INTEGRATION MODEL OF MOBILE LEARNING BASED ON AUGMENTED REALITY TECHNOLOGY

ZARWINA BINTI YUSOFF

A dissertation submitted in fulfilment of the
requirements for the award of the degree of
Master of Science (Information Technology-Management)

Faculty of Computing
Universiti Teknologi Malaysia

JANUARY 2014

"Dissertasi ini didekasikan teristimewa buat Ayahanda tercinta En Yusoff bin Hj Moin & Bonda tersayang Pn. Wakinah binti Atmo, serta semua ahli keluarga, yang sentiasa memberikan sokongan padu dan titipan doa dalam meneruskan perjuangan hingga ke akhirnya"

"May you find success in the path chosen for you, by Allah"

.

ACKNOWLEDGEMENT

With the name of ALLAH and The Merciful. All praise goes to ALLAH, God of. The Universe and All living things. Sholawat to Prophet of Muhammad S.A.W. Thankful to God that gave me the unbelievable strength to successfully complete this thesis and research. I thank to my father and mother also my family for their patience, understanding, support, pray and love. Without their support, I would not be able to finish this thesis.

I wish to express my sincere appreciation to my supervisor, Dr.Halina Mohamed Dahlan and Dr Ab Razak Che Hussin who is always encouraging and who has helped me to do successful research. There are always supported on my research ideas and activities until this research prototypes, Animal Fun Learning through Augmented Reality (AF-LAR) was awarded as a Silver Medal in ICRIIS'13 Innovation Showcase.

I am also indebted to Malaysia Government Programme for funding my studies with My Brain 15 Scholarship and Tabung Pendidikan Yayasan Angkasa. I able to complete my studies and concentrate on my research without facing any financial problems.

My sincere appreciation also extends to all my friends and others who have provided assistance at various occasions. Last but not least to UTM ViCubeLab's group members, Assoc. Prof Dr. Mohd Shahrizal bin Sunar, Dr Farhan Mohamed and Dr. Ahmad Hoirul Basori for their motivation, encouragement and inspiration in conducting my research successfully. Besides that, thank you to Prof Dr. Naomie Salim and all MSc IT Management lecturers' and friends; Siti Aminah, Siti Hidayah, Syamilla ,Sufiah, and Azila for their ideas, help and contribution in completing my thesis. May Allah bless all of you. Amin.

.

.

ABSTRACT

The limitation of current e-learning technology has caused a lack of student attention in educational environment. Therefore, this study describes the integration of mobile based learning through Augmented Reality Environment to incorporate the student attention elements by computer-generated content. To incorporate student attention element, this thesis propose an integration model of mobile learning through Augmented Reality, which the focused user is Standard 1 Primary School Student. To validate the model integration, this study has developed the AR prototype called AF-LAR (Animal Fun Learning - Augmented Reality) through smart phone technology as mobile based learning device. (AF-LAR) is an AR Book that adapts learning concept via mobile devices and enables student to bring and access the learning content anywhere and anyplace. AF-LAR has been developed using Metaio and Junaio channel while the design is incorporated with visual learner styles from Visual Auditory Kinesthetic (VAK) model with information visualization approach. The result of this study is evaluated by using attention element in Keller's Motivation ARCS Model to prove the student attention attribute from the prototype based on the five experts' perspective as targeted respondent. Descriptive statistics was chosen as a technique to evaluate the mean and reliability of attention attribute inside the proposed integration model to achieve the student attention in education environment.

