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**VSPad: Harnessing Learning Styles among Mobile Learners**

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**Abstract:** Educational applications that run on mobile devices are fast emerging, supporting a variety of learning activities. Yet one crucial area that has received little attention to date involves the learning styles of users and whether these affect their rate of learning. This paper describes the design and development of Visuo-Spatial Pad (VSPad), an application running on mobile devices that helps people remember lists of keywords better using their visual, spatial and auditory strengths. VSPad uses the number keypad structure of mobile phones for learners to remember the starting letters of keywords. Learners highlight letters that the keywords start with and whenever a list needs to be recalled, they simply retrace the way their fingers moved. Letters are associated with unique tones, helping auditory learners as well. The VSPad is also network-enabled, allowing keyword lists to be shared among learners.

**Introduction**

Mobile devices such as handheld computers and mobile phones are undoubtedly growing in popularity. In particular, mobile phone sales continue to increase, opening up new possibilities for teaching and learning. Perhaps one of the greatest attractions to learning on such devices is mobility. Mobility allows one to access resources, communicate and learn wherever one may be. Thus, by taking their mobile devices with them, students can access these educational applications and resources whether they are in their classrooms working on a science project, on field trips learning about geographical features, at home studying for a test, or even in a bus on the way to meet friends. Another advantage of learning via mobile devices is their near ubiquity. In Singapore, for example, mobile phone penetration rates are approximately 87% (IDA, 2004), while in Japan, mobile phones outnumber personal computers 5 to 1 (Cohen, 2002). Not surprisingly, therefore, research into educational applications that run on mobile devices are fast emerging, supporting a variety of learning and education-related activities of varying complexity. Examples include collaborative concept mapping (Silander, Sutinen & Tarhio, 2004) and the conducting of scientific experiments (Moher et al. 2003).

Usability issues concerning mobile devices for running are well-documented. Among them, two of the major ones are small screen sizes and limited input capabilities of such devices. While these usability issues do have a significant impact on the effectiveness of a mobile educational application, one important area that has not received much attention to date involves the learning styles of users and whether these affect their rate? or effectiveness? of learning. There are some grounds to suspect that some effects could be possible. The literature on learning styles over the past 40 years have shown that learners displayed increased learning rates when their learning styles were matched with teaching strategies (Dunn & Dunn, 1993).
In this paper, we recognize the importance of learning styles and describe the design and development of Visuo-Spatial Pad (VSPad), an application that helps people to learn better through their visual and spatial strengths. In the next section, we briefly review the literature in learning styles. Following this, we first describe a paper-based version of VSPad and report results on its use. We then present the VSPad application, highlighting its design, features and usage. We conclude with a discussion of our research and describe possible directions for future work.

**Learning Styles**

**Definitions**

Many definitions and models of learning styles exist. One popular definition by Dunn and Dunn (1993) describes learning styles as “the way in which individuals begin to concentrate on, process, internalize, and retain new and difficult academic information”. This definition highlights the type of information that would require learning style strategies, namely, new and difficult information, the reason being that learners tend to “lose” information when they attempt to process difficult information compared to simple information. For example, the name “John” would not be too difficult to remember for most people and hence, would not require learning style strategies whereas an expository text on nuclear fission would probably be out of the usual scope for most people. In this situation, learners would need additional help in processing the information. As a result, using the most effective way of processing information (or learning style) would give that extra edge in learning more effectively.

A second definition by Keefe and Languis (1983) states that a “learning style is the composite of characteristic cognitive, affective, and physiological factors that serve as relatively stable indicators of how a learner perceives, interacts with, and responds to the learning environment. It is demonstrated in that pattern of behavior and performance by which an individual approaches educational experiences”. This definition focuses on the interaction of the learner with his or her environment. Hence, learning is viewed as an interactive activity, not a passive process of feeding information to the learner. Given these two definitions, learning styles can be generally conceptualized as the most effective way of learning or acquiring information in a certain environment for individuals based on their capabilities and processing modes (Braio, Beasley, Dunn, Quinn & Buchanan, 1997).

