

Teaching on the Edge: Synthesis and Dissemination of a High Altitude Ballooning Curriculum for Undergraduate Students through the Web and an iBook

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This paper will discuss the results from the design, development and dissemination of online and digital media efforts to synthesize a high altitude ballooning curriculum for undergraduate students (including pre-service and in-service STEM teachers) on the web and for middle school STEM students through an Apple iBook project for the iPad. The content and materials for the website and iBook project resulted from a multi-year educational collaboration between Taylor University (led by Dr. Don Takehara and Dr. Hank Voss) and Ball State University (led by Dr. Melissa Mitchell). New web- and tablet-based teaching and learning materials were designed and created by Ball State's Integrated Learning Institute (iLearn) and Emerging Technology (ET) unit. In collaboration with Dr. Mitchell, Ball State's curriculum and media development team created an online educational site ("Teaching on the Edge: Using High Altitude Ballooning in the Classroom" (<http://ilearn.bsu.edu/tote/>)) as well as an accompanying Apple iBook for 6-8 grade students. The Teaching on the Edge (TOTE) project was funded as a subaward on an NSF CCLI/TUES grant to prepare for a widespread implementation of Taylor University's High Altitude Research Platform (HARP) to universities around the country and to integrate the HARP program into the STEM curricula for 6-8 grade science classes. As part of a wider implementation of a high altitude ballooning (HAB) curricula to pre-service and in-service teachers, the project website contains multiple lessons plans, data from actual balloon launches, and supplementary online learning materials and links. The website contains videos of an actual balloon launch, video interviews with science educators, and FAQ (Frequently Asked Questions) pages to assist teachers who want to use the HARP curriculum in their middle school science courses. Moreover, to provide additional learning materials for 6-8 grade science courses, a companion iBook textbook project was also created. Among its many features, the iBook includes a brief history of high altitude ballooning, video examples of hands-on classroom active learning activities, quizzes, and animated time-based and geographically accurate simulations of balloon flights. While Teaching on the Edge is a proof-of-concept project, it does showcase the potential for using online and mobile technologies to enhance and disseminate high altitude ballooning curricula to universities and secondary schools. A key objective of this project was to use online and digital technologies to more broadly disseminate existing HARP curricula, including the availability of resources and lessons for active, blended and mobile learning pedagogies. To broaden participation among teachers and students for the implementation of HARP in science courses, there is still a need for additional educational services and more widely available lesson plans and modules. Online and mobile technologies have much to offer the high altitude ballooning educational community in that regard. Online learning can be used for the training and professional development of the next generation of HARP educators. Portable tablets such as the Apple iPad offer the ability for students to take a hands-on learning approach in the field as part of a mobile learning strategy that enables robust social and content interactions during actual balloon launches. The creation and sharing of open and online educational resources is a critical step in building and sustaining a new culture of learning around high altitude ballooning curricula.

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I. Introduction

THIS paper details media production efforts taken by Ball State University to synthesize and disseminate a high altitude balloon (HAB) curriculum through the web and an iBook project. A HAB curriculum geared towards training and supporting the next generation of undergraduate pre-service and in-service teachers was developed as part of Taylor University and Ball State University's HARP program. In 2013, at the Academic High Altitude Conference (AHAC), Voss and Dailey presented a paper entitled "Express Launch: A New Capability for NearSpace."³ In that paper, the authors discuss the goal of "streamlin[ing] academic to near space (at low risk and cost) while still fully developing classroom experiments and maintaining the real-time data and launch excitement."⁴ At the conclusion of that paper, Voss and Dailey mentioned plans to make available "curriculum for teaching STEM using the HARP Platform."⁵ One of the results of those curriculum development efforts was the Teaching on the Edge (TOTE) Project (see Figure 1). The TOTE Project produced both a website and iBook based on the HARP platform.

