Meaning Contemplation from Information Visualization of Mobile Learning Content

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Abstract

The purpose of study is to confirm the effect of information visualization of learning contents within mobile learning. For this research, we created contents: first, that one be non-visualized text material; second, as visualized content via graphic, animation, and image focused on a PDA system. Learner's transfer abilities were tested by standard measurement tools during the session. As the result of experiment, we hoped to find the important truth, that visualized information on the mobile learning is effective in the understanding of learners' more than non-visualized information. In other words, to overcome limitation points of mobile devices, we have to visualize the content for mobile learning. In the future, result of this research will be affective on both mobile user interface designs and contents structure for mobile learning.

Keywords: Information Visualization, Mobile Learning, User Interface

1. Purposes

A growing interest in the use of mobile technology in education has emerged, and a number of pilot projects have tried to find out how these technologies cabs are integrated into learning settings (Chen, Myers & Yaron, 2002; Roschelle & Pea, 2002; Lundby, 2002; Danielsson, Hedestig, Juslin & Orre, 2004). Mobile learning can both complement and conflict with the formal education processes. On the positive end, learners can extend their classroom learning activities to homework, field trips, and

museum visits by reviewing teaching materials on mobile devices; and or collecting and analyzing information using handheld data probes. As a potential negative impact, mobile devices can also lead to disruption of the carefully managed environment for example, when students bring their own multimedia phones and wireless games machines, thus conducting private conversations within and outside the schooling process (Sharples, 2002). Nevertheless, the convergence of mobile communications and handheld computers offers the opportunity to develop technology that will assist individuals and group teaching/learning anytime, anywhere (Sharples et al., 2002).

The important of selecting and using of information rises gradually in our lives; also methods of information expression are changing rapidly. If expressed information within a picture format, as in previous periods of using the character, as human beings begin to use character, information was begun, to express content within a textual formation. As visual and auditory mediums develop, effective and importance of visual experience will undoubtedly realize advancement. Nowadays, as new media is used for classroom learning; it takes advantage of Information Technology, such as internet, mobile devices development is rapidly increasing optical information in the forms of pictures, tables and videos.

Information visualization is a process of transforming large quantities of data and information, which are not inherently spatial, into a visual form that allows users to perceive visually the meaning of the information instead of using their cognitive powers to figure it out otherwise (Zhang, 1996). Why must we consider the visual structure of contents? Our lives have become impacted with multiple forms of data processing: the ATM transaction, the online registration of our new software, the credit card purchase at the mall, the cellular phone call, etc. (Agutter & Bermudez, 2005). Through information visualization, we can help learners deal with the flood of information. When incorporated into the learning process, informative visualization can enable users to comprehend information better, to get information more quickly and to make more reasonable and relevant decisions. Information visualization strategies have been considered as a way to summarize textual data, so that the learners can comprehend huge amounts of data more efficiently and effectively.

The purpose of this research is to study the impact of information visualization strategies on both mobile user interface designs and information contents structure for mobile learning applications. Therefore, the following research questions have been

formulated: How does structured information visualization affect mobile learning across different contents for learner's transfer abilities?

2. Theoretical Framework

2.1. Mobile learning and environment

We take it for granted that we can talk to other people at any time, from wherever we may be; we are beginning to see it as normal that we can access information, take photographs, record our thoughts with one device, and that we can share these with our friends, colleagues or the wider-world. Newer developments in mobile phone technologies are also beginning to offer the potential for rich multimedia experiences and for location-specific resources (Future Lab, 2005). One important field where mobile technology can make significant contributions is Education. In the fast pace of modern life, students and instructors would appreciate using constructively some of their spare time, in order to work on lessons, at any place and or time, even when away from offices, classrooms and labs where computers are usually located (Virvou & Alepis, 2005).

Mobile learning is based on wireless Internet connections and uses mobile devices such as notebook computers, cellular phones, Personal Communication System (PCS) phones, and Personal Data Assistants (PDAs). The important features of mobile devices are portability, immediacy, individuality, and accessibility which are bringing about a change of paradigm in the learning model (Shotsberger, 2000). Mobile learning is unique in that it allows truly anywhere, anytime, personalized learning and can be used to enrich, enliven or add variety to conventional lessons or courses.

