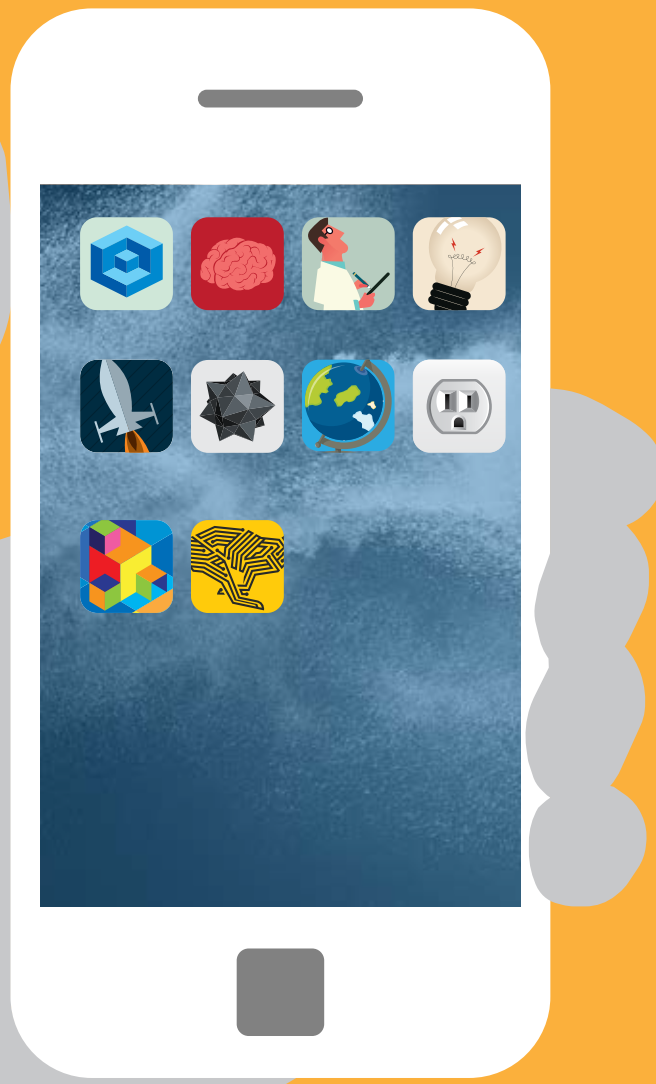
Using smartphone app design to engage students in biological ecosystems

THERE'S AN APP FOR THAT

Bradley Bowen and James Finch



Today's students are sometimes called "digital natives" because technology has been integral to their lives for as long as they can remember (Prensky 2001). Teachers can tap into this digital engagement with the full support of many parents, who believe that incorporating technology into the classroom can make learning more fun and relevant to students (Cavanagh 2013). This article describes how one science teacher based an activity on designing smartphone apps to clearly and concisely communicate the interdependent relationships of a biological ecosystem. The teacher designed the activity to address several aspects of the latest science standards (Figure 1, p. 42).

FIGURE 1

Addressing the standards.

Besides addressing standards of the Partnership for 21st Century Skills, the project design addressed the following *Next Generation Science Standards* performance expectations (NGSS Lead States 2013).

- HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.
- HS-LS2-6. Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.
- HS-LS2-7. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.

Problem definition

Working in teams of two or three, students developed smartphone apps that addressed the concept that organisms are dependent on the biotic and abiotic factors and relationships in their ecosystem and are also affected by human impacts. Each team was responsible for designing a different app. The students developed the app with a particular user in mind while making it quick and easy for the consumer to learn (Figure 2). Three essential questions drove the content of the lesson:

- How do biotic and abiotic interactions affect interdependent relationships in an ecosystem?
- What factors limit an organism within an ecosystem?
- What is the human impact on the ecosystem?