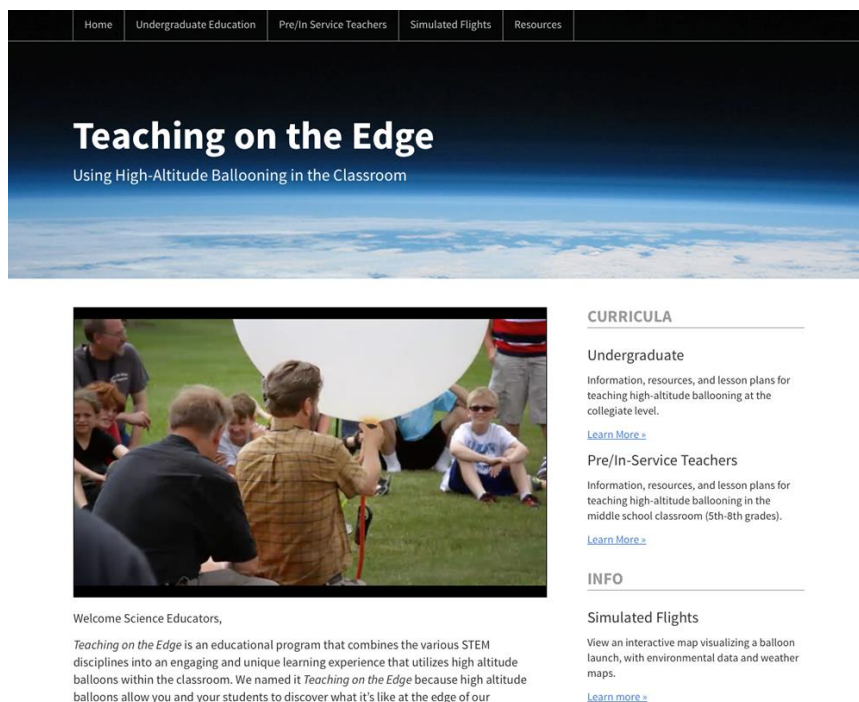


Figure 1. A screenshot of the landing page of the Teaching on the Edge website
(<http://ilearn.bsu.edu/tote/>)

In their book *A New Culture of Learning: Cultivating the Imagination for a World of Constant Change*, Douglas Thomas and John Seely Brown argue in favor of "learning environments in which digital media provide access to a rich source of information and play, and the processes that occur within those environments..."⁶ Existing HAB curricula and lesson plans with their rich real-world experiments, experiential field data, and hands-on project-based activities are the type of learning environments advocated by Thomas and Brown as critical to developing the next generation of STEM learners and researchers. An objective of the TOTE project was to use digital media to complement and enhance the project-based STEM learning and problem solving aspects of HARP. Towards this end, the TOTE project incorporates simulations of high altitude balloon launches using actual data, video demonstrations of balloon launches, and instructional videos for in-service and pre-service teachers.

³ Voss, H.D. and Dailey, J. "Express Launch: A New Capability for NearSpace," *2013 Academic High Altitude Conference (AHAC)*, URL: http://www.stratoballooning.org/sites/default/files/presentations/papers/Voss_2013.pdf.

⁴ *Ibid.*

⁵ *Ibid.*

⁶ Thomas, D. and Brown, J.S. *A New Culture of Learning: Cultivating the Imagination for a World of Constant Change*. Lexington, KY: CreateSpace, 2011. 37-38.

The TOTE project team brought together a variety of 21st century educational practices including the use of open educational resources (OER), leveraging the affordances of online and blended learning, and experimenting with tablet technologies and mobile learning (m-learning). While TOTE is a proof-of-concept project, it does demonstrate that educators can leverage the power of online and blended learning in the HAB curriculum. Furthermore, a wider dissemination of teaching and learning efforts around HAB will tend to bring additional educational expertise via instructional designers, media professionals, and training experts. While we encourage the sharing of lesson plans and resources around HAB, a project like TOTE indicates that the dissemination and adoption of this curriculum will also require additional training and development opportunities for teachers, students, and school administrators. Online and mobile technologies can be used in this capacity. For example, an online approach to teacher preparation might better reach and serve these target groups at the secondary school and university levels.

II. The Teaching on the Edge (TOTE) Project Team

The Teaching on the Edge Project was created at Ball State University through a subaward from the National Science Foundation. The lead unit on the project was the Integrated Learning Institute (iLearn) under the project direction of Richard Edwards and Steve Schuler. iLearn is an Academic Affairs unit at Ball State University that supports the development of online and blended learning courses, tools, and environments. iLearn has instructional designers who work with faculty to create online and blended courses, as well as a team of learning technologists who train faculty on the latest technologies and learning management systems. iLearn also have a research unit that explores the next generation of online and blended learning advances. For this project, the iLearn team worked with Dr. Melissa Mitchell, a Ball State faculty member who has been developing undergraduate curriculum for the HARP project over the last few years, in the synthesis of the HAB curriculum.

Design and development of the website and the iBook was coordinated and handled by Ball State's Emerging Technology unit, under the supervision of Brandon Smith. During a three-month production cycle for this project, web designers, graphic artists, and digital storytellers in Emerging Technology worked on the creation of the website and iBook. There was also a full time graduate student assisting with the writing and editing of the materials for the website and iBook.

