Educational Outcomes from the OpenOrbiter Small Spacecraft Development Program

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Overview
The OpenOrbiter program [1] is developing a low-cost framework for the creation of spacecraft by researchers and educators worldwide [8]. In addition to the technical objectives, educational assessment [2, 3] has also been a key focus. Students working on development of the spacecraft [4] were asked what types of benefits they sought from their participation [5]. The assessment of the attainment of these benefits is ongoing, in conjunction with continued development in pursuit of the creation of a set of designs that can be used to build a spacecraft with a cost of under $5,000 [13].

What Has Been Determined?
A more detailed discussion of assessment activities can be found in [2, 3, 5]; however several key points are illustrated by the figures shown herein.

- Significant benefit is shown in several categories of performance (see Figures 6 and 7).
- This benefit is attributed to program participation (see Figure 8).
- Both team leads and non-lead participants gain benefit from their participation (see Figure 9), with leads being shown to gain benefit in more (3 versus 2) areas.
- Areas where students believe that they can receive benefit from participation are numerous and varied (see Figure 1).

How Do Students Participate?
Students participate in the OpenOrbiter program in several ways:
- Participation as an extracurricular activity
- Participation as part of a class project
- Participation for an academic capstone / design project
- Participation in an independent study course
- Participation as part of the CSCI 297—Software Project Management through Experiential Learning course

Students design, develop, manage, test, and troubleshoot problems under all types of participation, gaining valuable experience.

Developing and Prototyping
We have created a simulation platform, called the ROOFSAT [23], shown in Figure 9, to facilitate the development and testing of the spacecraft software on a concurrent basis with the design and development of the spacecraft. This allows students who may graduate before the spacecraft construction is complete to gain the valuable hands-on experience in working with hardware that is sought by many private- and public-sector employers.

References:

Scholarly Activities
The OpenOrbiter Program has been the subject of six peer-reviewed journal articles [2-7], nine conference papers [1, 8-15] and seven oral / poster presentations [16-22]. These range from technical analysis of the structure, software and other spacecraft elements, to papers considering the use of the spacecraft and its impact on space policy to papers evaluating the educational benefits of the program and participation in it.

Figure 1. Areas of Desired Benefit from Student Participants.

Figure 2. OpenOrbiter in front of Earth.

Figure 3. Launch for Training Purposes.

Figure 4. Average Level of Improvement, by category.

Figure 5. Attribution of Benefit Attainment to Program Participation.

Figure 6. Comparison of Reported Skill / Expectation / Comfort Level Before and After Participation.

Figure 7. Comparison of Reported Skill / Expectation / Comfort Level Before and After Participation.

Figure 8. Comparison of Number of Individuals Showing Improvement between Team Leads and Non-lead Participants.

Figure 9. ROOFSAT Hardware.

Figure 10. OpenOrbiter Spacecraft.

Figure 11. Diagram of OpenOrbiter Configuration.

Figure 12. OpenOrbiter Spacecraft.

Figure 13. OpenOrbiter Spacecraft.

Figure 14. Average Level of Improvement, by category.

Figure 15. Attribution of Benefit Attainment to Program Participation.

Figure 16. Comparison of Number of Individuals Showing Improvement between Team Leads and Non-lead Participants.

Figure 17. Comparison of Reported Skill / Expectation / Comfort Level Before and After Participation.

Figure 18. Comparison of Reported Skill / Expectation / Comfort Level Before and After Participation.

Figure 19. ROOFSAT Hardware.

Figure 20. OpenOrbiter Spacecraft.

Figure 21. OpenOrbiter Spacecraft.

Figure 22. OpenOrbiter Spacecraft.

Figure 23. Comparison of Reported Skill / Expectation / Comfort Level Before and After Participation.

Figure 24. Comparison of Reported Skill / Expectation / Comfort Level Before and After Participation.

Figure 25. Comparison of Number of Individuals Showing Improvement between Team Leads and Non-lead Participants.

Figure 26. Comparison of Reported Skill / Expectation / Comfort Level Before and After Participation.

Figure 27. Comparison of Reported Skill / Expectation / Comfort Level Before and After Participation.

Figure 28. ROOFSAT Hardware.

Figure 29. OpenOrbiter Spacecraft.

Figure 30. OpenOrbiter Spacecraft.

Figure 31. OpenOrbiter Spacecraft.

Figure 32. Comparison of Number of Individuals Showing Improvement between Team Leads and Non-lead Participants.

Figure 33. Comparison of Reported Skill / Expectation / Comfort Level Before and After Participation.

Figure 34. Comparison of Reported Skill / Expectation / Comfort Level Before and After Participation.

Figure 35. Comparison of Number of Individuals Showing Improvement between Team Leads and Non-lead Participants.