ABSTRAK

Keterbatasan teknologi pembelajaran sedia ada telah menyebabkan pelajar kurang memberikan tumpuan semasa proses pembelajaran. Oleh yang demikian, kajian ini menerangkan integrasi model pembelajaran mudah alih berasaskan *Augmented Reality (AR)* dalam menggabungkan elemen tumpuan pelajar melalui teknologi janaan komputer. Untuk menggabungkan elemen tumpuan pelajar; kajian ini akan mencadangkan integrasi model pembelajaran mudah alih berasaskan teknologi AR yang direka untuk pelajar Tahun 1, Sekolah Rendah di Malaysia. Dalam mengesahkan cadangan model integrasi, kajian ini telah membangunkan prototaip AR yang dipanggil AF- LAR (*Animal Fun Learning-Augmented Reality*). *AFLAR* adalah Buku AR yang mengadaptasikan konsep pembelajaran melalui peranti mudah alih yang membolehkan pelajar membawa dan mengakses kandungan pembelajaran di mana-mana dengan mudah. *AF- LAR* telah dibangunkan dengan menggunakan perisian Metaio dan saluran Junaio dan reka bentuk yang dipadankan dengan model pembelajaran secara visual, auditori dan kinestetik beserta pendekatan maklumat visualisasi. Berdasarkan hasil pengujian, semua min telah mencapai standard yang telah ditetapkan. Hal ini telah menunjukkan ciri-ciri yang terdapat di dalam model cadangan boleh meningkatkan tumpuan pelajar melalui perlaksanaan prototaip. Kajian ini diharapkan dapat dijadikan panduan kepada penyelidik lain dalam mengintegrasikan model pembelajaran mudah alih berasaskan Teknologi AR dalam usaha untuk meningkatkan proses e-pembelajaran semasa dan untuk menggabungkan elemen perhatian pelajar di dalam persekitaran pendidikan.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURE

LIST OF ABBREVIATION

AR	-	Augmented Reality
3D	-	3 Dimension
VR	-	Virtual Reality
VE	-	Virtual Environment
GPS	-	Global Positioning System
GPRS	-	General Packet Video Service
UMPC	-	Ultra Mobile Personal Computer
ARCS	-	Attention, Recall, Confident, Satisfaction
VAK	-	Visual Auditory Kinesthetic
DST	-	Dunia Sains Teknologi
AF-LAR	-	Animal Fun Learning Augmented Reality
ICT	-	Information Communication Technology
MLearn	-	Mobile Learning
SDK	-	Software Development Kit
XML	-	Extensible Markup Language
HTML	-	Hypertext Markup Language
AREL	-	Augmented Reality Programming Language
PA	-	Perceptual Arousal
IA	-	Inquiry Arousal
V	-	Variability

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Introduction

This study will focus on integrating of mobile learning model through Augmented Reality Technology (AR) in order to incorporate the student attention elements from the limitation of current e-learning technology. In order to motivate this study, its support by the current research in mobile learning where is more focusing on evaluating the effectiveness of mobile learning systems, and the designing of mobile learning systems.

Mobile learning was choosing because of the progress development of communication and wireless technology in various fields. In a directly, it appear a new embedding application in Smartphone's such as email, productivity software, audio and video recording through camera, and others new features to be execute through the devices. This entire scenario is bringing the existing of mobile learning technology to enhanced learning technique in formal or informal environment to make the learning environment more interactively

The current research shows that, many students are lack of attractions in the current learning session. The concept of traditional book that used in primary school is having some limitation in convey the information especially in engaging their attraction during learning process. In realizing the enhancement of engaging student attraction through mobile learning, AR was choosen in enhancing the features of m-learning in term of visualize the learning

content to be appear in the real environment. This is because AR can make the learning environment more conducive and dynamic through the concept of visualizing the object as a learning content. Besides that, the features of AR which is registering the object in 3D, interactive in real time and combining the real and virtual object to be augmenting in real environment are supporting the visualization based approach to be embedded in mobile devices.

The model of mobile learning is proposed in this research to improve the learning technology through the integration of AR which is an emerging technology that enables users to see the virtual object in the real environment. The model will be proposed to support student attention via mobile learning where it can be improve the current limitation of e-learning software. Yet, there is limited research that conducted focuses on exploring the model integration of mobile learning through AR in enhancing student attention through visualization.

In order to achieve the objective, this study will implement the model integration through the concept of AR Book in gaining student's attraction during learning Science and technology for primary school in exploring the Animal World via mobile devices. The concept of AR Book is visualizing the 3D object through the learning content which can be display through mobile and tracking the object through the book.

1.2 Background of Problem

As far as the progress of e-learning technology as a medium in learning process, many researchers try to improve the learning process through technology as a key in enhance the students attention. Today, many mobile devices such as cell phones, notebooks and tablet computer are gaining more relevance to learning environments and education.

