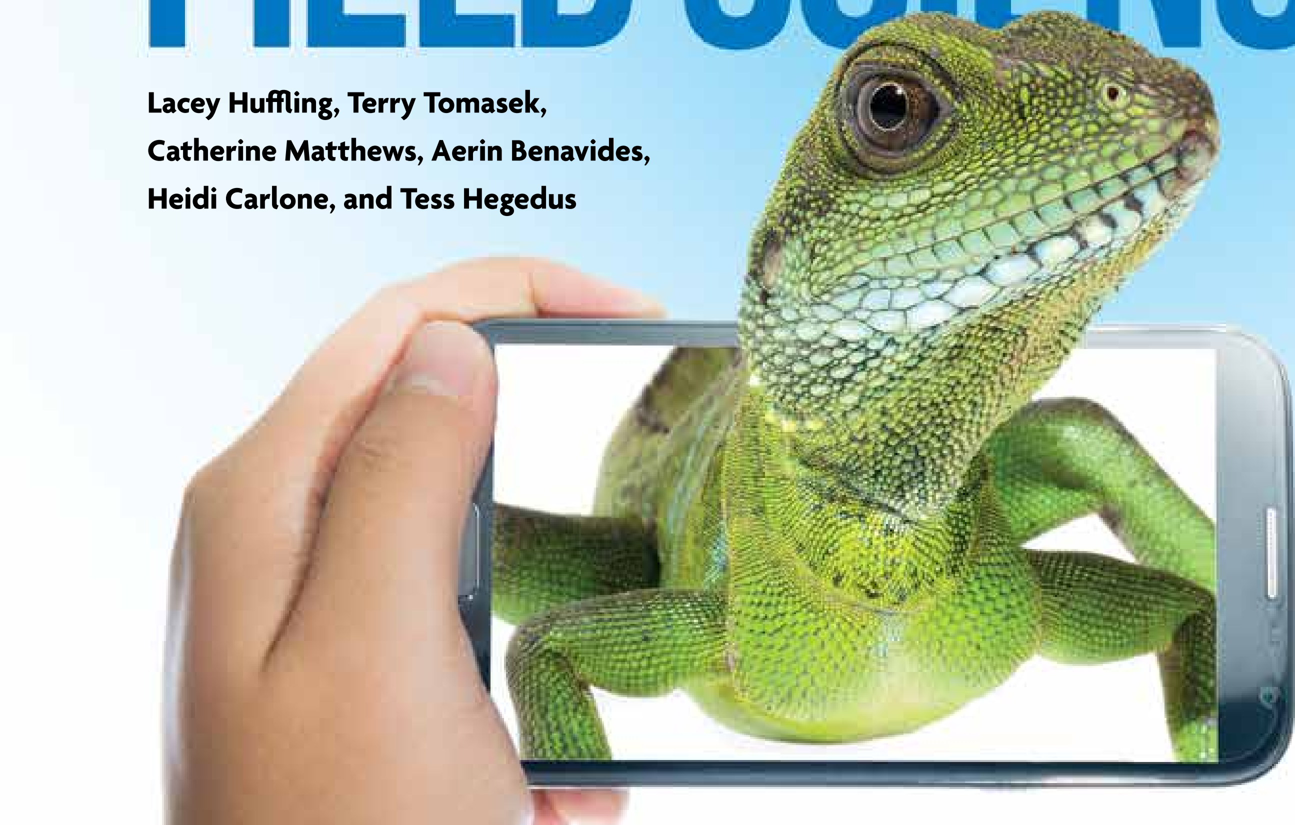
A herpetology research experience to build students' 21st-century skills

Using Mobile Devices in FIELD SCIENCE



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Students today need advanced tools and competencies to succeed in our global economy. Technology can provide students with critical learning experiences (Gee 2003; Gee 2004; Jenkins 2009) but is often affordable only to affluent students (Attewell and Winston 2003; Ito et al. 2008). All students, regardless of socioeconomic status, deserve to use technology to create and innovate, communicate and collaborate, and gain the 21st-century skills they need to be successful inside and outside the classroom (ISTE 2007).

