

EXPERIENCING MUSEUM LEARNING THROUGH MULTIMEDIA INSTRUCTIONS

Asmidah Alwi*, Elspeth McKay

School of Multimedia Technology and Communication, Universiti
Utara Malaysia, Sintok, Kedah, Malaysia

Article history

Received

31 July 2015

Received in revised form

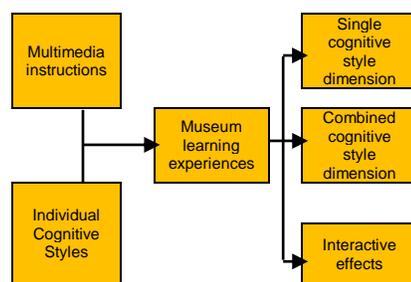
9 September 2015

Accepted

11 October 2015

*Corresponding author
asmidah@uum.edu.my

Graphical abstract



Abstract

The use of multimedia instructions for learning purposes has become very common due to the advances of the Internet technology. With this reason, museums around the world are utilizing such technology in order to provide richer museum learning experiences to their visitors. This paper discusses a study that investigated the relationship between multimedia instructional strategies with individual cognitive styles preferences in a museum environment. Comparison of the web-based and physical museum settings, the findings based on a pre-test post-test quasi experiment reveals that the general performances of museum visitors exposed to multimedia instructions in a web-based environment is better than in the physical environment. Further analysis on the individual cognitive styles preferences (SCSD) and the combined cognitive style (CCSD) were also discussed. The analysis also reveals that there is an interactive effect between the individual cognitive styles and the multimedia instructions in the museum learning experience.

Keywords: Multimedia instructions, museum learning, cognitive styles

Abstrak

Penggunaan arahan multimedia untuk tujuan pembelajaran telah menjadi kebiasaan disebabkan oleh kemajuan teknologi Internet. Dengan ini, muzium di seluruh dunia menggunakan teknologi itu dalam usaha untuk menyediakan pengalaman pembelajaran muzium yang lebih kaya kepada pengunjung mereka. Kertas kerja ini membincangkan satu kajian yang menyiasat hubungan antara strategi pengajaran multimedia dengan gaya kognitif individu di dalam persekitaran muzium. Melalui perbandingan di antara muzium berasaskan web dan muzium fizikal, penemuan berdasarkan ujian pra dan pasca menggunakan eksperimen kuasi mendedahkan bahawa pencapaian pengunjung muzium yang terdedah kepada arahan multimedia dalam persekitaran berasaskan web adalah lebih baik secara umumnya berbanding pencapaian di dalam persekitaran fizikal. Analisis lanjut mengenai gaya kognitif individu kognitif (SCSD) dan gabungan gaya kognitif CCSD) juga dibincangkan. Analisis juga menunjukkan bahawa terdapat kesan interaktif di antara gaya kognitif individu dan arahan multimedia dalam pengalaman pembelajaran muzium.

Kata kunci: Arahan multimedia, pembelajaran muzium, gaya kognitif

© 2015 Penerbit UTM Press. All rights reserved

1.0 INTRODUCTION

Multimedia is simply defined as the use of text, graphics, animation, audio and video to present information. The revolution of the Internet and the communication technologies has foreseen the information to be delivered or made available in computer-based instruction utilizing multimedia. Combination of these media or better referred as multimedia instructions allow information to be presented in a better way as compared to information dissemination in a single format. As suggested by Mayer [1] and Schnotz and Lowe [2], learning from multiple formats of instructions presumptively resulted in a better learning outcome as opposed to learning from a single format instruction. Nevertheless, there are research that proven otherwise [for example: Rasch and Schnotz [3]], hence the proposition remain inconclusive. Additionally, review of literature shows that in order to gain a more holistic understanding about how multimedia instruction could support learning, some other factors pertaining to the learning process such as the learning environment, learners' characteristics as well as institutional and administrative aspects should be considered when investigating the effectiveness of such learning instructions [4].