Furthermore, Ball State brought additional expertise to the TOTE project as two of the project leads, Steve Schuler and Brandon Smith, had previously worked on Ball State's Electronic Field Trip (EFT) program.⁷ There are many similarities between EFTs and the HAB curriculum. Electronic Field Trips are an interactive educational experience to make the rich content of national parks and museums available to secondary school students. The EFT project involved creating a website with games and activities to encourage active learning. The EFT project was also a TV show produced on location throughout the United States with on-camera subject matter experts that brought real world expertise into the classroom. EFTs also included lessons for the classroom based on standards-based, grade appropriate lessons for teachers. The synthesis of the HAB curriculum required many of the same skills and approaches as the EFT project.

III. Design and Development of the TOTE Website

From the beginning, it was an objective of the TOTE project to make existing HARP and HAB curricular materials as open and accessible as possible to the educational community. It was decided that the best way to do that would be put the materials online in a website specifically tailored to undergraduates and pre-service and in-service teachers. The website functions as a complement to on-going faculty preparation efforts to expand the use of HAB curriculum in secondary school science courses. As the website states:

One major criticism of teacher preparation programs is that they tend to emphasize either content or pedagogy independently and at the expense of a more integrated and conceptualized whole (Mason, 1999). The result of such programs is too often teachers emphasizing for detail and depth, rather than articulation and conceptual understanding. Introducing a HAB curriculum in a science methods class may help to mitigate such results and to increase pre-service science teachers' development of pedagogical content knowledge.

Initially, when visitors reach the Teaching on the Edge website, the landing page clearly identifies information, resources, and lesson plans that are separately tailored for undergraduate and pre/in-service teachers (see Figure 1).

⁷ For more information on Ball State's EFT program, visit URL: <http://www.bsu.edu/eft/home2/00front.htm>

The website includes the following information and features:

- a) Detailed information on new teaching and learning strategies (including curriculum development) using the HAB experiments in STEM disciplines that can be downloaded by undergraduates and pre/in-service teachers;
- b) Description of the equipment needed to perform the HAB experiments;
- c) Descriptions and examples of the data analysis procedures used in previously conducted HAB experiments;
- d) Middle School (6th-8th grade) lesson plans and teaching materials on HAB experiments to prepare undergraduate students training to be science instructors;
- e) A resources sections dedicated to lesson plans on the web, NSTA journal articles on high altitude ballooning, web links and resources, and HARP Network partners;
- f) Online videos about and/or related to HAB experiments (including editing existing videos and producing new videos to deliver new teaching and learning strategies);
- g) FAQ sections for both undergraduate and pre/in-service teachers related to the purpose and application of the website and the accompanying iBook.
- h) Interactive simulation based on previous high altitude balloon launch data.

In terms of synthesizing the curriculum, the project team initially had to organize and digitize existing lessons plans to add them to the website. This was a necessary, but time-consuming, process. Part of the need for the organization, synthesis, and digitization of the lesson plans resulted from how the curriculum was initially developed and refined. The TOTE curriculum was the culmination of a three-year NSF grant to Taylor University and Ball State University for the wider dissemination of the HARP program. Faculty from both schools collaborated to bring high altitude ballooning to undergraduate elementary and secondary science teaching majors through their science methods classes. Both universities already had the balloon launch and retrieval capabilities to support the HAB curriculum. Once the teaching majors had been through an iterative cycle of experimental design, data collection, and data analysis activities, those students prepared lessons to teach those processes to 6-8 grade students in local area schools. The curricular materials on the website were produced by the teaching majors under the supervision of trained faculty such as Dr. Mitchell. While this process produced a wealth of new curricular materials, it was in a variety of different formats. One of the recommendations for the future dissemination of HAB curriculum is to consider from the onset how these kinds of teaching materials will be archived and shared for later use. If materials are designed in advance with a principle of digital sharing and re-use in mind, such approaches will enhance our ability to use the web or the "cloud" as an effective mechanism for the dissemination of HAB curricula.

Since TOTE seeks to leverage the affordances of digital technologies to create an interactive learning environment, it features an interactive simulation based on previous high altitude balloon launch data (see Figure 2).

