

# REXUS/BEXUS ALUMNI – LOOKING AT THE LONG-TERM PERSONAL BENEFITS OF PARTICIPATION IN A PRACTICAL STUDENT PROGRAMME

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## ABSTRACT

After six rocket and six balloon launches, many students have successfully completed their involvement in the current format of the REXUS/BEXUS programme. It is both interesting and beneficial to look back now at how being involved in a practical student programme has affected their lives. The specific combination of traditional, open, and augmented learning environments that are a part of the programme is an opportunity afforded to few university students.

Collecting information from students that have completed their participation and are now progressing with their professional careers presents the opportunity to both look at what they have taken from the programme and to understand a little about how it has affected their options post-REXUS/BEXUS. This information has been taken via simple survey which has shown relatively good results for the programme.

It is difficult to truly determine the full extent of this influence, nonetheless, this knowledge can still be used to build upon those past experiences and endeavour to improve the programme from this feedback.

## 1. INTRODUCTION

### 1.1 The REXUS/BEXUS programme

The REXUS/BEXUS (Rocket and Balloon Experiments for University Students) programme [1] is realized under a bilateral Agency Agreement between the German Aerospace Center (DLR) and the Swedish National Space Board (SNSB). The Swedish share of the payload has been made available to students from other European countries through a collaboration with the European Space Agency (ESA).

EuroLaunch, a cooperation between the Esrange Space Center of the Swedish Space Corporation (SSC) and the Mobile Rocket Base (MORABA) of DLR, is

responsible for the campaign management and operations of the launch vehicles. Experts from DLR, SSC and ESA provide technical support to the student teams throughout the project.

The programme is targeted towards science and engineering students who have good concepts for experiments to be launched on-board either sounding rockets or high altitude balloons. The students are responsible for all aspects directly associated with their experiments and must provide the manpower for the management, engineering, and scientific aspects. In this programme, students must complete a full project life-cycle, beginning with proposal submission, development of an experiment, launch, and data analysis. The students are supported in their work with contact to experts, specific training, and written materials along with planning and financial support.

### 1.2 The educational environment

Since 2008, the REXUS/BEXUS programme has been carried out in its current format. During this time, the core educational component has remained much the same in concept but has developed and grown. The educational environment within REXUS/BEXUS is based around preparing the experiments in a similar manner to the way in which this is done for other sounding rocket and high altitude balloon activities. Within the programme, an augmented learning environment exists in the sense that although the focus is on open learning this is supported by more traditional methods throughout the programme including information material and supervision from experts.

Most students who participate in the programme actively continue their studies at universities at the same time. The feedback gained directly from some past-participants is that they were able to learn so much from their experiences because of the differences from

traditional university educational environments in terms of scope of the project and the hands-on approach.

The scope and nature of REXUS/BEXUS creates a highly effective environment for self-guided (autodidactic) learning to build upon previous education and is highly encouraged within the project both in terms of knowledge needed to complete the project and skills for the future. The self-directed learning of individuals can be seen as a necessary component of carrying out the work required for building an experiment within the programme considering that most teams have limited experience in this field (particularly for sounding rockets and high altitude balloons). Due to the variety and complexity of the experiments within REXUS/BEXUS it would also be practically impossible to implement a system by which the students could be informed on every relevant topic in a traditional setting. This is also seen to be a boon of the programme as with the correct incentives and support, this problem-based learning style can be particularly effective for the long-term retention of knowledge [2]. The benefit of this self-learning is two-fold, in this case, as it not only enables the team to carry out the project but also carries longer-term benefits that can be highly beneficial for the participants.

The open learning environment of REXUS/BEXUS, which facilitates the self-directed learning within the projects, can be seen to operate on two quite distinct levels. The first is via an augmented learning approach in the sense of the whole REXUS/BEXUS project-cycle that the teams must complete, where the open-learning task given is to carry out the work required to design, build, test, fly, and analyse an experiment for a sounding rocket or balloon with clearly structured elements of support. An example of the augmented nature of this environment is the feedback given to teams by visiting experts during experiment reviews (see Fig. 1). This is also then supported within the teams in differing forms of cooperative learning (depending on the team structures) due to the necessity of working in inter-disciplinary teams [3]. Another component of the programme that can be considered open learning within REXUS/BEXUS are the smaller tasks that are required within the project-cycle work. These generally consist of the component tasks required to build and fly an experiment such as elements of the design phase and testing, these focus more upon individual self-directed learning with feedback from experts regarding methodology and results than the cooperative learning environment of bringing all the sub-systems together.



