NASA STEM Digital Badges for Educators and Their Students:
A Pilot Program Bringing STEM into Middle Schools Using NASA Langley Research Center's Centennial Celebration

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Abstract: *A pilot program was developed for middle school (grades 6-8) educators and students to apply NASA real-world problems to classroom concepts through the use of digital badges, as part of NASA Langley Research Center's (LaRC) Centennial Celebration. Three sets of digital badges were developed on three of NASA's main missions: Earth Science, Aeronautics, and Journey to Mars. Each digital badge offers a total of 5 hours of professional development for educators and 2 hours of activities for students. These digital badges have introduced educators to NASA Langley Research Center's missions and 100th anniversary. Online discussion sessions, a requirement for these badges, has attracted educators new to the digital badge concepts. The LaRC Centennial badges provide a forum through which educators can learn about this new format of professional development. Educators report that these badges are worth their time and effort as part of their professional development. LaRC looks forward to building new badges in the future to expand beyond middle school and reach across the K-12 continuum.*

INTRODUCTION

Digital badges, or micro credentials, are online representations of learning experiences and activities that tell a story about the learner's education and skills (Gamrat et. al, 2014). Digital badges in education have been expanding since the 2013 "Chicago Summer of Learning" where the City of Chicago collaborated with the MacArthur Foundation, allowing K-12 students to engage in summer activities through Open Badges by the Mozilla Foundation (Hurst, 2015).

Digital badges allow users to drive their own learning through various sources, providing a certification of proficiency upon completion (Waters, 2013). Digital badges also allow educators to personalize their professional development and become knowledgeable in topics that they rarely learn in their credentialing programs or through formal learning opportunities (DeNisco, 2016).

NASA Langley Research Center's (LaRC) Office of Education developed a pilot program to use digital badges to correlate NASA real-world projects to STEM classroom content as part of NASA LaRC's Centennial Celebration. The digital badges in this pilot are part of the NASA STEM Educator Professional Development Collaborative (EPDC), a national educator professional development system comprised of and designed to serve STEM Educators at all levels, free of charge through various methods of delivery.

NASA STEM EPDC, led in collaboration with Texas State University, uses Digital Badges at Penn State University as their platform[1].

STRUCTURE OF THE NASA LANGLEY CENTENNIAL DIGITAL BADGES

A team composed of an in-service middle school science educator, a pre-service teacher, a NASA STEM EPDC educator, and a NASA Langley Research Center Education Specialist worked together to design the digital badges.

NASA-inspired problem-based activities were chosen with strong correlations to middle school (grades 6-8) Next Generation Science Standards on three of NASA's priorities: Earth Science, Aeronautics, and Journey to Mars[2].

Each topic comprises a digital badge for the educator and for the students. The educator and student badges mirror one another with pertinent background information, examples from NASA's workforce, and applications to NASA research.

[1] Features and details of the platform can be found at the following site - http://badges.psu.edu/features/

[2] The digital badges can be accessed at https://nasatxstate-epdc.net/ by searching for "NASA LaRC 100" on the search bar.

The digital badges are visually attractive and engaging with videos and images for each step. Educator badges equate to a total of 5 hours of professional development divided into five one-hour steps. Student badges equate to a total of two hours of activities divided into four 30-minute steps.

All three badges are structured in the following matter for educators and students, respectively:

TABLE 1

Detailed structure of the educator and student digital badges.

Steps	Educator Badge (Five 1-hour steps)	Student Badge (Four 30-minute steps)
1	Educators are introduced to the topic with background information.	Students are introduced to a short video or reading on the topic.
2	Correlations to the topic are presented to research done at NASA Langley Research Center.	Students see how NASA engineers, researchers, and scientists are working to solve a problem. Students hypothesize or plan their own solutions to the problem.
3	Educators are asked to review and complete the pre-selected problem-based activity following the recommended implementation steps.	Students perform an investigation and gather their own data based on the badge activity.
4	Educators participate of an online open discussion and reflection of best practices.	Students evaluate their data and draw conclusions. Students watch a video about a NASA engineer, researcher, or scientist working on the topic.
5	Educators submit a picture of their students at work or student designs as proof of implementation of the activity.	-

Each digital badge focuses on different aspects of STEM. For example, the Earth Science badge, titled Earth Right Now: NASA LaRC 100 Educator (or Student), focuses on science investigations on how cloud types affect Earth's Radiation Budget.

This digital badge offers the opportunity for educators to become part of the Global Learning and Observation to Benefit the Environment (GLOBE) community.

Using free GLOBE products, teachers can do observations with students as described in the digital badges. Details of each digital badge can be found on Table 2. Videos of NASA LaRC engineers, researchers, and scientists were produced to show examples of people working on current solutions. The identified researchers, as well as the links to the videos produced for the digital badges are listed in Table 2.

TABLE 2

Description of STEM focus and main learning outcomes for each topic selected for the digital badges.

Title of Digital Badge	Earth Right Now	Journey to Mars	Aeronautics
STEM Focus Area	Science	Engineering	Math and Science
Main Topic	How cloud types and cloud heights impact the amount of energy from the Sun, affecting Earth's Energy Budget.	How engineers use Mars' atmosphere to generate drag and slow down a capsule carrying a Mars rover.	How scale models of airplanes are used to test composite materials to design safer and more efficient aircrafts.
Activity Description	Create an atmosphere using a clear plastic container. Using a thermometer and cotton balls, gather temperature measurements to test differences between thin, high clouds and low, thick clouds on the energy reaching the surface.	Use different recyclable materials to create a design with minimal weight and large surface area to create drag to get the slowest speeds possible.	Graph data of flight time and distance a pre-selected paper airplane design performed using copy paper, cardstock, and newspaper to select which material performed the best.
NASA Workforce Example and Video Link	Atmospheric Scientist Dr. Yolanda Shea https://youtu.be/F1s5ow--ILs	Aerospace Engineer Alicia Dwyer Cianciolo https://youtu.be/USEnZrbeMYo	Engineering Technician Sam James https://youtu.be/nCtmPjX9a9M

INITIAL EVALUATIONS

A group of fifteen volunteers composed of teacher educators, in-service, and informal educators was assembled to evaluate both educator and student digital badges.

