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**REQUIREMENTS MODEL OF COLLABORATIVE MOBILE
LEARNING (CML)**



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MASTER OF SCIENCE (INFORMATION TECHNOLOGY)

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Abstrak

Teknologi mudah alih merupakan satu alatan inovasi yang membantu pembelajaran. Namun, kajian sedia ada berkaitan pembelajaran mudah alih (m-pembelajaran) belum benar-benar menggabungkan pendekatan pembelajaran tertentu bagi menghasilkan cara baru yang memberi manfaat kepada pembelajaran. Ekoran itu, banyak penyelidik percaya bahawa terdapat keperluan untuk menerapkan model pedagogi dan arahan ke dalam teknologi m-pembelajaran, terutamanya bagi menyokong pembelajaran berkumpulan. Pada masa sama, banyak penemuan menunjukkan bahawa pereka bentuk berhadapan cabaran dalam mereka bentuk sistem yang menyokong kerjasama melibatkan pelbagai alatan. Justeru, para pengkaji mencadangkan agar inisiatif membangunkan kerangka bagi pembelajaran moden dalam pelbagai persekitaran diusahakan. Kerangka tersebut perlu menyediakan maklumat yang kaya melalui m-pembelajaran bagi pembelajaran berkumpulan. Usaha ini membolehkan pembelajaran kolaboratif (CL) yang lancar, menyeronokkan, dan anjal berlaku. Oleh itu, kajian ini mengenalpasti kebarangkalian pembangunan model instruksional bagi aplikasi mudah alih yang menggabungkan CL dan m-pembelajaran yang dinamakan model pembelajaran mudah alih kolaboratif (CML). Bagi tujuan tersebut, mengenalpasti keperluan utama dengan meneroka isu-isu penting dalam model sedia ada dan kajian berkaitan dalam karya sedia ada, di samping menemubual pelajar merupakan keutamaan kajian ini. Model yang diusulkan dan prototaip yang dibangunkan telah dinilai dan disahkan oleh empat orang pakar. Di samping itu, 43 responden kajian telah menggunakan prototaip dan memberi maklumbalas penerimaan mereka menggunakan borang soal selidik model penerimaan teknologi (TAM). Hasil ujian menunjukkan penerimaan terhadap model amat tinggi, mengesahkan kefungisian CML. Penemuan seperti ini mencadangkan bahawa model tersebut mampu memperbaiki produktiviti, menunjukkan cara menggunakan teknologi mudah alih dalam CL. Kajian ini merupakan panduan kepada pereka bentuk dan pembangun dalam bidang m-pembelajaran.

Keywords: pembelajaran mudah alih (m-pembelajaran), pembelajaran kolaboratif (CL), pembelajaran mudah alih kolaboratif (CML), reka bentuk instruksional, aplikasi mudah alih Android.

Abstract

Mobile technology is one of innovative tools used to facilitate learning. However, the existing studies related to mobile learning (M-learning) have not deeply combined relevant learning approaches for giving a new way that benefits the learning sphere. Accordingly, many researchers believe that there is a need to incorporate pedagogical and instructive models into M-learning technology, especially for supports of team-learning. At the same time, many investigations prove that designers faced challenges in designing systems that involve collaboration with various stationaries. Therefore, researchers suggest for an initiative on more investigations for modern learning in modeling of M-learning domain. The model should provide rich amount of information through M-learning for collaborative learning (CL). This comes from understanding, collecting and modeling usable design, holds functionalities and non-functionalities issues to be the corner stone of the intended model. Consequently, this research studies the possibility of modeling an instructional model for Android mobile application combining the CL and M-learning concepts calls Collaborative M-learning (CML) model. Thus, determining the essential requirements by exploring the most important issues in the existing models and related works in the literatures, as well as interviewing learners are the priorities of this study. Content analysis method was used to analyze the gathered data in determining the requirements needed. The model and the prototype have been reviewed and verified by four experts. Also, 43 respondents in the field of Information Technology (IT) have tested the prototype and provided feedback on their acceptance, through Technology Acceptance Model (TAM) questionnaire under the usability evaluation. Results show that their acceptance upon the model is high, validating the functionality of the CML. Such findings recommend that the model is able to improve productivity, showing the technique to utilize mobile technology in CL. This study serves as a guidance for designers and developers in M-learning.

