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SUGGESTIONS FOR THE DESIGN OF E-LEARNING ENVIRONMENTS TO ENHANCE LEARNER SELF-EFFICACY

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ABSTRACT

In this paper e-learning is used as an umbrella term for all types of learning involving technology. Graesser et al (2007) note that technologies for learning exist that allow for e-learning systems to be much more than information delivery systems, but "unfortunately, the learning strategies of most students are extremely limited, so the systems must provide modeling of effective strategies, intelligent scaffolding, and accurate feedback" (p. 211). Self-efficacy is one area of human functioning where well-designed e-learning systems may be able to enhance performance. This paper was written to propose the intentional application of established instructional design practices and learning theory concepts for the purpose of creating e-learning environments that support the development of positive self-efficacy beliefs. Positive self-efficacy beliefs should, in turn, lead to enhanced achievement.

KEYWORDS

Self-efficacy, e-learning, self-regulation, instructional design

1. INTRODUCTION

E-learning is a term that has become an umbrella term for all types of learning involving technology (Dempsey & Van Eck, 2012). Graesser et al (2007) categorize many classes of technologies used in e-learning systems as *computer-mediated technologies* and note that "unfortunately, the learning strategies of most students are extremely limited, so the systems must provide modeling of effective strategies, intelligent scaffolding, and accurate feedback" (p. 211). One area of human functioning where well-designed e-learning systems may be able to enhance performance is self-efficacy.

Self-efficacy refers to “beliefs in one’s capabilities to organize and execute the courses of action required to produce given attainments” (Bandura, 1997, p. 3). Academic self-efficacy refers to those beliefs in the context of academic performance. Self-efficacy research in the context of learning has a long and rich body of research, in which many subject areas, learner groups, and delivery modes have been investigated. Pajares (2007) observed that “findings have now confirmed that students’ academic self-efficacy beliefs powerfully influence their academic attainments independent of possessed knowledge and skills, and that self-efficacy mediates the effect of such knowledge, skills, or other motivational factors” (p. 115). Learners with positive self-efficacy beliefs are more likely to participate, engage, persist, and have fewer negative emotional reactions in learning environments than students who lack these self-efficacy beliefs (Zimmerman, 2000).

This paper was written to propose the intentional application of established instructional design practices and learning theory concepts for the purpose of creating e-learning environments that support the development of positive self-efficacy beliefs. The creation of learning environments that are structured specifically to support the development of positive self-efficacy beliefs, while important for all content areas, may be especially important in content areas where learners are traditionally less than optimistic about their ability to be successful (e.g. science or mathematics).

2. BODY OF PAPER

In the last thirty years, research has provided ample support for the assertion that learner achievement is positively correlated with learner self-efficacy. Zimmerman (2000) summarized that "there is evidence (Bandura, 1997) that self-efficacious students participate more readily, work harder, persist longer, and have fewer adverse emotional reactions when they encounter difficulties than do those who doubt their capabilities" (p. 86). Four sources through which an individual develops self-efficacy beliefs are traditionally proposed: mastery experiences, vicarious experiences, verbal persuasion, and physiological and affective states (Bandura, 1997). Schunk and Pajares (2002) identified other sources of self-efficacy development, but commented that at least some of those sources are combinations of the four sources identified by Bandura. Some (e.g. Usher, 2009) have suggested that Bandura's list of four sources is not exhaustive and not necessarily in order of power of influence. However, these four sources are often cited as the major sources of self-efficacy development, and they will be used as the anchoring points of the present paper. A brief description of these four sources begins with *mastery experiences*.

2.1 The Sources of Self-Efficacy

Mastery experiences refers to the learner's prior success, or lack of success, at a given task. Prior success at a task, or a similar task, should provide the learner with positive beliefs about the ability to be successful with the task at hand. Likewise, a lack of prior success, either because the task is perceived as totally new or because of previous failure, will not enhance, and may reduce a learner's belief regarding success with the task at hand. *Vicarious experience* impacts a learner's self-efficacy beliefs for a task based on perceptions formed from observations or knowledge of others performing the same, or similar tasks. The more closely the observed individual is perceived as comparable to the observer, the more the observer's self-efficacy is likely to be impacted. *Verbal persuasion* refers to feedback the learner receives from others regarding their perceived belief in the learner's success at a specific task. Many factors contribute the strength of the ability for the feedback to enhance one's self-efficacy. For instance, the perceived credibility of the persuader is important. Finally, physiological and affective states contribute to self-efficacy beliefs. These elements are "especially relevant in domains that involve physical accomplishments, health functioning, and coping with stressors" (Bandura, 1997, p. 106). This area may not appear to be directly link to the design of e-learning environments, but there are many instances where e-learning systems can contribute to user stress. Therefore, design elements to reduce user stress may have benefits where self-efficacy is concerned. Let us now consider how the sources of self-efficacy can be addressed in e-learning environment design.

