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AeroEducate: Aeronautics-Themed Activity Development for STEM Education

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Abstract: The aviation industry faces pipeline shortages similar to that of other STEM fields. The Experimental Aircraft Association (EAA) collaborated with North Carolina State University (NC State) to address this shortage by revising and revamping the web-based AeroEducate. This educational platform increases awareness and engagement in aviation for formal and nonformal K-12 learners and educators by providing free, age-appropriate resources. Twenty-four newly developed aviation-themed, STEM standards-aligned activities with supporting, posters, and glossaries were recently added to this website. This paper and presentation provide an overview of how multiple agencies collaborated with industry partners to address STEM workforce needs through the development of aeronautics-themed resources and include a preview of some of the materials available for learners and educators.

Background and Overview

Integrated learning opportunities within STEM reflect the true nature of concept fluidity. There is no greater example of concept integration than in aeronautics where dependence and reliance on science, mathematics, technology and engineering is continuous. Aeronautics pursuit relies heavily on early exposure (Garcia and Manaia, 2019), but unfortunately these opportunities are not readily accessible for many youth. From early childhood, experiences and exposure frame our ways of thinking, methods of processing information, and to a certain degree, our preferences. Children are shaped and/or limited by information and experiences (Bonus, 2021). In efforts to provide broader exposure to aeronautics discovery and application, AeroEducate was launched by the Experimental Aeronautics Association (EAA).

The AeroEducate initiative aims to build and deliver a set of experiences for informal learners that enable and encourage exploration of aviation and aeronautics for a broad audience. Through private industry funding and partnerships with institutes and institutions of higher education, aeronautics-themed and contextualized experiential opportunities are provided for learners. AeroEducate aspires to help learners begin a journey that will enable them to discover a love for

aviation. The goal of this initiative is to plan and develop aeronautical experiences that inspire, engage and sustain learners’ interests in the field. In any given year, 80 percent of a child’s time is spent outside of a formal education environment (Stevens, Bransford, and Stevens, 2018, as cited in Nelson, Beecher, and Heid, 2019). Allen and Peterman (2019) identify that “Informal learning may lead to high levels of domain-specific expertise among those who are motivated to continue their learning” (p.19). Informal education has been a proven vehicle for sustaining interest and supporting the pursuit of STEM education and careers (Habig, Gupta, Levine, & Adams, 2020). AeroEducate broadens all learners’ access to the world of aviation. Through these experiences, learners explore pathways that may ultimately lead to expanded career opportunities within the field.

Aeronautics-themed Activity Development

A team of developers consisting of university faculty, institute personnel, and K-12 educators were selected to design and create the aeronautics-themed activities. The first task for the team was to conduct a thorough review of existing EAA materials, user interface, and access. Based upon this review, strategic areas of aeronautics’ content and skills were identified. Additionally, the team addressed the need for a central design process and, based upon this process, developed an activity format based upon learner level positioning.

Aligned with best practice, a student-centered constructivist design was followed for the activity structure. This provides a logically sequenced and easy-to-follow format for both formal and informal educators. This consistent organization provides detailed descriptions of activities, resource sets, and methods/approaches for framing engaging activities. The standardized activity format and structure is outlined in Table 1.

Table 1. Activity Outline for Facilitators and Learners

Facilitator Activity Brief -- Title of Activity	Learner Activity Brief -- Title of Activity
Key Concept and Essential Question: Objective: Standards Alignment: Time: Materials and Tools: Technology Enrichment: Background Information: Facilitator Actions: Guided Practice:	Scenario and Task: Learner Actions: Independent Practice:

Facilitator Activity Brief Components - *Key concepts and Essential Questions* characterize the grade-appropriate activity for learners. For example, concepts explored within grade 6-8 activities include: lift, the Magnus Effect, stability and aerodynamics, the four forces of flight,

buoyancy, friction, unbalanced forces, Newton's Second Law of Motion, and sound. Essential questions such as "What happens when a spinning object moves through air?" and "How do you stabilize a plane in flight?" help build context for real-world learning. Where appropriate, already developed EAA learning materials and STEM career videos are incorporated into newly developed activities.

Learning for both formal and informal settings is framed by the *Objectives* specifying the anticipated goal of the activity and identifying what the learner will be able to do and know as a result of the experience. *Standards Alignment* refers specifically to the learner-level designated benchmarks within the Next Generation Science Standards, Common Core Standards in Mathematics, and the Standards for Technological and Engineering Literacy. Aligning with standards situates the activity within the context of a trajectory of learning that is age-appropriate.

Time assists the facilitator in planning events and activities. The time ranges throughout the specific activity range from 30 - 60 minutes for younger ages to 60-180 minutes for older learners. *Materials and Tools* provide a list of equipment, supplies, and consumables required for the activity. The *Technology Enrichment* section provides related technology-focused experiences and resources and *Background Information* is included to help facilitators build context for the learning experience. The background knowledge enables learners to interact and fully contribute to aeronautics-themed activities. *Facilitator Actions* and *Guided Practice* describe ways the facilitator may engage and guide the learners through the activity to scaffold the learners' independent practice.

Learner Activity Brief Components - The Learner Activity Briefs are streamlined and adapted for each age band, increasing in complexity for the older learners. Learner directions and templates are provided, as needed, to support the learning experience. All activities are framed by real-world *Scenarios and Tasks* to build context for learning. Setting the stage with a challenge develops a sense of excitement and anticipation for learners. *Learner Actions* describe what learners will know and do during and, as a result, of the activity experience. *Independent Practice* builds individual and/or group autonomy and provides for learner-differentiated facilitation.