The progress of AR in computer platform had moved this technology in mobile computing area to generate more user experience on it. The first mobile AR systems, such as

Feiner's Touring Machine (Feiner et. al. 1997) relied on bulky backpack worn computers and custom build hardware, but Feiner was showed the potential of mobile AR systems for outdoor context sensitive information overlay, and the next is AR Quake where was develop by Thomas et al.2002 showed how these same could be used for outdoor gaming.

Furthermore, the emerging of technological concepts in education was generating the rapid development of education where it was bringing it into mobile based learning technology. O' Mally et al. 2003 have defined mobile learning as taking place when the learner is not at a fixed, predetermined location, or when the learner takes advantage of learning opportunities offered by mobile technologies.

Kukulska-Hulme (2005) defined mobile learning as being concerned with learner mobility in the sense of learners should be able to engage in educational activities without being tied to a tightly-delimited physical location. The traditional learning concept in education normally was bringing students in a classroom, using a normal text books, teacher explains the course based on their syllabus and using a white board or marker to give the overall explanation about the topic, scope of an experimental, observations and the real imaginations to engage students understanding level and their attractions in this learning process.

The traditional education is conducted in school are based on normal text books are less of student attention and focus. In order to enhance the student attention, the current research began to adapting the technology to enhanced learning. The usage of e-learning technologies via computer based tools like courseware application and slide based environment are the current adaptation in attract student to engage in their learning session. In generate the student attention, the concept of visualization is the most an effective ways to make the object is real and seeing through their eyes. Based on that, this study was change the adaptation of traditional learning into e-learning and directly moves it into mobile learning technology by incorporating student attention elements.

Student attention is the learner characteristics that must have during learning process, to generate their motivation. Attention is the important behavior of learner which can stimulate

learners to involve the student engagement and participation in construct the positive learning outcomes. The positive learning outcome only can achieved when student focuses in the learning content that conveying from any tools or method in teaching and learning process.

AR is an effective ways in visualize the learning content in enhance student attention. This emerging technology can be used in any fields to helping user in visualize the object or information in any situations. The progress of technology was bringing the e-learning to change into mobile learning to be adapting with the current embedding software in mobile. Although mobile learning is the powerful platform in conveying the learning content, it's still has some limitation in conducting the current research in mobile learning in order to incorporate student attention elements. In order to incorporate student attention elements through mobile, this study will propose the concept of mobile learning model to be integrated with Augmented Reality in enhance student attention in conveying the learning content through the adaptation of traditional books into AR Magic Book from mobile perspectives. The definition of mobile in this research is focus on using Smartphone's technology to embedding the AR content as an integration platform to achieve student attention through the AR Book.

1.3 Problem Statement

The main question in this research is **"How to model the AR integration in mobile learning by incorporate student attention elements?"** Besides the model integration as main problem in this research; the following question also needs to be solved:

- What is the limitation of current learning technology?
- What is the model that can be used in order to integrate mobile based learning through AR by incorporating student attention elements?

Based on the above problem statement, this research will be implementing based on incorporating student attention element in a classroom through Augmented Reality as an

emerging technologies. The terms of incorporating student's attention in AR is to construct the learning concept based on model integration of AR through mobile as learning tools. The objective for this research is clearly defines in next section.

1.4 Research Objective

The main objective of this research is to embed AR into mobile learning to improve the learning technology in classroom using the AR. In order to actualize this aim, there are other objectives that need to be achieved which are:

i. To investigate the limitation of current learning technology regarding to student attention problems

ii. To investigate the current integration of AR in mobile learning

iii. To propose the model integration of mobile learning through Augmented Reality by incorporating student attention elements.

1.5 Scope of Study

This research aim on integration of mobile learning technology which is focuses on Smartphone's environment and how the augmented reality can be embedded in the smart phone's through model integration. Based on the combination, technology incorporate student attention elements through concept of visualization and visual learner styles when embedding AR through mobile devices for educational purposes. The detailed of scope of study in this research are like below:

- Investigate the appropriate topic in learning science and technology for primary school student to be chosen in AR to be synchronizing into prototype
- Exploring about types of animal worlds that can be adapted into AR Book as a prototypes implementation

- Investigate the concept of visual learner and visualization to be embedding in design and develop the prototype by incorporating student attention elements.

