by students from high school and 29 from university.

3. Participants background

As presented in the previous section, the participation ratio of high school and university students was of 50% each. As it can be seen in Figure 2, a higher than expected number of participants were women with a representation of 38%. This was a very welcome surprise as usually that segment has lower participation in STEM-based events.

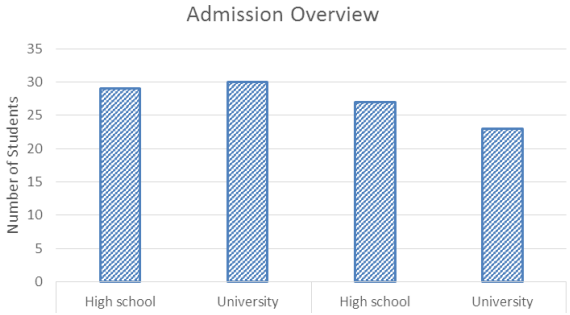

Fig. 1. Number of applications submitted vs number of admitted students.

The camp was opened to students from all over the country and as Figure 3 describes, 24 % came from rural areas of Costa Rica in comparison to 76 % from urban locations. There was a 33% of the high school students from institutions known as "scientific high schools" where students are given larger number of assignments in the STEM fields compared to what a traditional high school would. High School Students from technical institutions where they get even a technical specialization was 26 %. Traditional high school students represented a 41 % of the participants.

The staff was composed of various groups: (1) student volunteers, (2) invited lecturers, and (3) faculty from the UCR. There were 31 student volunteers in total: 16 from the main UCR campus, Rodrigo Facio and 15 from the Guanacaste campus. These volunteers came from different engineering departments, namely: mechanical, electrical, and computer science. This group had only 3 female members representing only a 19% of the volunteers.

The invited lecturers came from national and international institutions such as NASA, ARLISS and the UCR's Planetarium. In this group, the female and male representation was with 3 males and 3 females. They provided the students with theoretical, motivational, and demonstration talks. The faculty from the UCR was in charge of the organization of the event and its logistics.

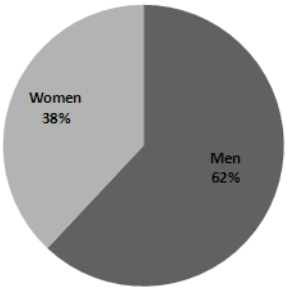

Fig. 2. Participants by gender.

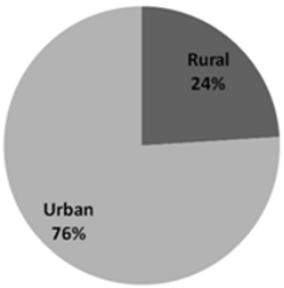

Fig. 3. Participants by geographical origin.

4. Methods Used and Activities

With this activity, the main objective was to apply different educational techniques, based on producing feelings and experiences in a non-formal environment.

Table 1. Overview of the activities scheduled at the camp.

Session	Day		
	Monday	Tuesday	Wednesday
Morning	Arrival and Opening Ceremony	Theory class and industry visits	Rockets launch
Afternoon	General Lectures	Hands-on: rocket building I	Closing ceremony
Evening	Astronomy lectures	Hands-on: rocket building II	

The students were divided in different groups that intended to have as many female and male students as well as students from high school and university from multiple areas of the country. This aimed to have a balance in each group and to force participants who did not know each other to interact as they would with other team members in a real scientific, engineer world. Figure 5 shows one of the groups and its diversity in gender, education level, and age.

Table 1 describes a general overview of the activities during the 2015 camp. Given that students from all over the country were participating, they were transported to the Guanacaste campus on the first day. Upon arrival, they settled at their hotel and the camp officially started with the opening ceremony. Later on that same day, various general lectures aim to motivate the students and introduce them to the topics they will be working on for the next three days.

These lectures included NASA engineer, Sandra Cauffman who gave an overview of how space missions are developed from design to launch to day-to-day operations to the end of the mission using as an example the Mars Atmosphere and Volatile Evolution (MAVEN) mission [6]. James and Becky Green, representatives

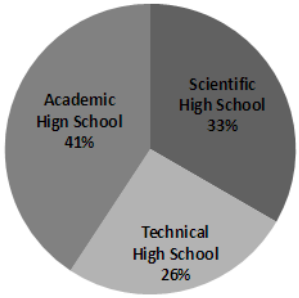

Fig. 4. Participants by type of High School.

Fig. 5. One of the groups working on their rocket.

from A Rocket Launch for International Students Satellites (ARLISS) [1] gave an introduction to several of the applications sounding rockets have in small satellite and space robotics research.

During the evenings starting on the first day of the camp, a set of astronomy lectures were given by physics professor of the UCR, Dr. Jose Alberto Villalobos and Erick Sanchez expert from the UCR's Planetarium. These talks were both given inside a portable planetarium and observing the night sky with telescopes. Figure 6 depicts the students around Dr. Villalobos during the outdoors astronomy lecture.