Integrating technology into instruction also helps science teachers incorporate the *Next Generation Science Standards* (NGSS Lead States 2013) into the curriculum. Students can use technology to develop and use models (practice 2); plan and carry out investigations (practice 3); analyze and interpret data (practice 4); and obtain, evaluate, and communicate information (practice 8) (see "On the web" for more *NGSS* connections). Mobile devices, in particular, can supply many of the scientific tools needed for investigations in the life and Earth sciences through a wide array of available applications, or *apps,* for such things as weather, geographic positioning, and identification.

This article describes our attempts to use technology to provide more authentic and engaging data-collection methods for students. The context is a herpetology research experience (HRE) sponsored by the National Science Foundation that provides diverse high school students with many "first-time" experiences—in our case, not only with reptiles and amphibians, or *herps,* but also with technology use as a scientific practice (Figure 1). As part of the fieldwork, students use mobile devices to record data for ongoing scientific investigations and to communicate and share findings. This article suggests ways to incorporate the project in your classroom.

FIGURE 1

Demographics of our students.

Race/ethnicity	2012 percentage (n = 72)	2013 percentage (n = 71)
African American	15.3%	29.6%
American Indian	18.1%	11.3%
Asian	1.4%	4.2%
Caucasian	36.1%	36.6%
Latino	19.4%	11.3%
Mixed	9.7%	7.0%

Gender	2012 Percentage (n = 72)	2013 Percentage (n = 71)
Female	48.6%	53.5%
Male	51.4%	46.5%

Students digitally document the capture of a snake. (Note: Safety glasses or goggles are recommended for woodland field activities.)

About the project

Two of our HREs are weeklong residential programs, and the other is a monthlong residential experience connected to a local university. During our programs, students work with ecologists and science educators to collect and analyze data for various science investigations. Our monthlong program simulates a typical high school block schedule with students attending class every day for 90 minutes. The investigations described here can be incorporated into high school biology, Earth science, or ecology classes, and the tools can be used in other science disciplines as well.

The scientific investigations

Our six field ecology studies (semiaquatic turtles, box turtles, frogs, lizards, salamanders, and snakes) focus on collecting data to help monitor local amphibian and reptile populations in North Carolina. Three studies (semiaquatic turtles, box turtles, and lizards) are mark-recapture studies, which help track individual organisms over space and time and provide data for population-level research. For example, in our semiaquatic turtle project, students have addressed such research questions as:

- What types of turtles are found in each body of water?
- What is the population estimate for each turtle species?
- What is the gender ratio of turtles for each species?
- Does trap placement (e.g., in high recreational use areas versus low recreational use areas) affect capture rate? And
- Does the type of bait used (e.g., sardines, chicken legs, kale, or hot dogs) influence capture rate?

FIGURE 2

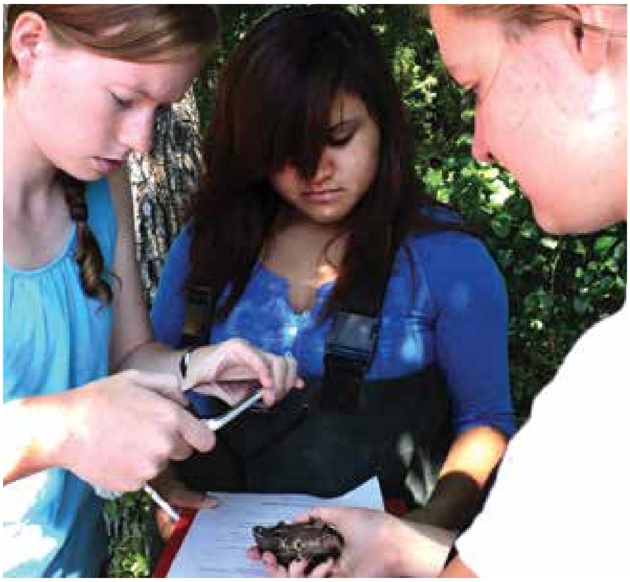
Field science apps.

