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littleBits

Not Just for the Kids

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The Penn State Harrisburg Library used grant funds to add two littleBits Workshop Kits to the circulating library collection. The Science, Technology, Engineering, and Mathematics (STEM) Librarian piloted a hands-on activity utilizing littleBits in the college classroom to better support the rapid prototyping skills of engineering students on campus, to promote science literacy to students, and to enhance librarian-student interaction. This article provides an overview of the workshops, which could be duplicated at other institutions, and shares the experiences of three different audiences of college students including challenges, successes, and opportunities for growth and future considerations in utilizing littleBits in an academic setting.

Introduction

Penn State Harrisburg's School of Science, Engineering, and Technology requires engineering and computer science undergraduate students to complete a senior-level Capstone Design Project before they graduate. These projects are a culmination of the student's one- or two-semester capstone design course and give the students an opportunity to link their classroom work with real-life scenarios. The projects are collaborative in nature with students completing the preliminary research and design phase in small teams. The capstone design projects often come with the backing of an industry sponsor and incorporate various forms of innovative technology. To better support the rapid prototyping skills of engineering students at Penn State Harrisburg, to promote science literacy to students, and to enhance librarian-student interaction the Science, Technology, Engineering, and Mathematics (STEM) Librarian piloted a hands-on activity utilizing littleBits. Using grant funds from the Penn State Harrisburg Student Activity Fee Committee, the library added two littleBits Workshop Kits to the circulating library collection. littleBits are color-coded, magnetic electronic building blocks, called "bits," that snap together to make various prototyped inventions possible. The function of the "bit" determines its color; the colors correspond to four functions: power, output, control, and extension (Little Bits, n.d.). littleBits are designed to be inclusive of all learners, though their primary audience is K-12, and therefore no wiring or additional devices are necessary to build.

The first littleBits workshop was piloted in three course sections of the mechanical engineering capstone design course. The same workshop was later incorporated into two additional courses: an upper-level Elementary Science Education course and a first-year Engineering Design course. At the end of the workshop each student group was to create a working flashlight using only the littleBits and a few additional materials. Each of the three audiences had different levels of experience with rapid prototyping, leading to different results when delivering the same workshop.

littleBits and Libraries

In recent years, librarians have become increasingly familiar with makerspaces, 3D printers, and even virtual reality technology. They may even have a hand in creating and bringing a makerspace into their own library building (Mann, 2018; Canino-Fluit, 2014). While academic libraries have ample experience in lending new and innovative technology to their users, academic librarians may avoid incorporating littleBits into their pedagogical practices simply because they have not seen it done before. The existing literature surrounding littleBits is heavily focused on using them in school and public libraries.

littleBits are purposefully designed to encourage collaboration and be easy to use by younger student audiences. littleBits partnered with researchers from the *School Library Journal* in an effort to expose more students to STEM disciplines and to promote, what they call, the "4Cs": critical thinking and problem solving, creativity and innovation, communication, and collaboration. The collaboration explored the nature of STEM in school libraries across the United States and resulted in a white paper that discussed not only the results of their research but also included several opportunities for educators and librarians to incorporate littleBits in their pedagogical practices (Jamalian, 2018).

littleBits are being used by school and public libraries in several interesting and collaborative ways. Four- and five-year old Kindergarten students at Davis Academy in Georgia are using them to create inventions related to zoo animals using only three bits at a time. Fifth graders at the same school are using littleBits and Lego pieces to create their own menorahs and dreidels while learning about Jewish customs (Brown, 2018). Students in elementary, prep, and high schools are collaboratively using littleBits to learn coding basics to create their own robotic inventions (Susilo et al., 2016; Ullman, 2016; Valenzuela, 2018). Librarians at the Mount Prospect Public Library in Illinois have included littleBits in their culturally diverse programming to include hands-on learning activities for their library patrons (Bartlett & Bos, 2017).

Academic libraries in Pennsylvania are expanding their collections to include non-book resources, such as littleBits, with the goal of exposing students to new technologies and to support new ways of learning (McGeary, 2016). Beyond Pennsylvania, Carleton University Library in Canada collaborated with other units on their campus to create an Emerging Technology Collection for circulation. At the request of engineering faculty, this circulating technology collection began as a pilot project in 2015 to circulate Raspberry Pis and Arduinos. As the collection grew, littleBits were added along with several other pieces of technology (Cross & Tucci, 2017). To demonstrate the optical properties of water, littleBits are incorporated into a spectrophotometer activity that has been tested in several academic settings, including graduate level science and engineering courses (Schollaert Uz, 2016).

Missing from the literature are details of how academic libraries and/or faculty members are using littleBits in the classroom to support the curriculum and promote scientific literacy. While the spectrophotometer activity is relevant to STEM students, the author provides no specific, or anecdotal, information on what students and faculty thought of the activity after it was tested in academic settings. Merely adding littleBits to academic library collections and hoping they are used is not a practical way to promote their use. To supplement and enhance the existing littleBits

literature, the aim of this article is to showcase one librarian's experiences utilizing littleBits in an academic setting to support the curriculum of two disciplines on a college campus.