Keywords: Mobile Learning (M-learning), Collaborative Learning (CL), Collaborative M-learning (CML), Instructional Design (ID), Android Mobile Application.

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List of Abbreviations

CML	Collaborative Mobile Learning
M-learning	Mobile learning
E-learning	Electronic learning
U-learning	Ubiquitous learning
BYOD	Bring Your Own Device
LMS	Learning Management System
CSCL	Computer Supported Collaborative Learning
MOOS	Massive Open Online System
ID	Instructional Design
CSCL	Computer Supported Collaborative Learning
CE	Collaboration Engineering
GSS	Group Support System
PSA	Process Support Applications
RLOs	Reusable Learning Objects
QR	Quick Response
CSAM	Collaborative Situated Active Mobile learning strategies
IT	Information Technology
UML	Unified Modeling Language
RAD	Rapid Application Development
TAM	Technology Acceptance Model
SPSS	Statistical Package for the Social Sciences
FRAME	Framework for the Rational Analysis of Mobile Education
ZPD	Zone of Proximal Development
HTML	HyperText Markup Language
XML	Extensible Markup Language
AOSP	Open Source Project
JIT	Just-in-Time compiler
API	Application Programming Interface
CE	Collaboration Engineering

PSS	Process Support Systems
GSS	Group Support System
PSA	Process Support Applications
ICT	Information and Communications Technology
SNS	Social Networking Services
mCSCL	mobile Computer-Supported Collaborative Learning
SDK	Software Development Kit
JDT	Java Development Tools
JSP	Java Server Pages



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CHAPTER ONE

INTRODUCTION

1.1 Overview

This chapter introduces related topics to this study, which represent background, followed by the problem statement, research hypotheses, and significance of the study. Finally, scope of the study is also presented in this chapter.

1.1.1 Mobile Learning (M-learning)

Since the beginning of this century, with the introduction of mobile devices, the term of Mobile learning (M-learning) became frequent along with Electronic learning (E-learning) and Ubiquitous learning (U-learning), the concept comes on the agenda since the vast emergence of wireless communications, Internet access and mobile device proliferation have defeat time and space limits on communication (Lai, Chang, Wen-Shiane, Fan, & Wu, 2013). The term of M-learning has increasingly grown among learners. It has become an interesting subject for researchers since a user may have more than one device. According to the annual report of International Telecommunication Union (2013) the quantity of mobile phone users around the world exceeds the real population. Figure 1.1 indicates the estimated number of mobile phone users.

In their study, Koh, Rawi, and Zhang (2011) stated that M-learning refers to the use of mobile devices such as laptop, tablet, smartphones or any portable computer anytime-anywhere, particularly with the rapid growth of wireless communication technologies and the innovative design of modern devices which represent the main factors that have supported the emergence of M-learning concept. The concept of M-learning concentrates

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REFERENCES

- Alarcon, R., Guerrero, L. A., Ochoa, S. F., & Pino, J. A. (2012). Analysis and design of mobile collaborative applications using contextual elements. *Computing and Informatics*, 25(6), 469–496.
- Al-Huneidi, A. M., Al-Huneidi, A. M., & Schreurs, J. (2012). Constructivism Based Blended Learning in Higher Education. *International Journal: Emerging Technologies in Learning*, 7(1), 4–9. doi:http://doi.org/10.3991/ijet.v7i1.1792
- Alkhazali, A. R. M. (2012). *Application of Mobile Tourism for Kedah*. Retrieved from doi:http://etd.uum.edu.my/2920/
- Allen, S., Graupera, V., & Lundrigan, L. (2010). *Pro smartphone cross-platform development: iPhone, blackberry, windows mobile and android development and distribution*. Apress.
- Almutairi, S., Bell, G., & Chen, F. (2013). An enhanced Use Case diagram to model Context Aware Systems. *Science and Information Conference (SAI), 2013* (270–274).
- Al-Rahimi, W. M., Othman, M. S., & Musa, M. A. (2013). Using TAM Model To Measure The Use Of Social Media For Collaborative Learning. *International Journal of Engineering Trends and Technology*, 5(2), 90–95.
- Al-rahmi, W. M., Othman, M. S., & Mi Yusuf, L. (2015). Social Media for Collaborative Learning and Engagement: Adoption Framework in Higher Education Institutions in Malaysia. *Mediterranean Journal of Social Sciences*, 6(3), 246–252. doi:http://doi.org/10.5901/mjss.2015.v6n3s1p246
- Al-Shemarry, M. S. J. (2010). *Requirement Model for E-Courses Management System in Iraqi Universities: A Case Study at Thi-Qar Universiti*. Universiti Utara Malaysia.
- Ameller, D., Franch, X., & Cabot, J. (2010). Dealing with non-functional requirements in model-driven development. *Requirements Engineering Conference (RE), 2010 18th IEEE International* (189–198).
- Arnold, N., & Paulus, T. (2010). Using a social networking site for experiential learning:

