The Book Reads You:
Better reading outcomes by re-imagining e-book readers as advanced computing devices

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ABSTRACT
In this paper, we explore the idea of continuous learning in a digital world through better performance for reading e-books. To gain context, we look at the current findings, challenges and gaps in learning using e-books. We then mention how companies like Amazon use the customer data generated on e-book usage.

Next, we explore the Quantified Self movement and ideas of Persuasive Technology which mention techniques to use data for better personal outcomes. Finally, we re-imagine the e-book reading device as an advanced computer and outline original ideas to harness its potential by applying the concepts of the QS movement. We argue that successful application of these ideas will lead to better reading outcomes for motivated learners.

KEYWORDS
Quantified self, e-books, digital devices, persuasive technology, captology

INTRODUCTION
Most people realize that reading more books leads to better career and overall success outcomes. As Card (1999) points out, hundreds of studies in different countries and time periods have confirmed that better-educated individuals earn higher wages and work in more prestigious occupations than their lesser educated counterparts. In today's competitive world, where innovation commands a premium, an approach of continuous learning matters even more.

E-books
With an array of devices from the Apple iPad to the Amazon Kindle, e-books are being widely adopted for reading. According to *"Global entertainment and Media Outlook 2016-2020"* by the Consulting Firm PriceWaterHouse Coopers, the e-books market stands at USD 20 Billion in 2015, and is slated to grow to approximately USD 30 Billion by 2020. According to the report, the category of professional books is the most digitized area of the book publishing market, and is growing at a rate of 11.7%, as opposed to a decline of 2.8% for print books. Though print books are still a more than four times larger market by revenue, the trend towards growth of e-books is clear. Table 1 below lists some of the devices currently sold in the market.

Device Name	Maker	Category
Kindle	Amazon	e-book reader
Sony Reader	Sony	e-book reader
Nook	Barnes & Noble	e-book reader
Kobo Reader	Kobo	e-book reader
iPad	Apple	Tablet

Table 1. Popular Digital Reading Devices

Apart from their portability and capacity to store hundreds of books, the key factor differentiating e-books from traditional print books is that they can record enormous amounts of data on a user's reading behavior. And this data can then be used to modify the user's behavior to deliver better learning outcomes.

How are students using e-books?
According to Gregory (2008) and Levine-Clark (2006) undergraduate students prefer print books over e-books. The tangible aspects of a reading a print book like the thickness and bulk of pages actually helps students navigate the text and gives them a "sense of place" which according to Wilson, Landoni and Gibb (2003) can be lost in e-book reading.

Furthermore, both Sheppard et al (2008) and Daniel & Woody (2012) find that in terms of learning performance, there is no significant difference between e-book versus print formats. However, Daniel & Woody (2012) found that electronic textbooks took significantly longer time for achieving similar results as print books.

These studies cast doubt on the effectiveness of learning from e-books. But while they focus on the usability aspects of e-books, they do not take into account the potential of e-books in capturing and exploiting reading data. One possible reason for this is

that e-book devices are evolving rapidly, and these studies were done using older devices and formats, hence could not consider new reading habits of a more digitally aware generation as well as new device capabilities.

How are companies using e-books?
According to Atler (2012), the big players in e-book publishing like Amazon, Apple, and Google can track how far the readers have read a book, how much time they take to read, what words do they highlight and what are the terms they search for. Amazon stores a reader's bookmarks, highlights, and annotations on its servers. The publishers then examine the data to get insights into how the people engage with the books.

However, no company has offered explanations of exactly how do they use the data. They might use it to offer similar recommended books and even help the authors to write according to reader needs, but there are no tools for the readers themselves to understand the data and maximize for their reading and learning performance. This gap can be addressed if methods are used from the Quantified Self (QS) movement.

Quantified Self & Persuasive Technology
The Quantified Self (QS) movement aims to capture a wide variety of an individual's data to help them modify their habits related to diet, exercise, finances and so forth. With the advent of wearable devices which can track everything steps taken in a day to blood sugar levels, we have the data which can be used to modify individual behavior.