1.6 Significance of Study

The powerful of innovative technology by Smartphone's will be used and can adapt in learning process as a new platform to improving the effective and efficiency of the technology by incorporate student's attention elements during learning process. The mobile learning concept through AR is a very great application that will shows to all student in what their learnt in real time, without go anywhere because this application are ubiquitous and portable can bring anywhere. This research will give the more value in AR environment especially on mobile platform, visualizing the learning in learning creatively, it also is supported by the easier way the mobile as a colorful display platform where it can increase student memorable, completed with the real experience in using it.

In realizing to bring AR on mobile phones, the future concept must to be appropriate with the mobile environment and user's experiences. So, in a directly, in this research it will investigate the concept of visualization that can be embedded in Book with AR Technology based on Science and Technology subject which can influences the learning through visual concept. All of the significant of this research will be achieve when the integration model of Mobile Learning through AR are proposed and can perform successfully.

Lastly, the significance of this study is, student will be exposure with the latest technology in mobile learning system, use the devices such as Smartphone's, tabs and mobiles effective and efficiently for learning purpose in contributing the student attention . The visual object will give more effects to students in term their memorizing, understanding and giving their motivations based on in learning by technologies.

1.7 Chapter Summary

This chapter discussed the overview of this study which firstly explains about a brief introduction about the research topic. The introduction discussed about concept of mobile technology and the adapted in the mobile learning technology to be function in educational environment. Some of the characteristic of mobile learning are introduced and AR Concept is briefly explains to be introduces in this study.

Chapter 1.2 discussed about the problem background of this research which explained about the limitation of current learning technology, where was brought it into e-learning and next into mobile learning technology where it can enhanced through visualization concept in AR as a tool to incorporate student attention elements.

There are three main objectives mentioned that need to be achieved which are first, to investigate the limitation of current learning technology and improve it through mobile, to investigate the current integration of AR as learning tools in mobile learning, to propose the model integration of mobile learning through AR and lastly and to evaluate model integration through prototype development. This chapter ends with explanation about significant of research conducted such as providing an AR Book Prototypes through mobile dimensions in order to enhance the concept of traditional book by incorporate student attention elements.

REFERENCES

A. Henrysson , Bringing Augmented Reality to Mobile Phones. Dissertation, No 1145, p.8-8, 2007

Azuma.R, A Survey of Augmented Reality.Presence :Teleoperators and Virtual Environments 6:4, 3-3, 1997

Azuma R. Special Section on Mobile Augmented Reality.Science Direct Journal. Computer & Graphics 35 (2011)vii-viii

Azuma. R, S.You, U.Neumann. Hybrid Inertial and Vision Tracking for Augmented Reality Registration University of Southern California, 1999

Abas, H., & Zaman, H. B. (2011). Visual Learning through Augmented Reality Storybook 2 Literature Review : Remedial Student, 157–167.

Bajura M. and Ulrich N.(1997). Dynamic registration correction in video-based augmented reality systems. *IEEE Computer Graphics and Applications*, 15:5 52-60, September.

Bishop, G. and Fuchs, H., 1992. Research directions in virtual environments.Computer Graphics, 26(3) August, pp.153-17.

B. Thomas, B. Close, J. Donoghue, J. Squires, P. De Bondi, M. Morris and W. Piekarski, "ARQuake: An Outdoor/Indoor Augmented Reality First Person Application", Proceedings of the 4th International Symposium on Wearable Computers, 2000, pp. 139-146.

Billinghurst M, Kato H., and Poupyrev I. (2001). The magic-book – moving seamlessly between reality and virtuality, *IEEE Computer Graphics and Applications* 21 no. 3, 6–8, ISSN 0272-1716.

C.V. Ramdas, N. Parimal, M. Utkrash, S. Sumit, K. Ramya, B.P. Smitha, " Application of Sensors in Augmented Reality based Intearctive Learning Environments", 2012 Sixth *International Conference on Sensing Technology (ICST), IEEE* 2012

Carmichael, G., Biddle, R., & Mould, D. (2012). Understanding the Power of Augmented Reality for Learning, 1761–1771.