- Appropriating, lurking, modeling and community building. *The Internet and Higher Education*, 13(4), 188–196. doi:<http://doi.org/10.1016/j.iheduc.2010.04.002>
- Baran, E., Correia, A.-P., & Thompson, A. (2011). Transforming online teaching practice: critical analysis of the literature on the roles and competencies of online teachers. *Distance Education*, 32(3), 421–439. doi:<http://doi.org/10.1080/01587919.2011.610293>
- Barker, D., Quennerstedt, M., & Annerstedt, C. (2013). Inter-student interactions and student learning in health and physical education: A post-Vygotskian analysis. *Physical Education and Sport Pedagogy*, (ahead-of-print), 1–18.
- Biel, B., Grill, T., & Gruhn, V. (2010). Exploring the benefits of the combination of a software architecture analysis and a usability evaluation of a mobile application. *Journal of Systems and Software*, 83(11), 2031–2044. doi:<http://doi.org/10.1016/j.jss.2010.03.079>
- Boticki, I. Wong, L. & Looi, C.-K. (2013). Designing Technology for Content-Independent Collaborative Mobile Learning. *IEEE Transactions on Learning Technologies*, 6(1), 14–24. doi:<http://doi.org/10.1109/TLT.2012.8>
- Bozkurt, A., Ozbek, E. A., Yilmazel, S., Erdogdu, E., Ucar, H., & Guler, E. (2015). February – 2015 Trends in Distance Education Research: A Content Analysis of Journals 2009 - 2013. *The International Review of Research in Open and Distributed Learning*, 16(1), 330–363.
- Brähler, S. (2010). *Analysis of the Android Architecture*. *Os.Ibds.Kit.Edu*. Retrieved from http://os.ibds.kit.edu/downloads/sa_2010_braehler-stefan_android-architecture.pdf
- Causevic, a., Sundmark, D., & Punnekkat, S. (2012). Test case quality in test driven development: a study design and a pilot experiment. In *16th International Conference on Evaluation & Assessment in Software Engineering (EASE 2012)* (223–227). doi:<http://doi.org/10.1049/ic.2012.0029>
- Chang, K.-E., Wu, L.-J., Lai, S.-C., & Sung, Y.-T. (2014). Using mobile devices to enhance the interactive learning for spatial geometry. *Interactive Learning*

- Environments*, 4820(January), 1–19.
- Cheng, X. (2015). Designing of a Mobile Collaboration Application for Student Collaborative Group Work: Evidence from China. In *IEEE CONFERENCE PUBLICATIONS* (544–551). doi:<http://doi.org/10.1109/HICSS.2015.72>
- Cheng, X., Li, Y., Sun, J., & Zhu, X. (2014). Easy Collaboration Process Support System Design for Student Collaborative Group Work: A Case Study. *System Sciences (HICSS), 2014 47th Hawaii International Conference on*. <http://doi.org/10.1109/HICSS.2014.64>
- Cheng, X., & Yu, J. (2015). Designing of a Mobile Collaboration Application for Student Collaborative Group Work: Evidence from China. *System Sciences (HICSS), 2015 48th Hawaii International Conference on*. doi:<http://doi.org/10.1109/HICSS.2015.72>
- Cheong, C., Bruno, V., & Cheong, F. (2012). Designing a Mobile-app-based Collaborative Learning System. *Journal of Information Technology Education Innovations in Practice*, 11, 97–119.
- Cowan, P., & Butler, R. (2013). Making geography mobile : using location aware technology to improve student performance in physical geography. *Journal of Research and Didactics in Geography*, 1(2), 85–105. doi:<http://doi.org/10.4458/0900-09>
- Creswell, J. W. (2009). *Research Design*. SAGE Publications. doi:<http://doi.org/10.4135/9781849208956>
- Creswell, J. W. (2013). *Research design: Qualitative, quantitative, and mixed methods approaches*. Sage publications.
- Dabbagh, N., & Kitsantas, A. (2012). Personal Learning Environments, social media, and self-regulated learning: A natural formula for connecting formal and informal learning. *Internet and Higher Education*, 15(1), 3–8. doi:<http://doi.org/10.1016/j.iheduc.2011.06.002>
- Daud, N. M. N., Bakar, N. A. A. A., & Rusli, H. M. (2010). Implementing Rapid Application Development (RAD) methodology in developing practical training