2.2 Sources of Self-Efficacy and e-Learning Environment Design

2.2.1 Scaffolding Recognition of Mastery Experiences in e-Learning

As observed by Hodges and Murphy (2009), connections between prior experiences and new experiences in e-learning environments, may not be readily apparent to some learners. In those situations, the importance of mastery experiences in the development of learner self-efficacy may be lessened because the learner does not realize them. To counteract the possible overshadowing of the new e-learning environment, care must be taken to alert learners to prior successes. Possible strategies for this include reminding the learner to reflect on past success. It may be important to stress prior success with both content and delivery mode. This could be accomplished by prompts asking the learners to make these reflections, or by asking learners to complete a pre-course survey to collect information about prior successes, then simply reminding the learner that success with the content, or in e-learning experiences, has been achieved. Education providers are collecting increasing quantities of information on learners, and information on relevant prior successes could be leveraged to provide the information needed to remind the learners about those successes. This type of intelligence within a system is preferred so that students are not prompted to recall a lack of prior success, which may decrease their self-efficacy. From a design standpoint, knowledge of a lack of prior success could be utilized by the e-learning system to customize course offerings and features in ways to enhance self-efficacy. For example, it may be better, from a self-efficacy standpoint, for some learners to be presented with course material in smaller "chunks" (Dick & Carey, 1996).

Small chunks may give them an opportunity to achieve success, thus creating mastery experiences that can enhance self-efficacy. Also, as the course progresses, learners could be routinely reminded of recent successes in the course. These routine reminders could be automated and might take many forms, perhaps depending on user set preferences. A learner might get an email message congratulating him or her on a recent high level of success on a quiz or test, or some type of on-screen badge might be selected as the desired form of validation of academic success.

2.2.2 Scaffolding Vicarious Experience in e-Learning

Learners in many e-learning environments are isolated from each other (e.g. Park, 2008, p.16). This is in many instances an artifact of the asynchronous, any time, anywhere selling point of many e-learning programs and not a specifically desired design feature. If learners are not in situations where they can physically see peers, or anyone associated with their e-learning experience, then designers should consider how vicarious experience could be scaffolded to assist with the development of positive self-efficacy beliefs. Graesser et al note that animated pedagogical agents "can mimic face-to-face communication with human tutors, instructors, mentors, peers, or people who serve other roles" (p. 217). Pedagogical agents in the mentor or peer role may be useful aids to vicarious experience related to self-efficacy development. Some work in this area has already been documented (e.g. Baylor & Kim, 2005). Less fantastic approaches to the vicarious experience component of self-efficacy development include testimonials from former, successful learners and the publication of aggregate performance data for similar learners. Schunk (1991) notes that "observing similar peers perform a task conveys to observers that they too are capable of accomplishing it" (p. 208). In many e-learning environments the direct observation is not possible. Publishing performance data on assignments from previous instances of the class, or live data from a current class for similar students would allow students in isolated e-learning environments to *see* how peers are performing. Would knowledge that other students are performing better or worse than an individual prompt a student to change study habits or seek assistance? How would knowledge of this type impact learner self-efficacy and achievement in the class? An important area of inquiry around these questions would determine the levels of peer achievement that serve to enhance self-efficacy in productive ways. For example, a student that sees he or she is doing much better than the peers in the classroom, may become over confident resulting in eventually diminished performance. On the other hand, a student that is doing much worse than his or her peers may suffer decreased self-efficacy, negatively impacting achievement. A key practice to avoiding these types of errors would be defining what is meant by the term *peer* so that students are compared only to those fellow students for whom there is a reasonable expectation of similar performance.