As Sherman & Nafus (2014) recount, the QS movement was founded in 2007 by Gary Wolf and Kevin Kelley of Wired Magazine. Wolf and Kelley reflected that the rapid growth of personal tracking technologies raised new questions about what personal data meant to individuals. In a TED talk in 2010, Wolf elaborated what it meant to see personal data "as a mirror" into self and what kinds of learning and insights could emerge from it. The movement gained momentum with around 20,000 participants across 30 countries. Using the latest software and hardware tools, the participants captured data on sleep, mood, mindset, pre-occupation, among other things.

But capturing the data is only one part of the equation. Significant work has been done on means to modify a person's behavior using the data captured through sophisticated tools. Fogg (2002) explores this dynamic and calls these tools 'Persuasive Technology' and their science as 'Captology'. Captology is defined as the area where technology and persuasion overlap.
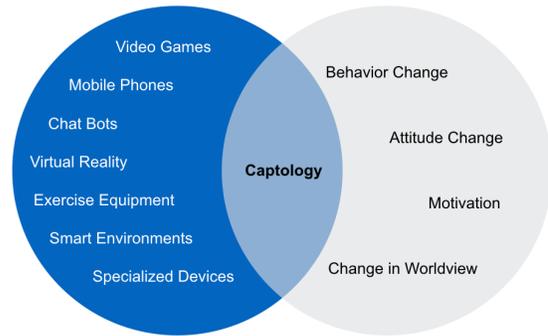
Figure 1. Captology aims to induce behavior change though technology

But while Fogg (2002) only elaborates the use of captology to persuade others, we believe that using data and methods of quantified-self movement, individuals can motivate themselves for better behaviors and performance.
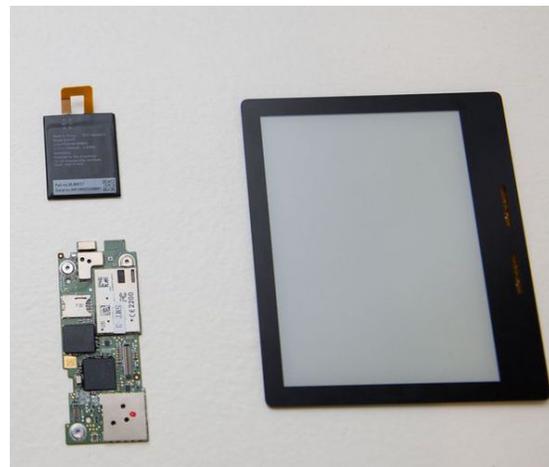
Figure 2. The e-book reader (like this Kindle Oasis) is an advanced computer

DISCUSSION OF NEW IDEAS
The ideas proposed are based on a re-imagining of e-book devices. We see e-book devices are more than machines carrying digital books, they are *advanced computers* with capabilities like:

- sophisticated and dynamic interfaces
- high processing power
- connectivity with other digital devices

This re-imagining of e-book readers leads us to see them as self-tracking devices which generate data on reading. We can apply the ideas of captology on this

data to stimulate behavior change and hence get better learning outcomes. Figure 2 gives a glimpse into the hardware of an e-book device. We explore some of the ideas next.

Reading in Differing Contexts

Reading speed is measured in Words per Minute (WPM). With the digital readers, it is easy to compute this value for multiple variables of context. For example, you could have differing reading speeds depending on the time of the day. In this case, the e-book reader could offer you a visual representation of your speeds according to morning, afternoon or night. Figure 3 shows a sample visualization of such data.
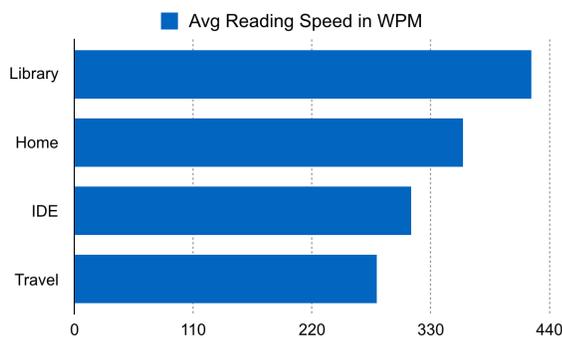
Figure 3. Sample chart showing reading speed in different contexts in life of a student

This data could help you optimize the time when you read the fastest. Similarly, other contexts could be:

- Reading at home versus at a campus or office
- Reading under stress (for exams) or for self-directed learning
- Reading performance tied to other regular activities like - exercise or meditation
- Reading on multiple devices - if user employs smartphones, tablets in concert - this would highlight which device is most useful

Just like reading speed, reading comprehension can also be analyzed across contexts to find out the right context for maximum performance. When this data is recorded and tracked across time, long term patterns will be revealed which can give us further insights for improvement. For example, a reader can set goals of reaching higher reading speeds or comprehension levels and achieve them by working on her vocabulary.