- application system. *Proceedings 2010 International Symposium on Information Technology - System Development and Application and Knowledge Society, ITSIM'10*. doi:<http://doi.org/10.1109/ITSIM.2010.5561634>
- Dewitt, D., & Siraj, S. (2010). World Journal on Educational collaborative m-learning module. *World Journal on Educational Technology*, 2(3), 169–185. Retrieved from www.world-education-center.org/index.php/wjet
- DeWitt, D., Siraj, S., & Alias, N. (2014). Collaborative mLearning: A module for learning secondary school science. *Special Issue: Game Based Learning for 21st Century Transferable Skills: Challenges and Opportunities*. JSTOR. Retrieved from <http://ovidsp.ovid.com/ovidweb.cgi?T=JS&PAGE=reference&D=psyc11&NEWS=N&AN=2014-06607-009>
- Donnelly, R. (2010). Harmonizing technology with interaction in blended problem-based learning. *Computers and Education*, 54(2), 350–359. doi:<http://doi.org/10.1016/j.compedu.2009.08.012>
- Egbokhare, F. A. (2014). Causes of Software/Information Technology Project Failures in Nigerian Software Development Organizations. *African Journal of Computing and ICT*, 7(2), 107–110.
- Espada, J. P., Crespo, R. G., Martínez, O. S., G-Bustelo, B. C. P., & Lovelle, J. M. C. (2012). Extensible architecture for context-aware mobile web applications. *Expert Systems with Applications*, 39(10), 9686–9694.
- Fazlina, S., Manap, A. A., & Rias, R. M. (2013). Mobile learning awareness among students at higher learning institutes: A case study. *Proceedings - 2013 International Conference on Informatics and Creative Multimedia, ICICM 2013* (226–229). doi:<http://doi.org/10.1109/ICICM.2013.46>
- Følstad, A., Box, P. O., Law, E. L., Hornbæk, K., & Copenhagen, S. (2012). Analysis in Practical Usability Evaluation : A Survey Study (2127–2136).
- Garcia, I. A., & Cano, E. M. (2014). Designing and Implementing a Constructionist Approach for Improving the Teaching-Learning Process in the Embedded Systems

- and Wireless Communications Areas. *Computer Applications in Engineering Education*, 22(October), 481–493. doi:<http://doi.org/10.1002/cae.20574>
- Gikas, J., & Grant, M. M. (2013). Mobile computing devices in higher education: Student perspectives on learning with cellphones, smartphones & social media. *Internet and Higher Education*, 19, 18–26. doi:<http://doi.org/10.1016/j.iheduc.2013.06.002>
- Goggin, G. (2012). *Cell phone culture: Mobile technology in everyday life*. Routledge.
- Green, S. B., & Salkind, N. J. (2010). *Using SPSS for Windows and Macintosh: Analyzing and understanding data*. Prentice Hall Press.
- Hasan, L., & Abuelrub, E. (2013). Usability testing for IAJIT openconf journal management system. *Journal of Software*, 8(2), 387–396. doi:<http://doi.org/10.4304/jsw.8.2.387-396>
- Hussain, A., Jomhari, N., Kamal, F. M., & Mohamad, N. (2014). mFakih : Modelling Mobile Learning Game to Recite Quran for deaf Children. *International Journal on Islamic Applications in Computer Science And Technology*, 2(2), 8–15.
- Itu. (2013). *International Telecom Union Annual Report 2013: Measuring the Information Society*.
- Järvelä, S., & Järvenoja, H. (2011). Socially Constructed Self-Regulated Learning and Motivation Regulation in Collaborative Learning Groups. *Teachers College Record*, 113(2), 350–374.
- Khader, A., & Almasri, M. (2014). the Influence on Mobile Learning Based (Tam), Mobile Readiness (Mr) and Perceived Interaction (Pi) for Higher, 1(1), 5–11.
- Khan, A. U. R., Othman, M., Madani, S. A., & Khan, S. U. (2014). A survey of mobile cloud computing application models. *IEEE Communications Surveys and Tutorials*, 16(1), 393–413. doi:<http://doi.org/10.1109/SURV.2013.062613.00160>
- Kirschner, F., Paas, F., Kirschner, P. a., & Janssen, J. (2011). Differential effects of problem-solving demands on individual and collaborative learning outcomes. *Learning and Instruction*, 21(4), 587–599. doi:<http://doi.org/10.1016/j.learninstruc.2011.01.001>