Learning styles refer to the most effective way of learning for long periods of time. Efficiency is achieved when there is a match between the information a learner receives with the perceptual mode that he or she is most efficient in. This is confirmed by research findings which showed positive effects of perceptual modes on learning (Barbe & Swassing, 1979; Braio et al., 1997). The Dunn and Dunn Model (1993) is one of the most widely accepted models on learning styles in the current literature. The model examines the preferences and strengths of learners in different learning environments and needs. Here, four perceptual modes are proposed:

- Visual (or sight)
- Auditory (or hearing)
- Tactual (or touch and fine motor movements)
- Kinesthetic (or gross motor movements)

Thus, tactual learners are most productive when they write or draw the information. For them, the act of writing gives them tactile information which they are able to assimilate very quickly. However, not everyone benefits from writing. Learners have been observed not to take notes during lectures and appear to retain much information after the lecture than those that took notes. On the other hand, kinesthetic learners need new experiences and learn best when they teach themselves or others. It is the act of teaching or going through the situation that helps them to remember information.

**Use of Learning Styles in Education**

Braio et al (1997) studied the effects of learning styles on reading test score performance on 81 special education students and 35 low-achieving general education students in an intermediate school. Both categories of students were further divided into two sub-groups:

- *Group 1* was incrementally matched according to learning styles for sound, light, temperature, design, mobility, tactual, kinaesthetic, auditory and visual elements; and
• Group 2 consisted of students who did not have their learning styles matched and/or who had no strong preferences for the above elements. Pre- and post-tests were administered to all students to determine reading achievement gains. Significant gains in reading achievement for both special education and general education students were found. Mean achievement scores reached increased steadily as modifications based on learning styles preferences were carried out in Group 1. Upon the withdrawal of these modifications, mean achievement scores fell significantly. There was no significant change in achievement scores for the control group (Group 2) which experienced traditional teaching throughout the 10-week period.

An increase in students’ academic performance was also reflected in a meta-analysis of thirty-six studies conducted to identify learning styles (Dunn et al., 1995). The meta-analysis confirmed what the growing body of research on learning styles was indicating that using learning styles can make a difference to children’s learning. It revealed that overall academic performance of students whose learning styles were matched to instructional modes was higher than those whose learning styles were not matched. The conclusion was that providing educational interventions that are compatible with students’ learning style preferences was beneficial and thus recommended.

Learning Styles in Software

Although many software applications have incorporated multi-sensory approaches to the delivery of content (Atkinson, 1998), not many have attempted to target such content at specific characteristics of learners. Current applications favor visual learners with the generous use of images, graphs, animations, movies, schematics and other visual objects. These greatly enhance the internalization process for visual learners but they may leave the auditory, tactile and kinesthetic learners feeling a little “lost” in the overwhelmingly visual environment.

St. Hill (1997) found that there were two outcomes that resulted from customizing presentation modes to match students’ learning styles. Firstly, student assessment outcomes improved. Secondly, student learning experiences appeared to have also enhanced. Results of St. Hill’s work showed a dramatic fall in failure rates (from 30% to 4.7%), and higher proportions of students obtaining High Distinction grades than C’s. The proportion of students who did not complete course by the end of the semester also fell from 26.5% to 9.5% within a year. Results from St. Hill’s study thus appeared to favor matching students’ learning styles through the use of appropriate presentation modes via application software (e.g. visual presentations for the visual learners and verbal explanations through audio files for auditory learners). Further evidence on the effectiveness of learning style strategies when applied to software design can be found in studies conducted by Riding and Rayner (1995) and Jonassen (1988). Findings here revealed that when individualized learning styles were considered in instructional design, improvements in learning were observed.

The Visuo-Spatial Pad

Overview

The key to maximizing learning is found in the customization of information to match the recipient’s most effective perceptual mode. The VSPad, an application developed to help people learn better through visual and spatial strengths, provides the means to customize information to match recipients that are highly tactile and visual. These learners have a higher propensity to take notes, read texts and remember diagrams and pictures. With mobile phones being a common communication tool, individuals have become accustomed to the keypad structure. By taking advantage of the individual’s ability to recall letters on keypads of mobile phones either through tracing the path their fingers moved or seeing where the digits are, the VSPad utilizes an important cognitive ability that many users do not realize they have – that of recalling letters from memory through their fingers or by sight.