C. Widemann, M.Ulrich, and C. Steger, "Recognition and tracking of 3D objects," Lect. Notes Computer Science, vol.5096, pp.132-141, 2008

Chen, C.-M., & Tsai, Y.-N. (2012). Interactive augmented reality system for enhancing library instruction in elementary schools. *Computers & Education*, 59(2), 638–652. doi:10.1016/j.compedu.2012.03.001

Keegen . D 2002; The future of Learning: From e-learning to m-learning, november 2002, Fern University

D.wagner and D. Schmalstieg.Artoolkit on the pocketpcpaltform .Tech.Rep. TR-188-2-2003, Technical Univ. of Vienna, 2003

D.wagner and D. Schmalstieg. Handheld Augmented Reality Displays .*In IEEE Virtual Reality Conference*,p.321-321, 2006

D. Wagner. History of Mobile Augmented Reality, Christian Doppler Laboratory for Handheld Augmented RealityProceedings of the *International Symposium on Mixed and Augmented Reality (ISMAR 09)*, 2009

D.W.F. van Krevelen and R. Poelman. A Survey of Augmented Reality Technologies, Applications and Limitations, The *International Journal of Virtual Reality*, 2010, 9(2):1-20

D, Forsyth, and J.Ponce, Computer Vision- A modern approach, 1st edition, New Jersey:Printice Hall, 2002

E. Bostanci, N. Kanwal, S. Ehsan, A. F. Clark, "Tracking Methods for Augmented Reality", International Conference on Machine Vision (ICMV2010), pp.425-429, *IEEE*, Hong Kong, 2010

Editors, S., Vaishnavi, V., & Kuechler, B. (n.d.). Design Science Research in Information Systems Overview of Design Science Research.

F. Yu. Real Time Augmented reality on Mobile Phone , University of Minchigan, 2012

Fiala M.,(2005). ARTag, a fiducial marker system using digital techniques, in Proc. CVPR 2005, San Diego, CA, pp. 590-596.

Fischler, M.A., & Bolles, R.C.(1981). Random sample consensus: a paradigm for model fitting with applications to image analysis and automated cartography. Communication *ACM*, 24(6), 381-395.

Fleming, N. D., Fleming, N. D., & Mills, C. (1992). Not Another Inventory , Rather a Catalyst for Reflection Not Another Inventory , Rather a Catalyst for Reflection.

VAK Model : http://www.jcu.edu.au/wiledpack/modules/fsl/JCU_090460.html

F.Zhou, H.B.L. Duh, M. Billinghurst. Trends in Augmented Reality Tracking, Interaction, and Display :A Review of Ten Years of ISMAR, *International Symposium in Mixed and Augmented Reality*

Neil Fleming's. (2001) VAK Model, Wikipedia, http://en.wikipedia.org/wiki/Learning_styles

Gu, Y. X., Koh, R. K. C., Chen, V. H.-H., & Duh, H. B.-L. (2010). Facilitating Learning Interests Through Mobile Information Visualization. 2010 10th IEEE International Conference on Advanced Learning Technologies, 323–327. doi:10.1109/ICALT.2010.92

Gaved, M., Mor, Y., & Thomas, R. (2012). Augmented reality and mobile learning : the state of the art Conference Item the state of the art.

Ozamli F, Cavus N, Basic elements and characteristics of mobile learning, Science Direct Journal. Com Procedia - Social and Behavioral Sciences 28 (2011) 937 – 942

Klopfer, E. and Squire, K. (2008). "Environmental Detectives – The Development of an Augmented Reality Platform for Environmental Simulations." *Educational Technology Research and Development* 56: 203-228.

Kounin, J. S., Sherman, L. W., Kounin, J. S., & Sherman, L. W. (2013). Behavior Settings, 18(3), 145–151.

Laouris, Y., & Eteokleous, N. (2005). WE NEED AN EDUCATIONALLY RELEVANT DEFINITION OF MOBILE, (June).

Hiltz, S.R. and Turoff, M. (2002). " What makes learning networkseffective?",Communicationsof the ACM(45:5) 2002, pp56-59

H. Kato and M. Billinghurst, Marker tracking and HMD calibration for a video-based augmented reality conferencing system, *Proceedings of the 2nd IEEE and ACM International Workshop on Augmented Reality (IWAR 99)*, 1999, pp. 85-94

H.-K. Wu, S. W. Y. Lee, H.-Y. Chang,, & J.-C. Liang, "Current status, opportunities and challenges of augmented reality in education". *Computers & Education*, 62, 41–49. (2013). doi:10.1016/j.compedu.2012.10.024

Ismail A.W. "*Single Point Interaction in Augmented Reality*", A thesis for Master Degree of Science (computer Science),UniversitiTeknologi Malaysia, 2011

James R. Vallino. Interactive Augmented Reality.Phd Thesis, University of Rochester, Rochester, NY.Nivember 1998

J. Fruend, C. Geiger, M. Grafe and B. Kleinjohann, "The Augmented Reality Personal Digital Assistant", Proceedings of the Second *International Symposium on Mixed Reality (ISAR),* 2001.