- Klassen, A. C., Creswell, J., Clark, V. L. P., Smith, K. C., & Meissner, H. I. (2012). Best practices in mixed methods for quality of life research. *Quality of Life Research*, 21(3), 377–380.
- Ko, E. H. T., Chiu, D. K. W., Lo, P., & Ho, K. K. W. (2015). Comparative Study on m-Learning Usage Among LIS Students from Hong Kong, Japan and Taiwan. *The Journal of Academic Librarianship*, 41(5), 567–577.
- Koh, Y. H., Rawi, M. F., & Zhang, W. (2011). Learning Anytime, Anywhere: An Ipod Touch Mobile Learning Experience @ Yusof Ishak (YI) Secondary School, Singapore. In *World Conference on Educational Multimedia, Hypermedia and Telecommunications* (Vol. 2011, pp. 3035–3042). Retrieved from <http://www.editlib.org/p/38292/>
- Koole, M., McQuilkin, J. L., & Ally, M. (2010). Mobile learning in distance education: Utility or futility. *International Journal of E-Learning & Distance Education*, 24(2).
- Kooloos, J. G. M., Klaassen, T., Vereijken, M., Van Kuppeveld, S., Bolhuis, S., & Vorstenbosch, M. (2011). Collaborative group work: Effects of group size and assignment structure on learning gain, student satisfaction and perceived participation. *Medical Teacher*, 33(12), 983–988. doi:<http://doi.org/10.3109/0142159X.2011.588733>
- Laal, M., & Laal, M. (2012). Collaborative learning: what is it? *Procedia-Social and Behavioral Sciences*, 31, 491–495.
- Laal, M., Naseri, A. S., Laal, M., & Khattami-Kermanshahi, Z. (2013). What do we Achieve from Learning in Collaboration? *Procedia-Social and Behavioral Sciences*, 93, 1427–1432.
- Lai, C., Wang, Q., & Lei, J. (2012). What factors predict undergraduate students' use of technology for learning? A case from Hong Kong. *Computers & Education*, 59(2), 569–579. doi:<http://doi.org/10.1016/j.compedu.2012.03.006>
- Lai, H.-C., Chang, C.-Y., Wen-Shiane, L., Fan, Y.-L., & Wu, Y.-T. (2013). The implementation of mobile learning in outdoor education: Application of QR codes.

British Journal of Educational Technology, 44(2), E57–E62.
doi:<http://doi.org/10.1111/j.1467-8535.2012.01343.x>