Android app or widget name	Apple app or widget name	Applications in the secondary science classroom
ArcGIS	ArcGIS	Maps and more maps
Compass	Compass	Use for orientation when outdoors
Converter	Convert Units for Free	Change measurements such as length, weight, and volume from metric to English or English to metric
Easy Voice Recorder	iTalk	Digitally record animal calls in the field or your own field notes
Folder Organizer Lite	Easy File Organizer	An organizational tool for your device
Frog Sounds	Audubon Reptiles and Amphibians	Listen to prerecorded frog calls
Gaia GPS Lite	Gaia GPS Lite	Topography maps
Google Earth	Google Earth	Use for orientation and map creation
GPS Essentials	TopoMaps–GPS Essentials	Use for orientation and GPS coordinates
My Tracks	GPS MotionX	Create a map as you walk or ride of where you've been
Photaf	Photosynth	Take panoramic photographs of environments
Project Noah	Project Noah	Data recording app that allows notes for field observations. Allows the upload and download of data to assess species richness and can be utilized for data deposition.
QR Droid	QR Reader iPhone or iPad	Scans query codes
RadarNow!	RadarNow!	Provides local weather updates
SimpleMoon	Moon Phase	Monthly calendars with Moon phases for each day
SoilWeb	SoilWeb	Gives soil composition for your GPS location
StopWatch	Stopwatch Analog+Digital	Use for timing events
Thermo	Thermometer	Gives you outside temperature (°C/°F) for your GPS location
WeatherBug	WeatherBug	Provides local weather updates

We emphasize student safety (Roy 2011) and follow scientific protocols for handling wild animals (see "On the web"). Data from our investigations are used to compare trends from year to year. Students also input data on individual organisms sampled to a statewide database of amphibians and reptiles—the Carolina Herp Atlas. A detailed description of our investigations, access to our datasheets, instructions on setting up investigations on school grounds, and ideas for incorporating these activities in the classroom are available online (see "On the web").

Technology in the field

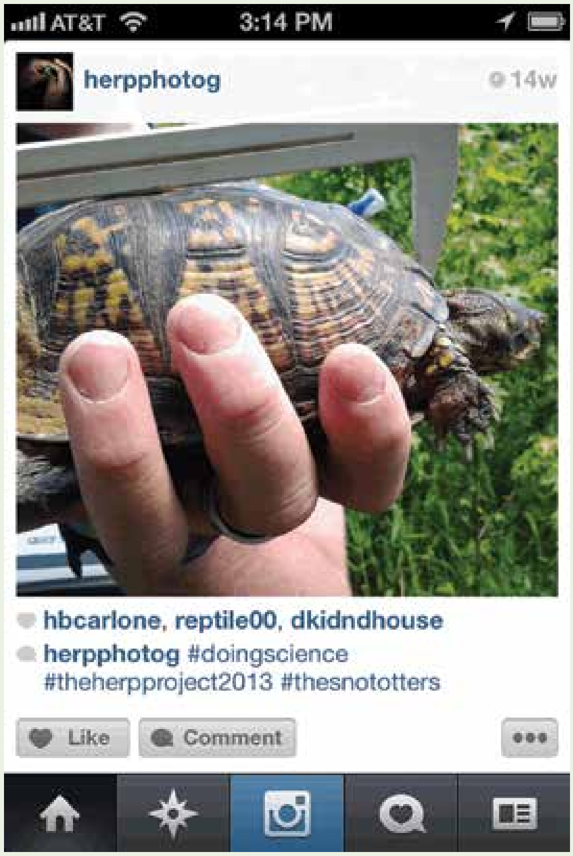
Using mobile devices was our attempt to make data collection—regarded as one of the least engaging aspects of previous investigations—more current, authentic, efficient, and engaging. With mobile devices, students eagerly participated in data collection and analysis. Student responses included: "It was very easy to input data, and it made me feel like I was actually a scientist," and "Filling in data electronically was very interesting because I got to experience something that scientists actually do once they capture an animal."