Running the littleBits™ Workshop

Workshop Materials

Two littleBits workshop kits, permanently added to the library collection, were provided by the Penn State Harrisburg Library and eight student kits were borrowed from the Penn State University Park Library. The larger workshop kits can be used by eight to ten groups, with four to five students in each group. The smaller student kits can be used by three to five students at once. In addition to the littleBits kits, each student group was given the following items:

- 1 paper bag
- 1 plastic cup
- 3 pieces of construction paper
- Tape (scotch, masking)
- Scissors

Using only these materials each group was to design a working flashlight. Small lightbulb "bits" are included in the littleBits kits; no additional light bulb was necessary. Groups were encouraged to be as creative as possible with their limited resources but were given no criteria other than it must be able to turn on, light up, and turn off.

Participating Courses

In Fall 2018 the workshop was presented to three sections of Mechanical Engineering (ME) 448: Engineering Design Concepts with a total of 102 seniors. The purpose of the workshop was to increase the students' rapid prototyping skills by first learning how to use this new technology and determine if it would be a helpful resource for their capstone design projects. The students worked in their small capstone design teams of four to five students. They were given no preparation for the workshop and were asked to begin immediately after a brief one-minute explanation of the littleBits workshop kits. The kits were distributed to the student groups along with the other materials for the workshop. The workshop ran for approximately 30 minutes and students used the remaining 20 minutes to present their designs to the rest of the class.

In Spring 2019 the same workshop was presented to one section of Education Science (EDSCI) 454: Modern Elementary Science Education with a total of 18 students in either their junior or senior year. The purpose of the workshop was to introduce the concept of circuitry to future elementary education teachers related to the Pennsylvania State Education Standard for Science. These students were given an instructional handout created by their education science professor on electric circuits and shown a two-minute video of Massachusetts Institute of Technology (MIT) graduates attempting to light a lightbulb (Martin, 2013). These students were then grouped into small teams of three to four students and given a short five-minute explanation of the littleBits workshop kits. The kits were distributed to the student groups along with the other materials for the workshop. This workshop ran for approximately 60 minutes and the students presented their designs to the class for approximately ten minutes.

The third workshop was presented in Spring 2020 to one section of Engineering Design (EDSGN) 100: Introduction to Engineering Design with a total of 22 students. The exploratory class was primarily first-year students who were considering future careers in engineering. This was a two-hour course and the littleBits workshop was held after a presentation on the campus library and library resources. The purpose of this workshop was to introduce rapid

prototyping skills to first-year students by allowing them to utilize a new form of technology. In addition, these students were introduced to the basics of circuitry during the workshop. Similar to the workshop conducted in ME 448, these students were given no preparation and were instructed to begin after a one-minute explanation of the littleBits workshop kits. The students worked in teams of 3-4 and were given 45 minutes to complete their designs and then presented their final designs to the rest of the class for 20 minutes.

Discussion

Challenges

After running the workshop in ME 448 it was clear that the combined three-section course was less than ideal. While these senior-level students enjoyed the hands-on activity, it was determined that this course was the least impacted by the littleBits workshop. Ensuring that each capstone design group had enough time to present their final design was difficult for such a large group, especially during the short class period. During the workshop it became clear that the student groups would have benefitted from having extra supplies to avoid waiting on the other groups to share the tape and scissors. The large group size also made it more difficult for the librarian to walk around the room and engage with each student group. In addition to some of the logistical challenges mentioned, the task of building a working flashlight was too simple for this senior-level course. These students were in the final stages of their engineering education and were able to master the littleBits technology within minutes. They quickly picked up on the color-coded design of the bits and did not struggle with designing a working flashlight. Ultimately, the most obvious challenge of the workshop for this student group was that the task was not challenging enough. These students were seeking a more complicated project, comparable to their own capstone design projects.

The students in EDSCI 454 ran into their own unique challenges during the littleBits workshop. Being elementary education majors, the majority of the students had not taken a dedicated science course in some time. Their professor gave them each a handout to complete before the workshop began. This handout included questions about and diagrams on alternating currents, direct currents, and closed and open circuits. Students were asked to draw a picture of a closed circuit that would result in a bulb being lit. After a few minutes of group discussion, the students shared that they did not remember much from their previous science classes and were looking forward to the workshop. Initially these students struggled to get their bulbs to light and did not notice that the "bits" were color coded. During the class discussion, after the workshop, the EDSCI students mentioned that they found the initial experimentation phase to be challenging but had fun working through the activity together.