The concept of mobile learning applied in this research is defined as a learning process where mobile computing is combined with e-learning, and as a teaching-learning-interchange happening through mobile devices such as mobile phones, PDAs, smart phones, tablet PCs and so on (Park, 2005). Also, Mobile learning, sometimes called m-learning, is learning accomplished with the use of small, portable computing devices. These computing devices may include: smart phones, personal digital assistants (PDAs) and similar handheld devices. There is some debate on the inclusion of tablet

and laptop computers. Often, wireless two-way internet connection is assumed as an integral component (MDDE, 2004).

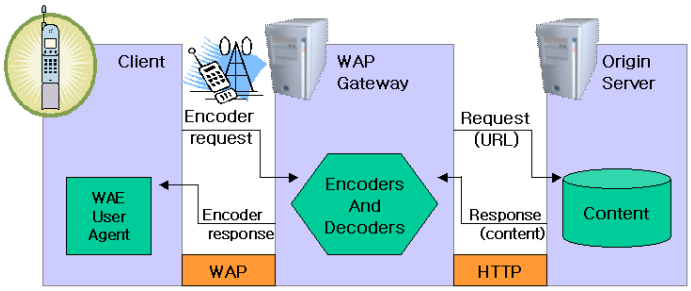

Figure 1. Structure of wireless internet for mobile learning

The mobile learning environment provides students and teachers with the opportunity to obtain any and all class-related material on their Palm handheld computers through a simple process of point-and-connect using infrared connectivity. As seen in Figure 1 the built-up information in a learning web-server is first delivered to the wired Internet. For the purpose of supplying learning content through wireless Internet, it's essential to connect Internet and Web-Server, thus making a bridge between the wired Internet and Web-Server. This then enables services to be provided through a WAP Gateway, which allows regular communication with mobile devices to occur.

The intersection of mobile computing and e-learning makes possible access to resources anytime and anywhere; strong search capabilities; rich interactions with users; powerful support for effective learning; and performance-based assessment. Abfalter et al. (2004) explains that in a mobile learning environment, "Teaching and learning are no longer confined to time and place. With mobile communication technologies, the time and physical boundaries of the traditional classroom are being expanded (Figure 2, page 2)."

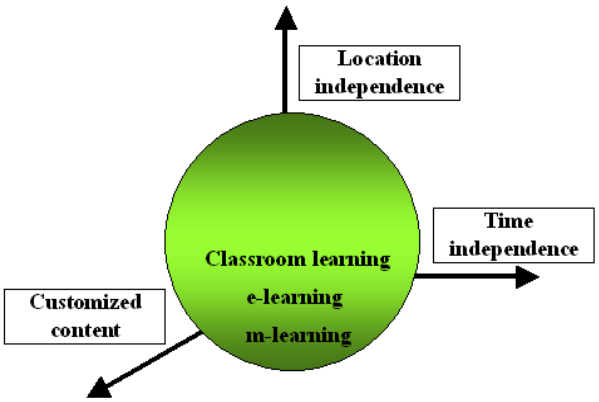

Figure 2. Expansion of mobile learning environment

2. Information Visualization of the Contents

Cognitive learning theory explains how mental processes transform information received by the eyes and ears into knowledge and skills in human memory. As shown in Figure 3, the visual lesson and auditory information enters the eyes and ears, is briefly stored in a visual and auditory sensory memory, then enters the working memory, and is finally stored in permanent or long-term memory (Clark & Mayer, 2004).

