littleBits education

THE MOST EFFECTIVE WAYS TO INTRODUCE ELEMENTARY SCHOOL STUDENTS TO CIRCUITRY

EFFECTIVENESS STUDY

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INTRODUCTION

Research starting from the 1960s to present day has shown that undergrads who are majoring in engineering and physics still don't have a basic understanding of circuitry. Yet, their instructors aren't addressing the problem; instead, they are building more complex topics on top of it.

The issue starts as early as elementary school, where teachers are expected to teach using "traditional" circuitry toolkits, often comprised of a lightbulb, a 9-volt battery, and alligator clips. While not a lot of research has been done on these traditional toolkits, it is clear that they fail to teach important circuitry concepts correctly. On top of that, the design of these kits is off-putting to many students, and especially to girls.

This has an impact on students later in life. Men go on to hold a disproportionately high share of STEM undergraduate degrees, particularly in engineering. And today, 84 percent of working professionals in science or engineering jobs in the U.S are white or Asian males (even though more women than men earn college degrees each year). As STEM careers become integral to the future of work, we need to do all that we can to attract women to STEM early.

New research from Dr. Kylie Peppler, Associate Professor of Education and Informatics at the Donald Bren School of Information and Computer Sciences at University of California, Irvine, examines the effectiveness of the types of toolkits that educators are utilizing to teach circuitry in elementary school classrooms – and how we can make them work for students in grades two through eight, today.

Dr. Peppler looked at the effectiveness of traditional toolkits alongside popular new in-classroom kits from companies including littleBits, SparkFun Electronics, ETA hand2mind, Elenco's SnapCircuits, and Squishy Circuits. She and her team determined that littleBits is one of the most effective toolkits for learning circuitry available today.

Following are the initial results from Dr. Peppler's research.

THE MOST EFFECTIVE TOOLKITS PUT CIRCUITRY INTO CONTEXT

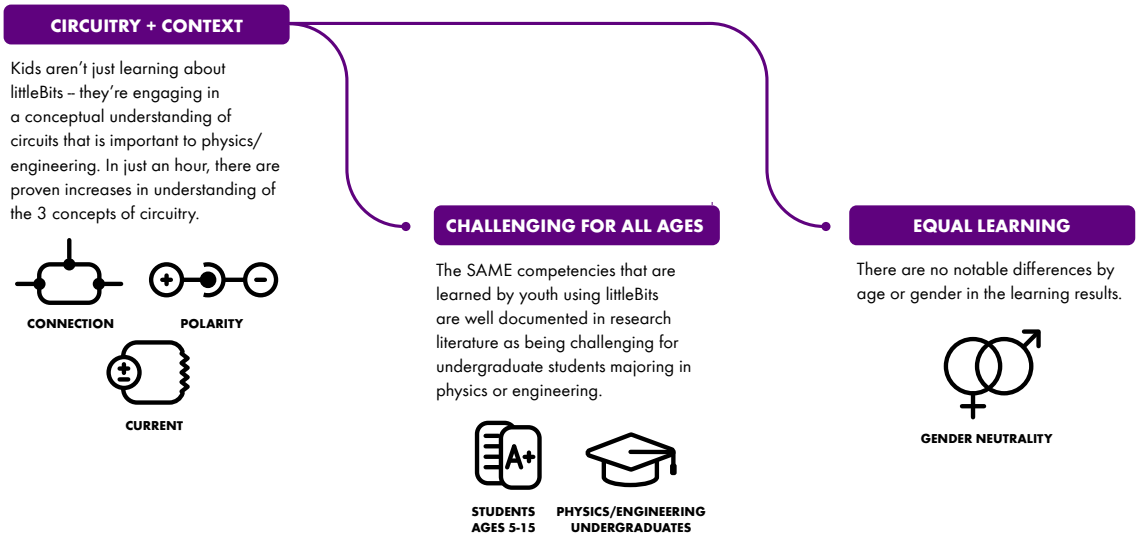
Being able to apply basic circuitry concepts to the real world helps students to put their lessons into context. Weaving real-world examples into learning can help kids understand why they're in school and how these lessons lead to them achieving their goals.

Dr. Peppler found that littleBits, in particular, is responsible for significant circuitry learning across students aged five-years-old to 15-years-old after a basic 90-minute introduction that includes circuit play, a five-minute introduction to circuitry, and a self-directed project. This includes increases in understanding current flow, connections, and polarity.

The same competencies that are learned by students working with littleBits are well-documented as being challenging for undergraduate students majoring in physics or engineering. Dr. Peppler found that students working with littleBits have a much easier time mastering these concepts. In other words, littleBits is doing a better job teaching circuitry concepts than the toolkits traditionally used by students in the classroom.

Specifically, littleBits promotes transferable understanding of circuitry learning to real-world problems – allowing students to engage in a conceptual understanding of circuits that is important to physics and engineering. Professor Seymour Papert, who came up with the idea that learning happens best through making, said it perfectly: "We need to produce people who know how to act when they are faced with situations for which they were not specifically prepared."

This study demonstrates that littleBits is one of the most effective tools in helping students learning basic circuitry concepts, and that it provides more affordances and support for learning than traditional materials – and even some other newer kits.



THE IMPACT OF CIRCUITRY KIT DESIGN ON LEARNING OUTCOMES

According to Dr. Peppler, the challenges typically associated with teaching circuitry to elementary students may be attributed to the poor design of previous toolkits. Students working with littleBits, for example, scored significantly higher than students working with traditional kits in their circuitry knowledge, which Dr. Peppler attributes to the design of the littleBits toolkit.

