

Download Delay and its Effects on Online Learning

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Download delay is the amount of time needed for instructional materials to appear on a Web page on the client computer after the page is accessed from the server; it is a new challenge specific to designing and using Internet-based materials (Davis & Hantula, 2001). Also known as “download time” in end-user computing literature, such delays are primarily a function of the size of the data files being transmitted from the server to the client and the technological limitations of the client and server computers and the network infrastructure. A file of the same size may download slowly or quickly on different client computers depending on capabilities of the hardware, speed of the network and connections, and relative efficiency in the design of programs and transfer protocols. In an Internet environment, download delay is usually a matter of seconds, often fractions of a second.

End-user surveys and expert advice on system design, Web page design, and Internet use consistently cite decreasing download (or system response) time as a primary concern. User surveys identify download delay as the most infuriating and troublesome issues in Internet computing (Ewalt, 2002; Khosrow-Pour & Herman, 2000). Shneiderman (1998) counsels that delays should be minimized because users find delays of even a few seconds to be intolerable; Rose, Khoo, and Straub (1999) identified download delay as the primary technological impediment to e-commerce; Borden (2000) argues that users care the most about speed; Howe (1998) states that every 10-second delay to load graphics before page contents can be seen risks losing 20% of the remaining viewers; and user interface design expert Nielson (2000) summarized the issue by simply stating that in every Web study he conducted, users asked for quicker download speeds.

This is not to imply that computer systems responded instantaneously to user commands before the advent of the Internet. Rather, download delay

appears to be related to system response time (the time between when a user issues a command and the system responds to the command), an issue studied in mainframe computing environments. The data on the effects of system response time on the end user are mixed, but appear to point toward an overall negative relation between system response time and user affective reaction; data on actual user performance are much less clear. Dannenbring (1983) found no effect for system response time on programmer’s performance and satisfaction while debugging programs; on the other hand Guynes (1998) found that variable system response times and long (mean 8.25 seconds) response times in document editing were associated with increased anxiety levels. Schleifer and Amick (1989) found that longer system response time associated with increased mood disturbances in a data entry task, and Barber and Lucas (1983) found that increased system response time was negatively related to user satisfaction with job characteristics, and system use in computer operators in a telephone company. These negative relations between system response time and affective reactions to the computer system were also found by Wirtz and Bateson (1995) in a study of at-home banking, and by Rushinek and Rushinek (1986) who surveyed more than 4,000 computer users and found that the single most important variable in satisfaction with the computer system was system response time.

Moving to the Internet, studies of delay in e-commerce are similarly equivocal. Otto, Najdawi, and Caron (2000) found no relationship between download delay (up to 15 seconds) and satisfaction measures; Rose and Straub (2001) found no relationship between download time (5- and 30-second delay) on the attitude toward the retailer; Rose Evaristo and Straub (2003) studied individuals from monochronic and polychronic cultures and found that the latter were less vexed by download delay,

and that perceived wait times varied significantly between the cultures. Conversely, Ramsay, Barbesi, and Preece (1998) found that Web pages with longer download delays were rated as less interesting and more difficult to scan; Rose, Lees, and Meuter (2001) found that increased download times were positively associated with page load aborts. Also, Rajala and Hantula (2000) found a negative relationship between download delay and purchases in online stores, and DiClemente and Hantula (2003) found an even stronger negative relationship between download delay and purchases in online stores and attitudes towards the stores when a time online clock was displayed on the screen.

In online education, there is little precedent for download delay as a factor in instructional design systems, because both online education and download delay are very new. Instructional design standards are clear with regard to latency of feedback, and standard practice is to provide feedback as quickly as possible. However, download delay increases the latency of page loading and display, not necessarily the latency of response to a user, although download delay can certainly impede delivery of feedback to a learner. In a study of students searching for answers to academic questions on a Web site, Jacko, Sears, and Borella, (2000) found that with short download delays, users prefer Web pages with both text and graphics, but as delays grow longer, users prefer text-only Web pages. Davis and Hantula (2001) conducted a systematic experimental study of download delay in online learning, varying delay of images on instructional Web pages exponentially from two to 32 seconds. Download delay had mixed effects on academic performance, time spent on each lesson, user satisfaction, and perceived effectiveness of the online learning system. The difficulty of the material to be learned, moderated by the experience level of the student, interacted with the download delays such that difficult material presented to students who did not have a background in the basic concepts being taught was most compromised by download delay. Attitudinal findings were mixed, but on the whole showed that increasing download delay was negatively associated with perceptions of ease of use and perceived effectiveness of the online learning system. Davis and Hantula (2001) argue: "The effects of download delay may be more complicated than

originally thought" (p. 260), and Rose and Straub (2001) propose that delay is not simply linear in its effects.

While instructional designers cannot always readily address server-side and network issues, Web page design is entirely in the purview of the instructional designer. Decisions regarding whether or not to include complex graphics, movies, sound, and other large (in kb) page elements must be balanced against possible download delay; indeed Jacko et al. (2000) found that users may attribute blame for long downloads of pages with graphics to poor design and selection of graphics, and Rose, Meuter, and Curran (2005) found that users' appraisal of Web designers' control over the factors leading to download delay had more of an effect on users' attitudes than did the delays themselves. However, it is not appropriate to assume that download delay must always be minimized as the primary design principle; rather, the added value of high-resolution graphics, audio, and video components must be subject to a cost/benefit analysis of the potential gains afforded by including such rich media, and the potential learning and attitudinal losses threatened by concomitant increases in download delay.

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