Download Delay, Tolerable Wait Time, and Online Learning

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INTRODUCTION AND BACKGROUND

Download delay, also known as "download time" and "tolerable wait time (TWT)," is the amount of time needed for instructional materials to appear on a Web page on a client computer after the page is accessed from a server. It is a new challenge specific to designing and using Internet-based materials (Davis & Hantula, 2001), but is related to an older mainframe computing difficulty known as system response time (SRT), the time between when a user issues a command and the system responds to the command. Download delay/TWT is primarily a function of the size of the data files being transmitted from the server to the client, the technological limitations of the client and server computers as well as the network infrastructure. A file of equal size may download more 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 with a broadband connection, download delay is usually a matter of seconds, often fractions of a second.

MAIN FOCUS: DOWNLOAD DELAY

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. Emurian (1991) found no link between SRT and performance when examining physiological responses to varying SRTs in video display terminals; 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 the system. 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.

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 monochromic and polychromic cultures, and found that the latter were less likely vexed by download delay, and that perceived wait times varied significantly between 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) and Hantula, Brockman, and Smith (2008) 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, making time passage and delay more explicit. Another important factor when considering download delay is with the user's experience with the subject matter and with the computer systems in general. Galletta, Henry, McCoy, & Polak (2004) found the tolerance for delay was partly mitigated by the "familiarity of terminology" of the sites being investigated; Ceaparu, Lazar, Bessieri, Robinson, & Shneiderman (2004) conclude that appropriate response time is relative to user's past experience. Similarly, Goodman and Spence (1978) found that system response time was most dependent on the task at hand, and that no set interval was clearly defined as optimum for performance. Mediating download time can alleviate some of these issues. Gorn et al. (Gron, Chattopadhyay, Sengupta, & Tripathi, 2004) found that color of the screen influences perceived wait time by the user, and that this later effected their evaluation of the site in that relaxation-inducing colors were associated with less-perceived wait time. Providing feedback seems to also act as a buffer to the frustration delay can have on users. Palmer (2002) suggests that interface design should include feedback mechanisms, as did Nah (2002), who found that total wait time is prolonged via feedback. Nah found that the feedback bar is an effective tool to moderate user dissatisfaction. Nielsen supports this notion, stating that progress indicators should be used for delay in excess of 10 seconds (1993).

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, there is variability in the research. Shneiderman (1984) warns that if the response is too quick, comprehension could be lessened, although response times exceeding 15 seconds can impede productivity. He later argues that delay can disrupt working memory and thus negatively impact the user's learning. Sundar and Wagner (2002) found that slow download time can have excitatory effects that can be beneficial for both education and marketing tools. 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 parametric experimental study of download delay in online learning, varying delay of images on instructional Web pages exponentially from 2 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 material, 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 perception 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.

FUTURE TRENDS

Although it appears that broadband Internet access is readily available for everyone, download delay will remain a problem in the online world for the foreseeable future. According to The Pew Internet & American Life Project (Horrigan, 2006), the majority of adults in the USA do not have a broadband connection at home, 22% have a dial-up connection and the majority of these dial-up users say they are not interested in switching to a broadband connection. Internet users in developing countries are expected to be even more subject to online delay, as the information infrastructure in these countries lags that of developed countries (Rose et al. 2003).

CONCLUSION

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 issue in Internet computing (Ewalt, 2002; Khosrow-Pour & Herman, 2000; Selvidge, Shaparro, & Bender, 2001). Shneiderman (1998) counsels that delays should be minimized