On the morning of the second day, the students were divided in two activity groups: one visiting Ad Astra Rocket Co. and another observing their first lectures. Introductory level rocketry lectures were given along with a small tutorial workshop on how to design and simulate model rockets using open-source software

Fig. 6. Observing night with telescopes.

OpenRocket. These lectures were the foundation the students required to understand the necessary concepts that will let them construct their rockets and launch them on the last day of the camp.

During the afternoon and evening of the second day, the students were guided on a step-by-step basis on how to construct the rockets they designed during the class in the morning. This hands-on work was instructed by Mr. and Mrs. Green who have over 12 years of experience building model rockets and have received an award for reaching and surpassing the Carmack line with a two-staged sounding rocket.

During the morning of the third day of the camp, the students gave the final touches to their rockets and the launch process started.

5. Results obtained

This was the first time for the Mechanical Engineering Department of the UCR to organize this kind of event and there were several lessons learned from a logistics and an educational perspective

The first one is referred to the participation of the students that were part of the 2015 Camp in the University Aerospace Engineering Group. There were about 10 volunteer students that joined the regular activities of the group, and even in a very active way they became leaders of some of their own groups during the camp. An important follow up to this active participation is that more than 90% of the 2016 Camp staff were student participants during the 2015 Camp.

At least 4 of the participants are actually doing their university studies in other countries, especially United States of America; and they are participating in important international events representing Costa Rica. For instance, one of the 2015 camp alumni participate in the last MDRS from Mars Society [7] and Google internships.

Unfortunately, there was a small participation from the industry. This is a cultural problem in Costa Rica, since that sector rarely collaborates with academia

Fig. 7. An S4 souding rocket launch at the last day of the camp. (UCR)

activities. Thus, this is a front that we have to explore further and use this kind of event as a catalyzer that facilitates the mutual collaboration between them.

6. Fundraising process and Collaborations

We had a fundraising process and collaboration established between the UCR and multiple institutions, both public and private. In addition, the media exposure the camp had at a national level in Costa Rica was very high. One of the most important collaborations we were able to establish was with the Ministry of Science and Technology of Costa Rica (MICITT). They participated in a very active way and gave financial support and facilitated media coverage to the event. Further, there was a partnership with the Engineering and Architects National Board.

Although the organization staff visited some aerospace industry companies in Costa Rica, there was a very little real collaboration towards the camp. As mentioned previously, it is necessary to continue working on this kind of event in order to motivate them to join and collaborate both financially as with equipment, know-how and personnel.

7. Pedagogical Impact

This kind of awareness activities become processes of pedagogical mediation and also recognize everyday learning, as suggested by Vygotsky [5].

Although in some cases this kind of events may be convenient, they are not necessarily the most appropriate or the methods creating the greatest impact in students. Thus, the authors wanted to explore and determine some forms of pedagogical mediation that create that emotion and motivation in students. In particular the authors were interested in identifying the main triggers that make students decide to pursue a career in science and technology. It could be through participatory processes as mentioned Gutierrez & Prieto [4]:

"Participation allows the passage of relations of dependency and paternalistic mechanisms, bureaucrats and vertical, and revealing a democratic culture of complete solidarity and the actual role of the people."

Also including processes in which the dialogue between professionals that tell their life stories to the young so that they can identify with and feel supported to know what they think and have lived other people who have gone the processes they will be encouraged, as it indicates Bohm [3]:

"When we thought of others it becomes our own thinking and thus treat it. And the same is true when emerges an emotional burden because, to the extent it affects us, also shared with all thoughts"

Finally, it is important to note that all these efforts have two mainly intentions: first to contribute with an increasing aerospace industry in Costa Rica, and second to motivate students to continue their studies in STEM areas in an sense of improve people life, as Assman [2] says: "Education will have a decisive role in creating social awareness necessary to reorient humanity".

Acknowledgements

It is very important to recognize the effort of the University of Costa Rica Guanacaste Campus, and the Mechanical Engineering Department.

To the Costa Rica National Engineering and Architects Board, for their support and collaboration for the Camp.

And to the staff, lecturers, volunteers and participants who worked with an excellent attitude and commitment.

References

[1]Aeropac Website. Retrieved from http://www.aeropac.org/ [2016-09-08]

[2] H. Assman,. Placer y ternura en la educación. Hacia una sociedad aprendiente. Madrid: NARCEA S.A. 2002.

[3] D, Bohm. Sobre el diálogo. Barcelona: Editorial Kairós. 1997.

[4] F, Gutiérrez & D, Prieto. (1996). Mediación pedagógica. Apuntes para una educación a distancia alternativa. Guatemala: Universidad de San Carlos de Guatemala

[5] L. Vygotsky. 1985. Pensamiento y Lenguaje: teoría del desarrollo cultural de las funciones psíquicas. Editorial la Pleyade. Argentina.

[6]MAVEN mission, NASA. Retrieved from https://www.nasa.gov/mission_pages/maven/main/index.html [Aug.31.2016]

[7] Mars Desert Research Station website. Retrieved from http://mdrs.marssociety.org/ [Aug.31.2016]