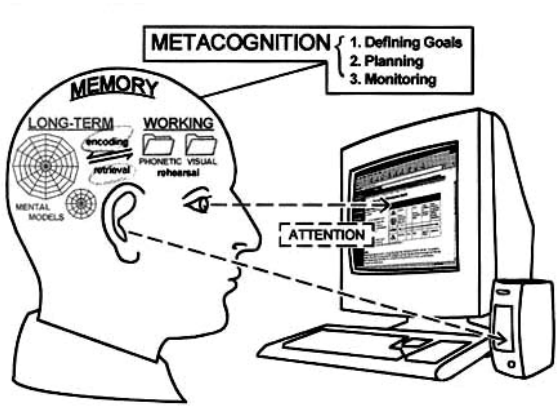

Figure 3. Cognitive process of human about information

According to Gerson and Eick (1997), visualization links the two most powerful information processing systems known—the human mind and the modern computer. The process-transforms data, information, and knowledge into a visual form exploiting a person's natural strength in rapid visual pattern recognition.

Research in information visualization focuses on helping people to visualize abstract or conceptual information by reducing its complexity (Zhang & Wolfram, 2001). Past studies on information visualization (Morris et al, 2003; Zhang & Wolfram, 2001; Keim, 2002; Zhang & Whinston, 1995) analyze and classify methods of data processing and presentation, thus reporting its advantages and characteristics. Nevertheless, research is limited on the importance of information visualization for the learner and the user.

As we all learn in unique ways and have different preferences for how we learn; interface design is a critical area for interactive systems and the learning process for learners. The interface design is affected by aesthetics and fashion as well as function, and forms a critical component in the overall desirability of a system, including its usability and effectiveness.

Visualization provides a number of benefits including: (1) an understanding of internal relationships among documents to help users make judgments about the relevancy of information in a search; (2) making the search and analysis process transparent, easier and more effective; (3) presents a visual environment with richer information for users; (4) the potential for new methods of information processing; and (5) the recognition capacities of humans: to either the discover or display information (Zhang, 1999).

As the need to cope with the information increases rapidly, techniques that can help individuals understand and rearrange information systematically are critical toward the process of content delivery. The primary objective of information visualization is to provide support for users to easily grasp large quantity of information that appears in search results and other querying contexts. Ultimately, information visualization strategies lead to an increase in a learner's convenience.

3. Research methods

3.1. Main research hypothesis

We expected that the group who received a visualized information contents would show higher transfer at achievement tasks, than the groups who received non-visualized information in textual based contents.

Hypothesis 1 There will be a meaningful difference in a learner's transfer ability between visualized information and non-visualized information on the mobile learning content.

Hypothesis 2 There will be a meaningful difference in a learner's transfer ability between mobile and Web media as concerned about the information visualization.

3.2. Participants of the study

The sample for this study was drawn from one elementary schools located in Suwon, Korea. One hundred sixty students of a similar achievement levels, based on pre-test had been divided into four experimental groups. Each group consisted of forty participants with the first experimental group receiving a visualized learning content through information visualization; a second experimental group receiving non-visualized content, as textual based contents on the mobile devices; the third experimental group receiving visualized learning content through information visualization; finally, the fourth experimental group receiving non-visualized learning content as textual-based contents on the Web. Within the experiment process, the students who didn't agree with the experiment subjects were exception.

3.3 Design

The study took place at the school of the participants. The instructional intervention were divided into 3 main phases; pre-testing, treatment, and post-testing. Treatments were carried out across five sessions based on the 4th grade level social studies contents. Assessment methods were the same for all students who participated in the four groups.

3.4. Material

During the sessions, four experimental tasks were employed in order to evaluate the degree of achievement through the learning of visualized contents; that we had developed for mobile learning and web based learning. The contents were focused on the social studies subjects and formatted for use with mobile learning. The process consisted of two types of contents: one text-based and the other was visualized content.

3.5. Attributions Questionnaire

The questionnaire was based on the 7th National Social Studies Curriculum of Korea.

We have also developed additional attribution items to evaluate each student on the effectiveness of information visualization based on their test performance. The questionnaires consisted of 20 items. Executed pre-test to unrelated 20 students with an experiment to confirm whether there were items that were not understood. Reliability of transfer ability, examination items, that were used in this research were *Cronbach* α=0.85.

4. Results

Executed, pre-test transfer abilities, of experiment groups to secure homogeneity between groups. As this result, as you shown <Table 1> there is no significant as statistical in transfer ability between groups (F=1.121, P>.05).