### Reading with Differing Visual Cues

On the front-end too, the e-book readers offer a variety of ways to customize the reading experience. These include different typefaces, type size, contrast and brightness, margins and line spacing - like those in Figure 4.

Figure 4. Kindle: options for visual cues

Multiple studies have explored the effects of these variables. For example, Dyson and Haselgrove (2001) found that medium line-lengths (55 characters per line) supported effective reading. Similarly, Bernard et al (2003) found that text in Times New Roman was found more difficult to read than text in Arial, and text of size of 10-point size was more difficult to read than text of 12-point size.
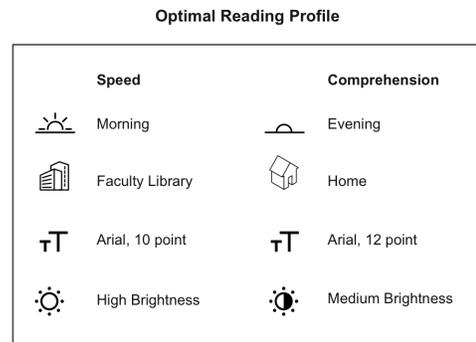
Figure 5. Sample visual for optimal reading profile based on reading patterns across time

These findings give us confidence to explore further ideas about effects of visual variables on an individual's reading speed and comprehension. Just like reading across contexts, reading with different visual cues can be visualized using simple graphs. This will enable the reader to understand what visual setup is the most suitable for his own case.

Building further on this, the user might be able to see his or her optimum reading profile like in Figure 5.

Utilizing Crowd Intelligence

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Our final idea proposes exploring the connected nature of these devices. This would be especially useful for textbooks which have specific portions which are difficult to read. By looking at reading speed data across thousands of users, the e-book publisher could mark sections of the book as particularly challenging. Here we assume that the more challenging a text section, the harder it is to read. The publisher could then dynamically present suggestions for additional reading or related concepts to readers by knowing if they are facing difficulty in that section.

Similarly, for a particular text, a reader should be able to see how she compares with the population who has read that text. For example, it should be visible that a section of a dense economics textbook has a global average speed of 200 WPM. This would give a clear baseline to the reader and motivation to go at higher speed, and also highlight possible areas of conceptual improvement.

CONCLUSION
It is commonplace to say that all leaders are readers. Celebrated American investor Warren Buffet is known to say that he devotes 80% of his working time to reading and thinking. To succeed in an economy which is driven by disruptive innovation, students and professionals need to be faster at learning to get ahead.

However, with exponentially growing amounts of information and increasing mobility of professionals, print books are becoming less convenient. If one has to keep up with the times, you have no option but to go digital. To address this need, e-book readers are gaining popularity and evolving their interfaces to make the task easier and pleasurable. While a necessary step, we believe that we are far from devices which can make us better at the task of reading itself. The technology is already there, but the applications have not been fully explored.

In this paper, we suggest some of the directions for a possible future to come by re-imagining e-book readers as advanced computers having a flexible interface, fast processing, and connection to a global network. The current e-book ecosystem has completely missed the opportunities offered by interpreting them as tools for captology. The behavioral models of quantified self, applied to data generated by e-book devices, can lead to markedly effective outcomes.

The key challenge here is publishers' willingness to further refine such ideas so they can be implemented in a simple user interface and be integrated into their ecosystem. Publishers do not look at data this way. The primary use of the data they capture is to maximize book sales. They have no pressing incentives to create tools for better learning outcomes. However, given sufficient demand from users, implementing these ideas is certainly feasible for big organizations like Amazon and Apple. We hope for a future where people with a burning desire to learn are helped by smart devices to achieve their goal of lifelong learning.

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