Co-designing a physical to digital experience for an onboarding and blended learning platform

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Abstract
'Children should learn to code', is a simple message that in recent years, has dominated the scene around the development of the computing and technology curriculum. A range of government, public, and privately funded initiatives have highlighted the value of introducing children to coding and computer science. Its role is the broader agenda of encouraging better engagement with Science, Technology, Engineering, Arts and Mathematics (STEAM). As a result of this increased focus, a number of products blending hardware, software, creative thinking and play have emerged onto the market. This paper introduces a co-design process of transforming a playful learning technology product, 'littleBits', into an online digital onboarding experience, to assist creative minds in understanding the technology.

Author Keywords
Onboarding, physical, digital, making, companion app, electronics, education, littleBits, creative

ACM Classification Keywords
H.5.m. Information interfaces and presentation
**BBC’s micro:bit**
Aims to encourage pupils of age 11 and 12 to learn code writing techniques by providing them with a free micro:bit board as well as purposefully designed online tools to facilitate access to needed learning materials.

**littleBits Chapters**
The littleBits chapters are about bringing people together to learn new skills, share project ideas and talk with experts at workshops designed to put the power of electronics in the hands of everyone regardless of age, gender, technical ability or language.

**littleBits Bits**
The littleBits physical library totals 65 colourful ‘bits’ which snap together through the use of magnets. Each bit is classified using the colour scheme of pink, green, orange and blue to represent different actions in a circuit; blue represents power, pink is associated with input bits like buttons and pressure pads, green represent an output such as LEDs, motors, buzzers etc. and orange is used for the connecting bits.

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**Introduction**
Computing has never before been so prominent in the everyday life of school children [1, 8, 9]. The recent shift towards teaching children to write computer programs has led to the introduction of coding into the National Curriculum in 2014, although only as a minor part of an otherwise hefty document¹.

The biggest challenge right now is how do we transform computing consumers into creators [3, 11]. As a result, a number of products targeting the curriculum with a range of both hardware and software, have emerged onto the market (see sidebar). This approach of using both digital and physical tools reflects a growing interest in connected objects and the way creative thinking and play are used as learning mechanisms. Moreover, the rise of accessible technology and increasingly visible communities, has led to the development of different platforms; from community funded projects (Particle²), to foundations set up to support the basics in teaching computing (Raspberry Pi³), all contribute to the upsurge in commercial interest. Disney has transformed the original Maker Faire⁴ into a huge commercial opportunity whilst introducing the maker movement and its activities to a wider community. Such practice has created a market and an audience that has really never been seen before, one that is increasingly commercially attractive but growing in an organic community driven way.

However, especially at curriculum level, this creates new challenges for those wanting to get ‘hands-on’ with these products. Selecting a product that can be used by a class of thirty students becomes as much about the financial investment as it does about supporting the curriculum material. One solution would be to attend local maker groups in order to get hands on experience from like minded people which gather to discuss interests around what has become a hobby⁵.

Following the change in the curriculum and adoption of STEAM over STEM, Ayah Bdeir from MIT, pre-empted this shift in 2009 [2], she introduced the first versions of the littleBits platform. It was only in 2012, during a TED talk⁶, where she introduced a market-ready product that offered a new way of learning through “Building blocks that blink, beep and teach”. Building on playful ideas of building blocks, from concrete blocks, to LEGO® bricks and transistor units, Bdeir’s motivation was to enable artists and designers to have the same powers as an engineer. More recently, the product is quickly attracting a growing following in schools, particularly in the US. However, the product’s high-end pricing means that fitting out a classroom with sufficient ‘bits’ to ensure a good experience for all students does represent a significant financial investment. The vast range of bits allows makers to snap together power, input and output components in order to make an electronic circuit. As blocks fit