Table 1 Result of pre-test between groups

	Sum of Squares	*df*	Mean Square	F	Sig.
Between Groups	43.623	3	14.541	1.121	.343
Within Groups	1893.450	146	12.969		
Total	1937.073	149			

Verification hypothesis, we make contents for mobile learning and web-based learning to visualized and non-visualized as text, and then we used the experiment with students.

Table 2 Mean and Std. Deviation between groups

	Non-visualized information		Visualized information	
	N	Mean(Std. D)	N	Mean(Std. D)
Web	38	15.71(3.66)	35	18.06(1.71)
Mobile	38	13.11(3.22)	39	15.28(3.91)

As you can see <Table 2>, there are some differences within the groups. Studying mass of transfer ability points that offer contents visualized information with Web and Mobile(web=18.06, mobile=15.28) appeared high, more than within a group which was offered contents of non-visualized information as textual base(web=15.71, mobile=13.11). We can find the importance of information visualizations from web and mobile learning.

As shown in <Table 3> ANOVA Table, there where differences between groups, within the information presentation methods (non-visualized, visualized information) of medium (web and mobile) ($p<.01$).

Table 3. Result of post-test between groups

	Sum of Squares	*df*	Mean Square	F	Sig
Between Groups	450.295	3	150.098	14.055	.000
Within Group	1559.178	146	10.769		
Total	2009.473	149			

Enforced post multiple comparisons by *Tukey;* methods to search whether differences were kept in mind between any groups were concrete. As the result, difference between groups which apply presentational methods of non-visualized information, such a textual base and visualized information, per web-based learning and mobile learning appeared. As shown <table 2> and <table 4>, the web has information of quantity by interface expression, special quality of medium more than the mobile, and transfer appeared higher and more than mobile learning. This is a rightful result. The other side, examined mobile studying aspects in priority, transfer ability averaged, there were differences, and express differences between two groups, as examined in post-test results, the non-visualized information as textual base and visualized information in mobile learning ($p<.05$).

Table 4 Result of post hoc multiple comparisons by *Tukey*

Group		Mean	Std. Error	Sig
Web(non-visualization)	Web(visualization)	2.347*	.766	.014
	Mobile(visualization)	0.428	.745	.933
	Mobile(non-visualization)	2.605**	.750	.004
Web(visualization)	Web(non-visualization)	2.347*	.766	.014
	Mobile(visualization)	2.775**	.761	.002
	Mobile(non-visualization)	4.952***	.766	.000
Mobile(visualization)	Web(non-visualization)	0.428	.745	.939
	Web(visualization)	2.775**	.761	.002
	Mobile(non-visualization)	2.177*	.745	.021
Mobile(non-	Web(non-visualization)	2.605**	.750	.004

visualization)	Web(visualization)	4.952***	.766	.000
	Mobile(visualization)	2.177*	.745	.021

5. Conclusion

Up to now we've looked at the effects of information visualization on mobile learning through the experiment. Proceeding from what has been said above, it should be concluded: that there is some different on mobile learning and web-based learning, because mobile devices have limitations including devices characteristics. The average point of web-based learning can conclude that web-based learning is affirmative more than mobile learning, both non-visualized and visualized information, and in information presentation the form appeared relatively high. However, because its purpose looks for effectiveness of information visualization in mobile learning, meaning information visualization could confirm enough in mobile learning as an experimental result. It can be assumed within experimental results, to overcome limits; that mobile devices have, and guarantee effective departmentalization of learning.

Future mobile devices are undoubtedly going to be even more complex, and have even more functions than the devices available today. Third generation mobile telephone networks are currently being launched in several countries, but according to market analyzers they'll not become widely used before the year 2007. Instead, the current 2.5 G technology will be sufficient for most users, for accessing information via smart phones and other mobile devices for several years to come (Andersson, 2003). In this way, mobile technology will probably become more and more important for learning in the future. However, the technology will probably mainly be used for learning small chunks of content (Strandvall, 2003). The study will provide some preliminary findings on the impact of information visualization strategies on both mobile user interface design and information contents structure for mobile learning applications. At the same time, the result of mobile learning research, based on information visualization strategies, may help learner's better process information and transfer their learning to multiple contexts.