Using a mobile device to record data in a turtle mark-recapture study.

FIGURE 3

Screenshot of uploaded photo on Instagram.



Though our project provides students with Android MP3 devices with Wi-Fi capabilities and front- and rear-facing cameras, the activities can be performed on most mobile platforms or tablets (no data plan needed). Figure 2 (p. 37) lists Android apps used in the project and their Apple equivalents.

Using the mobile devices

We use a variety of functions on the mobile devices—especially the camera, geographic positioning system (GPS), and wireless internet access—to support student learning and engagement in our investigations. Students use the camera to document species and to support habitat descriptions, studying their photographs or videos back in the classroom. Panoramic still photos (taken with the free Photaf app) are particularly useful when documenting impermanent wetlands, such as ephemeral pools.

We use various widgets (miniapps): a flashlight, compass, simple Moon phase, stopwatch, calculator, and QR Droid. The flashlight and Moon phase widgets are important during nighttime calling-amphibian surveys, and students use the stopwatch to time listening periods. QR Droid allows the device to scan quick response codes and other bar codes to help import and share data during indoor class sessions when Wi-Fi is available.

Students also use various other free apps for the project, including the Easy Voice Recorder app to record frog call choruses, which students replay later to improve their species identification. Students compare their recordings to prerecorded calls (from the internet or CDs) as they consider call variation due to temperature and proximity to urban environments. Students also use the recorded frog calls to elicit return calls from species in the field.

Students use the free Unit Converter app to convert Fahrenheit readings—common to weather data—to Celsius. Students also use the free My Tracks app to create interactive Google Maps of our study site by marking various waypoints for natural features or specific observations. These maps help determine locations of cover board and drift-fence transects on the property we survey. Google Earth and Google Maps support students' understanding of geographic space related to each investigation as well (see "On the web").

Using the free Intellicast app, students record the current temperature, relative humidity, and wind speed and direction before and after fieldwork. They also check the radar for storms in the area. Gathering these data encourages students to consider the relationship between animal behavior and atmospheric conditions.

We worked with undergraduate students at Elon University to develop our own Herp Project app (see "On the web"), which gives students access to data-collection forms. For example, in the semiaquatic turtle population study, students remove a turtle from the trap and identify the species. They then record the species data in the mobile device form, along with atmospheric data, location (including GPS coordinates), date, and time. They take various measurements of the turtle and photograph it from both the dorsal and ventral positions. Finally, students enter release data. This process is repeated for each animal in the trap.

In the classroom, we use the mobile devices' bookmark feature to mark and add a shortcut on the home screen for useful websites, such as the Reptile and Amphibians of North Carolina website (see "On the web") and two databases where students share their findings: the Carolina Herp Atlas and the Herp Project Database (see "On the web").

The atlas website, a citizen science project, allows people to note the presence of amphibian and reptile species in the Carolinas. Our students survey this database to determine which species we may encounter in Alamance, Cumberland, Hoke, Orange, and Robeson counties of North Carolina, where we work and live. The database shows that few people report particular species in some parts of the state, raising the question: "Are these species really here?" This presents ideas for subsequent investigations. Students input data collected during our field investigations to the database, often creating their own personal accounts, so they can submit additional data from their own communities as well.

The second database we bookmark is the Herp Project database, where students upload their data after returning to the classroom. This allows access to their data and previously collected data in real time.

Students share photos from their investigations on websites such as Instagram, Picasa, and Photobucket (see "On the web"). (We secure photograph releases from parents before any pictures of students are posted.) For Instagram, we designate one student per group to be the "photojournalist" in the field. Each group reviews the photojournalist's photos and jointly decides on hashtags to apply. (Hashtags, prefixed with the symbol #, mark one's photographs on various social media and are searchable). We then post the photographs and their hashtags using the Instagram app (Figure 3), so others can "like" and comment on them. We also create albums in Picasa and Photobucket that students share with their families as a way to inform them about their scientific experience, fostering parental involvement and support.