*Figure 1. A BEXUS team during an experiment review is an example of an important part of the augmented learning experience*

Although within REXUS/BEXUS the larger educational component appears to be that of the open learning environment, more traditional educational methods (see Fig. 2) are utilized to generate a transfer of knowledge critical for the successful development of experiments for flight. These focus around presentations regarding relevant topics and the manuals which describe technical information and details necessary for the construction of the experiments. These are not only an important component unto themselves but as a facilitator for the augmented education environment.



*Figure 2. Traditional Educational Presentations are an Important Part of the Learning Experience*

It is useful for an education programme, such as REXUS/BEXUS, to take a look back and examine the influence on the lives of the participants as by doing so can a programme continue to improve upon the long-term benefits for the participants. Having now completed three cycles of the current formant, it was time to look at collecting data in order to examine the perceived benefits of these different educational environments.

### 1.3 Long term personal benefits from the programme

There are a number of long-term benefits in particular that it is envisaged that the REXUS/BEXUS programme can provide. These focus around the skills and knowledge that can be learnt that are relevant for future careers in the space community whether that be in research or industry. It is hoped that these encourage and improve upon the chances for participants to enter or stay within space-related fields.

The practical and supplementary skills promoted within REXUS/BEXUS are generally applicable in common workplace or academic environments. Considering the aims of the programme, these specific skills were investigated in this study:

- Understanding of the space project life cycle
- Understanding of space project processes
- Design skills
- Practical skills (such as building/testing)
- Teamwork ability
- Confidence to take on tasks in your study/workplace
- Contacts with professionals in the space sector
- Contacts with your international peers
- Opportunities for further study or employment

Also considered in this investigation is whether these have had the desired impact in increasing the desire to pursue a space-career; as from the perspective of the programme, this is a personal long-term benefit. It is then interesting to see how many of the students pursue this career option and how relevant the REXUS/BEXUS experience is to them as they progress.

## 2 DATA COLLECTION

In order to collect data on the perceived long-term benefits from the students, a survey was conducted in order to look at the largest number of students possible at this stage. The survey covered topics relating to the experience of participants during the programme and afterwards, whereas this study focuses for on the long-term benefits.

As the questions for the survey covered such a broad range of topics, care was taken to ensure that the data collected was both representative and readily able to be compared at least within the survey itself. It's important to note that at this stage (not yet four years after the first launches of the current format) that a high percentage of the students are still completing their studies or are in the very early stages of their careers. Participants were asked for the most part to respond using non-comparative scales such as Likert and semantic differential scales, in order to return relatively comparable responses and to mitigate acquiescence bias [4] within the questionnaire. In order to reduce influence of the survey on responses questions that could be seen to have comparative elements within them were randomized so that different respondents were not presented with the same order for these questions.

The survey was distributed by the organizers of REXUS/BEXUS directly to many past-participants with the request that this be passed on further to those who were unable to be contacted. This distribution method can be considered to have some negative effects such as response bias (both negative or positive) due to personal contact with the conductors of the survey [5] but was utilized nonetheless due to resource limitations and practical constraints. Each survey participant was then led to an individual survey webpage using SurveyMonkey [6] with information about the questions, response types, and other relevant details such as future use of survey data. The survey was then conducted confidentially with all questions being voluntary, this was done in order to drive the respondent number and to avoid non-completion of the survey. Conducted electronically

At the time of the initial analysis 84 respondents had participated in the survey. This represents a significant proportion of students who have participated and provides a good base to begin data-analysis. Of these 84 respondents, a completion rate of 88% was achieved (completion is recorded when the respondent selects that they are finished) and on the data-sets presented here a minimum of 85% of the survey participants responded to these questions.

At this stage, the data has been preliminarily analysed using relatively simple techniques such as filtering and comparisons of responses (enabled by the non-comparative scales). Further work will be conducted in the future to investigate correlations between responses and the differences in response trends between students who have participated in the project at different times.

### 3 NEGATIVE EFFECTS ON STUDY

Despite the large number of perceived benefits, it was also of interest to investigate possible negative effects from REXUS/BEXUS. Feedback from the students during their participation clearly identified the time required to participate in such a project as being one of the more difficult aspects to manage individually within the project.

This feedback was seen most commonly from those students whose work was not part of any course module and when it was asked within the survey, it was found that of the respondents 64.5% received no course credits.