6. References

Abfalter, D., Mirski, P., & Hitz, M. (2004). Mobile learning-knowledge enhancement and vocational training on the move. computer & Education.

Agutter, J., Bermudez, J.(2005). Information Visualization Design: The Growing Challenges of a Data Saturated World. AIA Report on University Research 2005. 61-75.

Andersson, M. (2003). 3G far ingen masspridning fore 2007. [online]. Available http://www.uppsnappat.se/news!read.jspx?newsID=6281.

Clark, R. C., Mayer, R. E. (2004). e-learning and the science of instruction. San Francisco: Pfeiffer.

Chen, F., Myers, B., & Yaron, D. (2002). Using handheld devices for tests in classes. Human-Computer Interaction institute, School of Computer Science, Carnegie Mellon, University, PA. CMU-HCI-00-101.

Danielsson, K., Hedestig, U., Juslin, M., & Orre, J. (2004). Participatory design in the development of mobile learning environments. Learning with Mobile Devices Research and Development. LSDA.

Future Lab. (2005). Literature Review in Mobile Technologies and Learning. [online]. Available http://futurelab.org.uk/research/reviews/reviews_11_and12/11_01.htm

Gerson, N., Eick, S, G. (1997). Information Visualization. IEEE Computer Graphics and Applications, 29-31.

Hyungsung, P. (2005). Design and Development of a Mobile Learning Management System Adaptive to Learning Style of Students. Proceedings of the third IEEE WMTE 2005, 67-69.

Keim, D.A.(2002) Information Visualization and Visual Data Mining. IEEE Transactions on Visualization and Computer Graphics, 7(1), 100-107.

Lundby, K(ed). (2002). Knowmobile: Knowledge access in distributed training: mobile opportunities for medical students. Intermedia, 5, University of Oslo.

Mobile Learning Group. (2004). Retrieved from

http://www3.telus.net/~kdeanna/mlearning/

Morris, S. A., Yen, G., & Wu, Z., & Asnake, B. (2003). “Time Line Visualization of Research Fronts". Journal of American Society for Information Science and Technology, 54 (5)：413-422.

Roschelle, J., & Pea, R. (2002). A walk on the WILD side: how wireless handhelds may change CSCL. In G Stahl (ed) Proceedings of Computer Support for Collaborative Learning. Hillsdale, NJ: L Erlbaum & Associates.

Sharples, M. (2002). Disruptive devices: mobile technology for conversational learning. International Journal of Continuing Engineering Education and Life Long Learning, 12(5/6), 504-520.

Sharples, M., Corlett, D. & Westmancott, O. (2002). The Design and Implementation of a Mobile Learning Resource. Personal and Ubiquitous Computing, 6, pp. 220-234.

Shotsberger, p., Vetter, R. (2000). “How Mobile Wireless Technologies Will Changes Web-Based Instruction and Training”, Educational Technology, 40(5), 49-52.

Strandvall, T. (2003). Online Education in the Future: trends and technologies for e-learning. Paper presented at the 2003 BOLDIC: Baltic Nordic Network for Exchange of Experience in ODL. [online]. Available http://www.e-learnit.fi/tommy/tommy_paper.htm

Virvou, M., & Alepis, E. (2005). Mobile educational features in authoring tools for personalized tutoring. Computer & Education, 44, 53-68.

Zhang, J. (1999). Visual information retrieval environments. Ph.D. Dissertation, School of Information Sciences, University of Pittsburgh.

Zhang, J., & Wolfram, D.(2001). Visualization of Term Discrimination Analysis. Journal of The American Society for Information Science and Technology, 52(8):615–627.

Zhang, P., Whinston, A. B.(1995). Business Information Visualization for Decision-Making Support-A Research Strategy. Proceedings of the First Americas

Conference on Information Systems, August 25-27, 1995, Pittsburgh, Pennsylvania

Zhang, P.(1996). The Impact of Information Visualization on Human Problem-Solving Performance in a Complex Business Domain. Proceedings of The Second Americas Conference on Information Systems (AIS'96), 16-18.