Engineering design process

For this activity, the teacher incorporated components of a problem-solving process, particularly the engineering design process, in his instructional strategies. Typical elements of engineering design that the teacher covered include:

- **Define** the problem along with the criteria and constraints under which the solution needs to be developed.
- **Research** the problem with appropriate research methods to gain the background information needed to approach the problem practically.
- **Brainstorm** possible solutions without limiting the usefulness of each option.
- **Choose** the best solution by critiquing each possible solution based on parameters and criteria discovered through problem definition and research.
- **Build** a visual model of the solution so the feasibility of the solution can be monitored and adjusted as needed.
- **Test** the solution by exposing it to the parameters of the problem to learn about the solution's performance.
- **Communicate** the solution by documenting and presenting all results discovered during designing and testing of the solution.
- **Redesign** as needed through multiple iterations to attain an optimal solution.

A formal problem-solving process can help students better create an effective solution. However, the engineering design process may not always follow a linear path. The steps listed above can be modified to meet the unique challenges of a particular project. Regardless of such variations, students need to be engaged in the process to gain knowledge about the production of optimal solutions.

Research and brainstorming

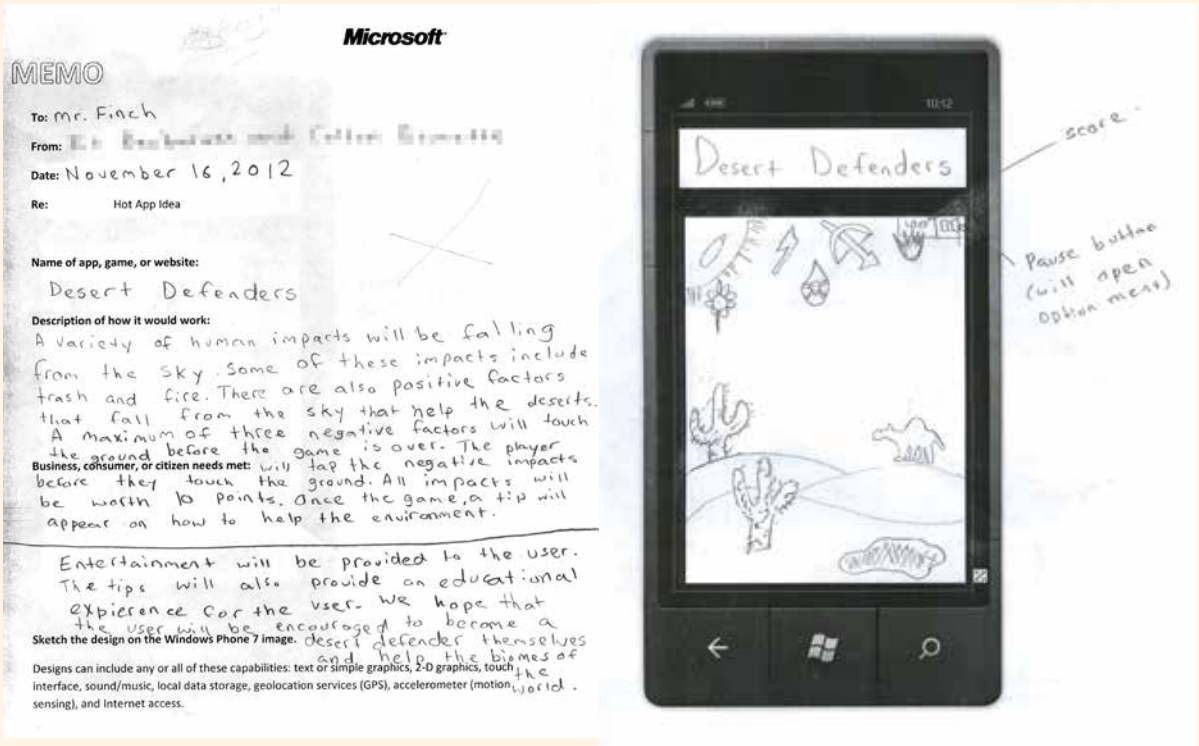
What makes a good app? Students researched existing smartphone apps and documented some of their favorites. The teacher challenged the students, as part of their research, to find websites that evaluated and critiqued different apps and discussed general components of effective and popular app designs. Each student documented his or her findings in a journal. As the students continued researching, they worked individually to generate their own ideas and then came together with the team to discuss the ideas for the ecosystem app. They also discussed with their teams the characteristics of good apps and how the different designs would meet the needs of consumers. (For several websites that list popular apps, see "On the web.")