Logically, the next step is to ask: “Did these students complete their degrees?”. The responses were surprisingly positive with no responses that any “don’t intend to complete” (one of three options). It is important to note that of those who responded only 48.7% had completed their studies that ran parallel to

REXUS/BEXUS. Nonetheless, this result contrasts with the example of “over 30 percent for the engineering, chemistry, mathematics and physics” [7] students in Germany for 2008. This great disparity suggests some correlation between participation in REXUS/BEXUS and completion of the students’ degrees. This could be attributed to the education within REXUS/BEXUS or the level of progression through the tertiary education system at time of participation but it is believed that this stems from the generally high calibre of students who complete the programme and that the commitment required to complete a REXUS/BEXUS project is similar to that required to complete university degrees.

### 4 EFFECTIVENESS OF LEARNING METHODS FOR LATER STUDY/CAREER

Considering the varied educational environment available within REXUS/BEXUS, of particular interest is which learning methods are effective for the students’ later study and careers and the comparison between these. Although individual learning experiences vary within the programme, when the participants of the survey were asked to “indicate how useful you found these for learning the skills and knowledge for your study/career after REXUS/BEXUS” closely grouped results were seen. Respondents were given the options of: High / Medium High / Medium / Medium Low / Low (seen as 5-1 in Fig. 3).

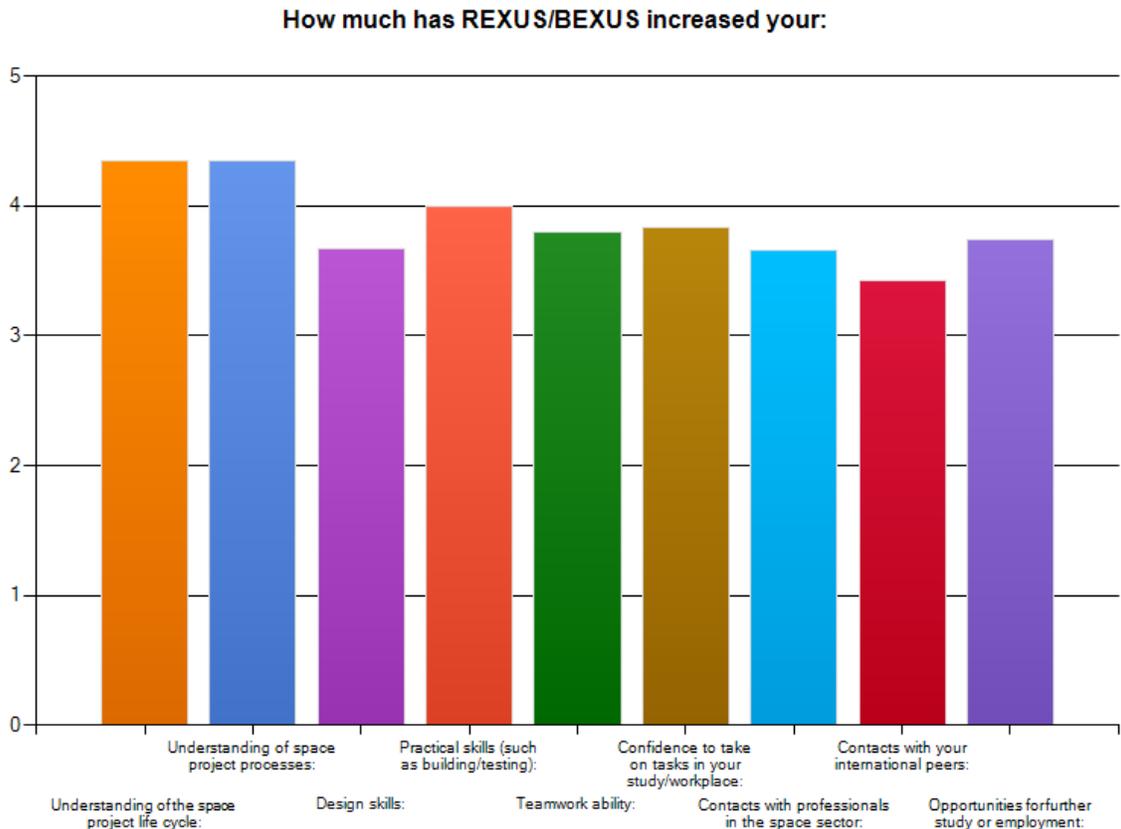


Figure 3. Rating Averages for the Effectiveness of Learning Methods within REXUS/BEXUS

Practical application of knowledge (design), Practical application of knowledge (building/testing), and Self-learning rated the highest with “High” responses of 52.2%, 53.6%, and 54.4% respectively and with all approximately 80% in the High / Medium High bracket. Rating averages for other categories can be seen in Fig. 3.