The third group who received the littleBits workshop were the first-year students enrolled in EDSGN 100. The workshop in this course was largely a success; the only challenge that occurred was the time allotted for the flashlight design. These students were early in their educational career, but all had a general interest in engineering. Because of this interest, they were initially given only 30 minutes to complete their design as the librarian and professor assumed the students would have no trouble finishing in this time. At the 30-minute mark however, when the students were instructed to stop, only one of the five student groups had completed the task. Due to a longer class period, this challenge was the easiest to overcome.

Successes

Overall, the workshop was deemed a success. Even though each class ran into challenges, some larger than others, the hands-on activity ran smoothly. Though no formal assessment of the workshop was captured, the informal feedback the librarian received from both participating students and their respective faculty members was overwhelmingly positive. In fact, the students and faculty member who participated in the EDSCI 454 workshop

enjoyed it so much that the faculty member used departmental funding to purchase several littleBits student kits for the education department. This will allow the education faculty members to run the same workshop on their own in future semesters. The students had fun in a low stakes environment where they were able to work together towards a common goal. littleBits are designed to be inclusive and easy-to-use and the students appreciated this technology for those reasons. Students with little-to-no background in circuitry were able to use the bits and learn how to properly design a working flashlight. The low access barrier to the littleBits kits was extremely helpful to the more novice students. The students knew they were not being graded on their final products which allowed them to work together relatively stress-free. Giving the students little preparation before running the workshop provided an effective learning experience. Ultimately, each student group that participated was able to create a working flashlight to share with the rest of their class. The designs looked and functioned differently, but by the end of the workshop all the flashlights were lit.

In addition to the students having fun, during each workshop the librarian was able to walk around and make personal connections with the student groups, particularly in EDSCI 454 and EDSGN 100 where the class size was much smaller. As a new librarian on campus, connecting with the students outside of their traditional library instruction sessions was a welcomed experience and a big success of the workshop. After speaking with the students, it was evident they appreciated this unique opportunity to navigate the task on their own. By providing no directions, other than the flashlights must work, the students were able to experiment on their own and learn from their mistakes. The more advanced students were not satisfied with "only" creating a working flashlight – they experimented with handheld designs that could fit into a coat pocket, designs with dimmer switches, and flashlights that incorporated more than one lightbulb. During the presentation portion, the student groups asked questions of each other, were genuinely intrigued by each other's designs, and were proud of each other.

From a science librarian's perspective, one of the more personal goals of the littleBits workshop was to promote science literacy to the students. This was successfully achieved in each of the three workshop sessions. Science is ever-present in our daily lives, in both big and small ways, and learning the fundamentals of a working flashlight is just one way to promote science literacy. Science matters but oftentimes, as was evident with the students in EDSCI 454, science can be intimidating if you feel underprepared. Utilizing littleBits to explore electrical circuits gave these students an opportunity to expand upon their existing knowledge and simultaneously put that knowledge into practice. It is important to encourage students to learn basic scientific concepts which they will carry forward into their careers as scientists and citizens. An unanticipated success of the workshop is that after working through it on their own, the elementary education students asked to borrow the littleBits kits from the library so they could incorporate them into their student teaching classrooms at the local elementary schools. Not only were these college students empowered by science literacy – they made immediate plans to promote science literacy in the classroom to others. After running these workshops, the library saw a slight increase in circulation of the two littleBits Workshop Kits; from zero checkouts in 2018 to 14 checkouts in 2020. This may not be a direct result of the workshops themselves, but it is encouraging. As more students learn about littleBits we hope they will find new and innovative uses for them.

Future Considerations

After running the littleBits workshop, two notable changes should be made to benefit students. First, to provide ample time and space for students to discuss, experiment, and present their flashlight designs, the workshop should be conducted with smaller courses. Presenting this workshop to three sections simultaneously was too much and this would also eliminate the need to bring extra supplies to ensure no student is waiting around for materials. Second, the workshop was deemed least impactful when presented to senior-level engineering students. For this reason, it is suggested to incorporate the workshop earlier in the engineering students' coursework. First-year students are less experienced engineers who were not looking for a more difficult task. When compared with the seniors, the

first-year students were also more enthusiastic about prototyping and completing their designs. In addition to the proposed changes, there is opportunity for growth for the littleBits workshop. To date, it has only been piloted in one section of EDSGN 100 but there are eight sections of the course being taught on campus in Fall 2020. By incorporating this workshop in more sections, more students will have the opportunity to increase their rapid prototyping skills and learn a new technology. This would also enhance the librarian's goal of promoting science literacy to a wider audience on campus.

Conclusion

After this brief pilot period it is clear to the librarian and the three faculty members that this workshop is worthwhile and should be continued. Ensuring that the class size is small and by targeting specific courses in the curriculum, this workshop can be effective in teaching new technology, enhancing students' rapid prototyping skills, and promoting science literacy to college students in an academic setting. In addition to the practical knowledge gained by the students, the engaging nature of the workshop allowed for relaxed and fun librarian-student interaction. It is evident now that littleBits, designed originally for a younger audience, is not just for the kids.

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