App design

After researching and discussing different ideas among the group, each team member identified the optimal characteristics for the app. The group then agreed on a set of characteristics to describe in a memo to the teacher (Figure 2). The memo documented the name of the app, critical functions, performance characteristics, and how the solution addresses consumer needs. The memo also included a sketch of an app screen and the general layout of the interactive touchscreen buttons. Required content for the memo can be modified according to what critical information the teacher

FIGURE 2

Sample app memo and description.



Microsoft

MEMO

To: Mr. Finch

From: [redacted]

Date: November 16, 2012

Re: Hot App Idea

Name of app, game, or website:

Desert Defenders

Description of how it would work:

A variety of human impacts will be falling from the sky. Some of these impacts include trash and fire. There are also positive factors that fall from the sky that help the deserts. A maximum of three negative factors will touch the ground before the game is over. The player will tap the negative impacts before they touch the ground. All impacts will be worth 10 points. Once the game ends, a tip will appear on how to help the environment.

Business, consumer, or citizen needs met:

Entertainment will be provided to the user. The tips will also provide an educational experience for the user. We hope that the user will be encouraged to become a desert defender themselves and help the biomes of the world.

Sketch the design on the Windows Phone 7 image.

Designs can include any or all of these capabilities: text or simple graphics, 2-D graphics, touch interface, sound/music, local data storage, geolocation services (GPS), accelerometer (motion sensing), and Internet access.

One student app design is called "Desert Defenders," which the student describes in a memo to the teacher *(above)*. The app teaches about human and environmental impacts on desert ecosystems through gameplay. According to the design concept, the first screen depicts a sensitive desert environment. A short description pops up with background information. Once play begins, icons representing both positive and negative human and natural impacts fall from the sky at the top of the screen toward the ground at the bottom. The positive impacts include water conservation, recycling, native animals, and regional plant life; negative impacts include acid rain, trash, excessive water use, CO_2 emissions, and invasive species. As a new impact icon appears, so does a short description. Users must tap the negative impacts as they fall. Any that hit the ground deteriorate the environment. Conversely, positive impacts that reach the ground improve the environment. The various impacts are each worth 10 points.

Once enough impacts hit the ground, the level is completed or the game ends. As the user progresses through different levels, the game becomes more challenging and the environments more complex. At the end of each level and of the game itself a short real-life success story about positive human impacts or tips for improving the environment are displayed; for example, a story about how choosing native landscaping options that require little watering can help in drought-prone areas. Players gain valuable knowledge about desert ecosystems and the positive and negative impacts that can influence environmental conditions.

wants students to include. Students can also develop multiple memos to illustrate a series of screen shots representing the sequence of navigation between various pages of the app. Students then presented their design concepts to the class, fielded questions, and received feedback. Based on this design process, students revised their conceptual design, demonstrating the ability to accept constructive criticism.

App development

Once the group completed the memo, they designed the app using free software from Microsoft called Windows Phone SDK 7.1 (see "On the web"). Other app-designing software is available for other device platforms, such as Apple and Android (see "On the web"). Some types of app design software require a basic knowledge of coding while others have simple drag-and-drop functionality. In choosing the software, teachers can decide how much technological knowledge and programming ability students will have to master to finish the project.

To begin developing the app, students followed the steps of basic coding provided through instructions, tutorials, instructional videos, and samples built into the software itself. The students also performed simple web searches to research other sources of information about coding. Students weren't

FIGURE 3

App summary sheet.

