Use of kite based measurement systems for service-learning in informal settings

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This is an abstract for a work-in-progress paper at the First Year Engineering Experience conference. Aerospace Curriculum for Community Engaged Learning, Education Research, Aeropod Technology, and Empowerment (ACCELERATE) is a service-learning project for teaching of STEM to first-year undergraduate engineering students and pre-service teachers through kite-based instrumentation payloads called Aeropods. The project is a collaboration between engineering and education at University of South Florida and NASA.

During each academic year, engineering students will take engineering design classes to develop Aeropods, supporting tools, and educational experiences for Novice Math and/or Science Teachers (NMSTs). A subset of these students will then work with real NMSTs during a 3-week, summer, service-learning outreach program for 9th graders. NMSTs that complete the outreach program will use experience gained during the summer to help teach STEM concepts in formal classroom settings. As a result, the outreach program also functions as a training and incubator of ideas so engineering students get a more realistic STEM learning experience.

Introduction

In developing better STEM curriculum, it is important to consider connections both between people in how they leverage tools and experiences and within people as connections are made to other knowledge. The academic theory of service-learning has been used for both types of connections. Service-learning connects people through the "service" that is done and current experiences to previous ones through reflection upon that service[1], [2]. It is through these connections that service-learning can be used to make STEM education less superficial.

Oftentimes, STEM educators want to provide cross-cutting experiences and higher levels of cognition—primarily because the nature of today's world requires solutions to complex problems. Instead of just remembering or understanding facts, experiences should lead to analysis, evaluation, and creation. Connections between academic learners and practitioners have the potential to provide these types of experiences especially when they are symbiotic and collaborative. In addition, the Integrative STEM Education literature pushes against a world where learning of one STEM idea is done in isolation of another [3], [4]. Higher levels of cognition are achieved as well through an "intra-connectedness" of STEM concepts.

One opportunity for developing connections through curricular development is in rethinking how technologies are shared, supported, and developed between academic learners and practitioners in support of better learning of science and engineering. With the right technology and approach, inquiry and investigation can help lead to higher levels of cognition based in a collaborative environment that supports interconnectedness of academic learners, community members, and practitioners. In addition, more fluidity between "science", "technology", and "engineering" would provide more room for connections to be made [5], [6]. For example, a parametric study and the design of a technology might be used to enhance scientific exploration. So, technology becomes less of a static tool that is leveraged and more so an opportunity for discovery.

In this work-in-progress paper, kite payloads called Aeropods are explored. The Aeropod itself is improved using the engineering design process and Kite platform itself is used as an earth science, remote sensing platform. The Aeropod technology is useful for this application because it has components that are simple to assemble, easy to manufacture, and useful to redesign considering engineering design requirements. Academic learners and practitioners can focus on the technology in learning how to follow protocols and procedures, collect scientific data, and improve the technology within an engineering design context.

Aeropod design

The Aeropod is a NASA technology developed at Goddard Space Flight Center for earth science applications. It is passively stable and is suspended by connecting an access point to the kite string. Data is captured from the Aeropod using a light weight camera that captures a color image every 2 seconds. The data is saved locally to the camera during field operations and is then downloaded off of the camera after operations have concluded. When using a kite platform and an Aeropod, it is important to go through a field testing protocol for safety and efficiency during a mission. It is through the process of scientific measurement and discovery that academic learners and practitioners can learn valuable concepts around science integration and inquiry. Design of better Aeropod platforms is also possible because most of its components can be 3D printed or manufactured in under two hours and the components are simple enough for a novice designer to improve as part of an engineering design based classroom activity.

Undergraduate students for the past year have explored the potential for an Aeropod to be redesigned in support of K-12 education. An example design is presented in this paper along with some contextual information on the design process. This work is expanded upon through the proposed service-learning summer experience outlined in this paper that would connect undergraduate students to novice math or science teachers (NMSTs) and rising 9^{th} grade K-12 youth. The summer experience has goals to allow 1. NMSTs to become proficient with Aeropod technology, engineering design, and remote sensing in collaboration with undergraduate students and K-12 youth, 2. Undergraduate student designers to participate in a realistic engineering design environment with potential users of their designs, and 3. K-12 students to be exposed to scientific inquiry and engineering design in an informal educational environment. The service-learning experience would ultimately be parlayed to formal educational environments as participants take lessons learned back to their respective institutions.

To date, the potential of the Aeropod platform for engineering design has been explored. Approximately 250 students have participated in groups of 4-5. One group’s ideas are shown in Figure 1. They created unique payload designs in CAD, fabricated their designs, and then presented their finalized designs to potential users of their technologies.