- Lan, Y.-F., Tsai, P.-W., Yang, S.-H., & Hung, C.-L. (2012). Comparing the social knowledge construction behavioral patterns of problem-based online asynchronous discussion in e/m-learning environments. *Computers & Education*, 59(4), 1122–1135.
- Lee, D., Moon, J., Kim, Y. J., & Yi, M. Y. (2014). Antecedents and consequences of mobile phone usability: Linking simplicity and interactivity to satisfaction, trust, and brand loyalty. *Information & Management*, 52(3), 295–304.
doi:<http://doi.org/10.1016/j.im.2014.12.001>
- Lee, Y. H., Waxman, H., Wu, J. Y., Michko, G., & Lin, G. (2013). Revisit the effect of teaching and learning with technology. *Educational Technology and Society*, 16(1), 133–146.
- Liu, I.-F., Chen, M. C., Sun, Y. S., Wible, D., & Kuo, C.-H. (2010). Extending the TAM model to explore the factors that affect Intention to Use an Online Learning Community. *Computers & Education*, 54(2), 600–610.
doi:<http://doi.org/10.1016/j.compedu.2009.09.009>
- Loncar, M., Barrett, N. E., & Liu, G. Z. (2014). Towards the refinement of forum and asynchronous online discussion in educational contexts worldwide: Trends and investigative approaches within a dominant research paradigm. *Computers and Education*, 73, 93–110. doi:<http://doi.org/10.1016/j.compedu.2013.12.007>
- McNaughton, D., Light, J., & Naughton, D. M. C. (2013). The iPad and mobile technology revolution: Benefits and challenges for individuals who require augmentative and alternative communication. *Augmentative and Alternative Communication*, 29(2), 107–116. doi:<http://doi.org/10.3109/07434618.2013.784930>
- Moser, M. (2011). Open Source Android Development Tools. *Online*[[Cited: Julio, 2011.] [Http://assets.en.oreilly.com/1/event/61/Open% 20Source% 20Android% 20Development% 20Tools](http://assets.en.oreilly.com/1/event/61/Open%20Source%20Android%20Development%20Tools).

- Nam, C. W., & Jang, S. (2013). The development of an ID model for collaborative learning in mobile learning environments. *Teaching, Assessment and Learning for Engineering (TALE), 2013 IEEE International Conference on* (207–212).
- Ng, J. W. P., Zemerly, M. J., & Hammadi, O. A. Al. (2011). Context-aware collaborative mlearning in an intelligent campus environment. In *2011 IEEE GCC Conference and Exhibition, GCC 2011* (63–64). doi:<http://doi.org/10.1109/IEEEGCC.2011.5752620>
- Ostrowski, \Lukasz, & Helfert, M. (2011). Commonality in various design science methodologies. *Computer Science and Information Systems (FedCSIS), 2011 Federated Conference on* (317–320).
- Paavilainen, J., Korhonen, H., & Saarenpää, H. (2011). *Comparing two playability heuristic sets with expert review method: A case study of mobile game evaluation. Media in the Ubiquitous Era: Ambient, Social and Gaming Media.*
- Pahl, G., & Beitz, W. (2013). *Engineering Design: A Systematic Approach* (Vol. 11). doi:<http://doi.org/10.1007/978-1-84628-319-2>
- Pegrum, M., Oakley, G., & Faulkner, R. (2013). Schools going mobile: A study of the adoption of mobile handheld technologies in western australian independent schools. *Australasian Journal of Educational Technology*, 29(1), 66–81. doi:<http://doi.org/10.1234/ajet.v29i1.64>
- Peters, V. L., & Hewitt, J. (2010). An investigation of student practices in asynchronous computer conferencing courses. *Computers & Education*, 54(4), 951–961.
- Peterson, R. A., & Kim, Y. (2013). On the relationship between coefficient alpha and composite reliability. *Journal of Applied Psychology*, 98(1), 194.
- Popov, V., Biemans, H. J. A., Brinkman, D., Kuznetsov, A. N., & Mulder, M. (2013). Facilitation of computer-supported collaborative learning in mixed- versus same-culture dyads: Does a collaboration script help? *The Internet and Higher Education*, 19(December), 36–48. doi:<http://doi.org/10.1016/j.iheduc.2013.08.002>
- Power, R. (2013). Collaborative Situated Active Mobile (CSAM) learning strategies: a