Table 3 shows the distribution of the volunteers based on instruction level. Six volunteers reviewed each digital badge. The others each focused on a specific digital badge based on their STEM focus area.

TABLE 3

Distribution of digital badge evaluators based on instruction level.

Distribution of Badge Evaluators						
Middle School Science	**Middle School Math**	**High School Science**	**High School Math**	**STEM Director or Science Specialist**	**Science Teacher Educator**	**Informal Educators**
2	1	3	2	4	1	2

Volunteers were asked questions focused on site design, appropriateness of material for targeted grade level, and likelihood of implementation in their own classrooms

Table 4 highlights questions related to content appropriateness for the targeted audience and usability.

TABLE 4

Evaluator responses to questions regarding activities in the digital badges.

Selection of Questions Submitted to Evaluators		Earth Right Now	Journey to Mars	Aeronautics
1. Were all of the activities and resources used in this badge appropriate for middle school?	**Yes**	10/10	10/10	10/10
	No	-	-	-
2. On average, how long did it take to complete each individual step in the TEACHER badge?	**< 1hour**	1/10	4/10	1/10
	1hour	9/10	5/10	9/10
	> 1hour	-	1/10	-
3. On average, how long did it take to complete each individual step in the STUDENT badge?	**15 mins**	1/10	-	-
	30 mins	7/10	7/10	7/10
	45 mins	2/10	3/10	2/10
	1 hour	-	-	1/10
4. In a scale of 0-5, where 0 is no implementation and 5 is implementation of all activities, how likely are you to implement these activities in your classroom?	**0**	-	1/10	-
	1	2/10	-	-
	2	-	-	1/10
	3	1/10	-	
	4	4/10	4/10	5/10
	5	3/10	5/10	4/10

REDESIGN OF DIGITAL BADGES

Evaluators all agreed that the activities met the targeted grade levels but shared detailed concerns about the time required to complete specific steps. Most concerns revolved around the Journey to Mars digital badge and the lack of time for students to follow the engineering design process of building, testing, and redesigning their capsules, in addition to making calculations to choose the best design. Adjustments were therefore made, distributing the engineering design process throughout the four steps of the student digital badge.

For example, in step two students learn about the problem, study the constraints and draw a design; in step three they build, test and gather data; and in step four they study the data, redesign their capsule and draw conclusions based on their calculations. Additionally, the activity sheets developed for the activity highlight each portion of the engineering design process across the four steps. Concerns about time to complete the engineering design process are commonly expressed by teachers implementing engineering design challenges in their classrooms. In an effort to identify additional solutions, educators completing the Journey to Mars digital badge are asked to provide feedback about the adjustments they make within the teacher activity sheets.

Other concerns were associated with the Aeronautics digital badge and the time it took to fold paper airplanes. Informal observations collected from educators indicate that the majority of students have never made a paper airplane. A very basic paper airplane model was selected to address these concerns. The student badges were reviewed and restructured, reducing and simplifying the amount of work per step. The main objectives were presented in a cleaner, simplified format, reducing the time to complete the steps.

PARTICIPATION OF EDUCATORS AND STUDENTS

The NASA Langley Centennial Digital Badges were released November 7, 2016 onto the NASA STEM EPDC Digital Badge website. As of the end of March, 2017 thirty-one educators were working through the digital badges and twelve have earned one or more digital badges. Only a handful of submissions have been registered through the student digital badges, as most educators are reviewing their own students' badge submissions.

A number of educators completing the digital badges have used the structure and activities within the digital badges to do professional development and/or after school activities within their school districts. For example, after implementing the activities in her class, one of the reviewers invited the NASA STEM EPDC educator to lead a professional development for 12 teachers in preparation for using the digital badges in a spring after-school program. The teacher educator who evaluated the badges used the activities with pre-service teachers to focus on STEM and problem-based activities. A STEM teacher used the activity within the Aeronautics digital badge and implemented the activities with Kindergarten students to teach sequencing. The same teacher then implemented the Aeronautics activity with fifth graders to talk about the four forces of flight. Educators in Puerto Rico have translated the activity sheets in order to implement them in their classrooms.

The majority of educators attending the bi-monthly live online discussions, required for step 4 of the educator digital badge, express that this is their first time learning about digital badges. Since December 2016, with the start of the online discussions, the number of participants working through the digital badges increased from three to thirty-one participants by the end of March 2017.

CONCLUSION

The NASA LaRC Centennial Digital Badges have been a unique way to learn about NASA activities and research. These digital badges have introduced educators to digital badges and their application in professional development and in the classroom. Although the number of educators participating in the offerings is low, most participants have never heard of or used digital badges.

These observations, in addition to feedback through the digital badge blogs, emails, and discussions during the online sessions, suggest there is excitement among educators with the structure and activities. This has allowed educators to join this new type of professional development and learn about techniques to use similar structures for their students. Educators and students participating in the program have learned about NASA LaRC's missions and 100th anniversary.

Digital badges are new to many educators. The LaRC Centennial Badges provide a forum through which educators can learn not only about NASA content and applications, but also about this new format of professional development. Educators report that these badges are worth their time and effort as part of their professional development. LaRC looks forward to building new badges in the future to expand beyond middle school and reach across the K-12 continuum.

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