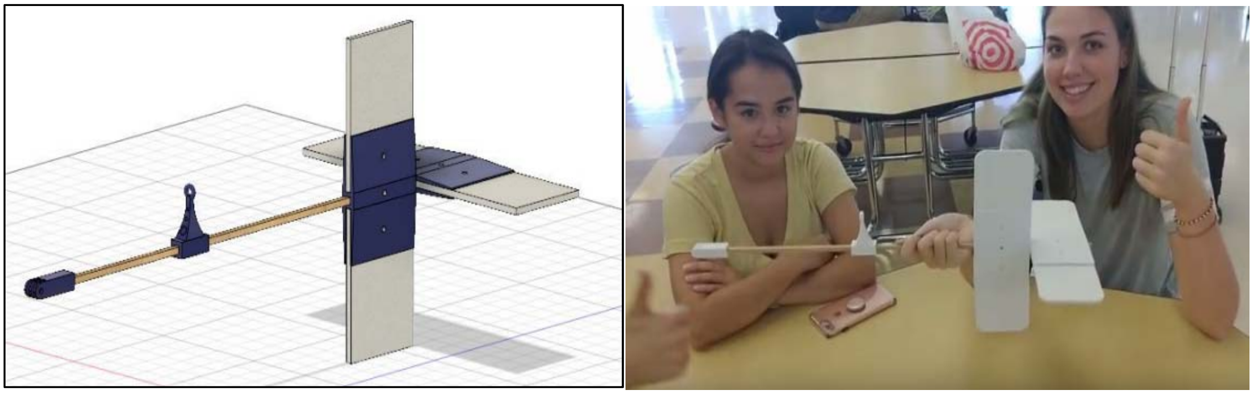

Figure 1: Visual of the engineering design process from conceptualization to fabrication

Undergraduate students also used the feedback from their initial fabrication to improve upon their design. As shown, this group decided to incorporate more transportability to their design by making a foldable dowel. This was a requested feature when they presented their design ideas.

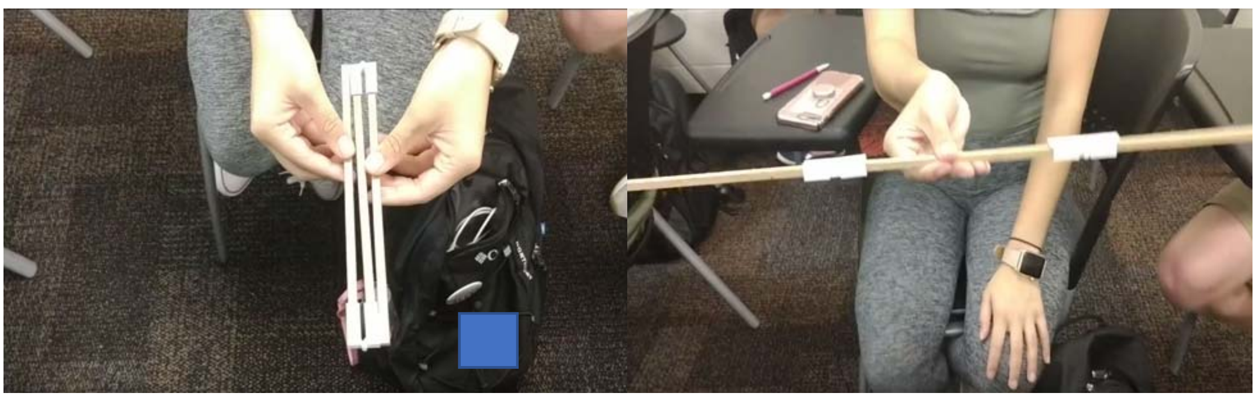

Figure 2: Added design transportability showing the dowel in the folded and deployed states

Because Aeropods are easy to manufacture and improve, a meaningful redesign is possible. This fabricated Aeropod will be used to facilitate service-learning activities in the Summer of 2019.

Next steps: service-learning

During Summer of 2019, a subset of students will be hired for the ACCELERATE program. Approximately 20 undergraduate students, 10 NMSTs, and 20 K-12 students will be selected for this opportunity. The program will be three weeks. The first week will be undergraduate students and NMSTs only. Undergraduates will present their ideas to the NMSTs around use of the Aeropod platform and fabrication of their Aeropod designs. This collaboration will result in finalized hardware and educational materials. Beginning week 2, K-12 students will join the program. The second week will be used to fabricate the payloads and learn flight protocols and procedures. The third week will be used to fly the payloads, get data, analyze the data, and discuss implementation strategies of activities in formal K-12 classroom settings. All three populations will participate in reflection activities throughout the summer experience which will lead to insight into how to structure research activities and improve the program structure.

References

[1] R. Sigmon, "Service-learning: Three principles," *Synergist*, vol. 8, no. 1, pp. 9–11, 1979.
[2] J. Luce, J. Anderson, J. Permaul, R. Shumer, T. Stanton, and S. Migliore, "Service-learning: An annotated bibliography linking public service with the curriculum," 1988.
[3] G. H. Roehrig, T. J. Moore, H.-H. Wang, and M. S. Park, "Is adding the E enough? Investigating the impact of K-12 engineering standards on the implementation of STEM integration," *Sch. Sci. Math.*, vol. 112, no. 1, pp. 31–44, 2012.
[4] N. A. Tran and M. J. Nathan, "Pre-college engineering studies: An investigation of the relationship between pre-college engineering studies and student achievement in science and mathematics," *J. Eng. Educ.*, vol. 99, no. 2, pp. 143–157, 2010.
[5] N. Tsupros, R. Kohler, and J. Hallinen, "STEM education: A project to identify the missing components," *Intermed. Unit*, vol. 1, pp. 1–3, 2009.
[6] N. R. Council, *Engineering in K-12 education: Understanding the status and improving the prospects*. National Academies Press, 2009.