- new perspective on effective mobile learning. *Learning and Teaching in Higher Education: Gulf Perspectives*, 10(2), 1– 18. Retrieved from <http://lthe.zu.ac.ae/index.php/lthehome/article/view/137>
- Ravitch, S. M., & Riggan, M. (2011). *Reason & rigor: How conceptual frameworks guide research*. Sage.
- Sarrab, M., & Elgamel, L. (2013a). Contextual M-learning system for higher education providers in Oman. *World Applied Sciences Journal*, 22(10), 1412–1419. doi:<http://doi.org/10.5829/idosi.wasj.2013.22.10.571>
- Sarrab, M., & Elgamel, L. (2013b). M Obile L Earning (M-L Earning) and. *International Journal of Distributed and Parallel System*, 3(4), 31–39. doi:<http://doi.org/10.3991/ijim.v3i4.986>
- Seliaman, M. E., & Al-Turki, M. . (2012). Mobile Learning Adoption in Saudi Arabia. *World Academy of Science, Engineering, and Technology*, 6(9), 356–358.
- Shaltout, M. S. A.-F. (2013). Proposed Model for the Learning Resource Center Based on Cloud Computing. *E-Learning “Best Practices in Management, Design and Development of E-Courses: Standards of Excellence and Creativity”* , 2013 Fourth International Conference on. doi:<http://doi.org/10.1109/ECONF.2013.73>
- Sironi, M., & Tisato, F. (2013). Capturing Information Flows inside Android and Qemu Environments. *arXiv*, 1–13. Retrieved from <http://arxiv.org/abs/1302.5109>
- Small, M. L. (2011). How to Conduct a Mixed Methods Study: Recent Trends in a Rapidly Growing Literature. *Annual Review of Sociology*, 37(1), 57–86. doi:<http://doi.org/10.1146/annurev.soc.012809.102657>
- Song, Y. (2014). Methodological Issues in Mobile Computer-Supported Collaborative Learning (mCSCL): What Methods , What to Measure and When to Measure ? *Educational Technology & Society*, 17(4), 33–48.
- Strijbos, J. W. (2011). Assessment of (Computer-Supported) Collaborative Learning. *IEEE Transactions on Learning Technologies*, 4(1), 59–73. doi:<http://doi.org/Doi10.1109/Tlt.2010.37>

- Syriani, E., & Ergin, H. (2012). Operational semantics of UML activity diagram: An application in project management. In *2012 2nd IEEE International Workshop on Model-Driven Requirements Engineering, MoDRE 2012 - Proceedings* (1–8). doi:<http://doi.org/10.1109/MoDRE.2012.6360083>
- Ting, Y.-L., & Tai, Y. (2013). A New Social Aspect in Collaborative Mobile Learning: Design Challenges and Learning Effects. *2013 IEEE 13th International Conference on Advanced Learning Technologies*. doi:<http://doi.org/10.1109/ICALT.2013.13>
- Violet UML Editor. (n.d.). Retrieved March 6, 2016, from <http://alexdp.free.fr/violetumleditor/page.php>
- Vygotsky, L. S. (1934). 1962. Thought and language. *Trans. E. Hanfmann and G. Vakar. Cambridge: MIT Press.*
- Vygotsky, L. S. (1978). Interaction between learning and development. *Mind in Society: The Development of Higher Psychological Processes*. doi:[http://doi.org/10.1016/S0006-3495\(96\)79572-3](http://doi.org/10.1016/S0006-3495(96)79572-3)
- Vygotsky, L. S. (1978). *Mind in society: The development of higher mental process*. Cambridge, MA: Harvard University Press.
- Wald, M., Li, Y., & Draffan, E. A. (2014). Synote: Collaborative mobile learning for all. *Procedia Computer Science*, 27, 240–250.
- Wasserman, A. I. (2010). Software engineering issues for mobile application development. *Proceedings of the FSE/SDP workshop on Future of software engineering research* (397–400).
- Wong, L. H., & Looi, C. K. (2011). What seems do we remove in mobile-assisted seamless learning? A critical review of the literature. *Computers and Education*, 57(4), 2364–2381. doi:<http://doi.org/10.1016/j.compedu.2011.06.007>
- Wong, S. H. R. (2012). Which platform do our users prefer: website or mobile app? *Reference Services Review*, 40(1), 103–115. doi:<http://doi.org/10.1108/00907321211203667>
- Wu, Y., Luo, J., & Luo, L. (2010). Porting mobile web application engine to the Android

platform. *Computer and Information Technology (CIT), 2010 IEEE 10th International Conference on* (2157–2161).

Yusoff, Z., & Dahlan, H. M. (2013). Mobile based learning: An integrated framework to support learning engagement through Augmented Reality environment. *2013 International Conference on Research and Innovation in Information Systems (ICRIIS)* (251–256). doi:<http://doi.org/10.1109/ICRIIS.2013.6716718>