Emphasizing the 'T' in STEM by using Smart Phone Technology for Data Collection

Jacob P. Koch
Clemson University
Graduate Teaching Assistant
864-367-1251
jpkoch@g.clemson.edu

Catherine A. DiBenedetto
Clemson University
251 McAdams Hall
Clemson, SC 29634
864-656-0296
cdibene@clemson.edu

Introduction/Need for Innovation or Idea

The National Center for Educational Statistics found less than 50% of the teachers surveyed (N = 3000) reported using technology more regularly for administrative tasks rather than instructional purposes (Gray, Thomas, & Lewis, 2010). Other research has indicated teachers use technology for non-instructional purposes rather than integrating technology into their instruction (Cuban, Kirkpatrick, & Peck, 2001; Russell, Bebell, O'Dwyer, & O'Connor, 2003; Zhao, Pugh, Sheldon, & Byers, 2002). Several barriers exist as to why teachers find it difficult to integrate technology into their classroom instruction. First, access to technology can be a problem. Although available, many times technology does not work when it is needed (Clark, 2006; Lim & Khine, 2006). Second, teacher beliefs about the use of technology for instructional purposes vary (Inan & Lowther, 2010). Third, time has been reported as an issue when managing student behavior and appropriate use of technology when integrated into a lesson (Wachira & Keengwe, 2010). Finally, professional development (PD) is needed to assist teachers with connecting technology to concrete classroom procedures (Wells, 2007). Providing PD related to hardware and software technologies for agricultural education teachers can improve awareness and ideas for classroom instruction (Williams, Warner, Flowers, & Croom, 2014). PD offerings related to technology integration might be beneficial for sustained modifications in teaching practices (Kopcha, 2012) because the 'T' in STEM has been frequently lacking (Scherer, et al., 2019).

How it works/methodology/program phases/steps

Innovative solutions for agriscience teachers who participated in the STEM it Up Conference helped transform an often-problematic device into a learning tool for students to easily access and learn technological skills. The goal of this PD was to introduce the use of a "smart" phone as a technological tool that teachers can utilize when teaching STEM concepts and research for agriscience projects to increase student engagement and improve academic achievement. Two problems discussed during the STEM it Up Conference were that teachers often find mobile devices to be a major distraction for their students, and that data collection for agriscience experiments was typically a difficult task. Not only was retrieving data difficult but generating functional graphs for data interpretation was also a challenge for some educators to teach and for students to learn. This PD allowed the participants to explore several activities using environmental sensors, which were then used to explain the scientific relationship between temperature and humidity, a concept taught in plant science curricula. Lesson plans were created and provided as resources for the teachers. The PD introduced several different environmental sensors for use in conducting agriscience experiments that paired with smartphones and Bluetooth communication. The sensors used for this PD were Bluetooth capable HOBO® brand sensors that are relatively low-cost. In conjunction with the sensors used, a corresponding free application, the HOBO® Mobile application, was downloaded by the participants and used to access and interact with the sensors. The Bluetooth capability of the sensors allowed the participants to access the devices that were positioned inside and outside of a demonstration greenhouse. Specifically, four sensors were used for temperature, light, humidity and light spectrum measurements. First, participants were instructed how to download the application on their smartphone to access the sensors; next had the chance to see and access the sensors using

their smartphones. All participants experienced each of the four sensors and generated data in real time and then downloaded a graph with the application on their personal device. The graphs created by the smartphone application were very easy to generate and were able to display different scientific relationships that are very important to greenhouse management and agriscience project research. The participants found both the application and the sensors very easy to learn and use. With 30 minutes to explore how to use the technology, each participant was able to learn the user interface of the application to access the sensors and generate an accurately labeled and easily read graph.