Names	(Student names)
Innovation Category	Smartphone app
Project Name	TrailTracker
Describe the Opportunity	The Trackster company provides a variety of hiking and biking products for outback adventurers. Customers are eager to have the latest equipment but also want to know about great hiking and biking trails to take full advantage of the new equipment they have recently purchased.
Explain the Product	The TrailTracker is easy to use! The user can enter a difficulty level, distance radius, and their zip code or longitude and latitude. The TrailTracker identifies hiking and biking trails to fit the criteria and suggests appropriate equipment depending upon the trail conditions and weather forecasts.
Defend the Innovation	Hikers and bikers want to quickly and easily find trails to fit their abilities and preparedness. They need to be sure they are properly outfitted for the excursions.
Present the Marketing Pitch	The TrailTracker is an easy-to-use trail finder plus much more. Users can enter a variety of trail specifications including difficulty level and location. The TrailTracker selects the trails most appropriate based upon the selected criteria. The TrailTracker is more than a convenience! It can be a lifesaver, ensuring that hikers and bikers select treks appropriate for their skill level and equipment stores. It can keep hikers and bikers safe from dangerous hikes for which they are not prepared and warn them of impending dangerous weather conditions.
Who is the customer?	
Location	In the initial release, the customer would be any hiker or biker located in the continental United States.
Population	Hikers and bikers of any age and ability level.
Personality	These customers would be physically active, conscientious about safety, and tech-savvy.
Behavior	The TrailTracker is as handy as one's phone. Everyone could make use of it with easy-to-use touch-screen capabilities.
Cost	The basic TrailTracker app would be a free download to customers of participating hiking and biking equipment stores and members of participating hiking and biking clubs.

FIGURE 4

Sample schedule.

Days 1–2	Day 3	Day 4	Days 5–9	Day 10
• Research and brainstorm good app designs and characteristics	• Finalize conceptual design • Complete app memo	• "Town hall" presentations • Receive formative feedback from class • Redesign as necessary	• App design	• Marketing presentations • Final project submission

expected to create a working app because of time constraints; instead, they created a conceptual design for an app that demonstrated understanding of biological ecosystems.

Marketing

After the group completed the app design, they created a 30-second video commercial to advertise the app on TV, YouTube, or a mobile device. The students were given the following questions to consider as they designed the commercial:

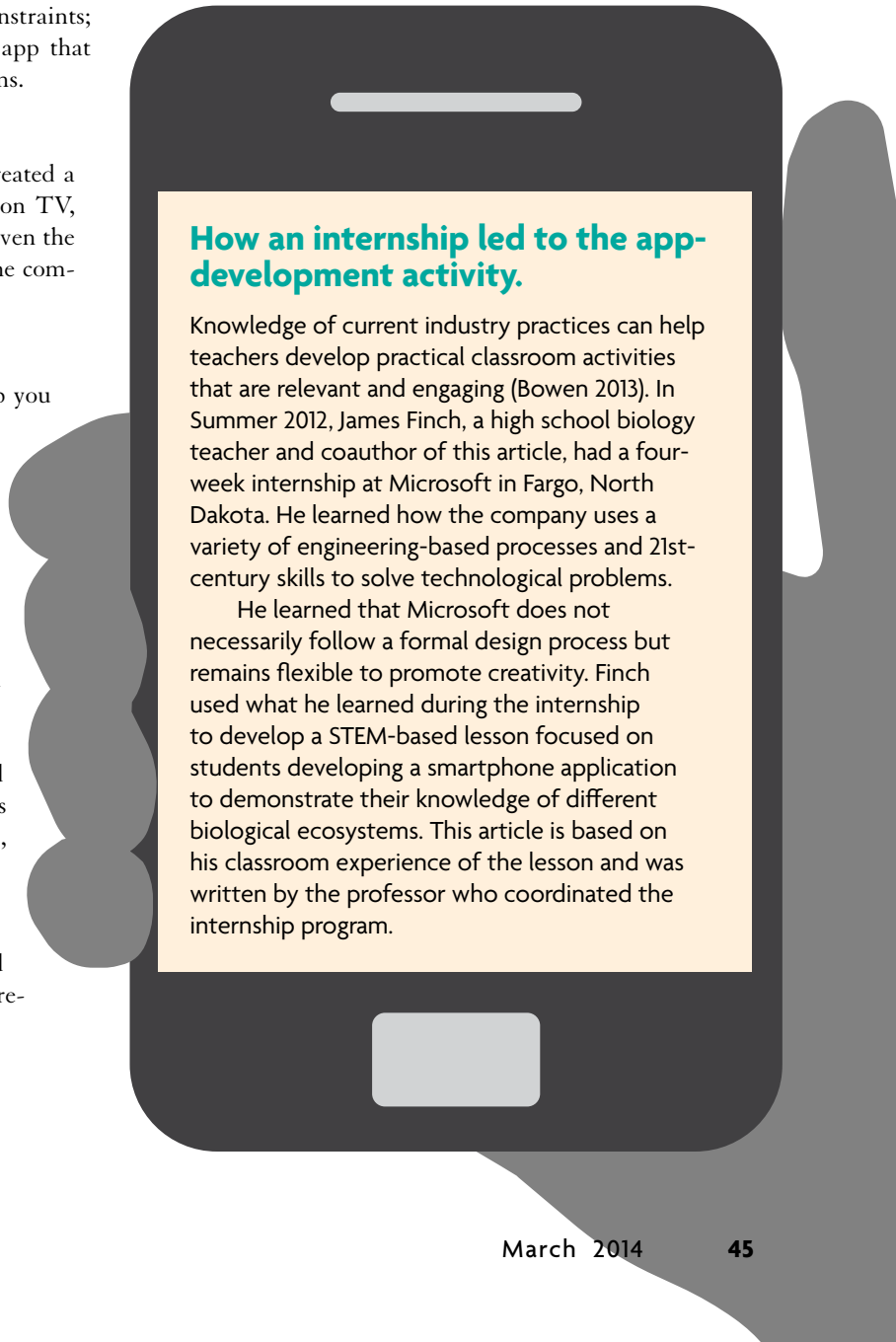
1. Why should someone use your app?
2. What needs are actually being met by the app you designed?
3. What group of individuals would this app be most useful for?
4. What sets your app apart from others already out there?