2.2.3 Verbal Persuasion in e-Learning

Verbal persuasion, perhaps more appropriately referred to in e-learning contexts as "social persuasion" (Bandura, 1997, p. 101), can take many forms. Feedback from instructors is probably the most frequently thought of example of social persuasion. However, informal feedback from classmates, or automated feedback from grading systems in the e-learning environment may be useful for enhancing learner self-efficacy. Pedagogical agents may be leveraged for the purpose of social persuasion and its influence on learner self-efficacy.

In the context of e-learning systems, there may be an interaction between feedback that combines the vicarious experience and social persuasion aspects of self-efficacy development. For example, feedback about a learner's ability to succeed because other similar students are succeeding straddles both of these categories. Feedback to learners is an important element of many instructional and learning theories. The social persuasion source of self-efficacy development is the source most closely associated with direct feedback to learners and, therefore, it should receive some significant attention in the design of e-learning systems. The development of useful, scalable technologies that address social persuasion may be even more important as e-learning systems increase in use and expand into large-enrollment systems like those planned for massive open online courses (MOOCs).

Email has been the targeted technology used by some researchers investigating verbal persuasion. Jackson (2002) used email messages that emphasized past successes of learners, related the fact that similar learners had previously achieved success, encouraged learners to work hard and stay on task, and provided stress-reduction tips.

Self-efficacy was significantly related to performance, and self-efficacy was enhanced in Jackson's experiment. Hodges (2008) found that specially designed email messages related to prior achievement did not enhance self-efficacy, but self-efficacy was positively related to achievement.

As learners' preferred modes of communication change, and features of learning systems evolve, attention will need to be given to the way such messages are delivered. Will learners want this type of feedback to be provided only within the learning system, or will they prefer the information be sent outside of the learning system? Who is best to deliver this type of information? Bandura (1997) highlights the importance of the source of the social persuasion and the source's perceived credibility. Investigations into how the credibility, influence, and success of the persuader are effected by the technology used to deliver the persuasive message will be important as more intelligent and automated systems are constructed.

2.2.4 Physiological and Affective State in e-Learning

Bandura (1997) explains the relationship between behavior, personal factors, and environmental factors as triadic reciprocalism (p. 5-6). The physiological and affective state of learners in e-learning environments can be addressed by taking efforts to create environments that are non-threatening and comforting, not frustrating to use, etc. This includes attention to message design, usability, and accessibility. Some learners are exceptionally stressed with respect to certain topics (e.g. math anxiety). In these cases, care must be taken to design environments that do not contribute to the learners' stress. For example, on screen timers measuring the length of time spent, or remaining, to work problems may be viewed as stressful for some learners. Designers of e-learning environments may not have control over the environments where their learners are using the system, but learners should be prompted to consider their physiological and affective states when they access such systems. It may be wise to take a break and return to the system when they are more prepared to engage with the system effectively from physiological or affective perspectives.

All learning systems should be subjected to intense usability testing so ensure that the act of interacting with the system is not somehow negatively impacting the learner. In the absence of time or resources for extensive usability testing, learning systems should be reviewed carefully against accepted best practices. For example, the Quality Matters (2013) initiative has published guidelines that stress organized materials and ease of navigation in online courses.

Table 1 summarizes how the traditional four sources of self-efficacy might be addressed in learning systems.

Table 1. Possible Self-efficacy Strategies to Incorporate in Learning Systems

Self-efficacy source	Suggested learning system feature
Mastery experiences	Providing information from academic history about former, related successes; automated messages that highlight recent prior success
Vicarious experience	Video testimonials from former, successful students; provide aggregate *peer* data to show relative performance
Verbal/social persuasion	Messages delivered by the learning system
Physiological/affective state	Usability testing; careful review of navigation and organization

2.3 Self-efficacy and Self-regulation

Zimmerman (2002) defines self-regulation as the "self-directive process by which learners transform their mental abilities into academic skills" (p. 64). Self-efficacy beliefs and the ability to self-regulate learning are strongly linked together. Students who can self-regulate their learning are able to achieve and realize academic successes, which in turn enhances self-efficacy for that particular learning task. As self-efficacy increases, the learner is more apt to persist at a skill, applying self-regulation strategies to continue with the learning task. The effective application of self-regulation strategies is essential for success in academic endeavors and the development of self-efficacy (Pajares, 2007, p. 119).