Considering that online learning accommodating multimedia instructions has now become prominent to support traditional learning setting or could also become an alternative form of learning on its own aiming towards effective learning experiences. Despite all the benefits and advantages of the multimedia instructions, there are challenges that need to be address. For example, the issue of which media combination will work best, and does the combination of different media formats really work in certain learning environment? Which combination works with whom? and many other issues need to be addressed. In fact, there are findings from previous work showing that not every format works for everyone. Often, there are accompanying variables must be considered when determining appropriate multimedia instructions for certain users/audiences. Schnotz [5] and Kollöffel [6] suggest that effectiveness of animation when used as instructional format depends on factors like learners' preferences towards verbal or visual format of the information, prior knowledge alongside other learners' characteristics. This therefore suggests that other factors such as learners' characteristic should be closely considered in the design of multimedia instruction for learning purposes. The diversity of learners surely forces careful and specific consideration in addressing individual needs and requirements.

Previous research that focuses on children performances when learning from multimedia instruction indicates the promises of multimedia learning. However, the findings remains inconclusive [for example see: Silverman and Hines [7] and Grimley [8]] due to other factors or learners' characteristics that should be taken into consideration when

designing multimedia learning environment. Obviously, it would be almost impossible to consider all learners' characteristics that could influence the effectiveness of multimedia instruction. Therefore, we are suggesting that investigating the way people process the information could be one of the many variables providing deeper understanding on the effectiveness of multimedia instructional format in helping the learning process. As such, individual cognitive style which is their preferred and habitual approach in organizing and representing information they receive potentially provides "an extensive and more functional characterization of students" [9]. Cognitive style is a human psychological dimension that is integrally linked to a person's cognitive system [10] whereby it is unique and likely to be a fixed aspect of a person cognitive functioning [11].

In the cognitive psychology field, several cognitive styles models have been developed. However, it should be noted that these cognitive styles models were derived from individual researchers' perspectives and contexts, hence the definition of cognitive styles therefore become very large and confusing. Riding and Cheema [12] then consolidated and categorized the various cognitive styles models into two dimensions: the wholist-analytic and verbalizer-visualizer dimensions. The wholist-analytic dimension describes the way an individual processes the information they received whilst the verbal-visual dimension explains the information representation strategy an individual adopts during thinking about the information they receive [13].

The cognitive styles model suggested by Riding has been developed into a computerized tool called the Cognitive Styles Analysis (CSA) tool enabling assessment of a person's position on the continuum for both wholist-analytic and verbal-visual dimensions based on the computer-generated ratio. Despite the critics on its reliability [14], CSA proven to be one of the most systematic and useful tool in identifying a person's cognitive preferences and have been utilized by researchers for so many years. Based on the two dimensions of cognitive styles, a person's cognitive preference is anticipated to be one of four style groups which are: analytic-verbaliser, analytic-imager, wholist-verbaliser or wholist-imager. Each of the four style group may have different basic preferences towards mode of instruction. Based on the categorization, a learner from the analytic-verbaliser category presumably will prefer text in contrast to those analytic-imager who may perform better given a captioned picture or diagram. Therefore, it is likely that different individual with different cognitive preferences will perform differently in a given context.

Based on the arguments discussed above, this research was conducted to examine the relationship between multimedia instructions in an online museum learning environment and the learners' cognitive style preferences. This paper provides the context of investigation as well as explains the experimental design. The findings will be discussed based on the results based on the results of single cognitive styles

dimension (SCSD) the combination between the cognitive style dimensions (CCSD). In addition interactive effects are also noted.

2.0 DIGITAL MEDIA IN MUSEUM CONTEXT

With the advent of Information and Communication Technology (ICT) exhibiting tools, museums are taking advantage of utilizing these technological tools to fulfill their educational roles. Instead of using the technology to record their collections into databases or embedding digital exhibits as the museum artifacts, museums are now manipulating the advantages and benefits of the ICT technology to enhance the complex process of museum learning.

ICT such as Web-based technology allows for richer instructional strategies by offering many new opportunities to enhance the design of online learning environments [15]. The literature reveals the unique nature and characteristics of the web-mediated or online environment that provides educational advantages [16]. Of particular interest is the capability of providing an interactive environment which is substantial in facilitating the current educational demand. This has been proven by looking at the increasing trend towards favoring online learning programs particularly in the increased levels of user-controlled online learning environments [17-19]. Consequently, online learning has now become important agenda for museums around the world which are adopting ICT tools that emphasize the use of Web-based multi-media. These enrich and fulfill their visitors' learning experiences [20]. Museums can now enhance their exhibits utilizing the opportunities offered by ICT tools [21, 22] hence provide richer learning experience for their online visitors.

