6.2020

iJIM

International Journal:
Interactive Mobile Technologies

Papers

Short Papers

Table of Contents

Papers

Short Papers

A Systematic Review of e-Service Learning in Higher Education

https://doi.org/10.3991/ijim.v14i06.13395

Valerie Bukas Marcus (✉), Noor Azean Atan, Sanitah Mohd Yusof, Lokman Tahir
Universiti Teknologi Malaysia, Johor, Malaysia.
valeriebukas92@gmail.com

Abstract—E-Service Learning is a service-learning course when the instruction and/or the service occurs online gains popularity among educators as we are transitioning to online learning platforms. The current study presents a systematic review of papers on the research involved information and communications technology (ICT) in the service-learning project. Studies have noted the growing use of ICT in service-learning projects for various purposes such as for communication and collaboration, data collection, reflection, and instruction delivery. However, very little research analysed students' engagement in this e-Service Learning environment. Future research should be done to investigate an effective application of technology in service-learning courses, especially to attain the attention of digital natives nowadays and engaging learners instead of merely using technologies in service-learning courses.

Keywords—E-Service-Learning; Online Service Learning; Technology Integration

1 Introduction

Educational paradigm that shifts toward distance and technology-supported course delivery birthed e-Service Learning [1]. Originally, e-Service Learning existed when instructors feels that student is disengage in online learning platform. Thus, combining it with Service Learning pedagogy will be able to cater to this gap since the nature of Service Learning required students to interact with each other, and throughout the learning process. With such a promising educational setting, e-Service Learning has gained a lot of attention among Service Learning practitioners. While there is an abundance of literature on service learning, as there is on e-learning, the area of e-service learning is still under-researched. Therefore, this article aims to study the area of research that has been explored in e-Service Learning so far. This study is vital as to date there is no systematic review presenting research trend in e-Service Learning despite the overwhelming claims stating that e-Service Learning bring benefits as much as traditional Service Learning. Major contribution of this article is to help fellow researchers that is interested in studying e-Service Learning regarding what current research has been done in e-Service Learning field, thus providing more insights, keep themselves up to date with this field and suggesting future directions of e-

Service Learning. To develop a relevant systematic review, the literature study was geared by the main research question- what has been studied in e-Service Learning? This study places its focus on the objective of e-Service Learning research that has been explored. A special focus was given to research of e-Service Learning in Higher Education setting because in this tertiary level, students will be equipped with skills that we aspired to produce – a future proof talents.

2 Methodology

The systematic review was conducted in line with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA; see Figure 1). PRISMA is often referred to within the information science field. The PRISMA statement allows for rigorous search of terms related to research that has been done in e-Service Learning.

2.1 Resources

Electronic databases such as Web of Science (WoS) and Scopus were used to conduct literature searches with a related relevant keyword to identify articles (see Figure 1). WoS is a robust database covering more than 250 field of studies and consisting more than 30000 journals meanwhile Scopus is one of the largest abstracts and citation databases of peer-reviewed literature and it provide extensive journal in social sciences such as education field.

2.2 Identification

The first phase identified keywords used for the search process. Relying on previous studies and thesaurus, keywords similar and related to e-Service Learning was used.

Table 1. The Search String

Databases	Keywords Used
Scopus	TITLE-ABS-KEY (({e-service learning} OR {service e-learning} OR {e-service-learning} OR {service learning online} OR {online service learning} OR {online service-learning} OR {service-learning online})) AND (({service learning} AND {technology integration}) OR ({service learning} AND {ict}))
Web of Science	TS= ((“e-service learning” OR “service e-learning” OR “e-service-learning” OR “service learning online” OR “online service learning” OR “online service-learning” OR “service-learning online”)) AND ((“service learning” AND “technology integration”) OR (“service learning ”AND “ict”))

2.3 Screening

Several inclusion and exclusion criterion are determined. First, in relation to literature type, article journals, book chapters and Scopus-indexed conference proceeding

are selected. Only articles in English are selected for review to avoid any confusion and difficulty in translating. Authors also only include article that is based on Higher Education setting. Selected article also must portray that they integrate technology during Service Learning phase. Then, each study was assessed against a set of inclusion and exclusion criteria. Excluded studies were tabulated against reasons for exclusion.

Table 2. Inclusion and Exclusion Criteria

Criterion	Eligibility	Exclusion
Literature Type	Journal (research articles), book chapter, Scopus-indexed conference proceeding	Journals (systematic review, review, meta - analysis, meta-synthesis)
Language	English	Non English
Setting	Higher Education	High schools, primary schools, kindergarten
Subject Area	Integrate technology during Service Learning phase	Did not integrate technology during Service Learning

2.4 Eligibility

The remaining articles resulted from screening process then are gone through the third process – eligibility. In this stage, authors manually examined all the articles thoroughly to ensure it fit the criteria determined. A full-text review was conducted for eligible studies, with the finalized set of published studies subjected to qualitative synthesis. Analysis was focused on specific studies that related to formulated questions. The data were extracted by reading through the abstract first then the full articles (in-depth) to identify appropriate themes and subthemes. Qualitative analysis was performed using thematic analysis in Nvivo 12 to identify themes related to research area that has been studied in e-Service Learning.

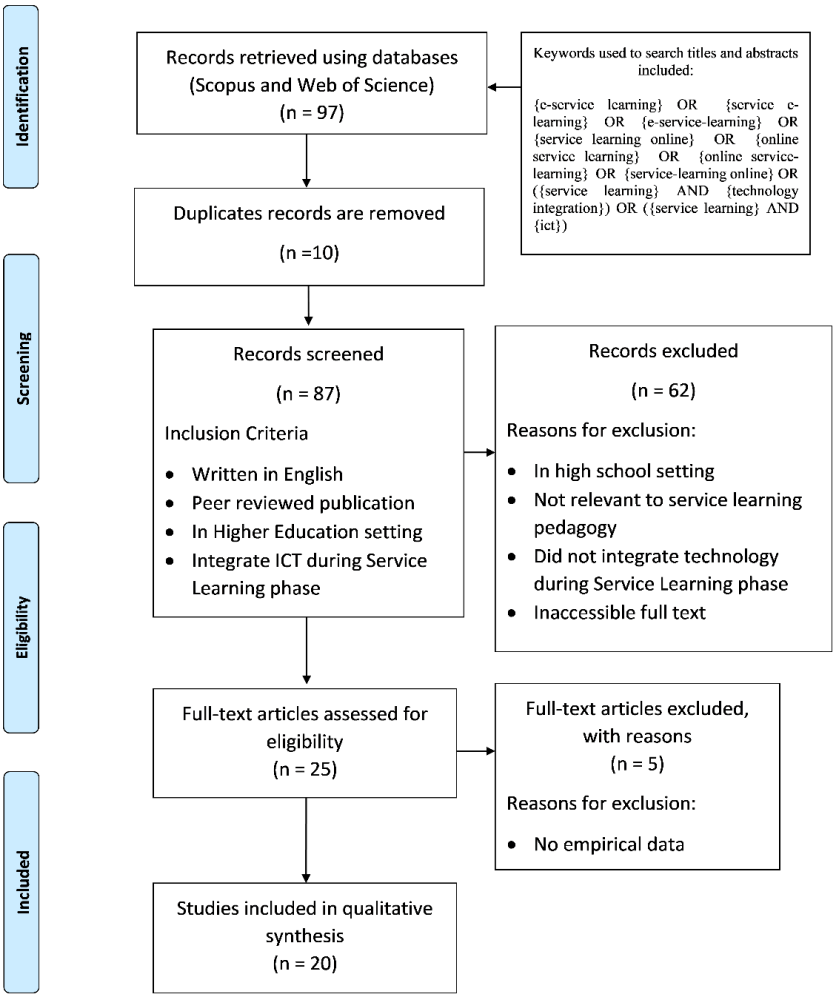


Fig. 1. A flow diagram detailing the application of PRISMA to the qualitative synthesis of published studies into e-Service Learning in Higher Education

3 Results

Ninety-seven published studies were identified as part of the systematic search with a final set of 20 studies included for qualitative synthesis. The review resulted in eight main areas in research regarding e-Service Learning in Higher Education setting. There are students' outcomes, challenges, success factors, impact, design and development, students' perception, reflection and comparison. The results provided a comprehensive analysis on the research area that has been studied in e-Service Learning.

Table 3. Results according to themes

Author	Students' Outcomes	Challenges	Success Factors	Impact	Design & Develop-ment	Students' Perception	Reflection	Compari-son
Purcell [2]					/			
Lawler [3]			/					
Garca-Gutierrez et al. [4]					/			
Yusof [5]	/						/	
Griffin [6]					/			
Nielsen [7]		/						
Shah [8]					/			
Howlett [9]					/			
Helms [10]					/			
Saitta [11]					/			
Jia [12]		/						
Gasper-Hulvat [13]				/				
McGorry [14]								/
Marcus [15]	/						/	
Guthrie and McCracken [16]							/	
Guthrie and McCracken [17]						/		
Salam [18]					/			
Chen [19]					/			
Fry [20]					/			
Ruso [21]					/			
Harris [22]				/				

Majority of studies reviewed focused on design and development of e-Service Learning and there are eleven of them [19][20][4][6][10][9][2][21][11][18][8]. A total of two studies focused on investigating students' outcomes from the e-Service Learning environment [15][5]. These two studies mainly investigate students' generic skills with the integration of e-Service Learning platform. Two studies discussed challenges in implementing e-Service Learning [12][7], meanwhile another two studies discussed the impact of implementing online service learning [13][22]. Apart from that, there

are also three studies that explores students' perception towards e-Service Learning [17][15][5]. A study about students' critical reflection [16], a comparison between online and traditional service learning [14] and success factors of e-Service Learning [3] resulted in one each.

Table 4. Results according to Methodology or Research Design

Author	Methodology/ Research Design
Purcell [2]	-
Lawler [3]	Case Study
Garca-Gutierrez et al. [4]	-
Yusof [5]	Mixed Methods
Griffin [6]	-
Nielsen [7]	-
Shah [8]	Case Study
Howlett [9]	Mixed Methods
Helms [10]	
Saitta [11]	Case Study
Jia [12]	Case Study
Gasper-Hulvat [13]	-
McGorry [14]	-
Marcus [15]	Action research
Guthrie and McCracken [16]	-
Guthrie and McCracken [17]	Qualitative Method
Salam [18]	-
Chen [19]	-
Fry [20]	-
Ruso [21]	Mixed Methods
Harris [22]	-

In term of methodology and research design stated, majority of the research paper implement case study followed by mixed methods, action research and qualitative method.

4 Discussion

Since e-Service Learning is quite new to educators, a lot of researcher focusing on proposing design and development for e-Service Learning. Transitioning from traditional face-to-face Service Learning to online platform can be quite troublesome and fear a lot of educators as they see online learning as a barrier [1]. Despite learners' interest in e-Service Learning, there is too few examples of community engaged learning in fully online courses have been documented, hence resulting this trend of research area in e-Service Learning.

M. Salam et al. [18] even proposed a technological framework for e-Service Learning and they suggest that educators should integrate suitable technologies in all phases of Service Learning depending on the nature and objectives of their projects. This is important reminder to educators since different project of Service Learning requires

different needs, and not "one size fits all". Researcher hopes that the design and development of e-Service Learning that they proposed will be able to help educators in making decision and plan what is the best implementation of e-Service Learning for their projects. Most importantly, Lawler et al. [3] highlighted that critical success factors to ensure successful implementation of digital technology service learning project are project management, strategy and technology and collaboration with organization. It is no doubt that E-Service Learning challenges educators to make full use of technology instead of replacing instructors with technology, focusing on design technology that conforms itself to the students' need, allowing the redesign and expansion of learning activities and creation of new learning possibilities that were not available previously in traditional face-to-face Service Learning setting. Flexibility also played a key role for instructors and for students [6]. Instructors that interested to integrate technology in their Service Learning project had to be flexible, think creatively and work through unexpected situations. In fact, these moments of technological failure are opportunities to model resourcefulness and creative thinking for students.

While there is an abundance of literature on service learning benefits to student's personal outcomes, the area of studies regarding students' learning outcomes in e-Service Learning is under-researched. In reality, e-Service Learning with technology rich environment is able to influence students' learning outcomes especially their generic skills. This is proven in study by Yusof et al. [5] and Marcus et al. [15] as they found out students also gained generic skills such as online collaborative skills, teamwork, global citizen, scholarship and adaptability with the integration of e-Service Learning platform. Thus, proved that hybrid strategy of service learning that combine both face-to face and online delivery can promote students' generic skills. Nielsen [7] also reported that students in online technical communication classrooms develop professional skills, contribute to the classroom and community and take greater responsibility for their education through service learning activities. Overall, the use of technologies actually enhances students' experiential learning process.

Although it is reported that service learning with technology integration had many benefits, Jia et al. [12] explores few challenges that happened among preservice teachers such as limited communication with classroom teachers, conflict between classroom teacher expectations and project requirements, inadequate project orientation and instructor support. Either way, Service Learning can create an authentic learning experience among students that connect technology integration with teaching content provided that instructors support students with project orientation and valuable feedback. Meanwhile, Nielsen [7] addresses three specific concerns that instructors in technical communication online service learning classroom encounter which are locating service opportunities, serving in isolated areas and enrolling and engaging non-traditional or part time students specifically when students need to find their own service placements. Nearly all the constraints discussed can be addressed with course planning and clear communication between all organization that involved. Course planning and communication are the most vital components in conducting online service learning classes.

Despite study by McGorry [14] demonstrate that there is no significant difference in outcomes between the online and face-to-face models, implementing Service Learning online is able to cater to the needs of digital natives learners nowadays. Both setting produced similar outcomes but transitioning to online service learning will not just improve students' personal development but also affecting their media literacy skills. As we are moving into era of globalization, future graduates are expected to access, analyze, evaluate, create, and act using all forms of communication. Media literacy is an essential skill in this digital skills and instructors should not be afraid of trying new methodologies suits with their own service-learning projects. As Internet technologies have become part of the daily communication pattern of a new generation of students, who see it as their natural environment in which to learn, play and work, thus it is important to expand students' use of the global digital network from superficial social interactions towards activities which enable them to become active and informed global citizens [22].

Instructors that often concern with disengage student in their online service learning course may consider using reflection journals to help students to connect their service to learning in the coursework as suggested by Guthrie and McCracken [16].

They found out that students felt reflection was essential to learning in order to gain multiple perspectives and being introduced to a diversity of ideas. Most importantly, students were empowered to assess their own individual learning goals and collaborate with others to make meaning of their service learning experience. Reflection process is so much easier and richer with the use of technology in e-Service Learning platform. Students that involved in e-Service Learning also reported a strong sense of learning from the open discussion. According to Guthrie and McCracken [17], active discussions and intentionally structured assignments support personal reflection and collaborative learning when implement within technology-rich learning environments.

Apart from this, majority of the studies reviewed employed a case study method as they attempted to explore a unique and new phenomenon in educational area such as e-Service Learning. Most of the case study is an exploratory process and make use of interviews and self-reflecting documents such as reflection to gain insight regarding e-Service Learning. Garca-Gutierrez et al. [4] noted that the best way to access this learning experience would be a narrative method— that is, the students themselves would tell us, through a semi-structured report, about their own experiences. In this way, the students collected the information and their experience in a descriptive and reflective way in their field notes.

5 Conclusion

The findings of this systematic review suggest that research regarding design and development of e-Service Learning is the most highly researched due to the transition of traditional Service Learning to online Service Learning to cater the need of digital learners nowadays, and also to guide instructors that is interested to implement technology in their Service Learning course. This review has several limitations. Firstly,

our review was limited to two journal databases due to authors would like articles came from peer-reviewed journals. It is believed that related studies in e-Service Learning has been published in non-indexed journals and may be included in future research to provide extensive overview of research area that has been discovered. Our review was quite extensive, but some articles need to be excluded as authors have no access to it. Although there are few researches investigate the effect of e-Service Learning on students' personal development, we believe that there is a need to dig deeper in researching about what happened among students during service learning especially when we are integrating technology. Any learning process involving technology and ICT often related with the lack of connection among learners and learning materials. Therefore, it is important for future research looking into students' engagement with learning process and analyzing their social network among each other. For future studies, more guidance should be used in the project to help students reflect on their technology integration–related beliefs, knowledge, and skills.

6 References

[1] L. S. Waldner, M. C. Widener, and S. Y. McGorry, "E-service learning: The evolution of service-learning to engage a growing online student population," J. High. Educ. Outreach Engagem., vol. 16, no. 2, pp. 123–150, 2012.