J.P. Lima, F. Simoues, L. Figueirido, J. Kelner, Model Based Markerless 3D Tracking applied to Augmented Reality SBC Journal on 3D Interactive Systems, volume1, 2010

J. Keller, “Integrating motivation 1,” 2000. How to integrate learner motivation planning into lesson planning: The ARCS model approach

J.K. Gilbert (ed.), Visualization in Science Education, pp 43-60. 2005 Springer,printed in the Netherlands.

Kiriakos N. Kutulakos, James Vallino, "Affine Object Representations for Calibration-Free Augmented Reality". Proc. 1996 *IEEE Virtual Reality Ann.Int.Sym*.(VRAIS'96).

Klopfer, E., Education, T., & Squire, K. (n.d.). Environmental Detectives – The Development of an Augmented Reality Platform for Environmental Simulations., 1–50.

Kukulska-Hulme, A. (2005). Current uses of wireless and mobile learning – Landscape study on the use of mobile and wireless technologies for teaching and learning in the Post-16 sector. JISC-funded project. Retrieved February 14, 2007

Luckin, R. and Stanton Fraser, D. (2011). "Limitless or pointless? An evaluation of augmented reality technology in the school and home." International Journal of Technology Enhanced Learning 3(5): 510-524.

Luckin, R., & Fraser, D. S. (2011). Int. J. Technology Enhanced Learning, Vol. 3, No. 5, 2011, 3(5).

Laouris, Y., & Eteokleous, N. (2005). WE NEED AN EDUCATIONALLY RELEVANT DEFINITION OF MOBILE, (June).

Mayer et .al 2008 R. E. Mayer. Multimedia learning. In The Psychology of Learning and Motivation { Advanced in Research and Theory, volume 41, pages 85{139, San Diego,2002. Academic Press.

Mahanta, D., & Ahmed, M. (2012). E-Learning Objectives , Methodologies , Tools and its Limitation, (1), 46–51.

M. Möhring, C. Lessig and O. Bimber, “Video See-Through AR on Consumer Cell Phones”, Proceedings of the 3th IEEE/ACM international Symposium on Mixed and Augmented Reality (ISMAR 04), 2004, pp. 252-253.

Medicherla, P. S., Chang, G., & Morreale, P. (2010). Visualization for increased understanding and learning using augmented reality. Proceedings of the international conference on Multimedia information retrieval - MIR ’10, 441. doi:10.1145/1743384.1743462

N.Nashirah ,N. Mahadzir, L. F. Phung, “The Use of Augmented Reality Pop-Up Book to Increase Motivation in English Language Learning For National Primary School”, Journal of Research & Method in Education (IOSR-JRME), Volume 1, Issue 1 (Jan-Feb 2013), pp. 26-38.

Oh, S., & Woo, W. (2007). Augmented Gardening System with Personalized Pedagogical Agents, 1–2.

O'Malley, C., Vavoula, G., Glew, J.P., Taylor, J., Sharples, M., & Lefrere, P. (2003). MOBIlearn WP4 – Guidelines for Learning/Teaching/Tutoring in a Mobile Environment. Retrieved February 14, 2007 from: http://www.mobilearn.org/download/results/guidelines.pdf

Paivio, A. (2006). Dual Coding Theory and Education, 1–20.

Parsons, D., & Cranshaw, M. (2007). A Design Requirements Framework for Mobile Learning Environments, 2(4), 1–8.

Prasertsilp, P. (2013). Mobile Learning : Designing a Socio-Technical Model to Empower Learning in Higher Education Mobile Learning : Designing a Socio-Technical Model to Empower Learning in Higher Education, 2(1).