3.0 MUSEUM LEARNING EXPERIENCE

The idea of museum learning has been interchangeably used or referred as the process of meaning making of the museum experience [23-25]. Learning in museums is in contrast to formal learning as the process resides within the visiting experiences, which take place in a setting without the requirements of a curriculum set and student attendance. Museum learning experiences have been conceptualised as the interaction of personal, social and physical contexts [23, 24]. The formulation of these three contexts has been organised and managed within the contextual model of learning as illustrated in Figure 1.

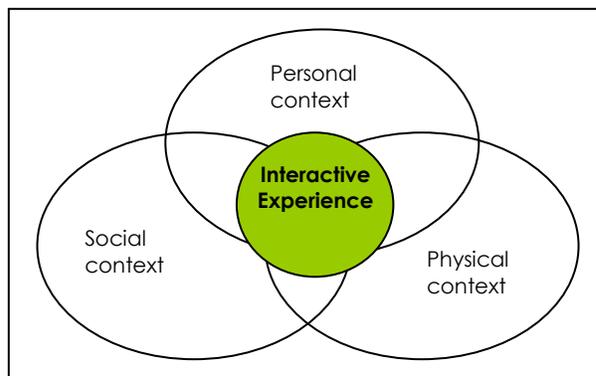


Figure 1 Contextual model of museum learning

The important point of this model is to state that learning is highly contextual. As learning is accepted as an active process as well as an outcome, information assimilates between these three contexts and depends heavily on one's mental structure/capacity [23]. Whatever event/data that has been stored within the individual's mental structure, might be interpreted in parallel as it potentially matches with existing prior knowledge, or resides as (unprocessed) information until it meets a situation which turns it into knowledge. This therefore suggests that cognitive psychology can offer valid techniques towards finding an understanding of the museum learning process [25].

4.0 THE FIELDWORK STUDY

The fieldwork employed a quasi-experimental design with three phases conducted in the primary schools and the museum. To do so, pre-test and post-test instruments were devised based on the Dinosaur Walk exhibition content as on display in the physical museum as well as in the museum website (for example; see Figure 2). To ensure that the instruments are appropriate for the participants' age group, the design and development of the instruments considered the Victorian Essential Learning Standard (VELS) which was adapted in the Dinosaur Walk Exhibition to guide the content development process. The VELS derived by the Department of Education and Early Childhood Development (DEECD) of Victoria, Australia provides the outline of what is important for all Victorian students to learn and develop during their time at school from Prep to Year 10. VELS provides a set of common state-wide standards for the schools either public or private across Victoria to plan student learning, assess student progress and prepare report to parents.

In total, there were 91 school children age 10 to 12 from three Victorian primary schools who were involved in the experiment. The first phase involved a screening test to measure the participants' cognitive preferences, using the cognitive style analysis (CSA)

computerized screening test. Based on the cognitive style ratio identified from the CSA, participants were equally assigned into the treatment group; either the online museum (T1) or the physical museum (T2) treatment groups. The CSA and the pre-test were conducted prior to the museum visit to determine the participant's prior domain knowledge related to the museum exhibits.

The treatment groups were then given access to either the online museum or the physical museum treatment respectively. For the online session, participants were given 30 minutes to browse the museum website. Meanwhile, participants of the physical visit treatment group were taken to explore

the physical exhibition in the museum within the same length of time. To conclude the experiment, a post-test was given to measure any improvement in the cognitive performance (or learning outcomes) derived from the museum's learning exhibits which was conducted at the end of the museum visit.