[2] J. W. Purcell, "Community-Engaged Pedagogy in the Virtual Classroom: Integrating eService-Learning Into Online Leadership Education," J. Leadersh. Stud., vol. 11, no. 1, pp. 65–70, 2017. https://doi.org/10.1002/jls.21515

[3] J. Lawler, "Critical success factors for partnering with nonprofit organizations on digital technology service-learning projects: A case study," in Higher education, emerging technologies, and community partnerships: Concepts, models and practices, IGI Global, 2011, pp. 106–123. https://doi.org/10.4018/978-1-60960-623-7.ch010

[4] J. Garca-Gutierrez, M. Ruiz-Corbella, and A. del Pozo Armentia, "Developing Civic Engagement in Distance Higher Education: A Case Study of Virtual Service-Learning (vSL) Programme in Spain," Open Prax., vol. 9, no. 2, pp. 235–244, 2017. https://doi.org/10.5944/openpraxis.9.2.578

[5] A. Yusof, N. A. Atan, J. Harun, and M. Doulatabadi, "Developing students graduate attributes in service learning project through online platform," 2019.

[6] M. Griffin, E. Saitta, M. Bowdon, and L. J. Walters, "Engaging stem: Service-learning, technology, science education and community partnerships," in Higher Education, Emerging Technologies, and Community Partnerships: Concepts, Models and Practices, IGI Global, 2011, pp. 51–56. https://doi.org/10.4018/978-1-60960-623-7.ch005

[7] D. Nielsen, "Facilitating service learning in the online technical communication classroom," J. Tech. Writ. Commun., vol. 46, no. 2, pp. 236–256, 2016.

[8] R. W. Shah, J. M. Troester, R. Brooke, L. Gatti, S. Thomas, and J. E. Masterson, "Fostering eABCD: Asset-Based Community Development in Digital Service-Learning," J. High. Educ. Outreach Engagem., vol. 22, no. 2, pp. 189–222, 2018.

[9] K. M. Howlett, J. Allred, D. Beck, and A. R. Mysore, "An english learner service-learning project: Preparing education majors using technology and the SAMR model.," CALL-EJ, vol. 20, no. 2, pp. 128–149, 2019.

[10] M. M. Helms, R. M. Rutti, A. A. Hervani, J. LaBonte, and S. Sarkarat, "Implementing and evaluating online service learning projects," J. Educ. Bus., vol. 90, no. 7, pp. 369–378, 2015. https://doi.org/10.1080/08832323.2015.1074150
[11] E. K. H. Saitta, M. A. Bowdon, and C. L. Geiger, "Incorporating service-learning, technology, and research supportive teaching techniques into the university chemistry classroom," J. Sci. Educ. Technol., vol. 20, no. 6, pp. 790–795, 2011. https://doi.org/10.1007/s10956-010-9273-0
[12] X. Jia, J. Jung, and A. Ottenbreit-Leftwich, "Learning technology integration from a service-learning project: Connecting preservice teachers to real-world problems," J. Exp. Educ., vol. 41, no. 3, pp. 261–276, 2018. https://doi.org/10.1177/1053825917738269
[13] M. Gasper-Hulvat, "'More Like a Real Human Being': Humanizing Historical Artists Through Remote Service-Learning," J. Exp. Educ., vol. 41, no. 4, pp. 397–410, 2018. https://doi.org/10.1177/1053825918808321
[14] S. Y. McGorry, "No significant difference in service learning online.," J. Asynchronous Learn. Networks, vol. 16, no. 4, pp. 45–54, 2012.
[15] V. B. Marcus, N. A. Atan, R. Talib, A. A. Latif, and S. M. Yusof, "Promoting Students' Generic Skills with the Integration of e-Service Learning Platform," Int. J. Emerg. Technol. Learn., vol. 14, no. 20, pp. 4–17, 2019. https://doi.org/10.3991/ijet.v14i20.11455
[16] K. L. Guthrie and H. McCracken, "Reflection: the importance of making meaning in e-service-learning courses," J. Comput. High. Educ., vol. 26, no. 3, pp. 238–252, 2014. https://doi.org/10.1007/s12528-014-9087-9
[17] K. L. Guthrie and H. McCracken, "Teaching and learning social justice through online service-learning courses," Int. Rev. Res. Open Distrib. Learn., vol. 11, no. 3, pp. 78–94, 2010. https://doi.org/10.19173/irrodl.v11i3.894
[18] M. Salam, D. N. A. Iskandar, D. H. A. Ibrahim, and M. S. Farooq, "Technology integration in service-learning pedagogy: A holistic framework," Telemat. Informatics, vol. 38, pp. 257–273, 2019. https://doi.org/10.1016/j.tele.2019.02.002
[19] C.-H. Chen, C.-H. Liao, Y.-C. Chen, and C.-F. Lee, "The integration of synchronous communication technology into service learning for pre-service teachers' online tutoring of middle school students," Internet High. Educ., vol. 14, no. 1, pp. 27–33, 2011. https://doi.org/10.1016/j.iheduc.2010.02.003
[20] G. W. Fry, "The Interface between Experiential Learning and the Internet: ways for improving learning productivity," Horiz., vol. 10, no. 3, pp. 5–11, 2002.
[21] N. Ruso, "The Role of Technology: Community Based Service-Learning Projects on Ethical Development.," Turkish Online J. Educ. Technol., vol. 11, no. 3, pp. 375–385, 2012.
[22] U. S. Harris, "Virtual partnerships: Engaging students in e-service learning using computer-mediated communication," Asia Pacific Media Educ., vol. 27, no. 1, pp. 103–117, 2017. https://doi.org/10.1177/1326365x17701792

7 Authors

Valerie Bukas Marcus is affiliated with the School of Education, Faculty of Social Sciences and Humanities, Universiti Teknologi Malaysia, 81310 Skudai, Johor Bahru, Johor, Malaysia. Valerie Bukas Marcus area of interest is eLearning. For more details contact at, valeriebukas92@gmail.com

Noor Azean Atan Is currently affiliated with the School of Education, Faculty of Social Sciences and Humanities, Universiti Teknologi Malaysia, 81310 Skudai, Johor Bahru, Johor, Malaysia. Author area of interest is eLearning and online learning.

Sanitah Mohd Yusof Is currently affiliated with School of Education, Faculty of Social Sciences and Humanities, Universiti Teknologi Malaysia, 81310 Skudai, Johor Bahru, Johor, Malaysia. Author area of area of interest is eLearning.

Lokman Tahir Is affiliated with School of Education, Faculty of Social Sciences and Humanities, Universiti Teknologi Malaysia, 81310 Skudai, Johor Bahru, Johor, Malaysia. Author area of interest is eLearning and online learning.

Article submitted 2020-01-24. Resubmitted 2020-02-22. Final acceptance 2020-02-22. Final version published as submitted by the authors.

BIM-VR Framework for Building Information Modelling in Engineering Education

https://doi.org/10.3991/ijim.v14i06.13397

Jing-Ying Wong (✉)
University of Nottingham Malaysia, Selangor, Malaysia
JingYing.Wong@nottingham.edu.my

Chun-Chieh Yip
Universiti Tunku Abdul Rahman, Selangor, Malaysia

Su-Ting Yong
University of Nottingham Malaysia, Selangor, Malaysia

Andy Chan, Sien-Ti Kok, Teck-Leong Lau,
Mohammed T. Ali, Essameldin Gouda
University of Nottingham Malaysia, Selangor, Malaysia

Abstract—With the advancement of information technology, Building Information Modeling (BIM) is evolving fast and play an essential role in Architecture, Engineering, Construction, Owner and Operators (AECOO) industry. Universities play an important role in the current BIM transition in construction projects as well as to embrace Industry 4.0. In this research, immersive Virtual Reality (VR) in BIM offer a unique, supportive environment for the user experience in visualizing and collecting data from the model. With Virtual Reality (VR), engineering education has a major breakthrough. Immersive interactions, stereoscopic 3D, real time multisensory simulations, virtual explorations, synchronous communications, data analytics and visual analysis – all these are impossible without VR. VR offers a student-centred learning environment that promotes active and collaborative learning, situated within simulated real-world contexts.

Keywords—BIM-VR Framework, Virtual Reality, Engineering Education

1 Introduction

Currently, Building Information Modelling (BIM) is introduced into the Architecture, Engineering, Construction, Owner and Operator (AECOO) sector at a rapid pace and tends to be seen as a cutting-edge technology and processes. Engineering education always strives to follow the interests of the construction industry and especially now BIM is a very important. According to Sabongi and Arch [1], the academic community moves more deliberately and thoughtfully to incorporate new technologies and to offer new courses.

Universities must focus on the strategy of using BIM as an innovative technology to allow the acquisition of new skills for the students and prepare them for their future activities in a more competitive world. School is an important driver for the growth of BIM knowledge [2]. Students' learning and teacher's teaching can be enhanced by appropriate advance technology. Technology could encourage more independent and active learning among students [3]. A key reason for the use of technology within a learning situation is to enhance the quality of learning and teaching [4].

Today's students are the "digital generations". They are born and grow up in a digital and technology-savvy world. Their learning styles have changed, e.g. preference of multitasking and social media awareness. Education and technology are always interconnected so it would be important to explore how technologies could be embraced by education. The digital generations obviously love modern technologies, and are positive towards online education and learning with technologies. For this reason, the virtual reality (VR) technology is a step to bridge our pedagogy and communication between the academia and nowadays students.

BIM course was introduced to Year 3 Civil Engineering students since 2015 as an optional course at the University of Nottingham. Significant changes are being introduced to BIM due to the major contribution of BIM in the AECOO industry. The course is to provide detailed knowledge and understanding of the fundamental concept of BIM to be applied in the life cycle of buildings/ infrastructure, which includes planning, design, construction, operation and demolition.

In addition, this module provides students with an opportunity to use digital design, planning, analysis and presentation tools to support the collaborative design and planning of a reinforced concrete building (e.g. an office building, a hospital, an airport terminal). Student work in groups on their design project to produce detailed architectural/structural design and documentation. Autodesk Revit software is an intelligent model-based process to plan, design, construct, and manage buildings and infrastructure. Then, Revit model is brought into Virtual Reality space by Oculus Rift Touch. It helps to create an interactive walk-through and provide students with a realistic sense on the actual live in the simulated environment. BIM shows a building at every step of its development and illustrate design, construction, and materials in detail. The embedded capacities of BIM make it a dynamic platform that allows multiple groups in different locations to work on projects.

Precise planning along with technologies are essential to make this course successful and effective to the students. It is essential to create interactive lesson for the new generation as they are growing up with technologies. Integration of the advanced technologies into BIM course teaching helps to deliver the course in more effective, engaging and interactive ways. It helps to improve the teaching and learning which would benefit both students and the University. In this research, VR will be integrated into BIM teaching and learning for an effective in and out of classroom engagement.

The aim of this research is to explore the teaching and learning experience by integrating Virtual Reality into Building Information Modelling (BIM) course in the Department of Civil Engineering at the University of Nottingham Malaysia (UNM). A BIM-VR framework is designed for modelling the existing structures. The framework makes use of object-based parametric modelling software packages to develop a data-

rich model for existing structures from extant documents and available knowledge. It is to reduce time, cost and increase quality in modelling of complete existing structures in terms of architecture, structural and interior design, mechanical, electrical and plumbing systems.

This study acts as a stepping stone to help more educators at UNM to explore the potential benefits brought by VR in other educational settings. VR can be employed to give immersive experiences to medical students, mechanical engineering students, student pilots, etc. This will result in better graduates who are knowledgeable in their respective fields meanwhile opening for new research areas on certain subjects.

In addition, students are able to experience the real construction process in BIM course with the integration of VR, prepare the future professionals who will be experts in BIM, good teaching and learning experience and hence improve the offered BIM course, and also to attract the outsider investors to invest in the BIM technologies to support the future BIM research.

2 Literature Review

2.1 Building Information Modeling (BIM)

Building Information Modelling (BIM) is a terminology developed to illustrate a broad set of discipline-specific software packages that handle all phases in the project lifecycle (LC) [5], representing as a semantically enriched and consistent digital building models [6];[7]. It can also stand for building information management which the control of the processes in the built and used model [8] and for building information marketing [9]d.

On the other hand, others could argue that BIM is the process of creating information about (future) building. This is even acknowledged in the BIM maturity levels [5];[10]. The US National Building Information Modelling Standard defines BIM as “A digital representation of physical and functional characteristics of a facility and a shared knowledge resource for information about a facility forming a reliable basis for decisions during its life-cycle; defined as existing from earliest conception to demolition” [11].

BIM maturity levels are a broadly accepted concept in the understanding of BIM, where Level 0 utilizes only 2D drawings and shared among different stakeholders either in a digital or paper format, Level 1 typically consists of 3D conceptual CAD drafting and 2D CAD drawings for approval of building documentation and the 3D Model is not shared among project team members, Level 2 is distinguished by collaborative working, and requires "an information exchange process which is specific to that project and coordinated between various systems and project participants" [12], and Level 3 that represents the full collaboration between all disciplines by means of using a single, shared project model which is held in a centralized repository, in which all parties involved can access and modify with no risks of any clashes and conflictions.

BIM software packages have provided the opportunity for interoperability, the ability to exchange/share information between separate computer programs without any loss of content or meaning [13]. They also couple project organizations together for an existing building [14], since in practice the benefits of BIM are based on the value added by the creation of an integrated model [5], which provides a resource for data sharing in a facility to enhance in facility management, operation and maintenance [15]. For instance, an air conditioning unit within a BIM would also contain data about its supplier, operation and maintenance procedures, flow rates and clearance requirements [15];[16].

BIM usage for existing structures has been widely studied in [17];[18] and its benefits have been widely espoused.

2.2 Virtual Reality (VR)

Virtual Reality is commonly referred to as a set of technological devices which include 'computers, head-mounted displays, headphones, and motion-sensing gloves' [19]. It is a technology that immerses the user into a computer-simulated environment establishing the sense of being transported into an utterly distinctive reality. The use of VR in simulating structure buildings has been introduced multiple times in the past [20];[21];[22] as well as owing to the noticeable advancement of technology in the past couple of years. The implementation of VR in various applications nowadays has become smoother.

Gaming development engines are used to facilitate the process of developing a VR environment, by using scripting languages such as 'C#' (C-Sharp) and 'Javascript' to manipulate objects in the three-dimensional (3D) reality. Scripting languages could also be merged with additional libraries to allow the retrieval of specific information from the database describing certain objects; the gaming development engines compile these scripting languages into native codes to ensure fast and reliable performance [23]. VR headsets are the hardware used to deliver the VR experience to the user, a head-mounted display (HMD) that allows the user to interact with the virtual environment in first-person view (FPV) with the help of tracking sensors.

Schrader [24] has established 'learning about technology', 'learning from technology', 'learning with technology' and 'learning from technology' which defines the different types of interactions either between the users and the content of the world or the users themselves [25]. VR system is developed to promote Engineering Education. VR can be used in any teaching when the real thing is high risk, impossible, inconvenient, too time-consuming or too costly [26]. VR helps to create an interactive walk-through and provide students with a realistic sense on the actual live in the simulated environment. With the VR, student's motivation can be enhanced and make learning experience more interesting. In addition, VR helps to improve group work skill and self-directed learning in problem-based learning narratives [27].

2.3 Integrating VR in BIM

The need for VR in BIM is increasing due to the advantages and value added to the BIM environment. The use of VR improves visualization and provides an accurate height measurement of the user, this technique is achieved through usage of the tracking sensors, allowing a proper scaling with the actual dimensions of the building for a better sense of relativity, which immerses the user in the virtual environment giving a better sense of the surrounding lengths and heights e.g. the distance between two columns, or floor to ceiling height. As VR is making use of the height of the user in the virtual environment, different safety aspects can be assessed e.g. railings heights, such that assumption can be made on whether the building is safe to be used in its current condition in reality.

Other aspects of safety such as routes and lengths of emergency paths [28] can be planned and tested in the virtual environment to allow sufficient time to escape by simulating the average speed and step length of a user. Moreover, this integration allows easier and faster viewing of the interior design of the existing structure. Therefore, this technique provides an opportunity to assess the potential of any change or retrofitting processes that are planned in the future.

Better visualization in VR provides better opportunity for application in the real estate and property development industries. VR allows showcasing of properties to be sold or rented, as the estate buyer can go through the building in a tour to view every aspect and component of the building with its unique properties (e.g. different types of floors are identified as oak or concrete) remotely, without the need to directly visit the real estate company. Mobile access could also be implemented to allow different overseas consultants to visit the existing structure for facility management and maintenance procedures without the need to travel. Therefore, this technique reduces the transportation time, costs and efforts in presence of the VR headset without losing any of the essential BIM concepts and semantically rich models.

