Information
in
e-Motion

Proceedings

BOBCATSSS 2012
20th International Conference
on Information Science
Amsterdam, 23-25 January 2012

Imprint

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E-Learning in Motion
A Study in the Transition from Paper to Electronic Text Books

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Abstract: In this paper, we report three extensive comparative tests for reading and learning by using paper, as well as a variety of interactive study forms. This work is part of the large Amsterdam E-Boekenstad (E-Book city) research project (www.e-boekenstad.nl and http://e-boekenstad.wikispaces.com/). The idea behind the experiments was to investigate to what extent the materiality of a book determines the usability of the book form (Haas, 1999). Our tests were conducted in 2010 and 2011. In the first test we compared learning from paper, a laptop and an e-ink e-reader. In the second test, we compared paper with reading from web pages. In the third test, we compared paper and material presented into a digital mind map. As it turns out, in a study situation, electronic reading can only beat reading from paper when it offers real added value. For example, this can be accomplished by providing a better overview and shorter comprehensive texts, like we did in our second study. The most important conclusion from all tests is that a simple translation from paper format to electronic format is not enough. Publishers should take advantage of the possibilities new techniques offer, and perhaps discard 'traditional thinking' in terms of linear essay-type books and paragraphs. Below we discuss the three experiments in more detail.

First Study: Paper versus Laptop versus e-Ink e-Reader

In our first study, 90 students participated. We used the marketing book: 'Digitale Marketing & Communicatie' (Digital Marketing & Communication') by Schuurmans (2008), which is part of the curriculum. Thirty students studied from the paper book. Another thirty students received the material as PDF file and studied the material on their laptops. The last group received the same PDF version, but used a 16 by 20 cm E-ink Irex-1000S e-reader. Before, during, and after the tests group discussions were held. The students were also asked to keep a logbook. The total duration of the experiment was twelve weeks. During this period the students were asked to study only from the version they received at the beginning of the test. The most striking result was that almost no one of the 'e-reader group' ended up studying from the Irex: they put the Irex aside.

They felt that using the Irex e-book was an obstacle in their learning process. The enthusiasm they initially had diminished quickly when they found out that the Irex was relatively slow, both in starting up, as well as in processing and 'turning pages'. Study-

ing people don't read a book from cover to cover, but jump from page to page, and chapter to chapter. They go to and fro through the text and compare pages, pictures and tables. The e-reader was too slow for this type of reading. Related to this fact is that e-versions only shows one page at the time. It does not permit fingers, pencils or small pieces of paper between pages, though electronic bookmarks are available. This is a general problem of e-books. It looks more a scroll than a book. In the e-versions, e-ink readers and laptops, students also couldn't make notes easily. The Irex does allow making notes with a special stylus, but writing legibly demanded serious training and patience. A remarkable insight was that the 'Irex e-reader group' postponed studying for their exam the longest of all groups. The expectations they held beforehand about studying with an e-reader couldn't be met. Apart from technological disadvantages, the design of the e-reader wasn't appealing either. Our young media students could not believe that it was in black and white only, and found it too big to take with them in their bags. The e-reader appeared not to be the cool gadget they thought it would be. E-ink readers are well suited for solid reading, but miss the functions of a laptop. The perception of students is that a novel device must incorporate all functions, a thing nobody expects from a book. Hence, the change from paper to e-ink was considered old-fashioned and not useful. As it turned out, the students from the 'e-reader group' either bought the paper book, used the e-book on a computer or laptop, or found ways to print the e-book.

Also the students using a laptop were unhappy. Also here note making and easy flipping though the pages was impossible. About half of the 'laptop group' students cracked the code of the protected e-book and printed it on paper. Also here, learning such a large text from screen didn't work for them. The laptop back lit screen was also irritating to their eyes. But most important, they couldn't actively study from screen. The e-book was so very much protected, that they couldn't 'copy and paste' parts in order to make a personal summary. In the group sessions they told us that it could have been an advantage of an e-book over a paper book, if one could easily copy stuff into once own summary. Also, they could not make notes in the document. Since this experiment considered a whole book they had to read through, many people got tired and irritated of all the scrolling and they missed a good overview.

The people that did learn from screen either couldn't crack the code or thought buying the paper book was too expensive. It was not the case that they actually preferred learning from screen. Both the Irex, as well as the laptop didn't provide any added value for them. Indeed it hindered them in studying. They missed the necessary overview and they couldn't study actively (underlining things, making notes aside, et cetera).

This leaves the question open, how students would react if they were tested by compulsory reading very long literary texts. After all, many people do like to read fat novels from e-ink readers, as the success of the Kindle proves. It is clear that the way and need to read depends on the subject matter and the ultimate goal of the reader.