Therefore, any e-learning system designed and built on a self-efficacy framework, must include support for self-regulatory strategies. The literature base for academic self-regulation is well developed, and several important self-regulation strategies have been identified. Many of these strategies can be supported or encouraged through features in e-learning systems. For example, Pajares (2007) lists "finishing homework and assignments by deadlines" (p. 119), "using the library for information for class assignments" (p. 119), and "participating in class discussions" (p. 119) as identified self-regulatory practices. Each of these practices can be supported through features built into e-learning systems.

2.4 Learning Analytics

Some of the features and strategies suggested in this paper require that the e-learning system have access to various demographic, preference, and performance data of the learners using the system. Access to, and use of, this type of data is gaining interest in the Education community. Johnson et al define Learning Analytics (LA) as "an emergent field of research that aspires to use data analysis to inform decisions made on every tier of the educational system" (p. 24) and note that it is an important upcoming technology for teaching and learning. The use of large data sets for decision making is not a new idea, but its application to educational endeavors is relatively new in the sense that tools and businesses are offering LA to a broader Education audience. Roy Pea (2013) has promoted combining LA tools and techniques with the theory and research from the field of Learning Sciences to personalize learning on large scales. Some of this personalization could be aimed at enhancing the self-efficacy of learners in e-learning environments. Not unlike current music and retail analytics that suggest new songs or artists, or other products a consumer may like, LA could be used to make suggestions about when learners need to seek assistance or change study habits. LA could be utilized to customize the e-learning environment, as described in this paper, to facilitate mastery experiences by helping learners recall past success or customizing how content is chunked; creating personally meaningful pedagogical agents to aid with vicarious experiences and/or social persuasion; and informing learners of the performance of other learners in the same e-learning environment. LA also may aid in the formation of positive self-efficacy beliefs through a combination of self-regulation and social persuasion or vicarious experiences. For instance, LA may be able to identify trends in successful students related to discussion participation or engagement with e-learning system features such as a calendar of due dates. The system could then inform learners about the behaviors of successful peers.

2.5 Professional Development for Course Facilitators

Many of the design features suggested thus far are possible in modern learning management systems at some, less than automatic level. For example, the current version of Desire2Learn's learning management system includes *intelligent agents* that allow the course facilitator to send messages to targeted groups of learners. The granularity with which learners can be targeted is small. This type of targeting messaging could be used as a middle-ground to a fully automated system for delivering peer information to influence vicarious components of self-efficacy development, or for delivering instructor feedback to address issues of social persuasion. Also, some unused features of learning management systems often can be hidden from learners, thus simplifying the screens used and increasing the usability of the system. There is often no shortage of workshops or other learning opportunities for course facilitators to learn basic learning management skills such as how to use the built-in system grade book. However, the rationale for the use of various features from a psychological perspective is often not included in these workshops. More professional development is needed that provides course facilitators with an explanation of why some features of a learning management system should be used from a learning design perspective.

3. CONCLUSION

One may notice that the suggestions in this paper share some of the same elements as Keller's (1987) ARCS model, however, there are differences. Keller's seminal work was a synthesis of many motivation concepts, but the current paper is focusing on learner self-efficacy.

Self-efficacy falls into Keller's *confidence* component of the ARCS model, but self-efficacy and confidence are not the same (see Bandura, 1997, p. 382), hence the application of Keller's work may aid in the development of positive self-efficacy beliefs, but perhaps not with the same amount of focus as the suggestions included in the present paper. This paper also includes ideas for integrating current technologies, such as Learning Analytics, to influence self-efficacy in ways that were not possible when ARCS was emerging.

Many of the design features of e-learning systems suggested in this paper have been implemented or studied in isolation. In this paper they have been collected together and organized around self-efficacy theory, with the primary purpose of suggesting that e-learning systems be designed to enhance learner self-efficacy. The long history of self-efficacy theory in the research literature, and the positive relationship that has been demonstrated between academic self-efficacy and learner achievement, provide a strong rationale for designing and developing an e-learning environment with this focus. Note that the ideas suggested in this paper are simply examples of how the various sources of self-efficacy could be addressed in e-learning environments. The list of ideas and examples is not meant to be exhaustive. It is intended to provide suggestions of areas where existing or emerging learning technologies can be applied toward the goal of enhancing learner self-efficacy. There are many ways in which strategies for enhancing self-efficacy may be interpreted and implemented in e-learning environments.

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