Gee [29] has indicated that an immersive, intelligent and digital environment provides an improved platform in the area of education. In addition, Michael and Chen [30] have demonstrated that serious games (is a game designed for the benefit of the user and marginally the user's entertainment) can provide the upcoming learners with an environment that motivates understanding and visualizing. Various research in this area recognized the benefit of some of the serious games in the education industry.

3 Methodology

3.1 Designed BIM-VR framework

BIM-VR framework can be carried out with any computer-based VR headset, which consists of a head-mounted display and tracking sensors connected to a computer device and wireless controllers. However, mobile-based VR headsets will not be compatible as they only operate with the restrictions limited to the ability of the mobile phone placed in the HMD that does not have the ability in terms of processing

power to run the final application. Moreover, controllers are not widely available for commercial use in the case of a mobile-based VR headset.

In this research, the chosen BIM software is Autodesk's Revit ® which is widely used in the industry and can be used to export to formats that will be favourable during the framework use. The computer graphics program used as a rendering engine is Autodesk's 3DS MAX ® which is used to convert Autodesk material library (AMC) materials to standard materials, through an available converter plug-in, which can be processed and visualized in the game development engine. Other alternatives exist such as rendering through a third-party renderer named NVIDIA Mental Ray which is readily available in most versions of 3DS MAX ®, but it was discontinued after the 2017 version.

Unity ® is the game development engine used which allows manipulation and scripting to form a platform to move through the existing structure in first person view. It is also used to develop and integrate the 360° interior inverted spheres. In addition, Unity ® provides no restriction on tools that can be added through object-oriented programming (OOP) using C# programming language in Unity® to convert to the VR. The hardware used to run the application produced by Unity® is Oculus Rift® CV1 consists of a HMD, 2 touch Controllers (one for each hand) and 2 infrared tracking sensors, which keep track of movement of the head and each hand.

Oculus Rift® was chosen as it has a built-in headphone, which is useful in the immersive environment when compared with its competitors that require an external headphone to simulate sounds. The touch controllers in the Oculus Rift ® can sense the movement of individual fingers. Therefore, Oculus Rift® provides a more realistic performance in the virtual environment. In addition, it provides wide range of available resources and libraries that reduce the workload required to finish a specified task.

Designed BIM-VR framework can be implemented using any BIM software, computer graphics program (rendering engine) and game development engine. The general flow of the designed BIM-VR framework is shown in Fig. 1. The framework is started with 3 different stages that are later combined into one model and accessed by the user; 1) Integrate VR into unity; 2) Create the visualization environment for the interior of the model; 3) Create the exterior BIM Model. The three stages were executed parallelly as demonstrated by the flowchart and each stage is further explained.

BIM-VR framework is designed to allow a brief description of items in the structures as the user line of sight crosses them e.g. provision of information for the materials used in the construction of the existing structure. It breaks the language barrier as it reduces the need for verbal communication and favors the visual communication of data and building related information through the data input into the database e.g. diameter, flow and pressure in a pipe is generated as a pop-up when the line of sight of the user meets the specified pipe. These data are extracted by using the scripting languages in the gaming development software by connecting to the dedicated server that inputs the data directly from the BIM software with the help of the corresponding BIM software Application Programming Interface (API). The main feature of the server is the data could be easily updated or appended by the user on the BIM model using the object based parametric software and directly viewed in the VR environment.

Designed BIM-VR Framework provides access to the BIM model and its data with no compatibility complications when transferring between two different BIM modelling software packages, thus eliminate the need of exporting the model into the Industry Foundation Classes (IFC) format and imports it to view on the other software package such that it provides a readily executable file (EXE) format that can be viewed on any platform.

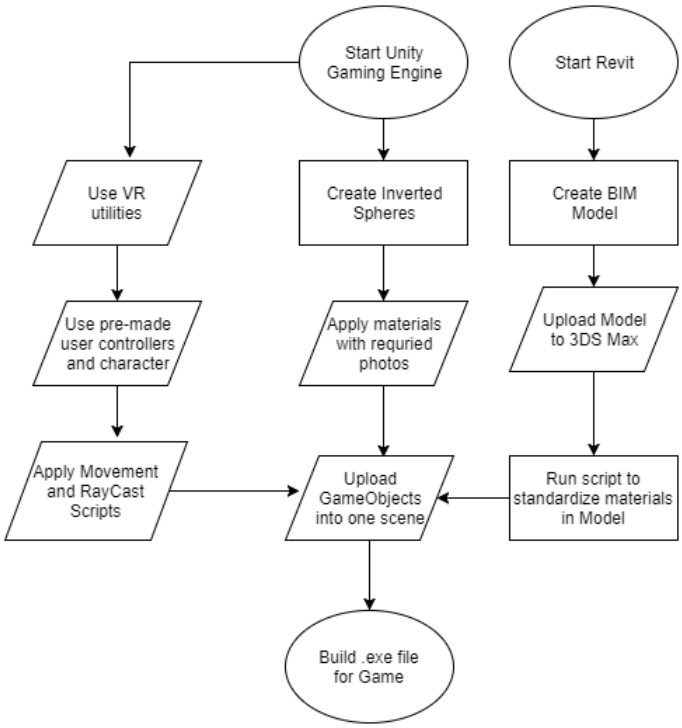


Fig. 1. Flowchart demonstrating the general flow of BIM-VR framework

Exterior and MEP modeling: The first step to produce a model of an existing structure in VR is to transfer the 2D extant drawings into a BIM modeling software on which architectural, structural, mechanical, electrical and plumbing models co-exist at the same time, without the need to model the interior design which is extremely time-consuming and difficult to model with high accuracy unless point cloud-based methods which are of very high cost are implemented. Fig. 2 demonstrates the modelled exterior design of the Trent Building in the University of Nottingham Malaysia that is based on actual construction 2D CAD drawings.

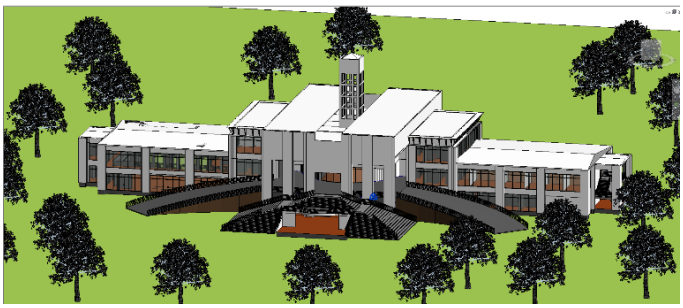


Fig. 2. Exterior model in Autodesk Revit® Software

Non-geometric information such as materials of building components is also added. The accuracy of the existing structure is viewed in VR. Therefore, the simulation is limited to the construction accuracy relative to the drawings at construction time, unless the drawings are updated after construction to produce an accurate representation of the existing structure. Modelling the exterior and MEP provides realism and better virtual environment as it allows the user to freely move in the first-person view and discover every element of construction in the existing structure. Fig. 3 shows a MEP system in one of the rooms of the Trent Building.

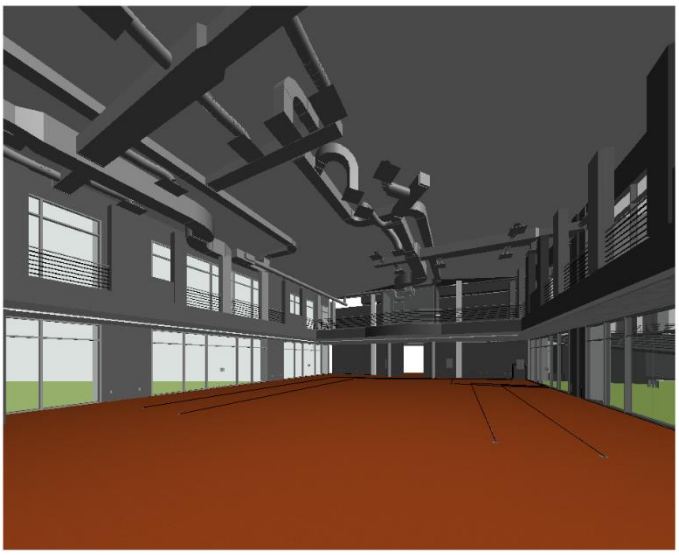


Fig. 3. Sample Air Conditioning System for one of the rooms in Autodesk Revit® Software

Exporting process: Exporting the Revit® 3D model to Filmbox format (.FBX) which is then imported in 3DS MAX® as shown in Fig. 4, ensures all desired objects in the existing structure are visible. For versions of 2017 and before a NVIDIA® Mental Ray®, plug-in readily exists in 3DS MAX® which uses ray tracing to render the model. Without this plug-in, textures will be missing in the model [31].

Fig. 4. Isometric view of exterior model in Autodesk 3DS max®

The model is then exported to .FBX format again which can be directly imported into Unity® in assets. However, this method does not produce textures for all components, so some textures are found to be missing. Material standardization is important to solve the problem of losing parametric information during the migration of a proprietary model into the Unity® based virtual reality platform. A plugin-in automatically identifies all the Autodesk material types inside the Revit model and standardizes them based on Standard Material .So, the end result in Unity® can be visualized in Fig. 5 [32].

A set of tools is designed in the virtual environment to facilitate the users' extraction of further detailed data. The provided toolkit contains

1. Length-measuring equipment,
2. Angle-measuring equipment,
3. Simple Calculator and
4. Material detecting equipment as shown in Fig. 5.

The length-measuring tool calculates the distance between two points whereas angle-measuring tool requires three points (A, B and C) and measures the respective angle between vector AB and vector BC. Simple calculator is added to assist the user with basic mathematical calculations, thus defying the need to remove the HMD for any calculations. In addition, a material detection tool is designed to identify the type of material incorporated into each building components in the existing model. A panel is also attached alongside the toolkit to guide the user on how to use each tool and automatically displays the returned results by the respective tool. This toolkit provides accurate data extraction technique from the existing structure while in the virtual environment with results of high accuracy that require no scaling or any form of manipulation.

Fig. 5. Overview of BIM in unity and the integrated tool-kit with its different components

Interior design visualization: One of the most complex challenges in modelling an existing structure is modelling the interior design of an existing building. It is possible that certain brands of materials and components are not available when the modeller need to use them according to the existing project specifications [33]. Moreover, the work is extremely time-consuming to model the interior design piece by piece for any existing structure and is difficult to yield a model that is perfectly accurate in comparison to reality due to the regular undocumented changes in buildings. Ibrahim and Krawcysk[34] have pointed out that we need to wait until new components are available on the market if a building is to employ creative and innovative design solutions.

Hence, BIM-VR framework introduces the concept of an inverted sphere which utilizes a low cost 360-degree camera. An algorithm is established in the game development engine to project the 360-degree photos on a sphere in which the user is placed virtually in its centre. This advanced photogrammetric method ensures extremely high accuracy in comparison with all other commercially known techniques in nearly negligible time. The user can move smoothly in the interior of the existing building among pre-defined points to visualize the interior design with all its details. Moreover, the user with a press of a button can transfer to the free-movement environment to view things beyond the photogrammetric ability of the 360-degree image viewer such as MEP systems, which are above ceilings and inside walls. In Fig. 6 all the inverted spheres used in the building are shown independently from the building structure from a bird-eye's view.

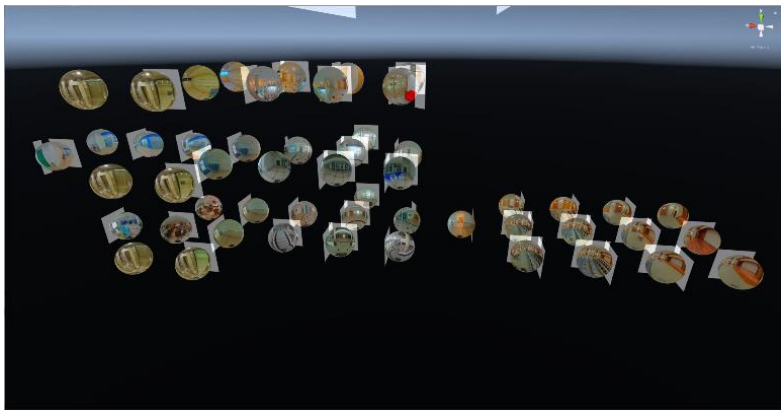


Fig. 6. Overview of all Inverted Spheres with different 360 images superimposed

VR integration methods: Using the BIM-VR framework provided by Oculus® rift for Unity® game engine three game objects were uploaded to the virtual environment, and several scripts were applied to these game objects to further enhance the user experience while using the environment created.

The first game object used is the first-person player controller (FPC), named in unity "OVRPlayerController", which provides a full visual model for the user and allows free movement using the touch controller's joystick for the user to be able to move freely inside the virtual environment while being able to view the surrounding through the head mounted display. The FPC game object is a parent object for 2 different game objects "ForwardDirection" and "OVRCameraRig".

Under the second game object there is the "TrackingSpace", a game object, which consists of another 6 children objects of interest as they track the users' left hand, right hand, left eye's view, right eye's view, center's view, and the whole user by adding further game objects as children under the following objects; the position and properties of each object that will be inherited and further used thus the usage of an OOP-based language.

The other two game objects used from Oculus® VR framework are the right hand's and left hand's controllers which were created by the oculus rift's team who applied scripts to them by stimulating movement of the buttons and joysticks in the virtual environment when applied by the user in the real world. Both controllers were added under the respective child game objects under the FPC parent one, which can all be demonstrated through the Unity® screenshot in Fig. 7.

Fig. 7. OVRPlayerController game object with its children objects

Helping the user to perform specific functions when prompted, Unity® class "MonoBehaviour" raycasts were used from the tip of the right-hand controller pointing to objects in the environment the concept of inverted spheres. Interior models further enhance the BIM by adding more realistic components to the existing structure and help the user in visualizing the actual environment. The main problem with modelling the interior design is the lack of inventory of each interior model. These models differ in their structure and design; therefore, the designer is required to start creating the model from scratch since sometimes the documents related to this design are not provided [35] leading to increasing time, amount and complexity of the task.

The concept of inverted spheres is introduced in the BIM-VR framework to help the designer add the interior model achieving the visual advantage of having the interior model in the BIM for the existing structure. The concept is achieved by using a 360 camera that takes photos for the interior model of the building, and these photos are later added to the inverted spheres in the unity game engine which allows the user to move between these spheres in order to tour the building and examine the interior design of the building as well as transfer between the BIM, to observe the MEP, and return to the inverted spheres. Fig. 8 shows a zoomed in view on one inverted sphere with the relevant 360-degree photo superimposed.

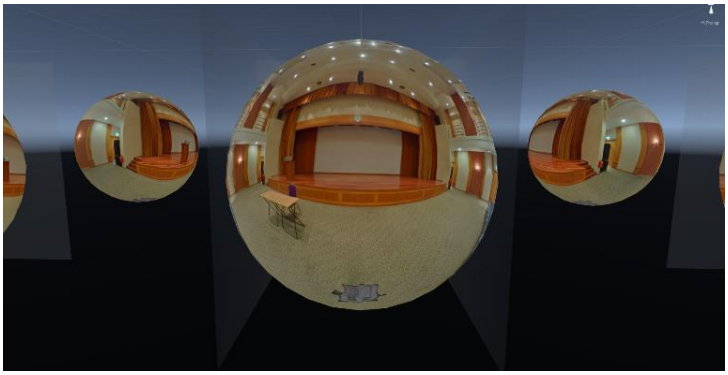


Fig. 8. A close view of one inverted sphere with its respective superimposed 360-degree image

The Unity® game engine already provides a sphere game object. However, these spheres need to be modified via a script written and added to the 'Editor' folder under the main 'Assets' folder in unity to create a new 'InvertedSpheres' object that helps the developer to use it later.

The 'InvertedSpheres' class has a function that creates a graphical user interface (GUI) for the developer to choose the respective game object and to choose a certain radius of the sphere. This script also creates a mesh renderer that is applied to the inverted spheres. The main idea of this renderer is to invert the sphere so the user could stand in the center of the sphere and easily view the full 360-degree photo that covers the sphere by rotating using the HMD. An invisible plane is created to cover the whole sphere horizontally to provide a ground for the user to stand on while viewing the photos. Without this ground the user won't be able to stand at the center of the sphere as the sphere is empty from the inside. Additionally, the movement script is updated to prevent the user from moving when in the interior design view inside the spheres; as for realistic view the user needs to be always at the centre of the sphere to see the photos that represent the actual interior design in a certain area or room. The invisible plane is created by using the plane game object in Unity® game engine and the application of s transparent material.

