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A Design Science Approach to High Immersive Mnemonic E-learning

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A DESIGN SCIENCE APPROACH TO HIGH IMMERSIVE MNEMONIC E-LEARNING

Extended Abstract

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Abstract

Today's students often have to interact with a lot of information and content, more precisely declarative knowledge, whereas their studying technique often is simple repetition and retention. To facilitate the process of learning the approach of this article is to suggest a novel paradigm of e-learning IS that rely on old memorization strategies. These strategies are based on the mechanism of mental associations like imagery, phonetic similarity or spatial imagination and will be applicable to a vast amount of subjects. In this extended abstract, we describe a mnemonic concept that is meant to encourage further research in mnemonic e-learning. This concept relies on the Method of Loci in combination with a head-mounted display. Due to its highly immersive character, we theorise that a head-mounted display is more appropriate to apply the virtual Method of Loci (vMOL) than a casual desktop display. The application of the vMOL with the help of a desktop display had been analysed in earlier studies. These studies indicated a high potential of the application of a vMOL.

Keywords: Mnemonics, Virtual Reality, Design Science, E-Learning, Method of Loci.

1 Introduction

1.1 Motivation & Research Method

The following design science approach is meant to address especially researchers in the field of e-learning and education. Our primary intention is to illustrate a promising way of research towards a new set of artefacts that foster the users' long-term memory performance by the use of mnemonic methods. Secondary, we seek to build a theoretical foundation that enables a practical approach towards mnemonic based e-learning information systems (IS). Therefore, this research follows the Design Science Research Methodology (DSRM) suggested by Peffers et al. (2007). It is divided into six essential steps and iterative cycles, starting with the problem identification and motivation, followed by the definition of the objectives of a proposed solution, the design and development of an artefact and finally its demonstration and evaluation. The last step is the communication of the research result.

Respecting this methodology, the problem identification, motivation and the objectives of a possible solution are briefly described in this extended abstract. Additionally, Peffers et al. defined four different entry points in their research process model, whereas the choice of the right entry point depends on the research processed so far. As mentioned above, the problem identification and motivation are specified. Theory based design principles and requirements are therefore the next important factors for an artefact. Hence, the adequate entry point can be assigned to step two, an "Objective Centered Solution" (Peffers et al., 2007).

1.2 Background & Research Question

The main principle of mnemonic methods is to associate learning content with an object or entity. This way it can be remembered easier than the actual learning content on its own (Yates, 1999). For example, an entity could be an image, an abbreviation, a catchy phrase or even a mental map of a spatial architecture (Putnam, 2015). As it requires less effort to remember these entities than plain text, the linkage between them and the learning content leverages the recall performance as long as certain design principles are followed to avoid a cognitive overload (Mayer & Moreno, 2003). Clearly, these techniques can also be used for general problems like managing today's information oversupply (Fassbender & Heiden, 2006). But especially the application in the students' curriculum can improve the chance to succeed in college (Hartwig & Dunlosky, 2012; McCabe, 2011). Putnam (2015) discovered a positive influence of the use of mnemonics on the students' motivation to learn and educate themselves. However, following the revised version of Bloom's well established taxonomy of learning domains (Krathwohl, 2002) which classifies educational goals, our approach addresses the level of "remembering". More precisely, this level describes the ability to retrieve relevant knowledge from the long-term memory.
The approach of integrating mnemonics into the students' curriculum was already promoted in the early 90s when Levin and Levin (1990) developed the so called *mnemonomies*, a set of pictorial compositions that ought to visualize hierarchical relationships within a botany classification system. These compositions were experimentally proven to be substantially easier to memorize than the abstract botanical terms. Nevertheless, the teaching community did not fully adapt mnemonic methods (Putnam, 2015). However, the first artefact in this DS approach will focus on the *Method of Loci (MOL,* also called *memory palace*) and its potential to serve as the basic concept of an e-learning information system. The idea of the classical *MOL* is to mentally navigate trough a familiar environment. On this tour, the person using the method places the items in certain locations (loci), e.g. on a table in the kitchen. Later, when the user intends to recall these items, he has to visit these locations in his mind, while the mental association between loci and item facilitates the process of recalling. Maguire et al. (2002) investigated the underlying substrate for this method's success and found that people with superior memory utilize a learning strategy that is based on spatial characteristics. They analysed the brain activity of their subjects using neuropsychological measures and brain imaging. The results showed a higher engagement in regions that are associated and critical to spatial memory. Therefore, the longevity and effectiveness of the *MOL* indicates a "natural human proclivity to use spatial context […] as one of the most effective means to learn and recall information" (Maguire et al., 2002, p. 94).