And finally the paper group: at first they thought they would miss out on an interesting experience, being in the 'boring' group, but afterwards they had nothing to complain when they learned about the negative experiences of their fellow students.

Judith Stoop and Joost Kircz

Second Study: Paper versus Computer Screen

A group of 197 students took part in our second experiment. Here we used a text on internal communication within companies (Van Riel, 2010). This text was not part of the curriculum, but has relevance within the broader reach of their study programme. Half of the students worked with the paper version. This paper version was made up of a couple of paragraphs from the book, a separate dictionary and a separate list of rehearsal questions about the material. All put together in a paper reader.

The other half of the group studied exactly the same text, though presented on a series of seven consecutive web pages. In this version the text was restructured to fit a computer screen. A mouse fly-over enabled the dictionary, while test questions were situated together with the relevant part of the text.

After 25 minutes of studying, all students made the same, multiple choice, knowledge test. In 6 of the 24 questions the paper group did better, though statistically speaking this was not significant. On the other hand, in 18 cases the 'webpage group' scored better of which 6 had a statistical significance of 90% or higher.

Group discussions were held with 31 students. In these mixed discussions, students explained how they had experienced studying in their respectively different ways. This helped us to better interpret the results of the quantitative part.

The conclusions of this project can be summarized as follows: Students have problems with long consecutive texts and prefer reading comprehensive chunks immediately followed by exercises and questions. Students study actively, that means that they make notes and summarise read material in their own words. This turns out to be very difficult with present day electronic equipment. The fact that the questions are tied to the text in the electronic version contrary to the paper version, where the questions were all at the end of the text, stimulated to answer the questions immediately. So, also here we see that our students dislike long linear texts as was already witnessed in the first test.

Third Study: Paper with Website versus Interactive Mind Map

Our third and last project entailed a comparative experiment between studying from an interactive mind map (on a pc) and on the other hand a paper document accompanied by a webpage with additional information, such as video material, a definition list, test questions and summaries (see: http://nyjmolen.home.xs4all.nl/geowijzer.htm).

The interactive mind map presented exactly the same content and literally the same text, though not as one single linear piece of text. The text was cut up into pieces that were presented in a logical scheme (see: http://nyjmolen.home.xs4all.nl/mindmap.htm). Videos, definitions, and test questions were also integrated in the mind map. A total of 173 students participated in this experiment. After studying for 30 minutes they had to fill out a multiple choice knowledge test. In this experiment we discovered no significant differences in the results between the two experimental conditions.

Also here, group discussions were held with, in total, 25 students. In these discussions we learned that the participating students faced problems and advances in both presentations.

Though, the interactive mind map introduced a learning curve, as it was a new way of presentation for them, this way of learning turned out to work quite well for most stu-

dents who used it. Since they had only 30 minutes to study, getting a 'summary', as they perceived the folded mind map was, was particularly useful. If they would have to study larger texts for a longer period, they considered an interactive mind map less useful. This is mainly due to the fact that they were afraid of missing a good overview. Also, they might miss essential information and context when they would only learn from a 'summary', they thought. As we experienced in the first test, scrolling a screen is considered cumbersome. Also, because a mind map can be folded out, it is not clear on first inspection how large the complete map would be. In other words, they found it hard to estimate the size of the study material and consequently how to make a plan on dividing time between the various subjects presented.

Many people in the 'paper group' checked the additional webpage that was provided. There was no material barrier not to do so, as the pc was right in front of them with the page ready on it. In their normal 'study reality' however, most of the students in the discussion groups, hardly ever visit an additional webpage that comes with a paper study book (many study books provide such a site). The barrier is too great and these students don't expect to find anything useful on such a page. Often such websites demand 'complicated' login codes, these students claim. Also, switching from a paper book to an online device is a barrier if you aren't convinced about the advantages it offers. If such a site would indeed provide means to study actively (tests, games, etc.) these students would very much be interested to consult it. When we let them brainstorm about the possibilities of such a website, most of them even got really enthusiastic. It could bring a welcome variety in ways of studying and it could help them to study actively.

These are only a few important results of our studies. Complete reports (in Dutch) are available on our website. In the ideal situation students like to study actively. Very basically that means that they feel the need to write things down on scrap paper, make summaries, underline words et cetera. Ideally it means they can 'do' something in an (inter)active way with the material. Think about tests and games. And that is were the opportunity for e-learning material lies: using the (inter)active potential of technique. Obviously we have to be aware that our results are a mixture of various components, such as the technology we tested, the study methods our students use, as well as, the kind of professional, non-academic, students of our school. So, it proves again that novel technologies are not of a one-size-fits-all kind. Pedagogical methods, the way study material is written, the possible technological dependence of study materials, such as interactive maps and videos, as well as the kind of material, level of abstraction and the ambitions of the students play all a role.

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