After creating the inverted sphere, a material is created with the type of 'Unlit/Texture' and the texture added is the 360-degree photo captured. This material is used to further enhance the quality of the photo using a 360-degree photo viewer. The number of spheres is equal to the number of photos taken by the user according to the respective number of views of the interior the user wants to provide.

The concept of movement between the spheres is achieved by adding extra invisible planes that are perpendicular to the horizontal plane. These planes are added depending on the spheres surrounding the current sphere that the user inputted. The spheres are equally placed and each sphere has a certain position depending on the user input. When the user looks at a certain direction and this direction allows the user to move into a different view of the interior design the user is prompted to press a button in order to view to the next view, this is achieved by having a raycast checking which invisible plane is the user pointing too and if the button is pressed the user is transferred to the center of the targeted sphere; therefore, it allows different views of the interior design and generalizes the concept of movement between the spheres; this process is demonstrated in the flowchart in Fig.9. For presentation purposes in this flowchart, 4 directions are only added, but the user can add infinite number of directions, including up and down, using the framework.

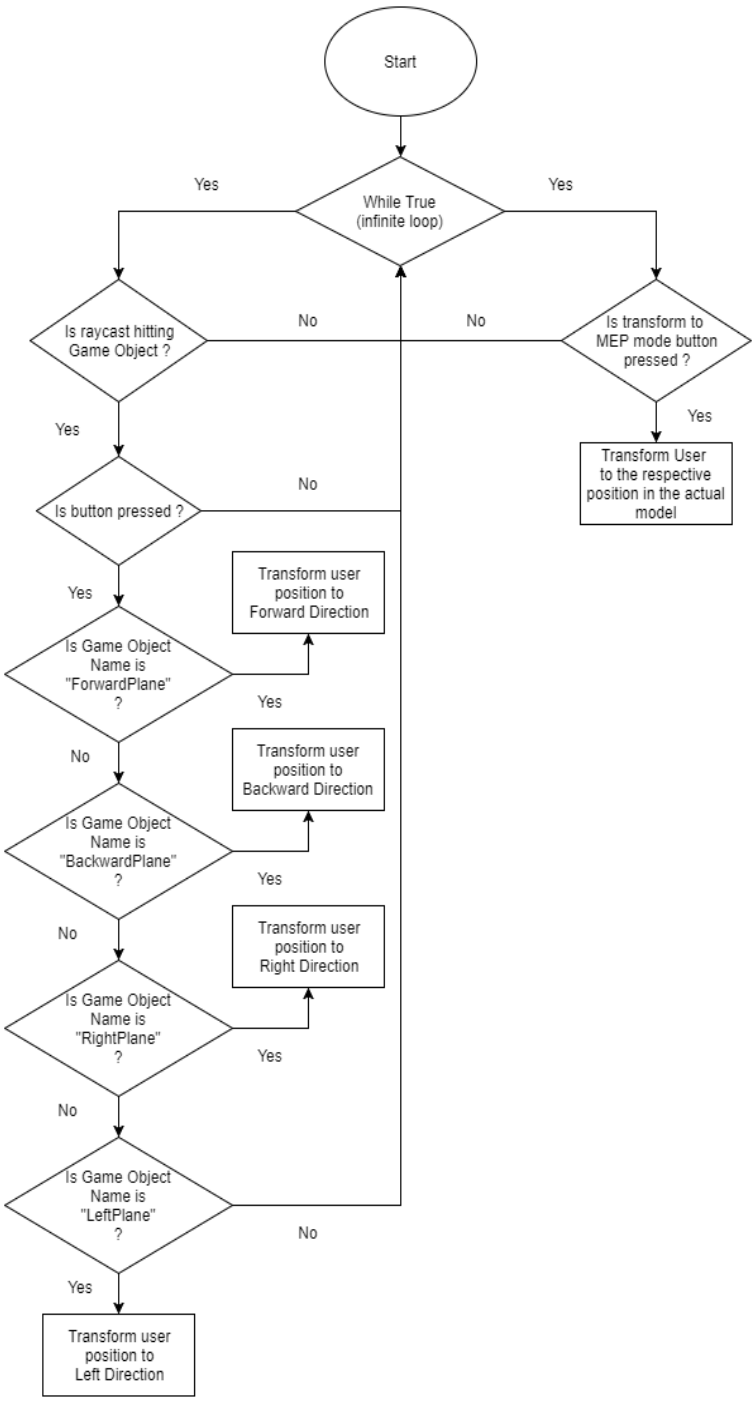


Fig. 9. Flowchart demonstrating the controls programmed on both controllers

The switching between the interior views in the Inverted Spheres and the MEP (as shown in Fig. 10) in the model allows the user to retrieve information such as the specifications of MEP.

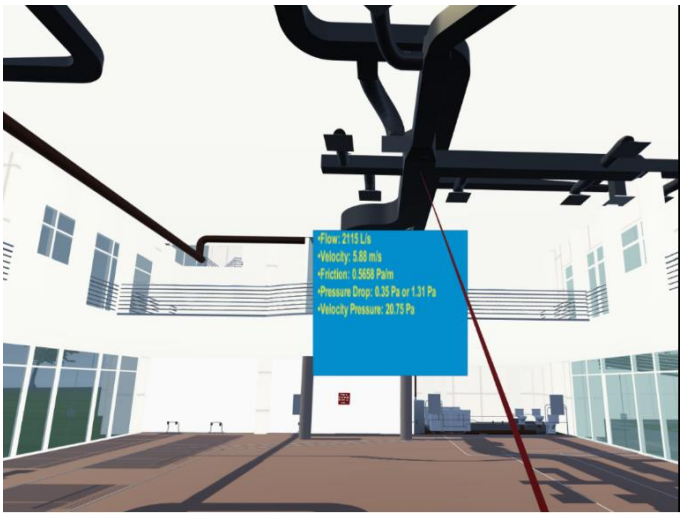


Fig. 10. Air conditioning system in the virtual environment and sample data extraction

Using the IS the user can visualize the interior of the BIM model accurately, and if data is needed to be extracted interiorly the user will be able to access the BIM model and use the toolkit to access the data. Using this method, the developer does not need to design the interior model as the IS visualization concept is achieved using a 360 camera to provide accurate results for the interior.

3.2 Questionnaire survey

VR has been integrated into BIM in teaching Civil Engineering through blended learning or hybrid virtual learning [36];[37]. Students are taught the fundamental concepts of BIM (e.g. life cycle of buildings - planning, design, construction, operation and demolition) and the functionality of BIM software. The 3D models in BIM allow students to feel space in a way that is not possible with traditional 2D drawings. Then, students can walkthrough and feel what it is like to be right inside the buildings that they have designed using Oculus Rift VR headset.

In VR, students are getting an immersive 360-degree view and they can “walk around” their new designs, e.g. future house, buildings and renovations. The idea is that students can sit inside a classroom, but walk virtually inside the models (using the VR headset) and evaluate every nook and cranny of something that does not exist physically, e.g. concealed conduits, wiring and building services. The technology also enables virtual interaction between various stakeholders in a project (e.g. architects, engineers, consultants and quantity surveyors) and the central maintenance of all sorts of data, hence to provide a holistic approach to construction projects. The immersive

interactions in networked virtual environments are difficult or even impossible in traditional classrooms or lab settings. The level of immersion and control of learning experiences is not possible without VR.

A data collection and survey were conducted to ensure the credibility of this study. Questionnaire survey was adopted in this project to explore the teaching and learning experience by integrating Virtual Reality into Building Information Modelling (BIM) course in the Department of Civil Engineering at the University of Nottingham Malaysia (UNM). In this study, a quantitative survey is used to evaluate the students' experience in using the BIM. The survey was developed from the review of the literature and what the researchers thought to be significant in exploring a new application software in engineering. The questionnaire was administered online using Google Form and it was designed with a 5-point Likert scale: 1 (Strong Disagree), 2 (Disagree), 3 (Neither agree nor disagree), 4 (Agree) and 5 (Strongly Agree).

The survey was divided into two sections.

Section 1: Perception towards augmented reality and virtual reality

Q1: I can virtually travel to places that I may not able to visit in future.

Q2: I can travel through time and explore ancient civilization and construction industry.

Q3: I can practice skills in a safe and non-threatening virtual environment.

Q4: I am able to see and learn the hidden Mechanical, Electrical and Plumbing (MEP) features and thus enhance my understanding.

Q5: I am able to learn the safe features in the construction.

Q6: I can grasp Design concept more readily and retain the information for longer time.

Q7: I am fully focused on learning content and removed from distraction.

Q8: I am able to trigger my own creativity in design.

Section 2: Learning experiences

Q9: The objectives of the workshop were made clear/available to me.

Q10: The teaching methods used in the workshop help me to learn.

Q11: The method of assessment (coursework, practical, etc.) allows me to demonstrate what I have learned on the workshop.

Q12: The level of the workshop is about right.

Q13: The workload on the workshop is about right.

Q14: The teacher was approachable.

Q15: The teacher was an able communicator.

Q16: The teacher was patient in explaining things which seem difficult to grasp.

Q17: The teacher retained my interest.

Q18: The teacher was helpful and supportive.

Q19: The teacher encourages me to take responsibility of my learning.

Q20: Sessions were paced appropriately.

Q21: I am satisfied with the venue and time allocation for the module.

Q22: I am satisfied with the learning support provided by the teacher.

Data Collection: The sample of study was drawn from undergraduate civil engineering students registered in the BIM course. They are from year 1 to year 3 students

age 19-21. The quantitative survey was administered at the end of the semester upon completion of the BIM course. The BIM course was conducted in the form of a compulsory BIM Group Design Project module in 13 weeks and 4 hours per week. The questionnaire was simple and it took approximate 10 minutes to complete. Students' participation was based on voluntary basis and no coercion was used. This is to adhere to the research ethical conduct that all human subjects are choosing to participate of their own free will. In addition, ethical standards also protect the confidentiality and anonymity of the human subjects. There were 57 students responded to the survey and the respond rate was good.

Data analysis: The data was analyzed using Microsoft Excel and IBM SPSS version 25. Descriptive statistics was presented using the bar charts and some statistical analyses were performed to construe the data.

4 Results and Findings

4.1 Demographic information

The students participated in this study came from a diversified spectrum of profiles. The students' demographic information is shown in Table 1. Most of the students participated in this study was male students (77%), Year 3 (65%) and Malaysian (81%).

Table 1. Students' demographic information

Gender	Frequency	Percent
Male	44	77%
Female	13	23%
Year of study	Frequency	Percent
Year 1	2	3%
Year 2	18	32%
Year 3	37	65%
Citizenship	Frequency	Percent
Malaysian	46	81%
International	8	14%
Missing	3	5%
TOTAL	57	100%

4.2 Virtual reality

Data collected had shown that most of the students had positive perceptions towards virtual reality (see Fig. 11). About 70% or more students agreed or strongly agreed that they could travel virtually, travel through time, practices safely, learn MEP features, learn construction safety features, grasp design concept, focus in learning and trigger design creativity. This approach to teaching has produced a positive impact on learning. First and foremost, students are relatively more enthusiastic to

improve their design models after finding out their weaknesses in virtual reality, which was difficult, if not impossible, in conventional architectural drawings. Apart from that, virtual reality promotes collaborative learning as it allows lecturers/students based in different geographic locations to collaboratively design, review, test and validate projects virtually.

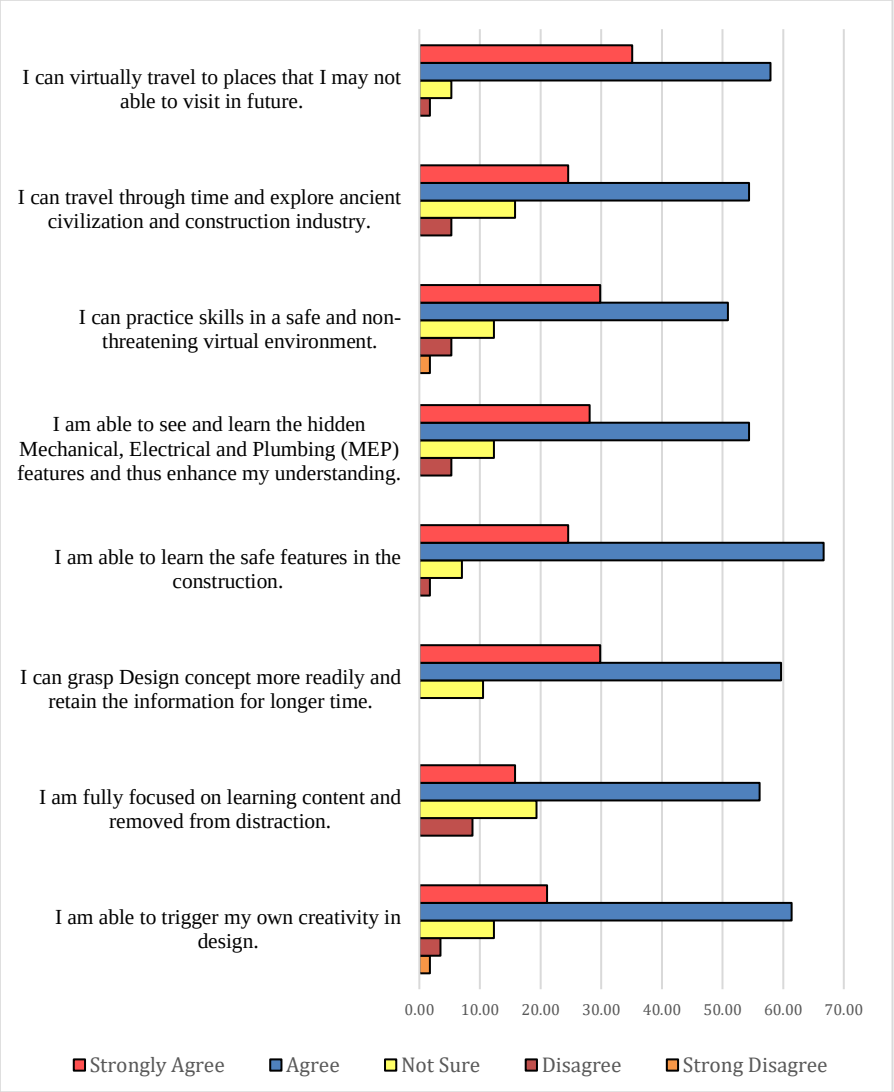


Fig. 11. Students' perceptions of augmented reality and virtual reality

4.3 Learning experiences

Data collected had shown that most of the students had positive learning experiences in the BIM course (see Fig. 12). About 70% or more students agreed or strongly agreed that the BIM workshop was useful, the teacher was an effective educator and the learning environment was encouraging. Apparently, the use of augmented reality and virtual reality in the BIM course had accommodated students' diversity and motivated them to learn. Every student learned differently. They possessed different kinds of mindsets and cultural backdrop, and therefore they memorized, thought, interpreted and understood things differently. Students have a unique blend of intelligences, capabilities and skills. According Gardner's Theory of Multiple Intelligences [37], every individual differs in eight intelligences. For instance, a student may have strong spatial skills but poor in linguistic. The integration VR learning is methodologically in conformity to Theory of Multiple Intelligences and supports diverse student needs.