As students developed the commercial, they documented their answers to these questions on an App Summary Sheet (Figure 3). Students wrote a script for the commercial and got feedback on it from the teacher and classmates. Then they created the commercial, using either Animoto or Windows Movie Maker for video editing (see "On the web"), being sure to include screenshots from their app.

Feedback and reflection

Students then presented their final app design and video commercial to the teacher and classmates, receiving feedback based on the following questions:

- Would you actually use the app?
- Would you tell your friends about it?



How an internship led to the app-development activity.

Knowledge of current industry practices can help teachers develop practical classroom activities that are relevant and engaging (Bowen 2013). In Summer 2012, James Finch, a high school biology teacher and coauthor of this article, had a four-week internship at Microsoft in Fargo, North Dakota. He learned how the company uses a variety of engineering-based processes and 21st-century skills to solve technological problems.

He learned that Microsoft does not necessarily follow a formal design process but remains flexible to promote creativity. Finch used what he learned during the internship to develop a STEM-based lesson focused on students developing a smartphone application to demonstrate their knowledge of different biological ecosystems. This article is based on his classroom experience of the lesson and was written by the professor who coordinated the internship program.

FIGURE 5

Rubric.

	Advanced: 15–14 points	Proficient: 13–10 points	Partially proficient: 9–6 points	Novice: 5–0 points
Addressing real-world needs **_____ pts**	• The app is highly engaging and addresses user needs in a unique way • Information provided is highly relevant and educates users on the biome • App could be used frequently in everyday life	• The app meets the needs of a potential user (business, consumer, citizen, etc.) • Relates specifically to the biome of study • The service or information provided is accurate and helpful • The user is engaged by the design and purpose of the app • App could be useful to users on multiple occasions or in various situations	• The app deviates from the "Proficient" criteria in two aspects • The app relates somewhat to the biome of study • The concept and function only slightly meet real-world needs	• Deviates from "Proficient" criteria in three or more aspects • The app does not relate to the biome of study • The app does not meet the needs of a potential user
Design **_____ pts**	• App appeals to multiple senses • App is fun and interesting while conveying accurate information • Concept is distinctive	***Creativity*** • Design is attractive and easy to navigate • App (including name, design, layout, purpose, and function) is unique, creative, and appealing to potential users • Accomplishes goals that other media sources do not or that are unique to mobile devices • Occupies a unique niche in the mobile market ***Usability*** • Provides the user with a practical and relevant source of information or service • Functions are easy to use and navigate	• The app deviates from the "Proficient" criteria in two aspects • The concept and function are somewhat unique and appealing • Design somewhat prevents easy use and navigation	• Deviates from "Proficient" criteria in three or more aspects • Little to no creativity is demonstrated • App would not be usable by intended users
Communication **_____ pts**	***Memo*** • Extremely professional and well written in conveying purpose of app ***Commercial*** • Creates excitement or "buzz" about product	***Memo*** • Communicates and highlights the main purpose of the app • Describes in detail how the app would work • Real-world needs are identified and met • Memo is neat and professional ***Commercial*** • Communicates and highlights the main purpose of the app • Real-world needs are identified and met • Targets a specific audience	• The app deviates from the "Proficient" criteria in two aspects • Memo and/or commercial identifies few real-world needs • Somewhat portrays the usefulness of app	• Deviates from "Proficient" criteria in three or more aspects • Memo does not convey usefulness of the app • Commercial does not convey usefulness of the app
TOTAL **_____ pts**	**Advanced** **45–42 pts**	**Proficient** **41–31 pts**	**Partially Proficient** **30–20 pts**	**Novice** **19 pts and below**