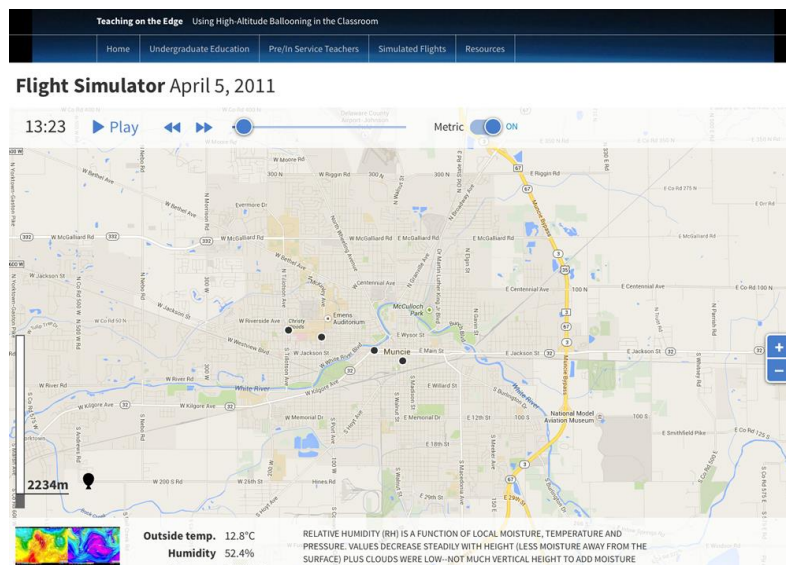


Figure 2. A screenshot of the flight simulator on the TOTE website. Note that the online simulator uses the actual flight data and geographic data to map the balloon's flight trajectory. It also shows additional flight data including outside temperature, humidity, air pressure, and weather maps.

For the project team, a tool like the Flight Simulator on the website was created to expand our possibilities for disseminating the learning outcomes of the HAB curriculum. While it should be a goal to expand and streamline as much as possible actual launch capabilities for high altitude ballooning, in practice there will always be groups of teachers and students for which an actual launch is beyond their resourcing ability. But when a HAB curriculum is placed online and designed with distance learners in mind, we can use digital technologies to gain some of the same learning outcomes and benefits *as if* there were an actual hands-on launch. The Flight Simulator uses the actual launch data and places it in a rich learning context using highly accurate online mapping technology. Using the data results from the Flight Simulator, teachers can virtually support a HAB module in their 6-8 grade science courses and use the power of simulation to encourage active, project-based learning in STEM education. Since the goal of the HAB curriculum is to facilitate student STEM learning around problem solving, prototyping, and evaluating and assessing real-world scientific data, simulations can be an important resource and technique for expanding learner engagement with high altitude ballooning.

Under the resource section of the TOTE website, there are numerous resources available to undergraduates and teachers. Due to the size of many of these resources (ranging up to 305MB), they have been archived in easy to download ZIP files. Resources available at TOTE include: lesson plans, lesson collections, additional lesson resources, the Teaching on the Edge iBook, information on Stratostar and NearSpace Launch, lesson plans and links to other materials available on the web, and a reference list of journal articles. There is also archived data from previous balloon launches that can be downloaded by teachers and students.

TOTE also uses video as an effective teaching and training tool. There is a welcome video explaining the purpose and goals of the website. There are video interviews with middle school teachers and students to provide further context to new teachers who might be interested in using the HAB curriculum in their classroom.

IV. Design and Development of the TOTE iBook

While the website functions as a hub for teacher preparation, there was an identified need to continue to expand the resources available to current and future middle school teachers who want to support the HAB curriculum. After a series of internal discussions between Ball State and Taylor, the TOTE team was tasked with producing an iBook textbook for the Apple iPad. This was designed to be a proof-of-concept demonstration to leverage the growing use of mobile learning technologies in middle school science classes. The iPad was chosen as the tablet platform due to its popularity and availability in many middle schools through the United States. The TOTE team designed an iBook to assist with student learning outcomes related to the HAB curriculum (see Figure 3).