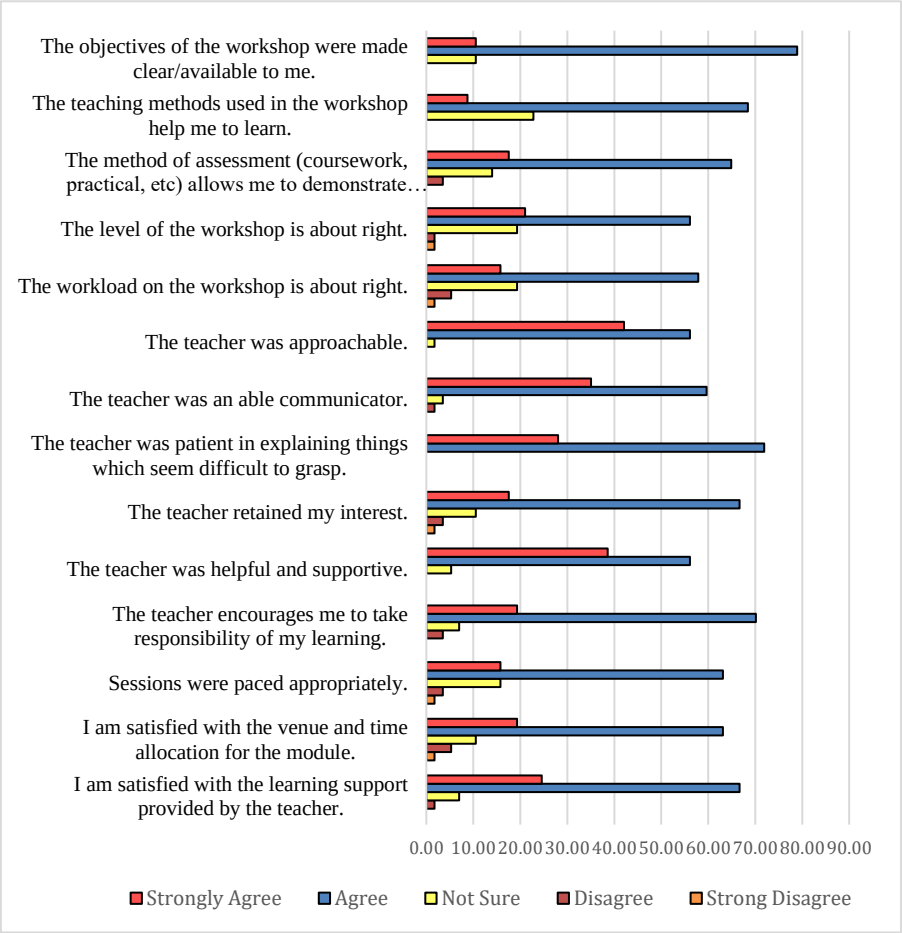


Fig. 12. Students' learning experience in BIM course

4.4 Gender differences

Mann-Whitney test had shown that there were no significant differences between male and female students in 21 questions except for Q4 (see Table 2). Female students were significantly more capable in learning and understanding the hidden Mechanical, Electrical and Plumbing (MEP) feature in an augmented and virtual reality environment (p = 0.025). However, there were no gender differences in the other aspects of evaluations.

Table 2. Ranks of Mann-Whitney Test

	Mean Rank for Gender		
	Male	**Female**	**Asymp. Sig. (2-tailed)**
Q1	28.76	29.81	0.819
Q2	28.30	31.38	0.515
Q3	28.50	30.69	0.648
Q4	26.58	37.19	0.025*
Q5	27.38	34.50	0.101
Q6	28.18	31.77	0.432
Q7	27.73	33.31	0.237
Q8	27.69	33.42	0.209
Q9	28.42	30.96	0.495
Q10	28.50	30.69	0.609
Q11	28.44	30.88	0.583
Q12	28.34	31.23	0.539
Q13	27.66	33.54	0.208
Q14	29.85	26.12	0.410
Q15	29.67	26.73	0.516
Q16	30.07	25.38	0.251
Q17	29.10	28.65	0.918
Q18	30.98	22.31	0.059
Q19	30.16	25.08	0.228
Q20	27.53	33.96	0.154
Q21	27.49	34.12	0.141
Q22	28.56	30.50	0.655

4.5 Year of study differences

Kruskal-Wallis test had shown that there were no significant differences among Year 1 to Year 3 students in the 22 questions (see Table 3). This could imply that students regardless of year of study were positive towards the use augmented and virtual reality in the BIM course.

Table 3. Ranks of Kruskal-Wallis Test

	Mean Rank for year of study			
	Year 1	**Year 2**	**Year 3**	**Asymp. Sig.**
Q1	34.25	27.36	29.51	0.764
Q2	39.25	27.31	29.27	0.557
Q3	37.50	22.28	31.81	0.067
Q4	37.75	24.64	30.65	0.265
Q5	37.50	27.67	29.19	0.626
Q6	36.25	28.36	28.92	0.764
Q7	42.75	27.22	29.12	0.378
Q8	39.75	27.00	29.39	0.477
Q9	29.00	29.00	29.00	1.000
Q10	20.00	28.67	29.65	0.614
Q11	17.75	28.56	29.82	0.491
Q12	18.75	30.42	28.86	0.574
Q13	21.00	30.56	28.68	0.670
Q14	17.50	27.47	30.36	0.402
Q15	20.50	29.92	29.01	0.678
Q16	21.00	25.75	31.01	0.246
Q17	28.50	31.08	28.01	0.742
Q18	19.50	29.03	29.50	0.638
Q19	26.50	26.92	30.15	0.676
Q20	30.50	26.36	30.20	0.638
Q21	28.50	24.53	31.20	0.266
Q22	24.50	28.97	29.26	0.893

4.6 The impact of virtual reality on civil engineering learning

With virtual reality, engineering education has a major breakthrough. Immersive interactions, stereoscopic 3D, real time multisensory simulations, virtual explorations, synchronous communications, data analytics and visual analysis – all these are hardly possible without virtual reality. Virtual reality furnishes a student-centred learning environment that promotes active and collaborative learning, situated within simulated real-world contexts. Students could explore their intellectual curiosity in ways that are seemingly impossible in traditional classroom settings. The unique blend of virtual reality and live virtual interaction creates powerful and immersive learning experiences that engage students in deeper learning.

In this VR project, an effective student-centred learning approach is being fully utilized. Learning of knowledge and skills is more meaningful when students are "learning by doing", situated within the learning context. Unfortunately, the conventional classroom lectures are usually out of context; it is analogues to someone who learns to swim by reading a book, but never got in the water. In VR however, ones could 'place themselves' in the virtual world that simulates real-world experiences. VR promotes learning through a "situated learning" approach. In a situated learning context, students develop knowledge and understanding by having concrete and hands-on experiences built on realistic problems.

In VR, knowledge of skills, attitudes and culture in the Architecture, Engineering and Construction (AEC) industries can be constructed through problem-solving within the virtual environments and communities. VR takes the BIM model to the construction site, allowing students to learn from the first-person experience. This gives students a strong illusion of exploring and testing the viability of an architectural design, and working together with other construction professionals. The motivation behind situated learning is typically that students become participants in their own learning by deep interaction with other parties and vivid objects presented in the 3D landscape. The real-time feedback given by other parties, and the interactive environments leverage knowledge construction. The same level of control and immersion is impossible without VR.

VR allows students to explore different realities and alternate their learning experiences (instead of sitting in classroom). Furthermore, such approach is beneficial for students who are physically disabled, and to demonstrate unrealistic and dangerous simulations. Students are engaged in "active learning" and the immediate engagement is useful in understanding complex engineering theories or concepts. Exploration and hands on approach aids in learning and better retention of knowledge and skills learned.

This approach to teaching has produced a positive impact on learning. Firstly, students are more excited and enthusiastic to improve their design models after "seeing" their weaknesses in VR, which was difficult, if not impossible, in conventional architectural drawings. Secondly, VR promotes collaborative learning. VR allows lecturers/students based in different geographic locations to collaboratively design, review, test and validate projects virtually.

5 Conclusion

In conclusion, the BIM-VR framework provides an extensive and generic platform that promotes its use for any existing building. The application on the Trent Building in the University of Nottingham Malaysia is proof that the framework can be used generally for any existing building without the complications induced by modelling interior design piece by piece or any other time-consuming and ineffective methods; therefore, the 360-degrees inverted sphere can be an efficient substitute for these conventional interior design modelling methods. Moreover, the integrated toolkit is an important tool for data extraction from the model through the HMD and the touch controllers. So, for future work this toolkit can be extended to perform other several tasks that assist the user in the virtual environment and eliminates the need for many site visits that can be either time-consuming or inefficient in terms of cost. The platform can be improved in future research to introduce the ability to edit the BIM model in the virtual environment where this data is eventually communicated in real time to apply these changes in reality and on the actual model. The integration of the MEP systems in the model provides the opportunity for continuous monitoring of the various systems which are embedded in the walls and are extremely difficult to monitor through other methods. In this area, a continuous monitoring mechanism can be im-

plemented in the future to predict and locate any failures in the system and avoid any disasters.

6 Acknowledgement

This research is supported by University of Nottingham Malaysia research grant UNEV0001entitled with 'Virtual Reality for Building Information Modelling in Engineering Education'.

7 References

[1] F. J. Sabongi and M. Arch, "The Integration of BIM in the Undergraduate Curriculum: an analysis of undergraduate courses," in Proceedings of the 45th ASC Annual Conference, 2009, pp. 1–4.
[2] A. Z. Sampaio, "Teaching Building Information Modelling in an Architectural School.," pp. 421–432, 2014.
[3] J. McKimm, C. Jollie, and P. Cantillon, "Web based learning," Bmj, vol. 326, no. 7394, pp. 870–873, 2003. https://doi.org/10.1136/bmj.326.7394.870
[4] M. Groves and J. O'Donoghue, "Reflections of students in their use of asynchronous online seminars," J. Educ. Technol. Soc., vol. 12, no. 3, pp. 143–149, 2009.
[5] F. Khosrowshahi and Y. Arayici, "Roadmap for implementation of BIM in the UK construction industry," Eng. Constr. Archit. Manag., vol. 19, no. 6, pp. 610–635, 2012. https://doi.org/10.1108/09699981211277531
[6] C. M. Eastman, C. Eastman, P. Teicholz, R. Sacks, and K. Liston, BIM handbook: A guide to building information modeling for owners, managers, designers, engineers and contractors. John Wiley & Sons, 2011. https://doi.org/10.1002/9781119287568
[7] A. Watson, "Digital buildings–Challenges and opportunities," Adv. Eng. informatics, vol. 25, no. 4, pp. 573–581, 2011.
[8] I. Panushev, "Building information management system." Google Patents, 09-Aug-2012.
[9] J. Huval, "Evolution of Technology: Innovations in Building Information Marketing. In. SMPS Webinars: Society for Marketing Professional Services.," 2019.
[10] R. McPartland, "BIM Levels explained. In Definitions for levels of BIM maturity from Level 0, through Level 1, Level 2 and Level 3 and beyond.," Natl. Build. Specif. RIBA Enterp. Ltd., 2014.
[11] NBIMS, "National Institute of Building Sciences: National Building Information Modeling StandardTM.," Princ. Methodol., 2007.
[12] SFT, "Building Information Modelling. In Level 2 Standards. Thistle Street, Edinburgh, UK: Scottish Futures Trust.," 2019.
[13] G. Aranda-Mena and R. Wakefield, "Interoperability of building information-Myth of reality," in Proc. of the European Conference on Product and Process Modeling (ECPPM'2006), 2006, pp. 127–134.
[14] C. S. Dossick and G. Neff, "Organizational divisions in BIM-enabled commercial construction," J. Constr. Eng. Manag., vol. 136, no. 4, pp. 459–467, 2009. https://doi.org/10.1061/(asce)co.1943-7862.0000109
[15] S. Azhar and S. Richter, "Building information modeling (BIM): Case studies and return-on-investment analysis," in Proceedings of the Fifth International Conference on Construction in the 21st Century (CITC-V), Istanbul, Turkey, 2009, vol. 1378, p. 1386.

[16] J. Mitchell et al., "Adopting BIM for facilities management: Solutions for managing the Sydney Opera." Cooperative Research Centre (CRC) for Construction Innovation and the, 2007.
[17] Y. Arayici, C. O. Egbu, and S. P. Coates, "Building information modelling (BIM) implementation and remote construction projects: issues, challenges, and critiques.," J. Inf. Technol. Constr., vol. 17, pp. 75–92, 2012.
[18] R. Volk, J. Stengel, and F. Schultmann, "Building Information Modeling (BIM) for existing buildings—Literature review and future needs," Autom. Constr., vol. 38, pp. 109–127, 2014. https://doi.org/10.1016/j.autcon.2014.02.010
[19] J. Steuer, "Defining virtual reality: dimensions determining telepresence.," J. Commun. Soc. Responses to Commun. Technol., vol. 42, pp. 33–56, 2000.
[20] M. Alshawi and C. W. F. C. W. Putra, "A Framework for an integrated CAD interpreter for architectural drawings," CIB W-65, Trinidad, WI, 1993.
[21] M. Alshawi and I. Faraj, "Integrating CAD and Virtual Reality in construction," in Proceedings of the Virtual Reality and Rapid Prototyping for Engineering Conference, Salford University, 1995.
[22] J. Whyte, N. Bouchlaghem, A. Thorpe, and R. McCaffer, "From CAD to virtual reality: modelling approaches, data exchange and interactive 3D building design tools," Autom. Constr., vol. 10, no. 1, pp. 43–55, 2000. https://doi.org/10.1016/s0926-5805(99)00012-6
[23] S. Wang, Z. Mao, C. Zeng, H. Gong, S. Li, and B. Chen, "A new method of virtual reality based on Unity3D," in 2010 18th international conference on Geoinformatics, 2010, pp. 1–5. https://doi.org/10.1109/geoinformatics.2010.5567608
[24] P. G. Schrader, "Learning in technology: Reconceptualizing immersive environments," AACE J., vol. 16, no. 4, pp. 457–475, 2008.
[25] A. Christopoulos, M. Conrad, and M. Shukla, "Increasing student engagement through virtual interactions: How?," Virtual Real., vol. 22, no. 4, pp. 353–369, 2018. https://doi.org/10.1007/s10055-017-0330-3
[26] V. S. Pantelidis, "Virtual reality and engineering education," Comput. Appl. Eng. Educ., vol. 5, no. 1, pp. 3–12, 1997.
[27] J. Abdullah, W. N. Mohd-Isa, and M. A. Samsudin, "Virtual reality to improve group work skill and self-directed learning in problem-based learning narratives," Virtual Real., pp. 1–11, 2019. https://doi.org/10.1007/s10055-019-00381-1
[28] W. Yan, C. Culp, and R. Graf, "Integrating BIM and gaming for real-time interactive architectural visualization," Autom. Constr., vol. 20, no. 4, pp. 446–458, 2011. https://doi.org/10.1016/j.autcon.2010.11.013
[29] J. P. Gee, "What video games have to teach us about learning and literacy," Comput. Entertain., vol. 1, no. 1, p. 20, 2003. https://doi.org/10.1145/950566.950595
[30] D. R. Michael and S. L. Chen, Serious games: Games that educate, train, and inform. Muska & Lipman/Premier-Trade, 2005.
[31] S. Kumar, M. Hedrick, C. Wiacek, and J. I. Messner, "Developing an experienced-based design review application for healthcare facilities using a 3D game engine," J. Inf. Technol. Constr., vol. 16, no. 6, pp. 85–104, 2011.
[32] C.-T. Chiang, C.-P. Chu, and C.-C. Chou, "BIM-enabled power consumption data management platform for rendering and analysis of energy usage patterns," Procedia Eng., vol. 118, pp. 554–562, 2015. https://doi.org/10.1016/j.proeng.2015.08.480
[33] J. H. Woo, "BIM (building information modeling) and pedagogical challenges," in Proceedings of the 43rd ASC national annual conference, 2006, pp. 12–14.

[34] M. Ibrahim and R. Krawczyk, "The level of knowledge of CAD objects within the building information model," in Association for Computer-Aided Design in Architecture 2003 Conference, 2003, pp. 172–177.
[35] K. Lindquist and A. Khan, "Blended Learning at a Leading Executive Education Institute: State of the Practice," in E-Learn: World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education, 2002, pp. 1706–1709.
[36] B. Akkoyunlu and M. Yılmaz-Soylu, "Development of a scale on learners' views on blended learning and its implementation process," Internet High. Educ., vol. 11, no. 1, pp. 26–32, 2008. https://doi.org/10.1016/j.iheduc.2007.12.006
[37] H. Gardner, Frames of mind: The theory of multiple intelligences. Hachette Uk, 2011

8 Authors

Jing-Ying Wong is affiliated with Department of Civil Engineering, University of Nottingham Malaysia. Author has interest in Building Information Modelling projects. For more details contact her at. JingYing.Wong@nottingham.edu.my

Chun-Chieh Yip is affiliated with Department of Civil Engineering, LKC.FES, Universiti Tunku Abdul Rahman, 43000, Kajang, Selangor, Malaysia. He is keen to know developments in area of civil.

Su-Ting Yong is affiliated with Foundation in Engineering, University of Nottingham Malaysia. The author is very patinated about learning and adopting the new developments in the education field.

Andy Chan is affiliated with Department of Civil Engineering, University of Nottingham Malaysia. He is interested in civil engineering field.

Sien-Ti Kok is affiliated with Department of Civil Engineering, University of Nottingham Malaysia. She is interested in the Civil Engineering field.

Teck-Leong Lau, is affiliated with Department of Civil Engineering, University of Nottingham Malaysia, 43500, Selangor, Malaysia.