Considering the results in respect to the different learning environments, we see that the augmented (practical skills) and self-directed learning environments rate the highest. Written information ranks relatively highly compared to the presentations and considering that these materials are tailored directly to information for completion of the REXUS/BEXUS projects, this is pleasantly surprising.

### 5 PRACTICAL AND SUPPLEMENTARY SKILL DEVELOPMENT

Following on from which learning methods were effective for learning future skills, it is interesting to see how the educational elements affected the skill sets of the past-participants. In order to do this, survey participants were asked to estimate the increase that REXUS/BEXUS was responsible for. Here the participants were given the options of Major increase / Significant increase / Some increase / Minor increase / No increase (depicted as a scale of 5-1 in Fig. 4).

The modes of the skill increase queries were all at Significant increase or Major increase (see Fig. 4) which was higher than expected but, nonetheless, a very positive response for the programme. The leading

increases in skills were for the space project processes and life-cycle understanding. This could be an attribute of these topics’ specialized nature but is also likely to relate to the differences between REXUS/BEXUS and more traditional learning environments due to the hands-on nature and breadth of the programme. This difference is also a likely candidate for contributing to the statistically significant high average responses.

### 6 RELEVANCE OF THE EXPERIENCE TO FUTURE ACTIVITIES

Considering the long-term benefit aspect of education and increases in skills from REXUS/BEXUS, it is important to see whether these benefits are carried on into future study or work.

As a part of the survey, respondents were asked how relevant the entire REXUS/BEXUS experience was to their situation (work or study) at the time of the survey. Here response options were: Very highly / Highly / Moderately / Slightly / Not at All. As seen in Fig. 5, the mode response is for the “Highly” option but highlighted in the figure is the unexpectedly high number of “Not at all” responses. This is a good example of the benefits of performing such a survey that it is now possible to go further and look to see if this response correlates to a particular subset of the participants in the programme.

**Below is a list of learning methods used in REXUS/BEXUS, please indicate how useful you found these for learning the skills and knowledge for your study/career after REXUS/BEXUS:**

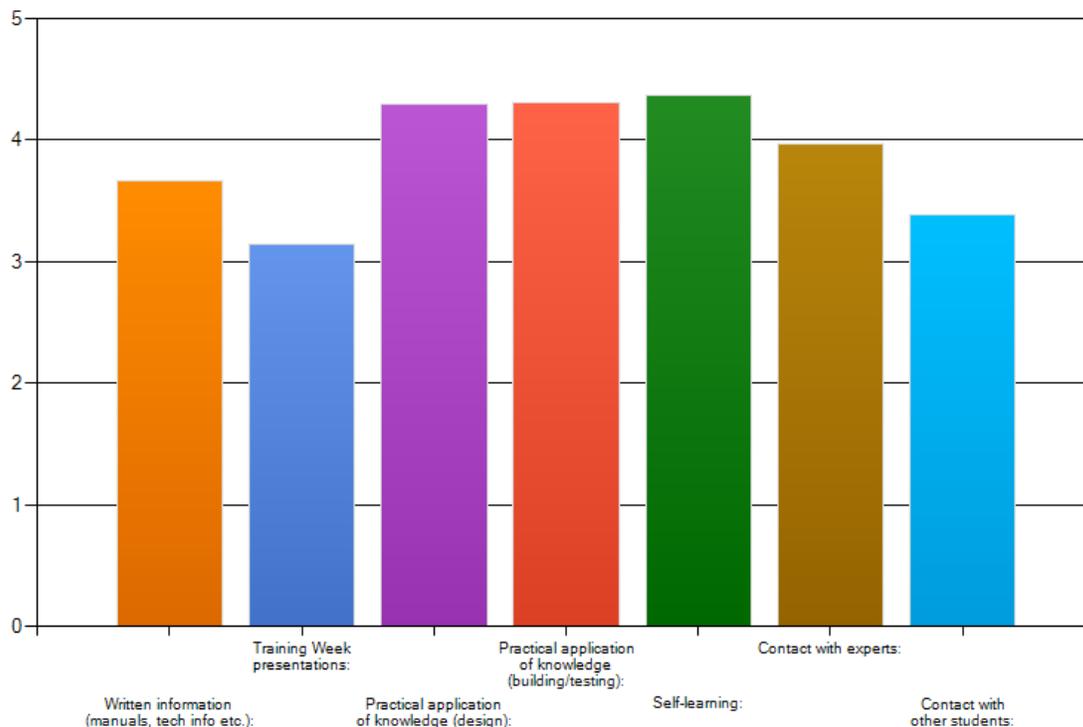


Figure 4. Rating Averages for the Contribution to Skill Increases from REXUS/BEXUS