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² https://www.particle.io/
³ https://www.raspberrypi.org/
⁴ http://makerfaire.com/
⁵ http://prestonhackspace.org.uk/
⁶ https://www.ted.com/talks/ayah_bdeir_building_blocks_that_blink_beep_and_teach?language=en
⁷ https://www.ted.com/talks/ayah_bdeir_building_blocks_that_blink_beep_and_teach
So far our ‘chapters’ have been aimed at different audiences from children aged 8-9, 3rd year university students and a team of non-technical academics (Fig. 1). These varied audiences offer a chance to see what works best for each age group. They also reflect the diverse learning communities in this space and how they intersect. Together without any need for retooling, creators can easily connect them, by pushing two or more blocks together. However, due to the nature of ‘littleBits’, it is essential to educate users on the correct way to snap bits together. This is achieved by incorporating magnets into the ‘bits’ which bridge the physical and digital connections with other ‘bits’; since opposite magnet poles repel, this technique is a simple yet powerful design feature that defers the learner from creating wrongly connecting electrical circuits. The emphasis on physical interaction and seemingly basic structure form a framework which enable people to become creators, inventors and contributors, by integrating littleBits into their real-world designs [3, 4]. Although the platform is aimed at any age (from eight upwards), its design and theming strongly suggest the younger audience as the main target whilst enabling teachers to educate kids with things they do not learn in school. For example, understanding how real world objects work through simple interactions: how a lift door stays open, how a night light comes on when human presence is detected or how home alarm systems work. The growing community of littleBits users, including an official ‘chapter’ system, means there is a growing collection of case studies and workshop resources available to use and access. A common feature of these workshops is an introductory process where the basic principles of littleBits operations and documented, albeit in a traditional method of learning (reading).

**Background**

Since adopting the littleBits platform, the Media Innovation Studio\(^8\) at the University of Central Lancashire (UCLan) has become a ‘littleBits chapter’ leader, part of a global network that shares knowledge and experiences about the platform from hosting workshops. The ‘chapter’ allows this research team to meet with like minded people through monthly online calls where the sharing of experiences, assistance in designing workshops, or leverage resources to help educate children about electronics takes place. To date, four ‘chapter’ workshops have been hosted, with five more in the pipeline (see sidebar). During this time, similar behaviours as to what Bdeir described [2] have been observed such as, the lack of understanding when too much play takes over, the increase of confidence in picking up and interacting with the technology and the expression in creativity. In order to capture a wider audience, the littleBits platform does indeed require no electronics or coding background.

However, littleBits offer users the ability to extend the platform further with the likes of bespoke bits such as the; Arduino\(^9\) and Makey Makey\(^10\) bits, Perf module (a DIY easy to prototype bit) and hardware development kit\(^11\) and cloudBit\(^12\). One of the issues with this new phenomenon of ‘creating’ is the original decision making process and initial cost. With a growing number of platforms to choose from, and different specification within a platform, the decision to commit to a platform is a complex mix of cost and service. What level of ongoing support can a user expect; should they choose a platform which is often emerging or a crowdfunded

\(^{8}\) http://mediainnovationstudio.org/

\(^{9}\) https://www.arduino.cc/

\(^{10}\) http://www.makeymakey.com/

\(^{11}\) http://littlebits.cc/shop/bits/bitlab

\(^{12}\) https://littlebits.cc/bits/cloudbit

**Figure 1:** Photograph taken from the littleBits chapter workshop in Lincoln. Here the participants used the learning resources provided by littleBits.
one? We feel this represents a gap that companion apps could usefully fill. If the users can test out a simulated experience before purchasing any devices, does this serve a purpose? Does the platform help in building a useful understanding of the product? Does it enable a higher level of engagement with the product on first use? In other words, can it be seen as an ‘onboarding’ experience? [7]. The ‘onboarding’ approach is often seen in games where, different skills are introduced to the player at the start of the game, or downloadable content is available at a cost, where the game wants to entice its players into thinking they need this additional content. In some instances, a player must have a basic understanding of these skills before they can proceed with the actual game, thus making them ‘onboard’ with the game world. With many of these development kits, the ‘onboarding’ experience is lost, generic or traditional tools seem to be missing an important opportunity to promote engagement. However, the design of well thought tools, time consuming activities such as learning and understanding, could be minimised [5].

Video games are an excellent example of how to design to encourage participation, motivation, and exploration. Video games by nature are educational [7], from the ways the game introduces new concepts to players but also as learning strategies as they progress through levels. With this in mind, many educational tools have been developed to teach computer science through play and game design [10]. One of the first was Logo, whereby a user will programme a virtual turtle in order to draw shapes. More recently, games design has also witnessed this shift and game makers such as GameSalad have come to light, allowing designers to create games with no coding, typically using a drag and drop interface. Scratch could be classed as an extension to tools like game creators [6], as it has been used to teach children simple lessons in programming, whereby users will create animations based around drag and drop building blocks that they can manipulate with simple instructions, as they code the individual elements on the stage. Arguably, the biggest franchise in transforming the physical play elements of a physical ‘brick’ into an online/software experience, comes from LEGO®. This has sought extensive research [14] studying how this company has transformed their physical product into online simulators, franchised video games and personalisation tools.