Mohammed T. Ali, is affiliated with Department of Civil Engineering, University of Nottingham Malaysia, 43500, Selangor, Malaysia.

Essameldin Gouda, is affiliated with Department of Electrical and Electronic Engineering, University of Nottingham Malaysia, 43500, Selangor, Malaysia.

Article submitted 2020-01-23. Resubmitted 2020-02-21. Final acceptance 2020-02-21. Final version published as submitted by the authors.

Development of Sensor-Based Blind Swimming Aids

https://doi.org/10.3991/ijim.v14i06.13403

Fajar Vidya Hartono (✉), James Tangkudung, Abdul Sukur, Firmansyah Dlis
State University of Jakarta, Jakarta, Indonesia
fajarvidya@unj.ac.id

Abstract—Blindness is a condition where the senses of vision are not functioning (low vision) or overall (total blindness). Persons with visual impairments are who can enjoy swimming with the help of sensors. The aim of the study was to create aids for sensor-based blind visual swimming that can be used during swimming exercises. The method used is a qualitative approach, the main data obtained through observation, questionnaires, interviews, and documentation and procedures of research and development used is the Borg and Gall model. This study is expected to contribute to blind swimming aids material products which are effectively used for swimming exercise skills. This study concluded that the product development sensor based blind learning swimming aids can be used for motion skills training for blind swimming athletes.

Keywords—Sensor, Blind, Swimming.

1 Introduction

Physical education and adaptive sports generally allow the realization of human life the possibility [1]of human organisms for full life, self-realization, social activity, and integration into society, with the help of motorized activities that are rationally organized as natural incentives for livelihoods, using retained functions, health remaining, natural sources, and mental strength. The emergence of disability can be motivated by health problems that arise from birth, chronic and acute diseases, and injuries that can be caused by accidents, war, riots, disasters, etc. It is estimated that there are 650 million disabled people in the world, around 10 percent of the population. One thing over the last thirty years, life opportunities and opportunities for many people who have disabilities have changed dramatically especially in the fields of education, health and employment. Many disabilities are motivated by health problems, and on the contrary conditions of disability can also affect health. The health sector has a role as a preventive measure until rehabilitation. Sports Disability is a relatively new phenomenon but it is also one that specifically addresses the context of social inclusion so that it attracts a lot of political and academic attention. Physical education and adaptive sports generally enable the realization of the possibility of a human organism for full life, self-realization, social activity, and integration into society, with the help of motorized activities that are rationally organized as natural incen-

tives for livelihoods, using retained functions, remaining health, natural source, and mental strength.

The ability of vision is very influential on the activities of daily life. The fault is physical activity or sports that can be carried out by people with blind people. Blindness is a condition of sensory vision in a person with a partial vision (low vision) or as a whole (totally blind). This can occur before birth, at birth and after birth. One of the potentials that can be developed for people with special needs is through sports. Sport cannot be separated from human life, because human life consists of two aspects, namely physical aspects and spiritual aspects that cannot be separated, sports include swimming. Swimming is a form of versatile training for all persons with disabilities, because it can include therapeutic activities, play, achievement and fun. Swimming is a physical activity carried out in water. This sport has elements such as body shape, basic techniques of motion mechanism, mentality and physical condition as a unity that must be owned by someone to be able to float and move from one place to another. Experience of researchers as a swimmer with special needs, especially people with visual impairments need a long time in providing basic swimming material. Another problem faced by researchers when training is when blind swimmers will make reversals to finish. It needs to be helped by tapping repeatedly in each session. Practice requires that the trainer stay alert on both sides of the pool and drain energy if some athletes do the same and repeatedly. The ability of high mobility in all aspects of life is a dream for each individual, including those who bear blindness. This also affects people with disabilities in physical activity or sports. The researcher obtained results that:

1. The unavailability of facilities and infrastructure specifically for swimming pools for persons with disabilities
2. Disability swimmers are still few who have an interest in swimming
3. Absence of disability specialty swimming clubs
4. Trainers who handle disability swimmers are still very limited

A sensor is a type of transducer that is used to change mechanical, magnetic, heat, light, and chemical quantities into electrical voltages and currents. Sensors are often used for detection when making measurements or controls. In the world of electronics, sensors are a very important component, especially in the field of robotics. By definition, sensors are components that can be used to detect changes, whether physical changes or chemical changes.

2 Literature Review

Research is the activity of collecting, processing, analyzing, and presenting data carried out systematically and objectively to solve a problem or want to test a hypothesis to develop general principles. The link between research and the development process requires an innovation. The UNESCO's Intergovernmental Committee for Physical Education and Sport (CIGEPS) believes that "swimming for all, swimming for life" (swimming for all, swimming for life) "project launched in collaboration with

the International Swimming Federation [2] is making a significant contribution to development humans because the impact is very large in terms of cutting the risk of drowning and water-related accidents caused by the inability to swim. Disabled Persons are those who experience physical, intellectual, mental, and / or sensory limitations for a long period of time in interacting with the environment can experience obstacles and difficulties to participate fully and effectively with other citizens based on the similarity of the rights of Article 5 paragraph (2) "Citizens who have physical, emotional, mental, intellectual, and / or social disorders have the right to receive special education.

Related to mobility also delivered by [3] Blindness can cause low physical work capacity, posture problems, orientation difficulties, depressions and problems with balance. Previous studies include information about these disturbances. Physical activity possessed by blind people is explained in Disability and Health Journal [4] Children with visual impairments (VI) often reveal higher levels of sedentary time and lower levels of fundamental motor skills (FMS), health-related fitness (HRF) and physical activity (PA) than peers without visual impairments. (Aspenes, S.T., & Karslen, 2012) “Swimming is unique among sports in combining factors such as the simultaneous contribution of arms and legs to propulsion, water immersion, and prone position”.

Especially for the Blind class explained according to [5] as follows: Sport Classes S/SB11-13 visual impairment. Athletes with a visual impairment compete in three sport classes from S/SB11 to S/SB13. (1) S/SB11: These athletes have a very low visual acuity and/ or no light perception. (2) S/SB12: Athletes have a higher visual acuity than athletes competing in the S/SB11 sport class and/ or a visual field of less than 5 degrees radius. (3) S/SB13: Athletes have the least severe visual impairment eligible for Paralympic sport. They have the highest visual acuity and/or a visual field of less than 20 degrees radius. In order to ensure a fair competition athletes in the S/SB11 sport class are required to wear blackened goggles. To ensure safety all S/SB11 swimmers must use a tapper, swimmers in the S/SB12 and S/SB13 sport classes may choose whether or not they wish to use one.

Table 1. Swimmers with Vision Loss. [6]

Disability Characteristic	Effect on Stroke Technique	Coaching Hints
Inability to use vision to determine proper head position. Inability to see demonstrations. Reluctance to move hands and arms away from torso.	Poor horizontal alignment (head too high or low). Poor lateral alignment (head not returned to neutral position after breathing). Inefficient stroke techniques. Inefficient stroke techniques, especially length of pull and distance of hand from torso during underwater pull.	Use orientation and mobility techniques. Move swimmer's head through desired movements. Use rich verbal descriptions. Move swimmer's body through desired actions. Use resistance and assistive training such as hand paddles, stretch cords, and fins to help swimmer experiment with propulsion movements. Teach arm movements on swim bench.
Inability to see end of pool and related fear of collision.	Stroke technique deteriorates and speed decreases as swimmer approaches end of pool.	Use tappers, sprinklers hanging from backstroke flags, or other methods to notify swimmer about end of pool. Teach swimmerto use stroke counts to estimate length of pool. Use padding in swim cap.

For blind swimmers an assistant who knocks swimmers is needed, this is conveyed by [7] following: Visual impairment can range from complete blindness to partial sightedness combining loss of visual acuity and field loss. Adaptations to sport include a sound-emitting ball for goal ball or cricket or a tandem cycle with a sighted pilot rider. In swimming, an assistant taps the head or shoulder of the swimmer with a soft-ended pole to indicate the pool end to enable turning and finishing. Research can be divided into several forms, namely basic research, applied, evaluation, and development. The division of research is based on the function and application in education and how long the results can be used. One research model that is relevant and can always be used is development research. Development research finds patterns, sequences of growth, change and especially has the intention to develop the object of research.

3 Methodology / Materials

The malfunctioning of the receiving channel of information in the sense of sight like a normal human being is an obstacle for people with visual impairments in carrying out daily activities. The general term used for this condition is blind people. The ability of vision is very influential on the activities of everyday human life. People who have normal visual abilities can get more information than those who experience vision problems. Research and development is expected to provide solutions to provide answers to the problems faced. Development research procedures basically consist of two main objectives, namely developing procedures for development research basically consists of two main objectives, namely developing products, and testing the effectiveness of products in achieving goals. Conceptually, the research and development approach includes 10 general steps, as described [8] as follows:

1. Research and information collecting
2. Planning
3. Develop preliminary form of product
4. Preliminary field testing
5. Main product revision
6. Main field testing
7. Operational product revision
8. Operational field testing,
9. Final product revision
10. Dissemination and implementation

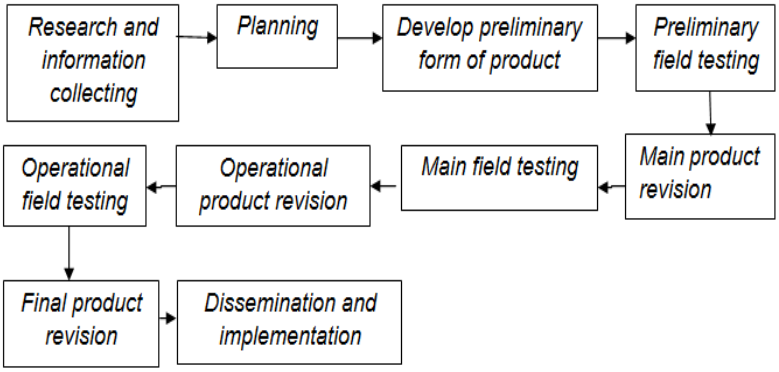


Fig. 1. Instructional Design R and D Borg & Gall

The descriptions are as follows:

3.1 Research and information collecting

The first step of the preliminary study includes needs analysis, literature study, literature study, small-scale research and the required standard reports.

- Need analysis and literature study there are several criteria including:
  - Are people who will be developed important?
  - Does the product have the possibility to be developed?
  - Do Human Resources who have the skills, knowledge and experience that will develop the product exist?
  - Is the time to develop the product enough?
- The literature study is conducted for a temporary introduction to the products to be developed. This literature study was conducted to collect research findings and other information related to the planned product development.
- Small-scale research conducted by developers has questions that cannot be answered by referring to research learning or professional texts. Therefore, develop-

ers need to do small-scale research to find out some things about the products to be developed.

3.2 Planning research

The second step in planning research includes:

- Formulate research objectives
- Estimating funds, energy and time
- Formulate researcher qualifications and forms of participation in research.

3.3 Design development (develop preliminary of product)

The third step of design development includes:

- Determine the product design to be developed (hypothetical design)
- Determine the facilities and infrastructure needed during the research and development process
- Determine the stages of implementation of the design test in the field
- Determine the task description of the parties involved in the study

3.4 Initial field test (preliminary field testing)

The fourth step of the initial field test is limited product testing including:

- Conduct an initial field test of product design
- Limited nature, both the substance of the design and the parties involved
- Initial field tests are carried out repeatedly so that a decent design is obtained, both in substance and methodology.

3.5 Revised limited field test results (main product revision)

The fifth step is a model or design improvement based on a limited field test.

Improvement of the initial product will be carried out after a limited field trial. At this stage of refining the initial product, more is done with a qualitative approach. The evaluation is more on the evaluation of the process, so that the improvements made are internal improvements.

3.6 Extensive test (main field test)

The sixth step is to test the product more broadly. This step includes:

- Test the effectiveness of product design
- The design effectiveness test generally uses the repetition model experimental technique.

- The results of the field test are processed in an effective design, both from the basic and methodological aspects.

3.7 Revision of operational product revision

The seventh step is the second improvement after a wider field test from the firs field test. The product improvement from the results of a wider field test will further strengthen the product developed, because at the previous field testing phase it was carried out with the existence of a control group. The design used was pretest and posttest. Besides improvements that are internal. This product improvement is based on evaluation of results so that the approach used is a quantitative approach.

3.8 Operational field test

The eighth step of the feasibility test should be carried out on a large scale. This step includes:

- Test the effectiveness and adaptability of product design
- Test of effectiveness and adaptability involving potential product users
- The results of the field test obtained a design model that is ready to be applied both in terms of substance and methodology.

3.9 Final revision of the final product revision

The ninth step is the improvement of the product being developed. This refinement is needed to more accurately develop the product. At this stage a product that has a level of effectiveness can be accounted for. The results of the final product refinement have a reliable "generalization" value.

3.10 Dissemination and final production implementation (Dissemination and implementation)

Publish to accredited national journals and international journals referred to and provide/present research results through scientific forums, or through mass media. Product distribution must be done after going through quality control.

The researcher chose the model from Borg and Gall to have the following reasons:

1. Produce a product that has a high validation value through a series of field trials and validated by experts;
2. Providing solutions to address needs in the field.
3. Generate new knowledge and knowledge of products developed through theoretical and practical research in the field.
4. Encouraging the creation of innovation processes based on current needs.

The thinking about blind swimming aids in this study is based on problems encountered in the field. The following is a table that presents the foundation for developing blind swimming aids products.

Table 2. Platform for the Development of Blind Swimming Aid Models

Factual Conditions	Obstacles	Solution
Disability swimming training especially blind people do not use the science and technology approach of swimming aids.	The time the trainer is seized to give instructions to the swimmer when doing pleasure, reversal and finish.	Creating and developing swimming aids that have quality by meeting aspects of originality, innovation excellence, safety, comfort and complete supporting data, so that clubs, athletes and coaches can use it to exercise and correct blind swimmers.
Disability swimming training especially blind people do not use the science and technology approach of swimming aids.	When making corrections and evaluations of one athlete, the other athletes are ignored considering the trainer must be upright and focus on just one athlete	Creating and developing swimming aids at affordable prices for blind swimmers
There is no single disability swimming club that has technology-based blind visual aids	Beginner blind swimmers must be given special assistance in handling both a series of movements and direction.	
	Swimmers experience obstacles when doing swimming movements even in the trajectory that isdetermining the direction with a straight swim	
	Swimmers experience obstacles when doing swimming movements even in the trajectory that is determining the direction with a straight swim	
	Touch instructions from the trainer in swimmer swimming athletes do different reversals and finishes so that it is very influential on the swimmer's movements	

Based on the table above, it can be explained that the development of swimming aids for visually impaired disabilities is a solution to the practical problems of factual conditions and obstacles encountered in swimming practice. The following is an overview of the tools used so far.