The memorization of lists of items is a common activity in many learning situations (e.g. naming the colors of the rainbow or the components of the human digestive system). Individuals have developed various techniques for memorizing lists albeit with varying levels of success. The VSPad addresses this need among learners and helps individuals remember lists of keywords better using their visual, spatial and auditory strengths. Recognizing the
need to make memorizing activities portable such that individuals can learn anytime and anywhere, the VSPad is designed as a J2ME-based (Java 2 Micro Edition) application that runs on Java-enabled mobile devices such as mobile phones and PDAs.

Figure 1 shows the VSPad running on a mobile phone. VSPad employs the number keypad structure of mobile phones for learners to remember the starting letters of keywords. This approach takes advantage of our observations that most owners of mobile phones are very accomplished at text messaging using the phone’s keypad. Given a list, a learner highlights letters that the keywords start with. As each letter is pressed on the phone’s keypad, the corresponding letter on the VSPad is highlighted. Each letter is also associated with a unique tone that is played when highlighted. This process of key presses is repeated until the learner is familiar with the movements over the keypad. Whenever a list needs to be recalled, the learner simply retraces the way their fingers moved over the keypad, with each location representing a word in the original list.

As designed, the VSPad helps learners remember information through 3 different modes in the Dunn and Dunn (1993) model of learning styles:

- Spatial strength – tactual learners remember by touching and moving their fingers over the mobile phone’s keypad;
- Visual memory – each letter is highlighted when pressed. Connecting lines appear between letters to show the sequence of key presses to be performed; and
- Auditory inputs – each letter is associated with a unique tone which is played when pressed.

Figure 1: The VSPad running on a mobile phone.

The VSPad is also network-enabled, allowing communities of users to be created so that learners can contribute and download new keyword lists. To participate, a user logs into a designated VSPad server by entering a user name and password. Upon successful validation, the VSPad downloads a list of available topics for the user to browse (e.g. “Biology”, “Astronomy”, etc.). After selecting a topic, titles of keyword lists associated with that topic are downloaded and upon selecting a title, the actual list is downloaded and displayed on the VSPad. The user can then choose to save it to the mobile phone or view other topics and lists.

Using the VSPad: An Illustration
Consider a student who has to remember the planets of the solar system as part of a science class. Using his mobile phone, he executes the VSPad application to help in the memorization task. Finding that the list of planets is not available in his mobile phone, he connects to the VSPad server by entering his user name and password (Figure 2a). On the server, keyword lists are organized into folders for easy access. Thus, the student scrolls through the list of topics available on the server until he finds the Astronomy folder (Figure 2b). Upon its selection, he sees the Solar System list and views the list of planets (Figures 2c and 2d). The VSPad then presents the number keypad and goes into “training mode” (Figure 2e). Here, the application prompts the student to enter the letter corresponding to the first letter of the first item of the Solar System list (“m” for “Mercury”), the first letter of the second item in the list (“v” for “Venus”) and so on until the entire sequence of letters corresponding to the planets has been traversed. Note that as each letter is pressed, a unique tone is played and the letter is highlighted. Connecting lines between letters are also drawn to serve as guides to the student. Once complete, the VSPad replays the entire sequence as a final reminder to the student (Figure 2f). VSPad’s training mode can be repeated for as many times as necessary until memorization is achieved. The student decides to download the list into his mobile phone and once complete, the list is available for access every time the VSPad is executed (Figure 2g).

Some time later, the student wishes to determine if he has successfully memorized the planets of the solar system. Launching the VSPad again, he selects the Solar System list again but this time enters VSPad’s “test mode”. Here, no prompt and connecting line are available and the student has to rely on his spatial, auditory and/or visual strengths to help complete the letter traversal sequence. At any time if the correct letter cannot be found after three attempts, VSPad will reset the test and return the user to the start of the sequence to prevent confusion over the actual sequence.

**Conclusion and On-Going Work**

We describe VSPad, an application running on mobile devices that aims to help people remember lists of keywords better using their visual, spatial and auditory strengths. Initial feedback from pilot studies with a couple of prospective students in secondary schools in Singapore had been positive in helping them to remember things faster and better through the VS Pad method. In addition, the novelty and simplicity of VSPad made learning fun too.

On-going work involves carrying out more user studies with a larger number of students, educators and parents to measure and compare the effectiveness of the VSPad method with conventional memorization techniques.
References