Results to date/implications

The participants (N = 15) of the PD all found the HOBO® Mobile smartphone application easy to use as well as the sensors to be trouble-free to access and incorporate into their plant science curriculum. Many participants reflected on the PD in a positive way and expressed an interest in purchasing Bluetooth capable sensors with corresponding smartphone applications for their own school -based agricultural education (SBAE) programs. The group consensus was they all had previously struggled to maintain students' attention because smartphones were a distraction. Participants were highly interested to use this technology as a tool for scientific data collection because most of their students have access to smartphones, or other technological devices, such as an iPad, to interact with the sensors. In addition to applying this technology to plant science curricula when teaching environmental aspects of growing plants, several agriscience fair project ideas were discussed with the participants. Many comments and reflections on the PD evaluation indicated participants gained new ideas and a better understanding and capability to conduct agriscience fair projects with their students using this new-found technology.

Future plans

To further the efforts of increasing awareness and use of these technologies, as well as to increase the rigor of agriscience fair projects in South Carolina, more sensors will be added to diversify this program to generate additional innovative ideas to teach agriscience when this PD is offered for agriscience teachers. Current efforts to create and conduct agriscience projects at Clemson University with pre-service teachers will also be expanded to provide undergraduates with experiences they can later apply to their teaching practices.

Costs/resources needed

Costs associated with the HOBO® brand sensors are relatively low, ranging from $70 to $180 each. The application to access and use the sensors was free, which keeps the software at no cost to the educator or the student. The sensors are well-built, designed to be sturdy and maintain long battery life, which makes them versatile and ideal for perpetual use within a SBAE program. The resources needed vary by project, however, these sensors can be mounted to anything, allowing them to be applied to numerous scientific investigations. Either two screws or two zip-ties are used for mounting and are provided with the purchase of each sensor.

References

Clark, K. (2006). Practices for the use of technology in high schools: a Delphi study. *Journal of Technology and Teacher Education, 14*(3), 481–499.

Cuban, L., Kirkpatrick, H., & Peck, C. (2001). High access and low use of technologies in high school classrooms: explaining an apparent paradox. *American Educational Research Journal, 38*(4), 813–834. https://doi.org/10.3102/00028312038004813

Gray, L., Thomas, N., & Lewis, L. (2010). *Teachers' use of educational technology in US public schools: 2009 (NCES 2010-040).* Washington, DC: National Center for Education Statistics, Institute of Education Sciences, U.S. Department of Education.

Inan, F. A., & Lowther, D. L. (2010). Laptops in the K-12 classrooms: exploring factors impacting instructional use. *Computers & Education, 55*(3), 937–944. doi.org/10/1016/j.compedu.2010.04.004

Kopcha, T. J. (2012). Teachers' perceptions of the barriers to technology integration and practices with technology under situated professional development. *Computers & Education, 59*(4), 1109-1121. https://doi.org/10.1016/j.compedu.2012.05.014

Lim, C. P., & Khine, M. (2006). Managing teachers' barriers to ICT integration in Singapore schools. *Journal of Technology and Teacher Education, 14*(1), 97–125.

Russell, M., Bebell, D., O'Dwyer, L., & O'Connor, K. (2003). Examining teacher technology use: implications for preservice and inservice teacher preparation. *Journal of Teacher Education, 54*(4), 297–310. doi: 10.1177/0022487103255985

Scherer, H. H., McKim, A. J., Wang, H. H., DiBenedetto, C. A., & Robinson, K. (2019). Making Sense of the Buzz: A Systematic Review of" STEM" in Agriculture, Food, and Natural Resources Education Literature. *Journal of Agricultural Education, 60*(2), 28-54. https://doi.org/10.5032/jae.2019.02028

Wachira, P., & Keengwe, J. (2010). Technology integration barriers: urban school mathematics teachers perspectives. *Journal of Science Education and Technology, 20*(1), 17–25. doi.org/10.1007/s10956-010-9230-y

Wells, J. (2007). Key design factors in durable instructional technology professional development. *Journal of Technology and Teacher Education, 15*(1), 101–122.

Williams, M. R., Warner, W. J., Flowers, J. L., & Croom, D. B. (2014). Accessibility and Usage of Technology by North Carolina Agriculture Teachers. *Journal of Agricultural Education, 55*(4), 191-205. doi: 10.5032/jae.2014.04191

Zhao, Y., Pugh, K., Sheldon, S., & Byers, J. (2002). Conditions for classroom technology innovations. *Teachers College Record, 104*(3), 482–515.