This research combines current knowledge and experience from conducting workshops with the littleBits kit and academic learning. The paper proposes, testing a way of onboarding users to their first experience with littleBits through a tablet based companion app to raise awareness, experience, exploration in technology, what forms collaboration and how the exchange of information takes place. The app has been developed to simulate the process of introducing a user to the technology, mitigating some of the issues of access to the product itself. It also allows us to determine to what extent participants learn from the app; first as a tool to simulate the experience and secondly, as a way of determining learning through a gamified experience similar to social games [5] and

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13 http://www.clickteam.com/

14 https://gamesalad.com/

15 http://ldd.lego.com/en-gb/download/
education coding platforms such as Codecademy\textsuperscript{17} and Enki\textsuperscript{18}.

**Onboarding through a Companion App**

Hosting "Chapters" workshops have provided valuable feedback, from observing participants interact with the platform to discussing learning outcomes. It became apparent that some form of interactive onboarding exercise is required. Aside from handing out recipes resources which demonstrate possibilities to users, it would be beneficial if some form of software based application could assist in the learning process of a user prior to getting their hands on the physical bits [4]. The software could also be used when there are more participants than required bits, by splitting the group into smaller groups, where some have access to the physical bits whilst others interact with the digital tools.

Essentially, this approach would create a blended learning environment where participants can continue their work in their own time but still have the benefits of the mentor during the workshop [12, 13].

The concept of the platform is to mimic the real world objects as closely as possible i.e. the physical objects use magnets to snap together, which is represented on screen via a "snap" graphic for successful actions (Fig. 3) and red waves when the magnets are repelling, indicating the bits are incorrectly placed (Fig. 2). The online tool onboards users with varying modes; free-to-play (Fig. 4, 5), an open area where users can play and train, during which users will go through stages in order to graduate the platform. With the help from a littleBits Bot, named “helperBit” (Fig. 4 and 6), a Microsoft’s paper-clip ‘Clippy’\textsuperscript{19} and SlackBot\textsuperscript{20} inspired feature, users are provided the needed help to determine what bit they need whilst suggesting alternative bits were necessary. As the bit is bot based, it will react to situation on the stage with witty comments, but also to capture information from the user. The helperBit also captures messages from the user, asking at certain stages of development "why you do this action?", or "what are you trying to achieve?". At the end of the training the messages captured form a report, which can then be fed into an assessment of the users understanding of the platform.

Furthermore, from hosting workshops with younger makers, it became apparent that some kids wanted to make the longest littleBits circuit by snapping together as many bits as they could. Unfortunately, this approach led to an extremely power hungry circuit and an unhappy maker, since the buzzer at the end of the circuit had no power to produce any sounds. This is why the companion app introduces the concept of power management to the power bit (Fig. 7). Each time a bit is added to the project, the power is recalculated and represented as red when there isn’t enough power to run the project. Additionally, the platform tracks and records a history of the user’s progress within the platform. This can then be saved and continued later or shared online for others to collaborate on. Currently, the app has been designed for a single user, however with its modular design approach it could be extended to allow multiple users to work on the same mounting

\textsuperscript{17} https://www.codecademy.com/about
\textsuperscript{18} https://www.enki.com/#about
\textsuperscript{19} https://en.wikipedia.org/wiki/Office_Assistant
\textsuperscript{20} https://get.slack.help/hc/en-us/articles/202026038-Slackbot-your-assistant-notepad-programmable-bot
board. As the platform has been designed to act as a companion to the physical bits, a basic shopping cart was created to inform the user of the total price of the project. For every bit the user drags onto the mounting board, the shopping cart is updated, allowing the user to keep track of the project's expenses, and later on buy the physical bits, if the cost of the kit is affordable.

**Conclusion**
The next stages of the research are to test methods of interaction with the software. As littleBits themselves state the ideal age for learning is eight and above, we feel that developing the onboarding experience for those under this age could sought interesting results. In the next few months we will be trailing the software with groups to capture data and understand how these types of tools are used in pedagogy.

**References**