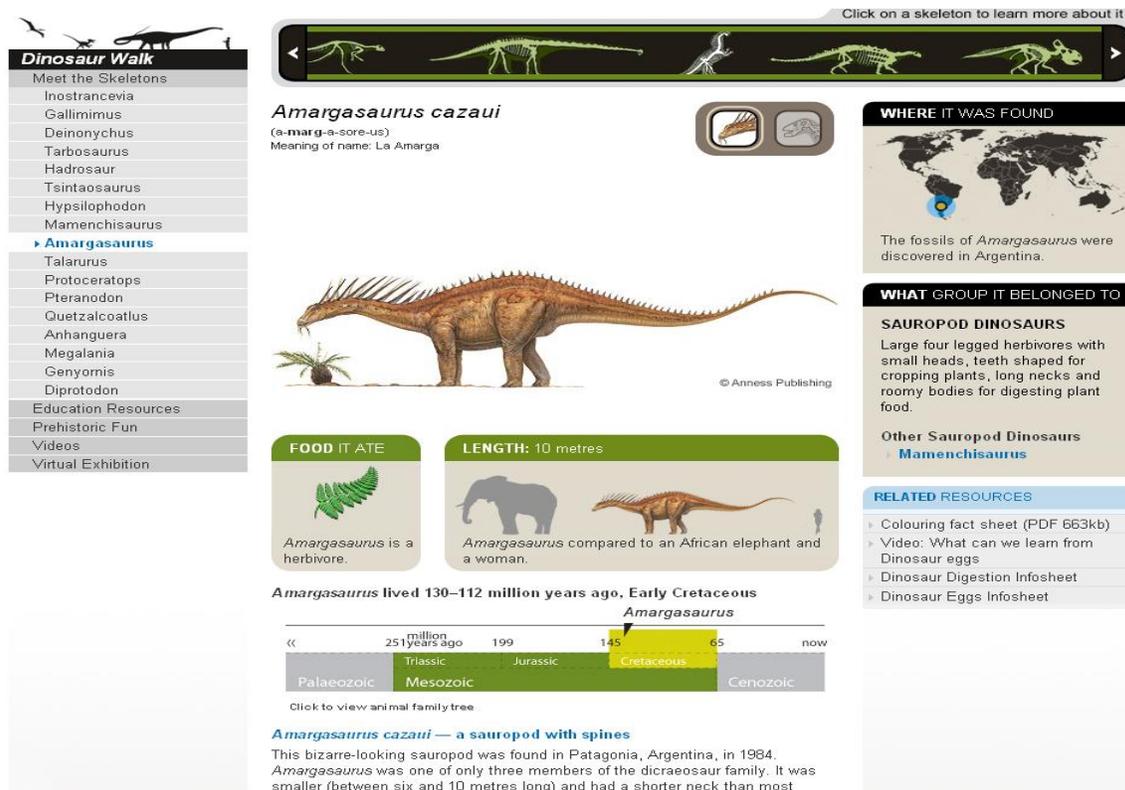


Figure 2 Example of information provided in the Dinosaur Walk website (courtesy of Melbourne Museum)

5.0 ANALYSIS AND RESULTS

The data gathered was analyzed using Quest Analysis Software [26] that applies Rasch Measurement Model. This paper will only focus on analysis on the performance of students according to the single cognitive style dimension (wholist-analytic and verbalizer-imager). Later, the analysis is extended to the combined cognitive style dimension (CCSD). In addition, further analysis was also conducted to see if there is any interactive effect of cognitive styles and the instructional strategies on museum learning performances.

The analysis based on SCSD is tabulated in Table 1. Based on the table, it is shown that the overall performance of participants in T1 has improved with

mean difference of 0.32 between pre and post-test. On the contrary, participants' performance in T2 found to decline by 0.09. Interestingly, it could be noted that all SCSD performance in the pre-test is higher in T1 compared to performance in T2.

5.1 Analysis of SCSD

Analysis on performance of SCSD as tabulated in Table 1 revealed interesting result. On the analytic-wholist dimension generally, the analytic shows a negative performance after the treatment whereas, the wholist improved significantly. Comparing both cognitive styles reveals contradictory results whereby analytics performances were better in T2 whilst wholists performed better in T1. Thus, the result indicates that

on the processing mode continuum, wholists seem to benefit most from the multimedia instruction in the web-based museum learning experience as opposed to the analytical group. On the verbalizer-imager

dimension, verbalisers outperformed imagers in T1 whereas in T2, imagers' performances were slightly better than verbalisers.