Before replicating this project, teachers should review district and school policies on using social media in the classroom. To ensure student safety, we create a group Instagram account, and only group leaders are permitted to upload photos to it. This helps us ensure that inappropriate comments or pictures are not uploaded. We designed a social media form (see "On the web") to collect students' ideas for hashtags.

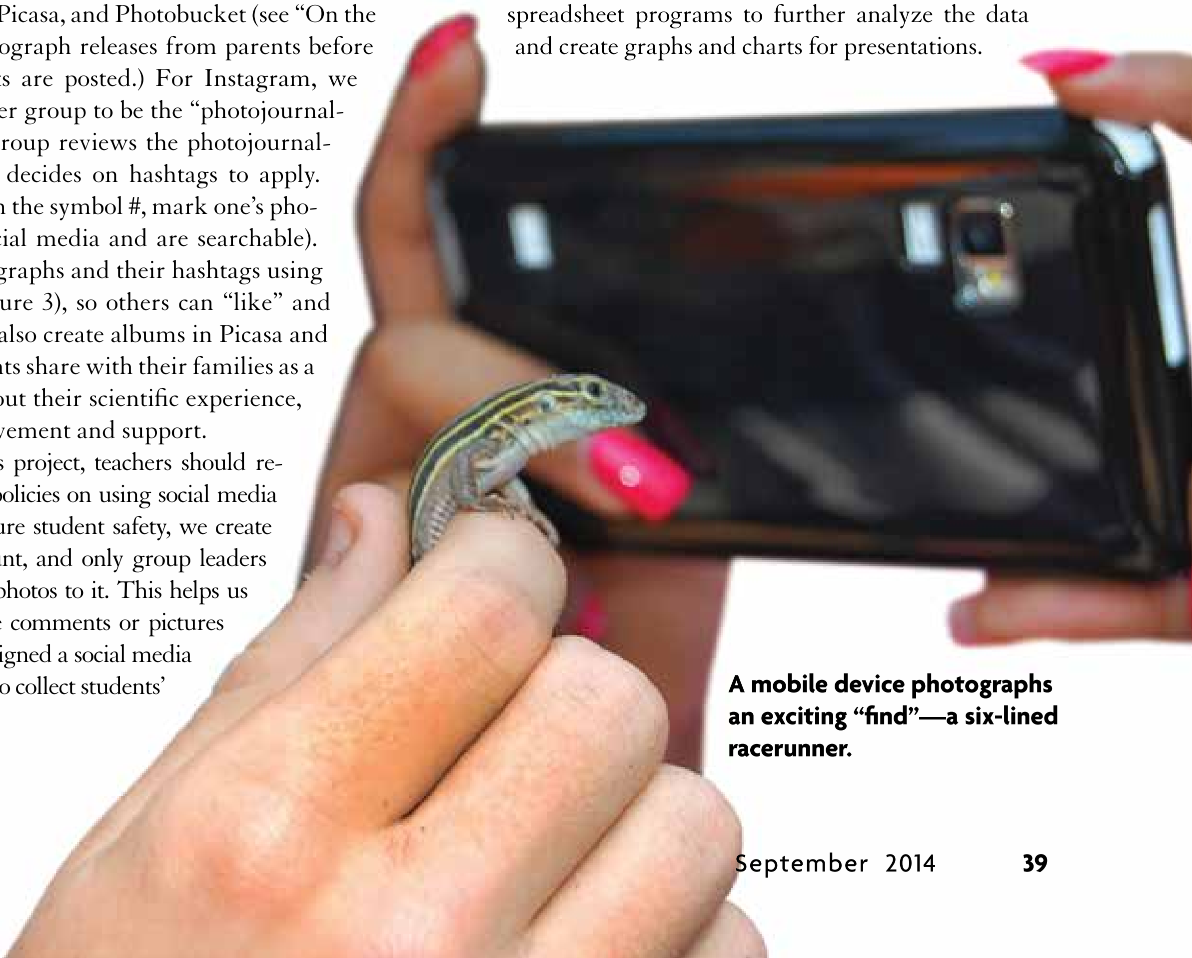
Conclusion

Comments on a student survey about the 2013 project were 68.7% positive, 17.9% mixed, and 13.4% negative. Fifty-five percent of the negative comments were due to malfunctions with the beta version of the Herp Project app, which we are addressing. We found three common themes in the survey comments and interviews with students:

1. Students see the value and authenticity of data collection;
2. They view technology as an extension of the scientific tools they are using; and
3. They are enthusiastic about and motivated by data collection and analysis.