4 Results and Findings

Disabled people involved in sports are the first and foremost athletes, and they have the same basic needs and dreams as other athletes. For them, coaching is an important factor in the experience of the quality of their sport. The development and success of exercise is almost always determined by several factors and perhaps even

more so for athletes with disabilities. Blind swimmers have many unique challenges to swimming, including the concept of swimming pool space, coaching methods, and the availability of tools. If this challenge is handled properly, then the problem faced will be a potential for the blind in swimming. The following swimming aids are available and have been used:

Fig. 2. Swimming Aids For The Blind

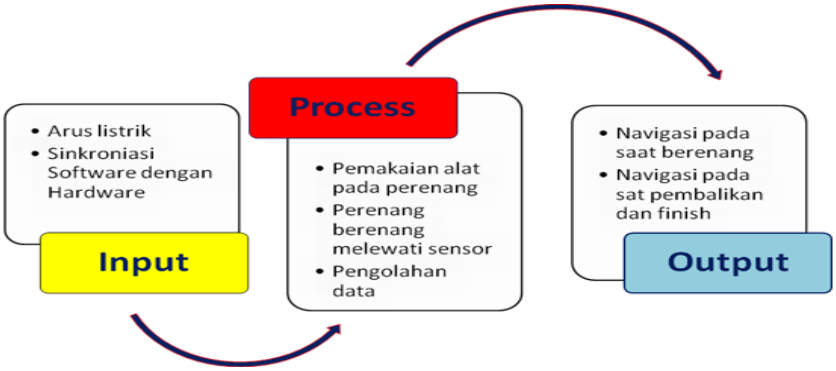


Fig. 3. Build a Swimming Aid System

The following is a simple scheme of blind visual aids which is developed:

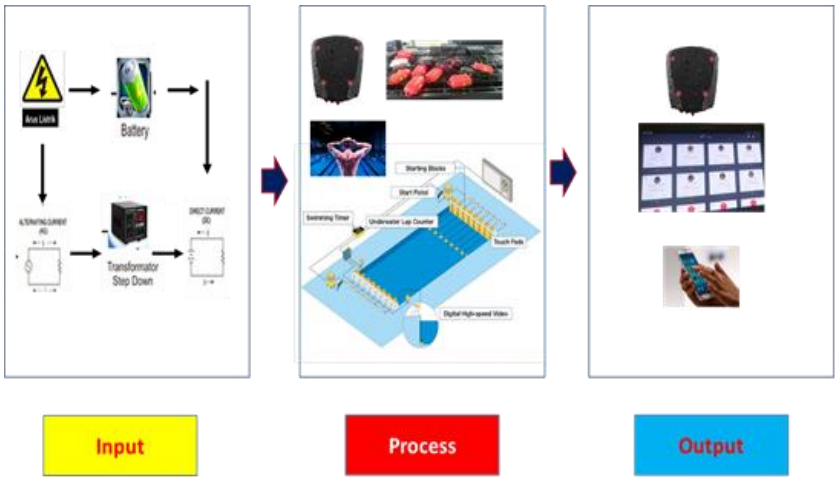
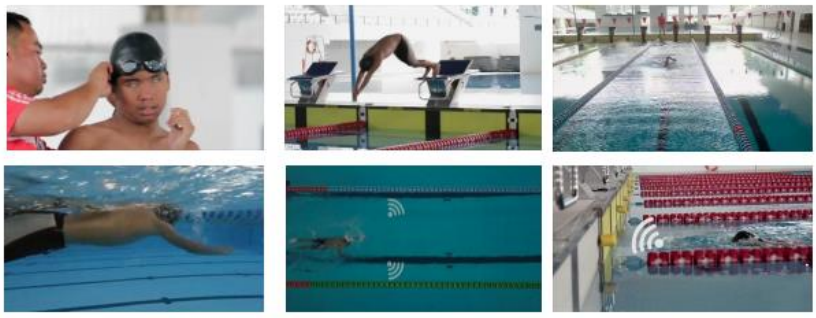


Fig. 4. Simple Scheme of the Blind Swimming Pool System

The idea or idea of developing blind swimming aids is in accordance with the problems faced by researcher and it occurs in the field (swimming pool) where as a trainer has difficulty in giving instructions to athletes. The development of the tool is intended as an effort to meet the needs of assistive devices for athletes to improve swimming skills through the fulfillment of training facilities, so as to improve the quality of training and support the development of disability swimming sports. Products Swimming aids for blind people produced:

Application for use of tools for blind swimmers:



The results of the effectiveness test are as follows:

The control group without tools there is a difference in swimming scores between pre- test and post-test at 11.25125 (in the Paired Samples Test table, mean column) with significance below (0.05) that is equal to 0.000, in other words that swimming exercises with no tools increase at 11.25125 or an increase of 10.05% from the pre-test score (in the Paired Samples Statistics table, the mean column) significantly.

Table 3. Paired Samples Statistics

Paired Samples Statistics					
		Mean	***N***	***Std. Deviation***	***Std. Error Mean***
Pair 1	Free_Test Without Tools	100.7100	8	19.72210	6.97281
	Post_Test Without Tools	111.9613	8	21.22119	7.50282

Paired Samples Test									
		Paired Differences					***t***	***df***	***Sig. (2-tailed)***
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Free_Test Without Tools - Post_Test Without Tools	-11.25125	4.24426	1.50057	-14.79954	7.70296	7.498	7	000

The experimental group with a tool, the difference in swimming scores between pre-test and post-test amounted to 12.49875 (in the Paired Samples Test table, mean column) with significance below (0.05) that is equal to 0.000, in other words that swimming exercises using tools have increased amounting to 12.49875 or an increase of 11.32% from the pre-test score (in the Paired Samples Statistics table, the mean column) significantly.

Paired Samples Statistics					
		Mean	***N***	***Std. Deviation***	***Std. Error Mean***
Pair 1	Free_Test with Tools	97.8813	8	19.67484	6.95611
	Post_Test with Tools	110.3800	8	19.79460	6.99845

Paired Samples Test									
		Paired Differences					***t***	***df***	***Sig. (2-tailed)***
		Mean	***Std. Deviation***	***Std. Error Mean***	***95% Confidence Interval of the Difference***				
					Lower	Upper			
Pair 1	Free_Test with Tools Post Test with Tools	-12.49875	4.29267	1.51769	-16.08751	-8.90999	-8.235	7	.000

Looking at the data above, the group results without the mean tool are 111.9613 and the results of the groups using the mean tool are 110.3800 (in the group statistics

table). From these data it can be seen that the value of the group using the tool is better than the group without the tool. The difference is also reinforced by a significant value smaller than 0.05 (5%), which is 0.008

Group Statistics					
	Group	***N***	***Mean***	***Std. Deviation***	***Std. Error Mean***
Post Test Values	Group A	8	111.9613	21.22119	7.50282
	Group B	8	110.3800	19.79460	6.99845

Independent Samples Test										
		Levene's Test for Equality of Variances		***t-test for Equality of Means***						
		F	ig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Value	Equal variances assumed	.709	.414	.154	14	.008	1.58125	10.26015	-20.42458	23.58708
	Equal variances not assumed			.154	13.933	.008	1.58125	10.26015	-20.43455	23.59705

From the whole it can be concluded that the group without tools and groups using the tool showed the results of increased training. The group using the tool has increased by 11.32% with a significant value of 0,000 and the group without tools has increased by 10.05% with a significant value of 0,000. From the two groups, it can be seen that the percentage increase between groups using tools and groups did not use a tool with a significant value of 0.008.

There is a difference in the percentage of increase in training outcomes between groups without tools (10.05%) and groups using tools (11.32%), this indicates that the results of the increase in groups using tools are higher than those in groups without tools. This means that the blind swimming aids model has been proven to be effective in significantly increasing the swimming training results of blind athletes.

5 Conclusion

This study concluded that groups using tools have increased by 11.32% with a significant value of 0,000 while groups without tools have increased by 0.05% with a significant value of 0,000. From the two groups, it can be seen that the percentage increase between groups using tools and groups did not use a tool with a significant value of 0.008.

6 Acknowledgement

Universitas Negeri Jakarta, Postgraduate Program organizes the Doctoral S3 Education Program. Universitas Negeri Jakarta, Sport Science Faculty Kementerian Riset,

Teknologi, dan Pendidikan Tinggi Republik Indonesia support Research Doctoral Dissertation. Research and Development Decree

7 References

[1] J. Knijnik, R. Spaaij, and R. Jeanes, "Reading and writing the game: Creative and dialogic pedagogies in sports education," Think. Ski. Creat., vol. 32, pp. 42–50, 2019. https://doi.org/10.1016/j.tsc.2019.03.005

[2] FINA, "FINA Handbook, Contitutions and Rules, Swimming, Open Water Swimming,Diving, Water polo, Synhcronised Swimming and Doping Control.," FINA Off.

[3] T. Çolak, B. Bamaç, M. Aydin, B. Meriç, and A. Özbek, "Physical fitness levels of blind and visually impaired goalball team players," Isokinet. Exerc. Sci., vol. 12, no. 4, pp. 247–252, 2004. https://doi.org/10.3233/ies-2004-0182

[4] A. Brian, A. Pennell, P. Haibach-Beach, J. Foley, S. Taunton, and L. J. Lieberman, "Correlates of physical activity among children with visual impairments," Disabil. Health J., vol. 12, no. 2, pp. 328–333, 2019. https://doi.org/10.1016/j.dhjo.2018.10.007

[5] "https://www.paralympic.org/swimming/classification."

[6] D. H. W. GailM. Dummer, "Moving to the Next Level: Swimming Instruction for Persons with Disabilities. In 37th National Adapted Physical Education Conference, Promoting Physical Activity for All, California Association for Health, Physical Education, Recreation and Dance.," San Diego, CA.

[7] S. Joshi, "Influence of sports environment in modulating behavioral response of visually challenged," vol. 2, no. 2, pp. 239–244, 2014.

[8] W. R. Borg and M. D. Gall., "Educational Research: An Introduction," New York Longman Inc., vol. 4, 2009.

8 Authors

Fajar Vidya Hartono is affiliated with the Sport Education, State University of Jakarta, Indonesia. Author area of interest is sports and developing ethics learning. For contact . fajarvidya@yahoo.co.id

James Tangkudungr is affiliated with the Sport Education, State University of Jakarta, Indonesia. Author is interested in sports education and digital development in sports field. For contact at james24061952@gmail.com

Abdul Sukur is affiliated with Sport Education, State University of Jakarta, Indonesia. Author is working in sport education development. For contact abdulsukur69@yahoo.com

Firmansyah Dl is Sport Education, State University of Jakarta, Indonesia Author is interested in sports education and digital development in sports field. For contact at firmansyahdlis.unj@gmail.com

Article submitted 2020-01-27. Resubmitted 2020-03-03. Final acceptance 2020-03-05. Final version published as submitted by the authors.

Development of SMASH Skills Training Model on Volleyball Based on Interactive Multimedia

https://doi.org/10.3991/ijim.v14i06.13405

Muhammad Suhairi (✉)
Universitas Negeri Jakarta, Jakarta, Indonesia
IKIP PGRI Pontianak, Kalimantan Barat, Indonesia
suhairims27@gmail.com

Moch. Asmawi, James Tangkudung, Achmad Sofyan Hanif, Firmansyah Dlis
Universitas Negeri Jakarta, Jakarta, Indonesia

Abstract—SMASH's skill is a technique that can be done by a person in a hard swooping towards your opponent to produce numbers. Interactive multimedia technology is expected to be a guideline for athletes in looking at more variation models of SMASH. The aim of development research is to produce an interactive multimedia volleyball playing skill training model. The method used in this research is development research design by Borg and Gall. The approach used in this study is a qualitative and quantitative approach. This study is hoped to improve volleyball skills by looking at the interactive multimedia volleyball playing practice model. This study concludes that interactive multimedia-based volleyball skill playing model can be used in the actual application of exercises.

Keywords—Interactive Multimedia, SMASH Skills, Volleyball.

1 Introduction

Technology has a very important role for the education process and also provides direction in the development of the world of education. The use of science and technology specifically in the development of packaging for interactive multimedia-based learning resources is needed for learning resources to be packaged in more interesting and more complete forms in their presentation. Multimedia is one of the supporting devices that can be used in this case. This is because multimedia technology includes several aspects that are synergistic, between text, graphics, static images, animation, film and sound. Multimedia technology will bring the new revolution of sport education, education thought and education theory in colleges and universities during the multimedia period. Sport education need to gripe the chance to change the traditional education mind. In colleges and universities, bring multimedia technology into the education, rich the teaching content, combine various media techniques to arouse students' learning interests with energy application to the teaching activities then to improve sport teaching in colleges and universities [1]. Understanding multimedia can be different from the point of view of people different. In general, multimedia is relat-

ed to use of more than one type of media to present information. Multimedia in learning produces visual information that is already well known in the learning process. With average abilities, people learn 1% through what they feel, 1.5% through what they touch, 3.5% through what they smell, 11% of what they hear, but 83% of what they see [2]. This research also found that memory levels were 10% of what they wrote, 20% of what they heard, 30% of what they heard and saw 50% of what they saw and heard, 70% of what they heard and discuss [3]. The utilization of multimedia tools can offer a flexible way for players understand the actions for the taught skills. With this in mind, a deeper insight about the use of multimedia tools in sport [4]. Multimedia teaching systems can effectively achieve resource sharing. Without space and time limits, students can rationally manage their time according to their time [5].

Through multimedia in the form of images, animations, and videos, supporters of interesting and attractive teaching and learning activities [6]. In his research stated that one of the right media and can be used in facilitating the learning process of volleyball is with the help of learning multimedia in the form of CD (Video Compact Disck). Multimedia learning is the type of learning provided. Students will be able to use this multimedia learning as a source of independent learning [7]. Multimedia technology brings a new revolution in sports education, educational thinking and educational theory in colleges and universities. Sports education needs to change from the mind of traditional education. In college, multimedia technology in the field of sports has an impact on education, many contain the content of the teaching and learning process, combining various media techniques to trigger students' interest in learning with applications so as to energize teaching activities then improve sports teaching in higher education. The appropriate use of media adds to the usefulness of a technology where in education it is inseparable from touch and technological progress. Many benefits can be obtained in the use of multimedia technology because this multimedia technology is able to overcome learning difficulties. States that the use of interactive multimedia in learning is also very possible to improve the expected thinking skills. In general, the benefits that can be obtained through the use of interactive multimedia is that the learning process can run more interesting, more interactive, the amount of teaching time can be reduced, the quality of student learning can be improved and the teaching and learning process can be done anytime, and can improve students' reasoning abilities [8]. Furthermore, the use of multimedia is aimed to overcome the limitations of space, time, and distance during the learning and training process [9]. Volleyball is a complex sport, so in volleyball learning if a teacher is lacking in developing creativity, students will have less of interest in participating in learning process. in the game of volleyball smash is a punch technique that is most needed. The effectiveness of the smash is influenced by physical ability and mastery of attack skills. [10]. It is expected that interactive multimedia in training or learning will be more effective and efficient so that achievements in the field of sports can be maximal or achievers especially in mastering the skills of playing volleyball. Mastery of volleyball skills is needed to make the game can run well. The skills can be in the form of skills: service, bottom pass, top pass, smash and block. Smash is a swooping, sharp and fast punch. By forming a punch attack hard when the ball is on the net, to be inserted into the opponent's area. The display of volleyball skill training models with print media and

interactive multimedia Compact (VCD) outside of hours of practice in a relaxed state is expected to be able to help the process of understanding the concept of volleyball playing techniques so that the field can see the training model showing the skill of playing volleyball and for novice players, it will increase their knowledge by watching various techniques of playing volleyball well.

The following is a comparison of the renewal of the learning model (old training model) and the new one with interactive multimedia-based.

Table 1. Comparison of renewal of old and new training models with interactive multimedia-based.

Old	New
Train based on the experience of the coach	Use a volleyball guidebook
There is no interactive multimedia video	There is interactive multimedia video
Variations The exercises given are not sequential from easy, simple to complex movements	Using the correct sequence of exercises from easy, simple to complex
Monotonous exercise, less fun (lack of variety)	Many choices of variations of practice
Athletes or students do not know previous experiences	With video athletes or students can find out the model that will be applied during training
Limited learning athletes (only in meetings)	Student athletes can learn more about the movements and techniques of volleyball training offline.
Access dependency	No dependency access (can be accessed offline)
There is no complex tutorial (VCD and textbook)	With multimedia VCDs and textbooks athletes or students can study independently

Related to the information, it shows that it is necessary to develop an interactive multimedia-based training model which can later be used as a solution to facilitate students in learning to play volleyball more effectively.

2 Literature Review

Research and development (Research and Development) according to Borg & Gall is a process used to develop and validate educational products. Development research finds development patterns, sequences of growth, change and especially has the intention of developing teaching materials for universities. Model development is the result of research oriented to product development results. A model is a description of a mindset. A model usually describes the whole concept that is interrelated [11]. This Development Model uses a system approach model, namely by principle, a stage will receive input from the previous stage and produce output for the next stage, so that all components work together to produce an effective learning [12]. Also explained that research and development is a process or steps to develop a new product or perfect an existing product which can be accounted for. Interactive multimedia becomes an application of learning that utilizes technological advancements that can arouse thoughts, feelings, attention, and willingness to occur in learning processes that enhance skills [13]. Is a research method used to produce certain products, and test the effectiveness of these products [14] According to States that development research is a study that aims to develop a new product or perfect an existing product [14]. States

that "Development research is research that is used to create new products and can develop products that have supported the analysis of needs that contain in the field (observation, interviews, initial needs questionnaire) [15].

Multimmedia is the use of a computer to present and combine text, grapics, audio, and video with links and tools that let the user navigate, interect, create, and communicat" [16]. Multimedia is defined as a combination of several media which is used to convey information in the from of text, graphics or graphic, movie, video, and audio animation. Multimedia includes hypermedia and hypertext. Hypermedia is a presentation media that includes text, silent grapics of animationm movie, video, and audio [17] Multimedia is an integration of two or more integrated media formats such as texts, images, graphics, souds, animations, and videos to feed information into computer systems [18]. This integration as a whole displays information, massages, or lesson contents. Throught these combined media, learning activities are rendered more interactive and reflect everyday life experience. Multimedia is a combination between several documents, text, art, sound, animation, and videos that are delivered through computers or electronic and digital equipment [19]. Smash is a way to play the ball efficiently and effectively in accordance with the rules of the game to achieve a hard hit aimed at releasing an opponent's game to produce points [20].