Table 1 Mean difference for SCSD according to treatment

Cognitive Style		Instructional Strategies						Mean Diff
		T1 (N=47)			T2 (N=44)			
		pre	post	diff	pre	post	diff	
All		0.34	0.66	0.32	0.85	0.76	-0.09	0.41
Processing mode	Analytic	0.75	0.67	-0.08	0.85	0.89	0.05	-0.12
	Wholist	0.33	0.65	0.32	0.84	0.73	-0.11	0.44
Thinking mode	Verbaliser	0.26	0.72	0.47	0.91	0.80	-0.11	0.58
	Imager	0.48	0.60	0.13	0.82	0.75	-0.07	0.19

5.2 Analysis od CCSD

Analyzing the CCSD, the general results indicate that performance in T1 is better compared to T2 for all CCSD. Obviously, wholist-verbaliser outperformed the other CCSD with mean difference of 0.67 in T1. The result also shows that wholist-imager perform the worst in T1 with the least mean difference of 0.08. Second best performer is the analytic-imager (0.44) followed by analytic-verbalizer (0.25).

As for T2, analytic-verbalizer found to be the best performer with only 0.11 differences in mean. However, it should be noted that analytic-verbalizer is the only CCSD that recorded improvement (with positive mean differences) when compared to the other three groups; analytic-imager, wholist-imager and wholist-verbalizer that recorded negative mean difference. This indicates that their performances declined after the treatment.

Comparison of CCSD performance in both T1 and T2 reveals interesting finding where wholist-verbalizer, the highest achiever (mean diff = 0.67) in T1 has found to perform the worst in T2 (mean diff = -0.18). The result also shows that two CCSD; analytic-imager and wholist-imager achievement is leveled with mean difference of -0.07.

Looking at the effect size determined by Cohen's *d*, wholist-verbalizer determined to have a large practical important difference (T1 mean diff = 0.67, T2 mean diff = -0.18, *d* = 1.44). The other three groups; analytic-imager, analytic-verbalizer and wholist-imager are calculated to be in the small size effect (*d* = 0.37, 0.33 and 0.23 respectively). The detailed performance of CCSD with instructional treatment (T1 and T2) is presented in Table 2.

Table 2 Performances of CCSD

Cognitive Style	Instructional Strategies				Effect Size Cohen's <i>d</i>
	T1		T2		
	Mean	SD	Mean	SD	
AI	0.44	0.79	-0.07	1.76	0.37
AV	0.25	0.50	0.11	0.31	0.33
WI	0.08	0.56	-0.07	0.72	0.23
WV	0.67	0.48	-0.18	0.68	1.44

5.3 Interactive Effects

Further analysis is to see if there is any interactive effect of the cognitive style and the instructional treatments. Figure 3 clearly illustrates that interactive effects does exist, whereby all CCSD performed better in T1 (the online museum treatment) compared to T2 (physical museum treatment). The most obvious is wholist-verbalizer where their performances were much contradicted in T1 and T2.

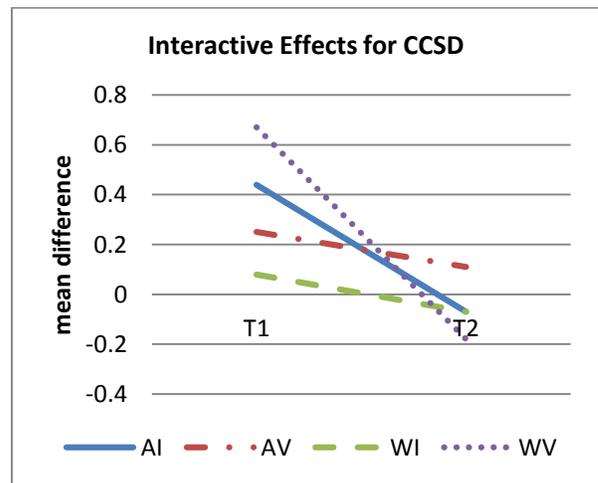


Figure 3 The Interactive effects of CCSD

4.0 DISCUSSION AND CONCLUSION

This paper discusses the differences in museum learning performance for individuals with difference cognitive preferences in with multimedia instructions in both online museum and physical museum environment. The analysis was conducted according to SCSD (analytic, wholist, verbalizer and imager) as well as according to the combination of cognitive style, CCSD (analytic-imager, analytic-verbaliser, wholist-imager and wholist-verbalizer).