Students discuss the mobile devices as a "cutting edge" extension of the digital scales, spring scales, calipers, thermometers, and wind meters they already use. With digital devices, students are eager to collect and report data. Remarks from our 2013 group included: "I loved how they connected our generation to science by using technology;" and the use of technology for data collection "is important to be able to feel like you're taking part [in] the greater picture or the learning process."

Mobile devices enhance students' acquisition of 21st-century skills and foster creativity and critical thinking as students use technology in new and innovative ways to enhance the data-collection experience. For instance, data are instantaneously populated to a spreadsheet, which eases data transfer to other databases, such as the Carolina Herp Atlas. Students use spreadsheet programs to further analyze the data and create graphs and charts for presentations.



A mobile device photographs an exciting "find"—a six-lined racerunner.

Students also develop the digital citizenship skills and dispositions they need to engage in internet-content analysis and to use mobile devices ethically and appropriately. By using these devices, students of all backgrounds can become more familiar and comfortable with scientific practices, moving them one step closer to scientific and technological literacy in the 21st century. ■

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On the web

Carolina Herp Atlas: *www.carolinaherpatlas.org*
Connections to the *NGSS* and ISTE student standards: *www.nsta.org/highschool/connections.aspx*
Cover board Google Map link: *http://bit.ly/1l4pzqn*
Google Maps: *https://maps.google.com*
The Herp Project app (for Android devices) and database: *http://nc-herps.appspot.com/HERPS.apk*
How to set up investigations on school grounds, ideas for incorporating activities in the classroom, and the social media form for students: *http://theherpproject.uncg.edu/herpetology-articles-books*
Instructions for safely handling wild organisms: *www.nwhc.usgs.gov* (search for Restraint and Handling of Live Amphibians); *www.teachervision.com/animal-care/resource/8682.html*
More apps to use in the field: *http://theherpproject.uncg.edu/apps-collecting-data*
Reptiles and Amphibians of North Carolina: *www.herpsofnc.org*
Scientific investigation descriptions and datasheets: *http://theherpproject.uncg.edu/research/herpetology-studies*
Social media websites we used:
Instagram: *http://instagram.com*
Photobucket: *http://photobucket.com*
Picasa: *http://picasa.google.com*
Twitter: *https://twitter.com*
Instagram account: *http://instagram.com/herpphotog#*
Twitter account: *https://twitter.com/theherpproject*
Website: *http://theherpproject.uncg.edu*

Overcoming hurdles.

Some students are not already skilled at using digital technology, due not only to economic barriers to owning and using computers at home but also to psychosocial obstacles such as fear (Stanley 2003).

One student commented about the device at hand: "I really didn't want to break it." When necessary, we spend extra time instructing such students until they are comfortable using the device.

Lack of internet access in the field is another hurdle. We overcame this by using widgets and apps that don't require the internet, such as the geographic positioning system (GPS), camera, flashlight, Easy Voice Recorder, and the Herp Project app. We used internet-enabled apps only in the classroom.

Spent batteries are another hurdle. Conserve power on the device by turning off the GPS, Wi-Fi, and Bluetooth capabilities. Also helpful is AppKiller, an app that turns off applications while not in use. Backup batteries can also be carried into the field.

Environmental conditions can damage mobile devices. We protect them with gel covers and screen protectors and attach lanyards so students can wear the devices around their necks, freeing their hands for other tasks. To keep devices clean and dry, we put them in Ziploc bags that allow for touch screen use through the plastic.

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