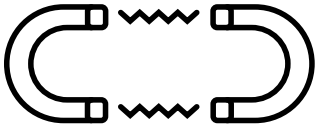
LITTLEBITS HAS SEVERAL DIFFERENTIATORS WITH RESPECT TO DESIGN:

- **LITTLEBITS IS INTUITIVE.** littleBits' color-coded Bits each have a specific function (i.e., motion, lights, sound, sensors, internet connectivity), and all the Bits snap together to make larger circuits. New concepts are easily transferred to a new littleBits kit or invention that a student hasn't seen before so they don't need to re-learn the basics of circuitry each time they play.

- **MAGNETS PROVIDE INSTANT FEEDBACK.** The choice of magnets over snaps (as in the case with Snap Circuits) seems to benefit learning, giving the learner some physical feedback on non-working solutions, which is important for learning.

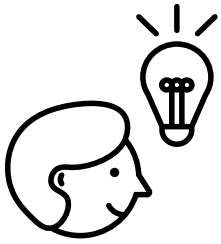
- **LITTLEBITS DEMONSTRATES CIRCUITRY BASICS.** Circuitry flows in a loop, and while other kits don't show this in a way that makes sense, littleBits makes building circuits simple and intuitive – allowing students to create powerful, sophisticated electronics in a matter of seconds. littleBits make conscientious design decisions to make everything transparent about the circuit. Furthermore, it is clear where and how the batteries are attached. With an ever-expanding library of Bits, educators and students can grow their collection and engage in increasingly complex projects as their understanding of the system and Bits grows.

STUDENTS WORKING WITH LITTLEBITS, FOR EXAMPLE, SCORED SIGNIFICANTLY HIGHER THAN STUDENTS WORKING WITH TRADITIONAL KITS IN THEIR CIRCUITRY KNOWLEDGE, WHICH DR. PEPPLER ATTRIBUTES TO THE DESIGN OF THE LITTLEBITS TOOLKIT.



MAGNETS PROVIDE PHYSICAL FEEDBACK

The choice of magnets over snaps (e.g., in Snap Circuits) benefits learning, giving the learner physical feedback on non-working solutions, which is important for learning.



PROVEN TO ENHANCE LEARNING

littleBits scored significantly higher than the traditional kit most often used in schools for teaching circuitry (e.g., 9V battery, lightbulb and alligator clips), due to significant design enhancements.

GENDER-NEUTRAL TOOLKITS PROVIDE AN ENTRYPOINT INTO CIRCUITRY

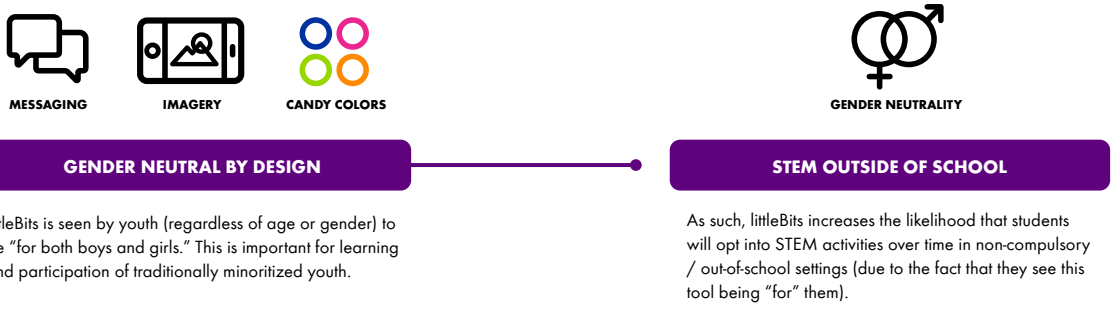
By nature, boys and girls identify differently with different types of kits. This study explored perceived "gendered-ness" across several STEM toolkits that encourage learning about circuitry and electronics, and examined how this might affect students' propensity to engage with these toolkits.

According to the research, littleBits is seen by students (regardless of age or gender) to be "for both boys and girls." It is one of the most gender-neutral kits on the market. This is extremely important when it comes to encouraging learning and participation from youth traditionally outside the STEM pipeline.

If a student perceives a kit as "for" them, they are more likely to gravitate towards that kit in various settings over time. This increases the likelihood that these students will opt into STEM activities over time in non-compulsory or out-of-school settings. And the more that students gravitate toward the STEM activities offered within littleBits' kits, the more students who will be exposed to STEM early and often (both in school and out), improving academic outcomes.

Dr. Peppler's research confirms that there is a perceived "gendered-ness" to common toolkits for circuitry learning. This perception may impact how students learn from and interact with these tools. Additionally, the research confirms that the design of various educational tools makes them appeal differently to young boys and girls.

Despite small differences between the boys' and girls' perceptions, littleBits is seen as largely appealing equally to boys and girls.



CONCLUSION

Students who have exposure to STEM early and often are more likely to build up a strong foundation in circuitry by the time they are in college. However, the design of the toolkits that they are exposed to have a significant impact on their level of interest and attention.

Students respond best to circuitry kits that: put complex topics into real-world context, have a clever and intuitive design, and appeal equally to both boys and girls. littleBits' kits stand out in each of these categories.

METHODOLOGY

In this study, Dr. Peppler and her team identified five circuitry toolkits available commercially, with the aim of evaluating their efficacy: e-textiles, Squishy Circuits, littleBits, hand2mind, and Snap Circuits.

More than 200 students, aged five to fifteen, were randomly assigned to one of the toolkits.

Pre- and post-assessments were administered before and after an 90-minute-long engagement with the assigned toolkit, to examine the situated understanding of circuitry within the assigned toolkit, and how children approached the other four toolkits.

THANK YOU.