Firstly, the results reveal that there is improvement in the learning performance for all SCSD in the online museum treatment but in physical museum environment, only the analytics demonstrate slight improvement. Comparing the cognitive style performances based on the wholist-analytic continuum suggests that wholist performs better in the online treatment and analytic bid the challenge in physical museum. Perhaps the combination of both textual and graphical information on the screen helps wholists to capture the knowledge easily than analytics. Meanwhile, despite having both textual and graphical information (similar to the online), the way the information being presented in the physical museum (scattered individually as objects / individual exhibits) allows analytics to process the information in chunks hence perform better than wholists.

Meanwhile, for the verbalizer-imager continuum, it could be seen that verbalizer performs better in the online environment as compared to imagers. This finding could suggest that the combination of both textual and graphical information seems to benefit verbalizers particularly when learning in an online environment. However, the consequence of both textual and graphical information being displayed together in the online could also distort the focus and concentration of the imagers. Moreover, some of the information is displayed in either text or graphical only, could possibly cause imagers to focus more on the images and miss some of the verbal information. Meanwhile, for verbalizers, they tend to focus more on the textual information therefore achieved better scores. This could be used as an indicator that online museum environment represents both textual and graphical information in a relational architecture could be an effective way to help learners with verbal cognitive preference in their learning process. This situation however differs in the physical museum in which some information could only be observed from the physical objects (exhibits). This finding is consistent with the rationale that imagers will try to picture their environment as a whole thus scored better than verbalizer.

On the other hand, analysis of the combine cognitive styles CCSD, reveals that wholist-verbalizers benefited the most from the multimedia instruction whereby they perform the best in the online museum treatment. As for the physical museum, the findings show that analytic-verbalizers have outperformed the others. Accordingly, an interaction effect was noted between the participants' cognitive

preferences and the instructional strategies in their museum learning performances.

Based on the results, it could be concluded that web-based museum exhibits using the combination of both textual and graphical information could benefits both wholists and analytics. However, the nature of the web-based information representation with such combination may provide more advantages to verbalizers than imagers. The emerging web-mediated technology tool is emphasizing the use of multimedia instruction that integrate both visual and verbal instructional formats. As people have their own cognitive preferences, attention should be given in the design and development of such learning environment particularly on the information representation formats to cater the broad range of human cognitive abilities [27].

This paper only reports the comparison between the instructional strategies of the museum exhibits (online museum exhibits and physical museum exhibits). For future work, it would be interesting to explore further in other the online environment or to conduct the same investigation using other content. As this research is manipulating the museum content which is an informal learning setting, it would be important to find out what would happen when we deal with content from formal learning environment. Other than that, investigation on other factors such as the use of frame or information structuring and other interface design issues are likely to interact with cognitive styles when affecting the learning performance. It would be interesting to see combination of other multimedia instruction such as audio and video as well on their effectiveness to increase learning performance.

Additionally, involving users during the design and development or evaluation process of such learning environment may provide richer information and detail understandings. It is a hope that findings from this study may either serve to inform the design and development of the web-based museum exhibits or for evaluation purposes. On the other hand, the findings could also be utilized in planning for information representation and of media formats in other web-based learning environment.

Acknowledgement

We would like to thank Melbourne Museum for their permission and full cooperation during the conduct of this research study.

References

- [1] R. E. Mayer 2009. *Multimedia Learning*. 2nd Edition ed. New York: Cambridge University Press.
- [2] W. Schnotz and R. Lowe 2009. External and Internal Representations In *Multimedia Learning. Learning and Instruction*. 13: 117-123.