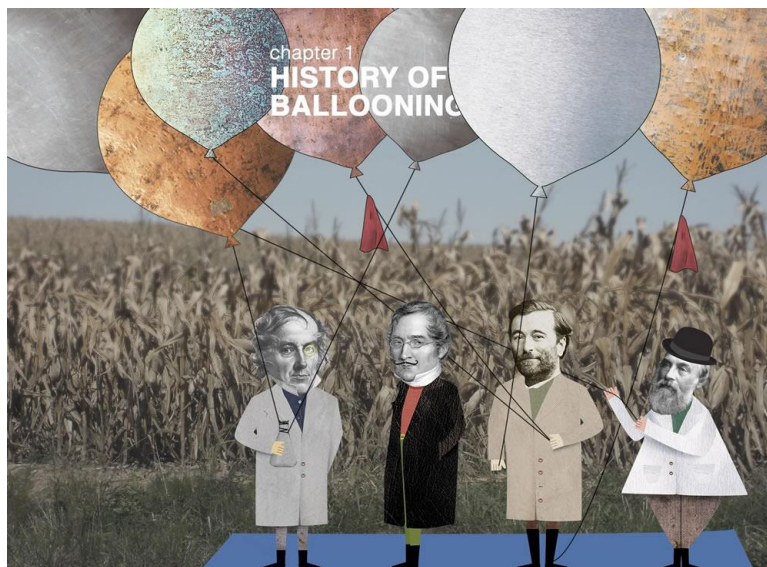


Figure 3. A sample page from the *Teaching on the Edge* iBook.

The iBook includes the following information and features:


- a) A free textbook dedicated to high altitude ballooning that is broken down into four chapters:
 - a. Chapter 1: History of Ballooning
 - b. Chapter 2: The Atmosphere
 - c. Chapter 3: What Happens During a Launch
 - d. Chapter 4: Projects
- b) Interactive learning activities to teach the science behind high altitude ballooning, such as interactive pages and quizzes;
- c) Interactive demonstrations of different hands-on projects that teachers and students can explore in the classroom related to the science of high altitude ballooning.

Visually, the design team of the iBook sought to make the graphic design (i.e. its look and feel) engaging for middle school students. It was also designed to take advantage of touch screens to make the learning more interactive. It is available as a free download from Apple iBooks. The iBook also contains additional learning projects related to the science behind high altitude ballooning. Each of the learning projects contains step-by-step video demonstrations. As with the role of the Flight Simulator on the website, the iBook is designed to bring the HAB curriculum into more classrooms whether they have the capability to organize an actual balloon launch.

Project 3 - Layers of the Atmosphere: Let's Get Our Hands Dirty

Project Steps:

- 1) Draw a picture of what you think your materials will look like once all of the materials have been added to the beaker. This is your prediction of what will float, what will sink and where each component of the system will be in relation to the others. Be sure to label each item and each layer.
- 2) Combine your materials in the beaker in this order:
 - 1) 50 ml of baby oil
 - 2) 50 ml of colored water
 - 3) 50 ml of corn syrup
 - 4) the marble
 - 5) sugar cube
 - 6) push pin
 - 7) rubber band
 - 8) paper clip
- 3) Draw a picture of what your beaker actually looks like. Be sure to label each item and each layer.
- 4) Place your beaker in a safe and secured area where it will be unharmed for an extended period of time.
- 5) After one week draw your third and last picture of what your beaker looks like. Be sure to once again to label all the different items and layers.



Tap pencil to draw.

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Figure 4. Example of a Hands-on Science Project with a "how-to" video in *Teaching on the Edge of Science* iBook

The iBook can be seen as a supplement to the website. It contains the basic information necessary to assist student understanding about the history and science behind high altitude ballooning. It includes three lessons that teach basic scientific strategies for understanding how GPS works, how the scientific method operates, and how the earth's atmosphere is a system of interrelated parts. Students can also take an iBook with them into the field during an actual balloon launch. The iBook provides students with information related to different parts of a balloon launch from planning to retrieval. It is important to note that this begins to connect the HAB curriculum with new teaching and learning opportunities around mobile learning. Since iPads are portable and handheld devices, they can be physically brought by teachers and students to actual balloon launches. Future uses of iBooks and iPads could be developed around the HAB curriculum to utilize the computing power and interactive nature of tablet technology to further enliven and enrich its connections to real world, inquiry-based project learning.

V. Final Thoughts

The Teaching on the Edge project was designed as a proof of concept for the wider dissemination of the HAB and HARP curriculum, but we are only at the start of what is possible for the digital future of HAB curricula. Due to the engaging learning environments created by high altitude ballooning, advancements in digital media and online and mobile resources can contribute to the growth and refinement of how high altitude ballooning can make a broader impact on STEM learners in secondary schools. For members of the HAB community focused on teacher preparation, the TOTE project suggests that we continue to explore the possibilities of online education and mobile technologies around preparing teachers for the pedagogical benefits of high altitude ballooning. Finally, mobile technologies such as the iPad hold much promise as a supplemental learning tool for middle school students as they participate in high altitude balloon launches.

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