Additional to actual structural components and content of the materials is the consideration of learner progression within the activity. The activities are designed to address logical learner development grade bands: K-2, 3-5, 6-8, and 9-12. This 4-point grade band clustering is used in national benchmark standards to guide the development of age-appropriate content, proficiencies, and readiness. Targeting these grade bands and being informed by standards ensures that the activity and structure variations within newly-developed activities are learner-dependent.

The intent, design, and structure of the aeronautics-themed activity development was strategic in that it fulfills areas of focus within existent EAA outreach materials, aligns with STEM education standards sets, and can be implemented in both informal and formal settings. Maintaining a materials repository that is freely accessible is an ongoing objective of the AeroEducate initiative. Below is information on how to access the AeroEducate materials.

Materials Access

All content is freely available to registered users at AeroEducate.org. Resources are organized by grade band and easily accessible through a learning management system. The library of materials includes: activity guides, facilitator guides, student guides with templates, posters, national standard alignment charts, and developmentally appropriate glossaries. Examples are provided in Figures 1, 2, and 3.

Figure 1

AeroEducate Activity Access Page

The screenshot shows the AeroEducate website interface. At the top is a dark blue navigation bar with the EAA AeroEducate logo on the left and menu items: STUDENTS, TEACHERS, CHAPTERS, PARENTS, CAREERS, and EXPLORE. Below the navigation bar is an orange banner with the text: "This site is currently in beta. Please report any issues you may find here: aeroeducate@eaa.org". The main content area has a light blue background and features a section titled "Free Standard-compliant Classroom Activities". Below this title is a paragraph: "Jump right in with our fully developed activities. Each is ready to be downloaded and used in your classroom with little to no work." There are two main content blocks. The first is a white box containing an image of hands working with cardboard and glue, titled "K-2: Paper Bag Bernoulli". The text below the image describes an activity where students create a paper bag mask with a moving tongue to demonstrate lift using Bernoulli's Principle. The second block is a dark blue sidebar titled "Getting More From AeroEducate Beyond the Classroom". It contains three sub-sections: "Eagle Flights" (connecting with a local EAA pilot for a free introductory flight) and "EAA Chapters" (joining or starting a local chapter for social and educational activities). At the bottom of the main content area, there are navigation arrows and a "See All Activities" button.

Figure 2
Supplemental Poster

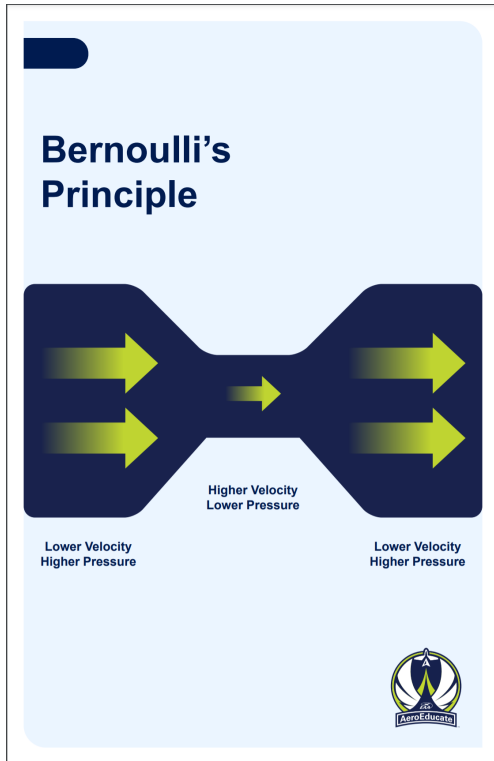


Figure 3

National Standards Alignment

National Standards

Grades 9-12

The Next Generation Science Standards (NGSS) are K-12 science content standards. NGSS describe what students should know and be able to do. There are three distinct and equally important strands, or dimensions, within NGSS.		Activities					
		1 Flight Stability	2 Airfoil Design	3 Gliders	4 Propeller Design	5 Lighter-Than-Air	6 Composite Wings
Disciplinary Core Ideas (DCI) are the key ideas in science.	PS2A: Forces and Motion	X	X	X	X	X	
	PS2B: Types of Interactions	X	X	X	X	X	
	PS1A: Structure and Properties of Matter						X
	PS1B: Chemical Reactions						X
	PS3A: Definitions of Energy					X	
	ETS1A: Defining and Delimiting Engineering Problems	X	X	X	X	X	X
	ETS1.B: Developing Possible Solution	X	X	X	X	X	X
ETS1.C: Optimizing the Design Solution	X	X	X	X	X	X	
Science and Engineering Practices (SEP) describe what scientists do to investigate the natural world	SEP 1: Asking Questions and Defining Problems	X	X	X	X	X	X
	SEP 2: Developing and Using Models	X	X	X	X	X	X
	SEP 3: Planning and Carrying Out Investigations	X	X	X	X	X	X

Summary

Designed for informal educational structures and non-formal providers, the AeroEducate initiative offers younger generations an initial exposure to the world of aviation and aeronautics. Real-world and context-based experiences spark learners’ interests and may help them discover a personal and/or professional passion for the field. Through AeroEducate, EAA provides resources for facilitators that build awareness and exposure opportunities for youth. The collaboration between EAA and NC State demonstrates how higher education and industry partners can and should work together to address STEM workforce needs.

References

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