



Investigating the Effects of Computer-Generated Contextual Landmarks on Short-Term Recall of E-Texts

Jon Dron 
Athabasca University

Rory McGreal 
Athabasca University

Vive Kumar 
Athabasca University

Jennifer D. Davies 
Athabasca University

Correspondence:

Jon Dron
Athabasca University
Email: [jond \[at\] athabascau.ca](mailto:jond[at]athabascau.ca)

Abstract

E-texts have many advantages over their paper counterparts, especially when they are reflowable and available as open educational resources (OERs). Unfortunately, research suggests that e-texts are, on the whole, less memorable than p-texts, in part due to their relative lack of visual navigational landmarks that help to anchor recall. The Landmarks project team is, therefore, building an application that inserts computer-generated artificial imperfections – abstract or representational landmarks – into the display of e-texts, that remain consistently associated with text passages even when documents are reflowed or reformatted. We hypothesize that it may consequently be easier to recall the associated contents. The application is designed to provide the means to present modified open texts using a range of generated landmarks and variations on them, and to test recall of the content. In this initial pilot study, results of tests for readers receiving different landmarks will be compared, with the intent of identifying promising approaches to use for future studies.

Keywords: e-text, recall, OER, navigation, landmark, reading



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Introduction

Open e-texts in reflowable formats, such as HTML or ePub, are superior to closed p-texts in most ways. Amongst other things: (a) the environmental and financial costs of production, storage, and distribution are much lower; (b) for open educational resources (OERs), editing, remixing, and repurposing are much more easily done; (c) presentation is more flexible; (d) they are more durable; (e) they, and annotations of them, are more easily shared; and (f) with the right devices, they can be read in the dark, or in the bath, and they can be more legible, especially for those with cognitive or visual impairment. However, for the purposes of learning, their contents are normally less memorable (Mangen et al., 2013; Hou et al, 2017; Johnston & Salaz, 2019; Furenes et al., 2021). Among the more significant of the many reasons for this shortcoming is their relative lack of visual landmarks to assist recall: (a) the curvature of pages; (b) the visibility of earlier and later pages; (c) the consistency of layout; (d) the imperfections of the paper and print; (e) the coffee stains; (f) the handwritten annotations; and (g) the small creases in pages, and so on, which provide visual anchors that help readers of paper texts remember what they have read (Mangen et al., 2019; Myrberg & Wiberg, 2015). Such issues are less profound in fixed-format e-texts such as PDF files, but these are far less useful as OERs, being less accessible, less remixable, less easily edited, less adaptable to different needs, and more demanding of larger, more expensive, devices to support easy reading. If OERs are to achieve greater impact, this problem must be solved. One promising avenue of exploration would be to provide artificial landmarks bound to each passage that flow with the text, thus providing visual anchors to associate with the text. This is the purpose of the Landmarks project.

The Study

For this pilot study, the Landmarks project team is building an application that creates distinctive artificial visual landmarks for sections of OER texts (sentences, paragraphs, etc.), computed using a hash value of the section contents, that therefore stay consistent no matter how the section may be reformatted or resized, or on what device it is displayed. The landmarks may be abstract background patterns of varying intensity, glyphs or patterns shown in margins or scroll bars, small tweaks to typefaces, or more skeuomorphic images like coffee stains or smudges. The application will also provide tests of short-term recall, so that the effects of different treatments (or no treatment at all) can be compared.

We hypothesize that readers supplied with distinctive context-dependent landmarks will recall more of the text than those without such landmarks, or with non-distinctive patterns or glyphs. The need for the latter is due to the high probability that most of the landmarks the application will provide will make reading more difficult. This is probably a good thing because there is compelling (though contested) evidence that recall of content that can be improved by making the text itself more difficult to read. This is hypothesized to be because disfluency leads to deeper processing, which in turn improves retention of knowledge (Diemand-Yauman et al., 2011). However, the benefits are far from uniform, because what may be desirable difficulty for one reader may be too disruptive for the next (Eskenazi et al., 2021). Whether or not recall is improved by making the text less legible, we will need to control for the effects of simply adding clutter to the interface.

Although, to the best of our knowledge, no one has attempted to study the effects of such treatments on content recall before, there is plentiful evidence that distinctive landmarks of this

kind can substantially improve the capacity for users to find previously read passages of electronic texts (Piolat et al., 1997, Czerwinski et al., 1999; Uddin et al., 2017; Mollashahi et al., 2018), implying that visual landmarks do have some impact on at least navigational recall. This may be because, as a species, we have evolved to navigate and remember features of the physical world using the shapes and patterns around us, including their visual relationships with one another.

