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The effects of integrating mobile devices with teaching and learning on students' learning performance: A meta-analysis and research synthesis

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ABSTRACT

Mobile devices such as laptops, personal digital assistants, and mobile phones have become a learning tool with great potential in both classrooms and outdoor learning. Although there have been qualitative analyses of the use of mobile devices in education, systematic quantitative analyses of the effects of mobile-integrated education are lacking. This study performed a meta-analysis and research synthesis of the effects of integrated mobile devices in teaching and learning, in which 110 experimental and quasiexperimental journal articles published during the period 1993–2013 were coded and analyzed. Overall, there was a moderate mean effect size of 0.523 for the application of mobile devices to education. The effect sizes of moderator variables were analyzed and the advantages and disadvantages of mobile learning in different levels of moderator variables were synthesized based on content analyses of individual studies. The results of this study and their implications for both research and practice are discussed.

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1. Introduction

1.1. Integrating mobile devices with learning and instruction

Mobile computers have gradually been introduced into educational contexts over the past 2 decades. Mobile technology has led to most people to carry their own individual small computers that contain exceptional computing power, such as laptops, personal digital assistants (PDAs), tablet personal computers (PCs), cell phones, and e-book readers. This large amount of computing power and portability, combined with the wireless communication and context sensitivity tools, makes one-to-one computing a learning tool of great potential in both traditional classrooms and outdoor informal learning.

With regard to access to computers, large-scale one-to-one computing programs have been implemented in many countries globally (Bebell & O'Dwyer, 2010; Fleischer, 2012; Zucker & Light, 2009), such that elementary- and middle-school students and their teachers have their own mobile devices. In addition, in terms of promoting innovation in education via information technology, not only does mobile computing support traditional lecture-style teaching, but through convenient

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information gathering and sharing it can also promote innovative teaching methods such as cooperative learning (Lan, Sung, & Chang, 2007; Roschelle et al., 2010), exploratory learning outside the classroom (Liu, Lin, Tsai, & Paas, 2012), and game-based learning (Klopfer, Sheldon, Perry, & Chen, 2012). Therefore, mobile technologies have great potential for facilitating more innovative educational methods. Simultaneously, these patterns in educational methods will likely not only help subject content learning, but may also facilitate the development of communication, problem-solving, creativity, and other high-level skills among students (Warschauer, 2007).

However, despite the proposed advantages of using mobile computing devices for increasing computer accessibility, diverse teaching styles, and academic performance, currently researchers found mixed results regarding the effects of mobile-devices (e.g., Warschauer, Zheng, Niiya, Cotten, & Farkas, 2014), and very few studies have addressed how best to use mobile devices, and the effectiveness of doing so.

1.2. Review of the research into integrating mobile devices with teaching and learning

There are seven studies which reviewed the research into integrating mobile devices with teaching and learning and can be divided into two types according to the devices they focused on: (1) those focused on how laptops are used in schools and (2) those focused on the applications of various types of mobile device in education (see Appendix A).

Regarding the review of laptop-based programs, Zucker and Light (2009) believed that school programs integrating laptops into schools have a positive impact on student learning. However, they also believed that laptop use did not achieve the goals of increasing higher-level thinking and transformation of classroom teaching methods. Penuel (2006) reviewed 30 studies that examined the usage of laptops with wireless connectivity in one-to-one computer programs. Those studies found that students most often used the laptops to do homework, take notes, and finish assignments. General-purpose software such as word processors, web browsers, and presentation software were relatively common. Bebell and O'Dwyer (2010) examined four different empirical studies of laptop programs in schools. They discovered that in most schools participating in one-to-one programs there were significant increases in grade-point averages or standardized tests of student achievement, relative to schools that did not provide such programs. In addition, they found that most students used their laptops to write, browse the Internet, make presentations, do homework, or take tests. Furthermore, teachers made more changes to their teaching methods when they had increased opportunities to use laptops. Students participating in one-to-one programs also had a deeper engagement with what they were learning when compared to control groups.

Fleischer (2012) conducted a narrative research review of 18 different empirical studies on the usage of laptops. These studies found a large range in the number of hours that students used laptops, from a few days to as little as 1 h per week. The most frequently used computer functions were searches, followed by expression and communication. In most studies it was found that students had a positive attitude toward laptops, and felt that they were more motivated and engaged in their learning, and it was further believed that teachers conducted more student-centered learning activities. Moreover, considerable differences in classroom educational practices arose from the diversity of teachers' beliefs about the usefulness of laptops. Fleischer (2012) also found several challenges regarding the use of laptops in classrooms, such as encouraging teachers to change their previous beliefs and teaching methods (e.g., teacher-centered lectures) in response to their students' greater flexibility and autonomy; how to reconcile the conflict between the students' desire for independent study and the need for teachers' guidance; and how to facilitate teachers' competence by designing an appropriate curriculum and teaching models for laptop usage programs.

With respect to the research on the use of mobile technology in education, Hwang and Tsai (2011) provided a broad discussion of studies on mobile and ubiquitous learning published in six journals between 2001 and 2010. In their review of 154 articles, they discovered that the use of mobile and ubiquitous learning accelerated markedly during 2008; researchers mostly studied students of higher education, and the fields most often researched were language arts, engineering, and computer technology. Frohberg, Goth, and Schwabe (2009) categorized 102 mobile-learning projects, and discovered that most mobile-learning activities occurred across different settings, and took place within a physical context and an official environment, such as a classroom or workplace. Regarding the pedagogical roles that mobile devices play in education, most research has used mobile devices primarily as a sort of reinforcement tool to stimulate motivation and strengthen engagement, and secondarily as a content-delivery tool. Few projects have used mobile devices to assist with constructive thinking or reflection. Furthermore, most learning activities using mobile devices have been controlled by the teacher, with there being only a handful of learner-centered projects in existence. Concerning the communication functions, very few projects have made any use of cooperative or team communication. Moreover, the vast majority of studies have made use of novice participants; little research has involved experienced participants. When sorted according to educational goals, it was found that the vast majority of research has focused on lower-level knowledge and skills, and ignored higher-level tasks such as analysis and evaluation. Wong and Looi (2011) investigated the influence of mobile devices on seamless learning. Seamless learning refers to a learning model that students can learn whenever they want to learn in a variety of scenarios and that they can switch from one scenario or one context to another easily and quickly (Chan et al., 2006; Wong & Looi, 2011). Wong and Looi (2011) selected and analyzed a sample of 54 articles on the use of mobile devices to facilitate seamless learning, and found that all 54 articles contained 10 features, including formal and informal learning, personalized and social learning, and learning across multiple durations and locations.

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