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The Redesign of an Extensive Learning Environment for Medical Education

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Abstract: This paper documents and explores the rationale and methodology underlying the user interface and experience redesign of a medical training program intended for internal medicine doctors preparing for their licensing certification. Specifically, it considers how principles of effective instruction such as content *interleaving* and *spacing* may be incorporated into the design of complex learning environments that contain content that requires months, if not years for users to learn.

Keywords: design, medical education, extensive learning environments, interleaving, spacing

Introduction

This paper—a collaboration between academia and industry—presents a case study of ongoing efforts made in the context of a large-scale redesign of a medical training program. So doing, we hope to illustrate how notions such as “transforming learning, empowering learners” play out in the wild.

The case of medical education

Internal medicine doctors in the USA are required to pass certification exams in order to receive and renew their license to practice. The average time spent preparing for the exam is measured in months. Historically, doctors have relied upon self-study using traditional media such as recordings of lectures, flash cards, and textbooks. We use the term *extensive learning environment* (ELE) to differentiate interactive learning environments wherein a lengthy investment of time (months, years) is required to develop a deep understanding of some subject matter.

Applying theory to design practice

The research conducted to date on both *spacing* and *interleaving* (Brown, Roediger, & McDaniel, 2014) were deemed compelling enough to incorporate into the redesign of an extensive learning environment for internal medicine education. The principle of spacing concerns the accepted wisdom that studying in small increments over a period of time is more effective than cramming large amounts of information in a shorter duration. The principle of interleaving, as opposed to block sequencing, refers to the order in which related ideas are taught.

This paper will explore how these two principles of effective instruction were ultimately incorporated into a revised mobile-based design. An added contribution of this paper will be a methodological examination illustrating how theory of learning and user-centered techniques can reflexively inform the redesign of an ELE.

Overview of the design problem

In order to fulfill medical certification requirements, internal medicine doctors must successfully complete a comprehensive examination spanning 17 content areas. Because internal medicine doctors are tasked with helping other doctors diagnose both common and difficult to identify illnesses, they must be prepared to encounter patients presenting a wide spectrum of symptoms. In order to receive a passing score, a doctor should expect to correctly answer close to 200 out of approximately 240 questions. Exam questions are presented in the form of short and long form clinical narratives, wherein the doctor must select a correct diagnosis from a multiple-choice list based on the information presented. Given that up to 15% of all test-takers will not successfully pass their certification exam in a given year and therefore become at risk of not being able to practice medicine, the examination is considered extremely high stakes. Most prospective test-takers invest several months of preparation for the exam, which can only be taken once each calendar year.

Limitations of the previous design

The initial version of the ELE utilized a desktop web-browser interface. In short, the program was only somewhat more sophisticated than a set of flashcards with explanations instantiated in digital format. While seemingly adequate as a study aide (we record 100,000+ study sessions to date), the research and design team decided that a rethinking of the application’s design was required in order to better meet the learning needs of users.

Methodology behind the redesign

The process of redesigning the ELE began with reexamining the content to be learned as well the context for application. According to official exam blue print, doctors would be provided a total 8 hours to complete an exam of approximately 240 items. Therefore, a secondary objective would be to train doctors to answer at an average rate of 2 minutes per question.

The next step in our design process was to develop user personas (see Pruitt & Grudin, 2003) through a combination of interviews, surveys, and information gleaned from online forums dedicated to studying for the certification examination. We learned that internists preparing for the exam were either in the process of completing residency/fellowships, or already working fulltime positions in hospitals (a requirement for keeping the job is passing the examination). As a result, most reported finding it extremely challenging to allocate adequate preparation time.

Finally, we enlisted the aid of “naïve” experts, individuals with expertise in either educational theory or UI/UX design but no prior experience using our original application, in order to generate fresh insights and critiques about our application that we might otherwise be blind to.

Rationales and the redesign

As previously noted, three overarching themes became the driving impetus for the redesign of the ELE: (1) respecting users’ time; (2) a structure of interleaving and spacing; and (3) simplifying user interface/experience.

Respect for time

The original incarnation of the ELE allowed users to select the topics they wanted to study. Each topic had a fixed number of questions. Users would then work through however many questions they had selected.

In the new incarnation of the ELE, users instead determined how much time they wished to allot to a brief study session. The program would then allocate a fixed number of problems based on the desired answering rate of 2-minutes per question.

Structured interleaving and spacing

Given that our database of questions and answers includes close to 1600 items, it was perhaps to be expected that users attempting to master said items would utilize a block based approach (topic by topic) in order to organize and make sense of the material.

In order to simultaneously provide some manageable structure while respecting our desired principles, we chose to divide our corpus of problems into 16 groups of 100 items each. Each group contained a representative distribution of items across all 17 content areas as indicated by the official exam blueprint. For example, a topic such as cardiovascular disease which comprises 14% of the actual exam, would appear roughly 14 times per group.

Simplifying user interface and experience

The overall flow of our current ELE can be summarized as follows: A user picks a desired time of study and is presented a series of questions. Users *cannot* control the order of questions, or the content matter of said questions. The program allocates the questions in predetermined groups of 100 items. Users progress through each group of 100 at their own pace, and may review groups that they have already completed.

Concluding remarks and future work

As the content being presented in computational learning environments continues to become increasingly complex, we believe that the need to identify and adhere to organizing principles of both user interface *as well as* cognitive interaction design will only become increasingly essential towards maximizing the utility and effectiveness of said environments for learners. We have attempted to provide readers with a brief peek “under the hood” of how a large-scale for-profit business makes use of academic research to transform learning and, we hope, empower learners. Presently, we are conducting small-scale usability studies before rolling out the revised product to our user base. Future work will involve data analyses comparing the effectiveness of our structured interleaving solution to the original design. We look forward to sharing this data at a future conference.

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