Experiments will be performed to attempt to identify what kinds of landmark (including intensity, visual appearance, placing, etc.), if any, have a greater effect on immediate recall, by comparing test results for those receiving different treatments.

The Landmarks application is being built as a web-based application, using open-source technologies, and it will be released as open-source software on a public repository. One or more instances of the application will be made available through the web, making use of existing OERs to provide content, and those who may have an interest in learning their content will be invited to visit and take the tests. The results will be analyzed to explore differences in recall between different treatments of each text.

Limitations

If a positive effect on recall is found, the consequences for learning using digital media may be profound, reducing or removing one of the most substantial barriers to e-text and, especially, to OER uptake. However, this initial pilot study is just the first step, and it has some significant limitations.

In this study, for the sake of keeping within a tight timeframe and budget, all interactions with the system will be anonymous and, though we will collect and correlate data such as visit duration, use of scrolling, screen size, and operating system, we acknowledge that any data we collect will only reveal coarse correlations at best. We hope that we will be able to attract enough visitors that the many possible confounding variables will average out, and we hope to be able to provide sufficient texts to compensate for innate differences in content and presentation, but it is unlikely that the data we collect will offer more than an indication of the need for further study. We will not know about prior knowledge or motivations to visit, will know nothing of the demographics of the visitors, will have limited information about repeat visits, will have only approximate data relating to how reading behaviours are affected, will have limited scope for comparing effects for different topics, presentation styles, or pedagogical approach, and will have only limited clues as to the causes of any effects we see. The results, though, will help to inform future work during which we hope to, among other things:

- Perform pre-tests to reveal existing knowledge;
- Capture demographic data to discover whether there are any consistent differences in approach to and use of e-texts;
- Test for longer term recall, and for comprehension;
- Use more OERs to control for the effects of the texts themselves on reading;
- Refine and extend the number of landmarks available;
- Control more accurately for the type of device;

- More closely observe reading behaviours to attempt to identify how they vary according to treatment;
- Engage research subjects to gain richer insights into how they respond to the various Landmarks, and their perceptions of the application itself;
- Create an application that can deal with common e-book formats such as ePub and Mobi, and that can work as a mobile app.
- Provide accessible versions of the application that, for example, provide subtle audio landmarks for those using screen-readers.

We recognize that there are many different kinds of spatial landmarks, including those constituted in their relationships to one another, as well as beacon cues, associative cues, and directional cues (Chan et al., 2012), all of which may play a role in recall of traditional p-texts. Our application will primarily focus on beacon and associative cues because the nature of reflowable text means that spatial relationships between navigational cues cannot be consistently maintained. It may be that this is not enough to assist effective recall. Equally, we may not identify the most effective kinds of landmark, some may be inherently distracting, and others may render differently under different conditions, especially when the effects are subtle. This will remain an ongoing exploration.

Conclusion

This is just the beginning of what we hope will be a longer research journey. While even minor improvements in knowledge retention will help to close the gap between paper and screen, we are under no illusions that this work will solve all the problems preventing greater uptake of e-texts for learning. There are likely to be many other reasons that e-texts are less memorable than p-texts, including (notably): (a) the distractions of general-purpose computers; (b) limitations of screens (especially those of desktop and laptop computers); (c) limited haptic feedback; (d) difficulties flitting through multiple pages; (e) dislike of the devices; (f) brightness of displays, and so on. There seem to be variations depending on the type of text, the subject, and the context of learning (Rasmusson, 2015) as well as the extent to which the medium has been exploited (Furenes et al., 2021), so the chances are that many different variables will affect one another, and those simple causes will combine to create difficult or impossible to predict effects in any given case.

Author's Contributions

All authors contributed to the development of the project and ideas presented in this paper. The paper itself was mainly written by author 1, then corrected and approved by the co-authors.

Open Researcher and Contributor Identifier (ORCID)

Jon Dron  <https://orcid.org/0000-0002-6521-7302>

Rory McGreal  <https://orcid.org/0000-0003-4393-0921>

Vive Kumar  <https://orcid.org/0000-0003-3394-7789>

Jennifer D. Davies  <https://orcid.org/0000-0001-6599-2432>

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Ethics Statement

Ethics approval has been granted by the Athabasca University Research Ethics Board.

Conflict of Interest

The authors do not declare any conflict of interest.

Data Availability Statement

Source code for the project (at the time of writing, incomplete).

<https://github.com/jondron/landmarks>

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