- Is the app easy to use?
- Would you pay to use the app?
- How well does the commercial market the app?
- How often would you potentially use the app (daily, weekly, monthly, yearly)?

Students reflected on the feedback and documented the process in their journals, which were reviewed by the teacher.

Based on this teacher's experience, the project should take about ten 50-minute class periods, but the schedule may be adjusted based on varied project requirements or specific students' needs (Figure 4, p. 45). The teacher developed a rubric spelling out expectations for the project (Figure 5). It can be modified to measure other specific project requirements.

Teacher reflection and future considerations

Overall, the teacher considered this a very engaging activity that met the appropriate standards and increased student learning in many areas. The teacher also made comments and suggestions for improvement:

- At the outset, the teacher should spend 30–45 minutes covering the basic features of the app design program so students can spend more time developing the app and less time figuring out how to work the software.
- The schedule may be shortened by eliminating the commercial portion. However, the teacher would like marketing and business students at the school to collaborate with the biology students to develop marketing for the project, even if only outside of the regular class schedule. This would encourage interdisciplinary projects, a component of STEM learning (Partnership for 21st Century Skills 2013).
- Although learning how to use the app-development software was challenging for both the teacher and the students, the teacher considered this experience valuable because it mirrored the experiences of professionals in the field (sidebar, p. 45). App developers constantly face challenges for which they may not have the needed information or skills to overcome. They may have to apply existing knowledge in different ways, gain new knowledge through self-learning, and use multiple resources to solve the problem. Likewise, students completing this project had to find ways to progress even when they got stuck on a particular step.

Conclusion

To complete the project, students needed to understand their ecosystem and synthesize new information from their own research to deliver the content necessary to build their apps. The activity integrated various types of content knowledge, incorporating the engineering design process, using 21st-century skills, and giving students a different perspective on the apps they use every day. Students better understood ecosystem dynamics from having to develop a commercial product that would present those dynamics to a broad public. Students used an engineering design process to form a creative solution to the product design. The project met the standards for specific biology content as well as giving students an understanding of formal problem-solving processes and the need for 21st-century skills. Although this project was specifically about biological ecosystems, the app project is extremely adaptable and can be used on a variety of content areas and lessons. ■

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On the web

Animoto: *www.animoto.com*

App design software

For Android; includes free software, tutorials, and samples of coding for app design: *http://developer.android.com/index.html*

For Android and iPhone; includes drag-and-drop applications, tutorials, and video demonstrations: *http://ibuildapp.com*

For iPhone; drag-and-drop platform with no coding and step-by-step guidance: *www.appmakr.com*

Microsoft Windows: *http://dev.windowsphone.com/en-us/downloadsdk*

Websites that list popular apps: *channel9.msdn.com/Shows/Hot-Apps; www.appbrain.com/apps/hot/;* and *http://iphoneapplicationlist.com/apps/popular*

Windows Movie Maker: *http://windows.microsoft.com/en-us/windows-live/movie-maker#t1=overview*

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