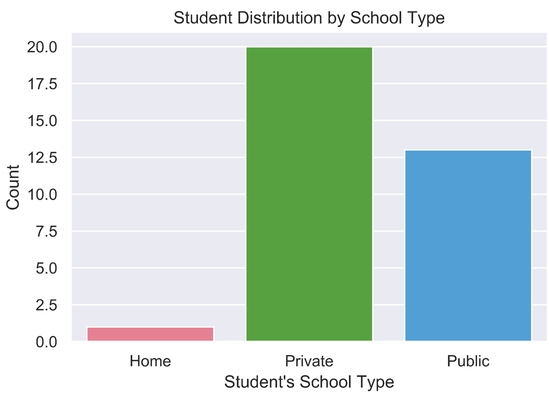
STAR Academy: Space and Planetary Sciences for High School Students at the Arecibo Observatory

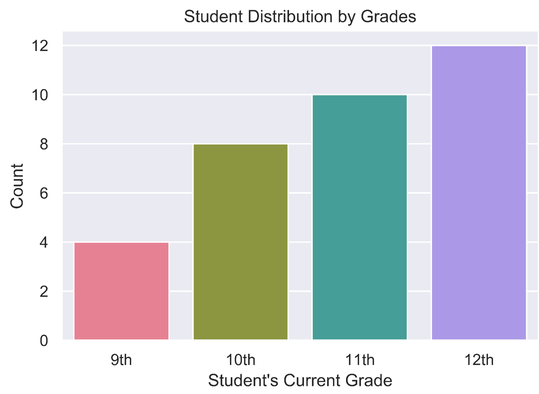
B. Rivera-Muñiz[1] , S. Santiago[1] , and A. Virkki[2]

[1]Arecibo Observatory (SUAGM) (brivera@naic.edu), [2]Arecibo Observatory (UCF)

Introduction

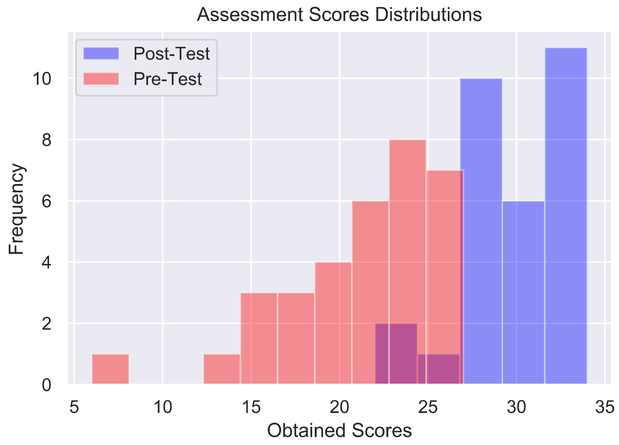
STAR Academy is an out of school program for highly qualified high school students living in Puerto Ri-co, that aims to close the gap between demand and production of STEM graduates in Puerto Rico. The academy focuses on four main pillars: Space and Planetary Sciences, Research, Coding(one of the most necessary skills for 21st century scientists, coding [1]), and Leadership Skills. STAR Academy requires 16 on-site meetings, consisting on 1 day of interviews and selection of candidates, 14 weeks of intense study of space and planetary science concepts/units and research, and 1 day of scientific research presentations.

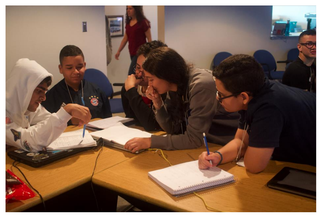




Program Outcomes

At the start of the Fall 2019 semester, each student took a pre-test that evaluated their knowledge in basic scientific concepts and astronomy, with a maximum score of 34 points. The results of this test showed an average score of 21, a median of 22, and a range of 6-27. After completing all 13 units, the students took a post-test that was identical to the pre-test. The results of this test showed greatly improved scores, with an average score of 30, a median of 30, and a range of 22-34 points. 30 students successfully completed the program and presented 20 individual and group research projects in a variety of topics related to astronomy.





Curriculum Content

Each of the units is aligned to middle school and upper school Next Generation Science Standards [2]. All the in-person meetings were designed with a combination of traditional and contemporary instructional methods, with the aim of providing greater variety and more instructional efficacy to students from diverse learning styles and backgrounds [3]. When designing the units, Bloom's Taxonomy [4] was also taken into consideration, combining it with contemporary approaches like problem-based learning [5], with the purpose of developing main concepts and ideas, and having the students answer their own questions that are generated via the warm-up/introduction activities [6]. Through the program the students apply the newly learned concepts to evaluate or create solutions for problems related to astronomy or planetary sciences, in a higher-order thinking activities and research that foster scientific aptitudes.

Unit	Topic
1	The Scientific Method Computational Thinking and Google Colaboratory
2	Early Astronomy & The Electromagnetic Spectrum Python Basics
3	Observations and Instruments Data Analysis with NumPy
4	Planetary Systems Data Analysis with Pandas I
5	The Solar System Data Analysis with Pandas II
6	Chemistry of the Universe
7	Asteroids, Meteoroids, Meteors, Meteorites, and Comets Data Visualization with Matplotlib
8	More About The Solar System Data Visualization with Seaborn I
9	Earth Data Visualization with Seaborn II
10	Atmospheric and Environmental Sciences Linear Regression
11	The Sun, Star Types, and Space Weather K-Means Clustering
12	Space Exploration
13	Stars, Star Clusters, Galaxies, and Cosmology

Acknowledgements

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References

[1] S. Leon. (2015) *"An education for the 21st century means teaching coding in schools"*. The Conversation.

[2] L. Okhee, E.C. Miller, and R. Januszyk. (2014) *"Next generation science standards: All standards, all students"*. Journal of Science Teacher Education. 25.2, 223-233.

[3] H. Gardner, (1992) *"Multiple intelligences"*. 5. Minnesota Center for Arts Education.

[4] L.W. Anderson, (1994) *"A Revision of Bloom's Taxonomy"*. Univ. Chicago Press.

[5] G. Gorghiu, et al. (2015) *"Problem-based learning-an efficient learning strategy in the science lessons context. Procedia-social and behavioral sciences"*, 191, 1865-1870.

[6] Č. Serafín, Dostál, et al (2015) *"Inquiry-based instruction in the context of constructivism"*. Procedia-Social and Behavioral Sciences, 186, pp.592-599.