Development of auditory design guidelines for improving learning on mobile phones

Tae-Hyun Kim [a], Sung-Hee Jin [b], *

[a] POSCO Group University, POSCO R&D Center, Songdogwahak-ro, Yeonsu-gu Incheon, 21985, South Korea
[b] Academy of Convergence Education, Inha University, 100 Inharo, Nam-gu, Incheon, 22212, South Korea

ABSTRACT

Although auditory information in mobile learning (m-learning) can be an important resource for delivering knowledge and information, the importance of guidelines for designing auditory instructions has largely been overlooked. Therefore, this study considered the characteristics of m-learning, mobility and personalization, with the aim of developing and validating auditory design guidelines to improve learning on mobile phones. The present study covers m-learning with cellphones only. Auditory design guidelines were developed and revised using an iterative educational design research process. The auditory design guidelines were developed by analyzing previous studies related to m-learning and auditory interface design, and revised using three validation methods. The expert reviews and usability evaluations were conducted as an internal validation method, and a field evaluation was used as an external validation method to confirm the feasibility and educational effects. The results showed that the auditory design guidelines could be applied effectively to the design of audio instructions delivered on smart phones. Finally, a total of ten guidelines were developed, three for auditory-only design, four for attention design, and three for personalization design. This paper discusses the theoretical, empirical and practical aspects of the design guidelines presented.

© 2015 Elsevier Ltd. All rights reserved.

1. Introduction

The increasing popularity of mobile devices, such as smartphones and iPads, has increased the interest in mobile learning (McCrea, 2010). Students are provided with a learning environment, where they can search for information anytime and anywhere with their mobile phones because of their small device size and wireless internet capability (Hoppe, Joiner, Milrad, & Sharples, 2003; Kossen, 2001; Kukulska-Hulme & Traxler, 2005; Quinn, 2009). On the other hand, because the displays of mobile learning devices are relatively small compared to desktop or laptop computers and they can be used while walking around, most have limited capacity to display visual information. Consequently, learners may experience difficulties "maintaining" visual attention on the screen. Considering the mobile learning characteristics of portability and mobility, an auditory presentation of the instructional content might be the optimal means of obtaining information (Kim, 2012).

Despite auditory information in an instructional design field being an important design factor in conjunction with visual information, previous studies of auditory designs have only examined auditory interfaces and feedback in e-learning or m-

* Corresponding author. Academy of Convergence Education (#1517 Hightech), Inha University, 100 Inharo, Nam-gu, Incheon, 402-751, South Korea.
E-mail addresses: thkim9@poscohrd.com (T.-H. Kim), shjin@inha.ac.kr (S.-H. Jin).

learning environments in a restricted manner (Brewster, 2002; Leplatre & Brewster, 2000; Walker & Brewster, 2000). Many studies have evaluated general design guidelines for m-learning environments (Hayhoe, 2001; Parsons, Ryu, & Cranshaw, 2007; Rainger, 2005; Trifonova, 2003; Vavoula, Lefrere, O'Malley, Sharples, & Taylor, 2004). Despite this, practical guidelines on auditory information design are unavailable, leaving many instructional designers to rely on their experience when designing auditory information. Therefore, the aim of this study was to develop and validate auditory design guidelines to support a learner's self-directed learning in a mobile learning environment. Accordingly, educational design research was applied to achieve this research purpose (De Villiers & Harpur, 2013; Teras & Herrington, 2014). This paper provides useful auditory design guidelines that can help to address some of the limitations of the display size and stability in mobile learning environments.

2. M-learning and auditory information

M-learning, which emphasizes the features of "mobility" and the advantages of e-learning, can be defined as self-directed learning using portable mobile devices without tempo-spatial restrictions (Hoppe et al., 2003; Kukulska-Hulme & Shield, 2008; Quinn, 2009). Although m-learning generally covers all types of learning with mobile devices using wireless internet, such as notebooks, cellphones, iPads, and tablet PCs, the scope of this study is limited to learning from mobile devices with small displays, e.g., cellphones, which can be carried easily in one hand.

Many studies have explained the characteristics of mobile environments in terms of mobility, accessibility, interactivity, instant connectivity, etc. (Kalakota & Robinson, 2001; Kumar & Zahn, 2003; Quinn, 2009), among which mobility is an essential feature. In an e-learning environment using desktop computers, visual information is the primary source of information with auditory information being secondary. Auditory instructions, however, are very important in an m-learning environment, which features mobility and small displays. Despite this, previous studies related to the design of m-learning lessons dealt mainly with visual design guidelines (Hayhoe, 2001; Rainger, 2005; Trifonova, 2003). Few auditory design guidelines have been proposed to design m-learning configurations which treat auditory information as the primary medium for teaching knowledge and skills (Brewster, 2002; Leplatre & Brewster, 2000; Walker & Brewster, 2000). There has been no comprehensive set of validated practical guidelines to support designers in generating auditory instructions to supplement visual objects — both textual and non-textual — in m-learning lessons, which run on small-screen mobile devices, such as cellphones. Therefore, there is a need for comprehensive auditory design guidelines which have been validated.

Auditory information in m-learning lessons needs to be designed with consideration for the physical limitations of mobile devices and two important characteristics of m-learning: mobility and personalization. Mobility is the most distinguishing characteristic of an m-learning environment; m-learning often occurs on the move and in public places, such as subways, buses and cafés, which have many distractions. Therefore, *mobility* should be taken into consideration in the design so that all the information on non-text objects as well as text that is presented on the screen can be acquired by auditory information alone. Non-text objects can include visuals, graphs and tables. Learners should be able to interact with the content easily, even when on the move, and the learners' attention should be guided. According to Schannon and Schramn (1964)'s communication theory, the sender and receiver communicate in the shared field of experience using signs and symbols, during which noise can interfere with that information. Overcoming external noise in public spaces is important for maintaining the learners' attention. In addition, because m-learning occurs using personal mobile devices rather than public devices, m-learning should allow the m-learning environment to be customized according to individual preferences (See Table 1). Therefore, the aim of this study was to develop and validate guidelines on auditory information design, interaction design and environment design.

3. Research method: educational design research

Educational design research was chosen to guide this study because this study addressed an educational real-world problem for which there were no clear guidelines or solutions available (Anderson & Shattuck, 2012). An interactive

Table 1
Auditory design directions considering the challenges for m-learning.

Mobile environments	Challenges and affordance for m-learning	Auditory design directions	Auditory design categories
Mobility	• High possibility of learning while on the move.	1) All the information presented on screen through text as well as non-text should also be provided as auditory information	Information design
		2) Interaction with contents while on the move should be easy	Interaction design
	• Learning is conducted not in separate places but in an open space with noise.	3) Support for the learner's attention should be included.	Information design
Personalization	• Learning is done with the mobile devices that the individual owns • Phone call or text messaging is possible during learning	4) The learner should be able to configure the auditory information environment	Environment design