Peng, H., Su, Y., Chou, C., & Tsai, C. (2009). Ubiquitous knowledge construction: mobile learning re-defined and a conceptual framework. Innovations in Education and Teaching International, 46(2), 171–183. doi:10.1080/14703290902843828

P. Smith, & V. Brown, (2011). Mobile Augmented Reality as an Emerging Technology in Education. In M. Koehler & P. Mishra (Eds.), Proceedings of Society for Information Technology & Teacher Education International Conference 2011 (pp. 3362-3365)

R. E. Mayer and R. C. Clark. e-learning and the Science of Instruction: Proven Guidelines for Consumers and Designers of Multimedia Learning. John Wiley and Sons, 2. edition edition, 2008.

R. A. Burkhard, (2005)." Strategy Visualization : A New Research Focus in Knowledge Visualization and a Case Study Introduction : Strategy Implementation through Visualizations Related Work : Towards the New Field Strategy Visualization".

S. Feiner, B. MacIntyre, T. Höllerer and A. Webster, "A touring machine: Prototyping 3D mobile augmented reality systems for exploring the urban environment", Proceedings of First IEEE International Symposium on Wearable Computers (ISWC '97), 1997, pp 74–81. Cambridge, MA.

Sraples M, Taylor J, Vavoula G, Towards a Theory of Mobile Learning , Centre for Educational Technology and Distance Learning, University of Birmingham, UK, September 2005

T.Roffman , T.Frise, Mobile Augmented Reality for Learning , Seminar: Mobile Learning Winter Semester 2011/2012, Computer Supported Learning Research Group

S. Malik. Robust Registration of Virtual Object for Real Time Augmented Reality,Master thesis, Ottawa-XCarletonInstitute of Computer Science, Carleton University, 2002

Schmalstieg, D., Fuhrmann, A., Szalavari, Z., Gervautz, M., (1996).StudierstubeAn Environment for Collaboration in Augmented Reality. In CVE ’96 Workshop Proceedings, 19-20th September 1996, Nottingham, Great Britain

T.Domhan. Augmented Reality on Android Smartphones. Jun 2010

U. S. Junghare, V. M. Thakare , & R. V. Dharaskar, “Review based comparative study of visualization techniques for learning on mobile devices”, (2011).

Vachetti, L., Lepetit, V., & Fua, P. (2004, October). Stable real – time 3D tracking using online and offline information. IEEE Transactions on Pattern Analysis and Machine Intelligence, 26(10), 1385-1391.

Visual Learning Styles, accesses by http://www.vark-learn.com/english/page.asp?p=biography Editors, S., Vaishnavi, V., & Kuechler, B. (n.d.). Design Science Research in Information Systems Overview of Design Science Research.

Winters, N. (2006). What is mobile learning? In M. Sharples (Ed.), Big issues in mobile learning: Report of a workshop by the kaleidoscope network of excellence mobile learning initiative, University of Nottingham

William A.Hoff, khoi Nguyen. "Computer vision-based registration techniques for Augmented Reality"Procedings of Intelligent Robots and Computer Vision XV, SPIE Vol. 2904, Nov 18-22, 1996, Boston, MA, pp.538-548

Wu, H.-K., Lee, S. W.-Y., Chang, H.-Y., & Liang, J.-C. (2013). Current status, opportunities and challenges of augmented reality in education. Computers & Education, 62, 41–49. doi:10.1016/j.compedu.2012.10.024

Wu, W.-H., Jim Wu, Y.-C., Chen, C.-Y., Kao, H.-Y., Lin, C.-H., & Huang, S.-H. (2012). Review of trends from mobile learning studies: A meta-analysis. Computers & Education, 59(2), 817–827. doi:10.1016/j.compedu.2012.03.016

Y. Park and J. M. Brill, “Emerging Technologies to Support Engaged Learning in the Interaction Age : Taking a Pedagogically Disciplined Approach to Innovation,” 2007.

Yuen, S. C., & Johnson, E. (2011). Augmented Reality : An Overview and Five Directions for AR in Education, 4, 119–140.

Zonglei HUANG. "Computer Vision-based Registration for Augmented Reality".A thesis for degree of Master of Science, Canada, 2002

Zagoranski, S., & Divjak, S. (2003). Use of augmented reality in education. *The IEEE Region 8 EUROCON 2003. Computer as a Tool*., 2, 339–342. doi:10.1109/EURCON.2003.1248213