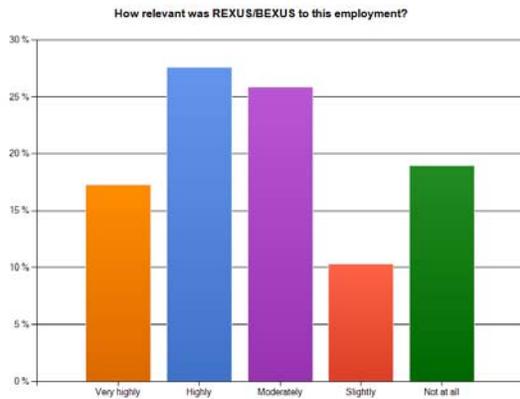


Fig 5. Responses to the Relevance the REXUS/BEXUS Experience to their Current Situation as a Percentage of Total Responses

## 7 EFFECT ON CAREERS IN SPACE

Although not necessarily perceived as a personal benefit unto itself, it is an aim of the programme to increase the participants' interest in pursuing space-related careers. It was expected that this would have a less positive response than factors such as increases in skills as many of the students participating already have an interest in space science and technology.

The result seen in the results paints a different picture as 37.0% responded that they were much more likely to pursue a career in space and 39.7% more likely, for a total of 76.7% of the students seeing some personal increase in desire to join the space community. It appears that in this case, the expectation was that interest in space and interest in a space career were directly linked but it would seem that this is more tenuous than presumed.

A more solid long-term personal benefit is whether those who have since their participation become employed were able to find a position in a space related field. The survey found that 63.6% of those responding as being employed at the time of their responses had joined the space community. This shows a difference between those who would like to pursue space-related careers and those who have been able to find such positions and clearly identifies an area that can be improved upon.

## 8 PENETRATION OF THE REXUS/BEXUS CONCEPT

In terms of recognition of the students' participation in REXUS/BEXUS, it is necessary to look at the general recognition. Considering long-term benefits, these are most likely to come from direct knowledge of the programme within the space community. Both of these would be very difficult to practically measure.

The media impact of REXUS/BEXUS has been tracked over time via monitoring Google [8] relevant results. This was chosen as a method due to its simplicity. Using a suitable search term (in this case "rexus bexus") the total number of Google results (in this case google.de was used) was then multiplied by the percentage of relevant results (results that are about the topic of interest) that were shown in the first 10 results. It must be noted that Google results do not accurately reflect true numbers of results [9] and this effect appears to be exacerbated for certain amounts of returns. As such, this is a very rough measure of the media impact, alike to sticking a thumb in a bucket of water to test the temperature, it quickly generates results that are easily comparable.

In May of 2011, REXUS/BEXUS was seen to be returning 700 to 1000 thousand relevant returns which corresponded to an average of 93% of DLR's relevant returns over April and May. This roughly corresponds to the true total results for "rexus bexus" and "dlr". This signifies a significant penetration of the REXUS/BEXUS concept through media activities, especially over the last year.

## 9 CONCLUSION

Having completed three cycles of REXUS/BEXUS in the current format, it has proven worthwhile to look back at those students who have completed their participation. It has been interesting see that some preconceptions and expectations are not as they appeared and the identification of areas that can be improved upon will prove useful for future considerations. The combination of different educational environments within REXUS/BEXUS is a unique opportunity that with hard-work and perseverance can prove very beneficial in the long-term.

It is difficult to determine the full extent of the programme's influence on the lives of the participants but nonetheless, this investigation has proved to be a good starting point. Future analysis of this data and future data collection will hopefully bring even more information that can be used to make informed decisions in the future of REXUS/BEXUS.

The data taken via survey from the past participants has proven to highlight some areas that can be improved such as the relevance of the experience in the future and improving the future options for students who have participated. The responses have also identified strengths and weaknesses from the unique educational environment and now improvements can be considered to help participants take advantage of unique learning opportunity.

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