- [3] T. Rasch and W. Schnotz. 2009. Interactive And Non-Interactive Pictures In Multimedia Learning Environments: Effects On Learning Outcomes And Learning Efficiency. *Learning and Instruction*. 19: 411-422.
- [4] M. K. Tallent-Runnels, J. A. Thomas, W. Y. Lan, S. Cooper, T. C. Ahern, S. M. Shaw, et al. 2006. Teaching Courses Online: A Review of the Research. *Review of Educational Research*. 76: 93-135.
- [5] W. Schnotz. 2008. Why Multimedia Learning is not Always Helpful. In *Understanding Multimedia Documents*. J.-F. Rouet, R. Lowe, and W. Schnotz, Eds., ed: Springer US. 17-41.
- [6] B. Kollöffel. 2012. Exploring the Relation Between Visualizer–Verbalizer Cognitive Styles And Performance With Visual Or Verbal Learning Material. *Computers & Education*. 58: 697-706.
- [7] R. Silverman and S. 2009. The Effects Of Multimedia-Enhanced Instruction On The Vocabulary Of English-Language Learners And Non-English-Language Learners In Pre-Kindergarten Through Second Grade. *Journal of Educational Psychology*. 101: 305-314.
- [8] M. Grimley. 2007. Learning from Multimedia Materials: The Relative Impacts Of Individual Differences. *Educational Psychology: An International Journal of Experimental Educational Psychology*. 27: 465-485.
- [9] S. Messick. 1984. The Nature Of Cognitive Styles: Problems And Promise In Educational Practise. *Educational Psychologist*. 19: 59-74.
- [10] E. R. Peterson, S. G. Rayner, and S. J. Armstrong. 2009. Researching the Psychology Of Cognitive Style And Learning Style: Is There Really A Future? *Learning and Individual Differences*. 19: 518-523.
- [11] R. Riding and S. Rayner. 1998. *Cognitive Styles and Learning Strategies: Understanding style differences in learning and behaviour*. London: David Fulton Publishers.
- [12] R. Riding and I. Cheema. 1991. Cognitive Styles-An Overview And Intergration. *Educational Psychology*. 11: 193-215.
- [13] R. Riding and E. Sadler-Smith. 1997. Cognitive Style and Learning Strategies: Some Implications for Training Design. *International Journal of Training and Development*. 1: 199-208.
- [14] E. R. Peterson, I. J. Deary, and E. J. Austin 2003. The Reliability Of Riding's Cognitive Style Analysis Test. *Personality and Individual Differences*. 34: 881-891.
- [15] T. Anderson. 2008. Ed. *The Theory And Practice Of Online Learning*. Edmonton: Anthabasca University Press.
- [16] J. Martin, E. McKay, E. Hawkins, and Murthy. 2007. Design-personae: Matching Students' Learning Profiles In Web-Based Education. In *Enhancing Learning Through Human-Computer Interaction*. ed London: Idea Group.
- [17] T. Anderson and F. Elloumi. 2004. *Theory and Practice of Online Learning (Issues in Distance Education)*. Antabasca: Anthabasca University Press.
- [18] D. H. Jonassen, K. L. Peck, and B. G. Wilson. 1999. *Learning with Technology: A Constructivist Perspective*. New Jersey, Ohio: Prentice Hall.
- [19] A. Inglis, P. Ling, and V. Joosten. 1999. *Delivering Digitally: Managing the Transition to the Knowledge Media*. London: Kogan Page.
- [20] P. Lester. 2006. Is the virtual exhibition the natural successor to the physical? *JOURNAL OF THE SOCIETY OF ARCHIVISTS*. 27: 85-101.
- [21] B. Soren and N. Lemelin. 2004. Cyberpals!/Les Cybercopains! A Look at Online Museum Visitor Experiences. *Curator*. 47: 56-83.
- [22] B. Soren. 2005. Best Practices In Creating Quality Online Experiences For Museum Users. *Museum Management and Curatorship*. 20: 131-148.
- [23] J. H. Falk and L. D. Dierking. 1992. *The Museum Experience*. Washington D. C.: Whalesback Books.
- [24] J. H. Falk and L. D. Dierking. 2000. *Learning from Museums: Visitors Experiences and the Making of Meaning*. Walnut Creek: AltaMira Press.
- [25] G. E. Hein. 1998. *Learning in the Museum*. London and New York: Routledge.
- [26] R. J. Adams and S.-T. Khoo. 1996. QUEST: The Interactive Test Analysis System. ed. Victoria, Australia: Australian Council for Educational Research.
- [27] McKay. 2003. E., Managing the Interactivity of Instructional Format and Cognitive Style Construct in Web-Mediated Learning Environments, in *Advances in Web-Based Learning–ICWL 2003*, W. Zhou, et al. Editors. 2003. Springer: Berlin Heidelberg. 308-319.