Management of Lecture Time: Using the Web to Manipulate Extrinsic Cognitive Load

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ABSTRACT

The variety of new technologies available for classroom use requires a choice not just between the technological options, but among them as well, since an educator may choose a single option or include a mix of media. In this study we investigate a particular mix of advanced technology and its effect on student learning outcomes. Our experimental design compares outcomes from a traditional teaching format with those of a more advanced web-based format. Our model is based on cognitive load theory, is developed from perceptions of the students, and is analyzed using factor analysis. The results based on this qualitative model show promise for delving further into the assessment of learning. This would provide researchers with additional tools to help evaluate their results and educators with a basis on which to make decisions regarding which advanced technologies to use.

Keywords: cognitive load theory, electronic learning (e-learning), instructional technology, Web-based instruction

INTRODUCTION

The traditional method of teaching, in which instructors, considered to be subject matter experts, present material to a classroom of students who then supplement their in-class material with other forms of reinforcement (readings, textbooks, homework, etc.) is argued to be both the best and the worst form of instruction (cf. e.g., Kirschner, Sweller, & Clark, 2006; Michael, 2006). The overwhelming volume of research devoted to teaching and learning is evidence that most researchers believe that something better is out there. As new technology is introduced into society, it is quickly adopted for classroom use and often claimed to be a better method. Yet recent research seems to indicate that most new technologies (multimedia classrooms, distance learning with audio and video feeds and computer-based training) has not lived up to its potential to achieve better learning outcomes (cf. e.g., Lou, Bernard, & Abrami, 2006; Weston, 2005). Is there a better method that utilizes advanced technology? Although the answer to this question will likely remain elusive for some time, the literature has identified several key dimensions that any ap-
proach to improving learning outcomes must address. Mayer and Moreno (2003) present a theory of multimedia learning that is based on how the human mind processes information. In their presentation they cite five different scenarios which might result in cognitive overload, but also offer nine methods based on 12 years of research to alleviate induced overload. Their methods are based primarily on presentation of the material, but also include focusing the material only on information relevant to the material needed to learn (i.e., excluding extraneous material), and avoiding presenting redundant material. Cognitive load theory emphasizes that the major objective of instruction is to assist the learner in forming and automating schema (Paas, Tuovinen, Tabbers, & Van Gerven, 2003). Schema are elements of information that are held together in long term memory, and upon automation, can help the individual by bypassing short term memory, which is limited in its ability to process information (Paas, et al., 2003). Clearly then, any approach to improving learning outcomes must include these dimensions of presentation, clarity or focus, and practice which helps to induce the development and automation of schema. In that light, we investigate a method of teaching that utilizes advanced technology in its attempt to improve learning outcomes, but must be managed properly in order to obtain a greater benefit than traditional methods.

We suggest that traditional lectures, which can be viewed ahead of time by students using Web-based technology with which they are very familiar, coupled with classroom time that is devoted to addressing issues of confusion or ambiguity in the students’ comprehension of lecture material, along with time devoted to solving problems or investigating salient examples, can provide this greater benefit. Advanced technology allows the student to view or listen to the recorded lecture at any time prior to the scheduled class time at just about any place. Lecture audio and video can be prerecorded along with instructor notes and other visual aids and stored on a Web site to which the students are given access. The student can either visit the site with a Web browser and view the lecture immediately or can download it and view it at a later time, even to the point of downloading it to a handheld device and viewing it while engaged in other activities, such as during exercise periods or while having lunch. Once viewed, the student is then prepared to explore the topics presented in the lecture in more detail. Classroom time can then be devoted to answering student questions about the lecture or to working problems and examples to further reinforce the concepts presented in the lecture. The purpose of this article is to present the results of an evaluation of such a system of learning by comparing it to a strictly traditional method. In so doing, we also offer a model of extrinsic cognitive load based on perceptions of the students using factor analysis.

THEORY AND MODEL

Research into human cognition and learning has focused on its architecture, that is, working and long term memory, how these structures interact, and the processing of elements in working memory into schemas that can be shifted into long term memory for later use (Paas & Kester, 2006).

Working memory is limited in its ability to process a number of elements simultaneously. It is theorized to hold only seven items simultaneously (Miller, 1956) and this number is further restricted when processing interacting items (Sweller, Van Merrienboer, & Paas, 1998). This limitation of working memory inhibits learning (Ayres, 2006).

Long term memory represents the subconscious storage of items, which are usually organized into schema and are accessed through the filtering mechanism of working memory (Sweller et al., 1998). This portion of the human cognitive architecture is what allows people to overcome the limitations of working memory (Kalyuga, 2006). By storing integrated, related and categorized facts in long term memory (schema), a person can utilize this knowledge quickly and easily without getting bogged down by the limitations of working memory. An expert in any particular field can rely on these...
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