The use of information systems to enhance the *MOL* was suggested in the late 90s by Storkerson and Wong (1997). They proposed the application of the *MOL* by the help of multimedia and hypermedia due to a higher intelligibility of communications in a spatial context. In the subsequent years researchers analysed different versions of a *vMOL* Compared to the classical *MOL*, the user navigates through a virtual, digital environment like in a computer game instead of exploring a well-known environment in mind. This digital environment then serves as a template for the users *memory palace*. Hedman and Bäckström (2000) built a 3D virtual environment for standard personal computers. It sought to enhance the students learning ability in a course of philosophy. The authors emphasized that one major advantage of a digital virtual world lies in the fast development and improvements in the gaming industry (Hedman & Bäckström, 2000). It empowers developers to create a complex virtual world to fit the requirements of a *virtual memory palace protocol*. Fassbender and Heiden (2006) later used a similar approach. They hypothesized that exploring a *virtual memory palace* instead of stressing ones creative abilities could facilitate the application of the *memory palace*. Six years later, Legge et al. (2012) conducted one of the widest studies that evaluated the potential of a *virtual memory palace protocol*. The experiment included 142 participants (divided into three groups with different learning instructions) and it could be shown that the recall performance of the *vMOL* was not significantly different to the classical *MOL* method. Results indicated that it is neither mandatory to use a familiar, richly detailed environment, nor to invest an extensive amount of training (about five minutes is sufficient). However, the compliance rate was significantly higher within the *virtual memory palace* group. In other words, the participants using the protocol involving a virtually presented 3D environment actually used the *MOL* to recall the learned items more often than the other group. (Legge et al., 2012) This indicates, that the virtual environment has a positive influence on the users intention and/or ability to apply the *MOL*. Therefore, we intend to examine how the *vMOL* could be designed to increase its effectiveness and applicability for an e-learning purpose. In this context, we operationalize effectiveness by a few central aspects that are needed to successfully utilize the *vMOL*:

- The time needed for the training to use the virtual *MOL*
- The actual use of the *MOL* after the initial training to recall the learned items (compliance rate)
- The amount of remembered items, immediate after applying the method and later to test the long-term memory performance
- The intention to use the virtual *MOL* as an e-learning IS

2 High Immersive Memory Palace

Due to studies that revealed multiple positive correlations of the level of immersive presence on a variety of latent variables, we suggest to implement a *vMOL* with a higher lever of immersive presence to address the aspects of effectiveness. Immersive presence describes “the subjective experience of being in one place or environment, even when one is physically situated in another” (Witmer & Singer, 1998, p.1). Proven to be crucial for a successful performance in virtual environments (VE), immersive presence may reduce the cognitive burden, which is associated with task performance. (Agarwal & Karahanna, 2000) It is therefore positively correlated with task performance (Witmer & Singer, 1998) and significantly impacts perceived enjoyment and performance. (Liu et al., 2014) Furthermore, it is found to have a positive influence on learning and engagement as well (Bredl et al., 2012; Dede, 2009) and it may even foster the user’s memory recall performance regarding virtual objects, the spatial layout or even procedural knowledge. (Lin et al., 2002; Mania & Chalmers, 2001; Ragan et al., 2010; Sowndararajan et al., 2008) Nevertheless, the design of a VE has a significant impact on the level of the user’s perception of presence. Hence, there are certain characteristics a VE has to provide and fulfil to enable a presence leveraging virtual world. The more a VE is designed based on principles that combine sensory, symbolic and actional parameters, the higher the participant’s suspension of disbelief that he or she is situated in a virtual reality (Dede, 2009). For example, driving sensory factors for a stronger perception of presence and therefore stronger memory performance are tactile, olfactory and auditory cues (Dinh et al., 1999). Furthermore, Ragan et al. (2010) conducted an experiment with a virtual world that was presented to the participants by different devices, such as a head-mounted display (*HMD*), generating different levels of immersive presence. In this virtual world, the participants had to perform procedural tasks and later on, repeat them in a real world setting. Their hypothesis was based on the idea, that a higher level of immersion offers more spatial cues, which foster the spatial understanding. They found a positive correlation between high immersion and a better memory performance of procedural knowledge. (Ragan et al., 2010) Therefore, high immersion should facilitate the association between location and information, which is the main principle of the *MOL* and hence, lessens the burden to apply this technique.

Adapted from these findings a virtually presented *memory palace* that is optimized towards a high immersive experience might create a higher level of effectiveness as described above. Consequently, we suggest a *vMOL*, which is implemented for a *HMD* and therefore runs as a virtual reality environment. This virtual reality *MOL* will then serve as an artefact (step 3 in the *DSRM*) to examine the research question.

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