3 Methodology / Materials

Development research is a research approach that is linked to work design and development and has a purpose for designing in a training environment and strives for a scientific understanding of fundamentals.

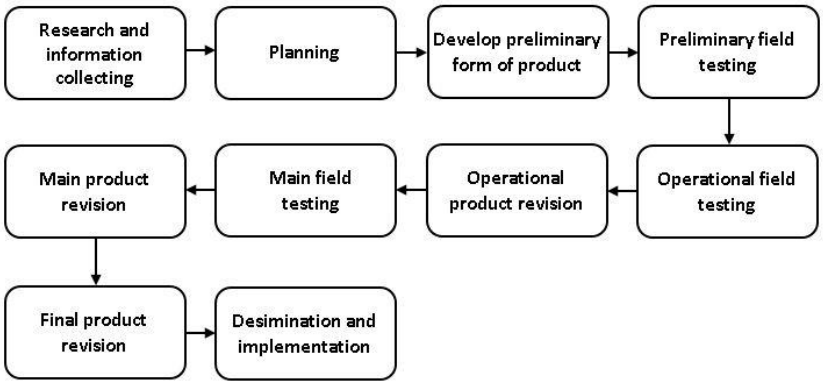


Fig. 1. Stage of Design Risearch and Development Walter R. Borg and Meredith D. Gall.

Components in system approach models according to Walter R. Borg and Meredith D. Gall consist of 10 stages, namely:

1. Preliminary study (Research and Information Collecting)
2. Planning research

3. Design development (Develop Preliminary of Product)
4. Early stage trials (Preliminary Field Testing)
5. Revised Limited Field Test Results (Main Product Revision)
6. More extensive product testing (Main Field Test)
7. Revised Result of Broader Field Test (Operational Product Revision)
8. Feasibility Test (Operational Field Testing)
9. Final Revision of Final Product Revision Results
10. Dissemination and Implementation of Final Products (Dissemination and Implementation)

Based on the understanding of the development of learning models, there are at least four characteristics, namely:

1. Goal oriented
2. Conditions
3. Systematic
4. Evaluation and revision

Each model designed and developed is preceded by the existence of a clear objective formula.

Research on the development of interactive multimedia volleyball skills training models specifically has several objectives including:

1. Develop a design plan for interactive multimedia volleyball skills training models
2. Obtain empirical data about the effectiveness and efficiency of the results of developing interactive multimedia volleyball skills training models.

The development research procedure basically consists of two main objectives, namely developing the product, and testing the effectiveness of the product in achieving the goal. Adaptation is realized in the form of technical planning goals and types of activities to be carried out in each stage. If the ten steps of research and development are followed correctly, it will be able to produce an educational product that can be accounted for. These steps are not the standard things that must be followed. It can be adjusted to the needs of the researcher. The characteristics of the model developed are training models of interactive multimedia volleyball smash skills specifically having several objectives including:

1. Develop a model design of interactive multimedia volleyball skills smash training
2. Obtaining empirical data about the effectiveness and efficiency of the results of the development of an interactive multimedia volleyball smash skill training model.

4 Results and Findings

The results of the development of this interactive multimedia-based volleyball smash skill training model are products in the form of printed books and * .exe soft files which are packaged in the form of VCDs. Interactive multimedia volleyball

based smash skills training models include, text, images, animations, and videos as well as knowledge quiz score analysis of volleyball. The research implementation of this interactive multimedia volleyball smash training model is generally divided into eight main stages, namely:

1. Research needs analysis
2. Product preparation
3. Expert validation and phase I revision
4. Small group trials
5. Revisions stage II
6. Large group trials
7. Operational revisions
8. Product effectiveness test

The following will present data on the results of research and development:
Table of results can be seen in the attachment.

Table 2. Results of need analysis Analysis of interactive multimedia based volleyball training models.

No.	Questions	Score	Total Score	%
1.	Have you ever attended volleyball lectures	60	60	100
2.	Are you a volleyball player	28	60	46,66
3.	Do you master all the techniques of volleyball	24	60	40
4.	Does the trainer use a fariative model in practice	25	60	41,67
5.	Is the model used by the trainer already varied	20	60	33,33
6.	Does the coach ever provide interactive multimedia to help you practice	0	60	0
7.	Do you feel the need to develop volleyball skills training models	60	60	100
8.	Do you feel that there are needs to be an interactive media that helps you better understand volleyball games and better master their skills	60	60	0

From the results of the needs analysis above, there are several important points that are key to the need for development to be carried out. Among other things, that:

1. Out of 60 100% students said the trainer had never provided interactive multimedia to help practice
2. Out of 60 students 41.67% of students stated that the model used by the trainer when practicing was still not varied
3. From 60 students 100% stated that there was a need to develop volleyball skills training models
4. Of 60 100% students felt the need to develop interactive multimedia volleyball skills training models

Whereas, based on the results of observations conducted by researchers, it has not yet been revealed that the practice media in the form of video and interactive, and the models used still use conventional drill models.

For development planning the researchers worked with multimedia experts, volleyball lecturers, and volleyball coaches with National tutoring, to obtain a training

model for smash skills in interactive multimedia volleyball. At each stage of research and development, there are design steps and its explanations are described and modified in accordance with the objectives and conditions of the actual research. Following are the stages of the model development plan:

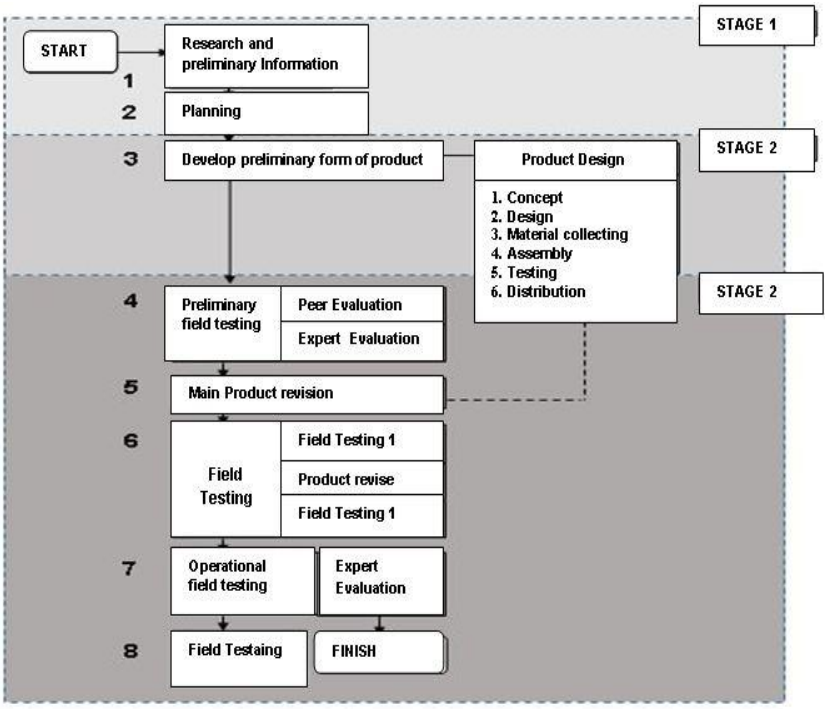


Fig. 2. The flow illustrated above is a path that has been modified by the researcher. The flow used is adjusted to the actual field conditions. Taking into account the availability of time and funds, a number of steps will be modified but not out of the chosen path. The flow is the flow of research and development by Borg and Gall and combined with the development of Luther's interactive multimedia model by Sutopo [21].

The following is a description of the stages of each model development plan:

Stage 1

1. Conduct research and data collection for initial research or need assumptions for 60 students of Physical Health and Recreation Education.
2. Development planning is done by determining objectives, limiting the scope, and preparing a trial plan.

Stage 2

1. Develop the initial product, which is then evaluated by 3 media experts, 3 volleyball experts. The development of interactive multimedia products refers to six stag-

es of multimedia, namely: concept, design, collecting materials, assembly, testing, and distribution.

Stage 3

1. Small group trials, using 12 student subjects in Physical Health and Recreation Education.
2. Product revision (according to the results of the analysis on small group trials). The product refinement process still refers to six stages of interactive multimedia concepts: concept, design, collecting materials, assembly, testing, and distribution.
3. Field trials (large groups) using 60 subjects of Health and Recreation Physical Education students, with 60 or more respondents.
4. Make product revisions according to the results of large group trials. The product refilling process still follows the interactive multimedia concept: concept, design, collecting materials, assembly, testing, and distribution.
5. Conduct operational trials to determine product effectiveness.

Table 3. Expert Evaluation and revision Phase 1. Interactive multimedia products that have been created are evaluated by media experts

No	Assessed Aspects	X	Xi	Percentage	Category
1	***Multimedia graphic design***				
	The opening view	12	12	87,5	Good
	The design of images, text and icons on each menu is interesting to generate interest in learning	11	12	100	Good
	Background design on each menu is interesting to generate interest in learning	11	12	75	Good Enough
	Clarity and accuracy of text size	10	12	100	Good
	The image size on each frame and the icon on the menu is precise and clear	11	12	91,7	Good
	Contrast between background, text and images	11	12	91,7	Good
	The size of the video frame is precise and clear	11	12	91,7	Good
	The overall exploration of multimedia graphic design	12	12	100	Good
2	***Animated graphics and sound effects***				
	Animation changes the color of the button when highlighted	10	12	83,3	Good Enough
	Transition animations between frames when moving from one menu to another	10	12	83,3	Good Enough
	Opening animation at the beginning of the template (when auto run)	11	12	91,7	Good

	Animation when closing the application	10	12	83,3	Good Enough
	The sound effect of the button when highlighted is clearly heard	12	12	100	Good
	The video sound is clear when playing	11	12	91,7	Good
3	***Combination of images, sounds and videos***				
	Background color combination with text	12	12	100	Good
	Back sound combination with video sound	11	12	91,7	Good
	Back sound combination with button sound effects	11	12	91,7	Good
	Position of each menu	12	12	100	Good
	Placement of video frames	12	12	100	Good
	Placement of video frames	12	12	100	Good
4	***Ease of use***				
	How to choose a menu by clicking on the menu in question makes it easier for students to operate multimedia	12	12	100	Good
	How to turn off and turn on music	12	12	100	Good
	The way to get out of the application is easy to understand	12	12	100	Good
	Overall operational ease	12	12	100	Good
Total		271	288	94,09	Good
Average		11,29	12	94,09	

Based on the evaluation of learning technology developed on interactive multimedia, there are four main assessment variables namely multimedia graphic design, animation and sound effects, a combination of sound and video images, and ease of use.

Based on the data presented above, the results show that interactive multimedia products of volleyball skill training models obtain a total score (X) of 271 from the maximum score (Xi) 288 with a percentage of 94.04, which means that overall the product meets the Good criteria so that it can used in actual learning. Based on the data presented above, the results show that interactive multimedia products of volleyball skills training models are appropriate for use in actual learning.

Table 4. Trial small groups of interactive multimedia volleyball practice media models.

No.	Item	X	Xi	Percentage	Category
1.	Completeness of the smash training model in increasing students' knowledge and skills	3.71	4	92.75	Good
2.	The accuracy of the training model with the concepts of volleyball smash skills	3.79	4	94.75	Good
3.	The accuracy of the description on each volleyball training model	3.81	4	95.25	Good
4.	Video accuracy	3.75	4	93.75	Good
5.	Multimedia graphic design	3.78	4	93.25	Good
6.	Animated graphics and sound effects	3.71	4	92.75	Good
7.	Combination of images, sounds and videos	3.67	4	91.75	Good
8.	Ease to use	3.81	4	95.25	Good
Total		30.03	32	93.81	Good

The results of the trial of a small group of interactive multimedia volleyball smash training models obtained from 12 students were obtained based on student responses consisting of 8 main variables namely; model completeness, model accuracy, accuracy of description, accuracy of video, graphic design, animation and sound effects, combination of images, sound and video and ease of use that gets a score of (X) 30.03 from maximum score (Xi) 32 which means good average with a percentage of 93.81% in the good category, so that it can proceed to large group trials.

Table 5. Revision Phase 2 for interactive multimedia-based training models from volleyball experts.

No.	Item	Average of item	Xi	Percentage	Category
1	Completeness of training models in increasing student knowledge and skills	3,78	4	94,50	Good
2	The accuracy of the training model with the concepts of volleyball smash skills	3,81	4	95,25	Good
3	The accuracy of the description on each model	3,67	4	91,75	Good
4	Video accuracy	3,74	4	93,50	Good
5	E-learning graphic design	3,79	4	94,75	Good
6	Animated graphics and sound effects	3,83	4	95,75	Good
7	Combination of images, sounds, text and videos	3,83	4	95,75	Good
8	Ease of use	3,83	4	95,75	Good
Total		30,28	32	94,63	Good

The revision of phase II of an interactive multimedia volleyball training model obtained from the responses of volleyball experts and media experts consisting of 8 main variables, namely; completeness of the model, accuracy of the model, accuracy of description, accuracy of video, graphic design, animation and sound evaluation, combination of images, sound and video and ease of use that obtains a score of (X)

30.28 from a maximum score (Xi) 32 which means good average with a percentage of 94.63% with a good category, so it can be concluded that this product can be used in a larger group trial.

Table 6. Trial Large Group media interactive multimedia volleyball practice media model.

No.	Item	Average on item	Xi	Percent-age	Category
1.	Completeness of the smash training model in increasing students' knowledge and skills	3,88	4	97	Good
2.	The accuracy of the training model with the concepts of volleyball skills	3,86	4	96,5	Good
3.	The accuracy of the description on each model	3,83	4	95,75	Good
4.	Video accuracy	3,80	4	95	Good
5.	Multimedia graphic design	3,87	4	96,75	Good
6.	Animated graphics and sound effects	3,81	4	95,25	Good
7.	Combination of images, sounds and videos	3,86	4	96,5	Good
8.	Ease of use	3,93	4	98,25	Good
Total		30,84	32	96,38	Good

The results of a large group trial of interactive multimedia based volleyball smash skills training model obtained from 60 students were based on the students' responses to Health Physical Education and Recreation IKIP PGRI Pontianak which consisted of 8 main variables namely; completeness of the model, accuracy of the model, accuracy of description, accuracy of video, graphic design, animation and sound evaluation, combination of images, sound and video and ease of use that obtains a score of (X) 30.84 from a maximum score (Xi) 32 which means good average with a percentage of 96.38% with a good category, so it can be concluded that this product can be used in actual training.

To find out the effectiveness of the product in the form of an interactive multimedia volleyball skills training model which is tested on students whether it is effective or ineffective, then there is data that must be collected, namely data about volleyball game skills for students. This data collection is carried out after a large group test (field test 2). Data collection test effectiveness using the T test with SPPS software. The following data is presented in summary: Data on the value of the pretest of volleyball smash skills from the subjects in the effectiveness test can be seen in the following table:

Table 7. Product Effectiveness Test interactive multimedia based volleyball training model for students who take volleyball training (pretest and posttest)

Respondent	Smash	
	Total Score	***Average Score***
40 Students	372	9,3

The posttest value of volleyball smash skills from the subjects in the effectiveness test can be seen in the following table:

Respondent	Smash	
	Total Score	***Average Score***
40 Students	663	16,57

Based on the data, it shows that the results of the pretest and posttest volleyball skills of the smash test of the pretest obtained a total value of 372 average scores of 9.30 and after the posttest the total value was 663 with an average value of 16.57. The training model of smash skills in playing interactive multimedia-based volleyball was developed by researchers to help teaching staff (teachers and lecturers), trainers and students, in training volleyball smash skills, increasing volleyball playing skills, and as a reference for volleyball training and learning as well. From the results of previous studies on volleyball learning using interactive multimedia with the subject of field trials (large groups) 30 people and did not test the effectiveness of the product. stated that interactive media products such as volleyball games were declared fit for use in volleyball learning and training [22]. The development of multimedia in the field of sports information is needed as an increase in sports information systems [23].

In the previous research, the researcher considered that the subject was not represented, because the subject used was still relatively small and only focused on the media and the variation of the training model given had not varied. In this study the development of interactive multimedia was carried out featuring media containing videos of various variations and combinations of exercises. The exercise model is more varied so it is not saturated to improve volleyball skills. The subjects of the field trial (large group) of 60 students, and the results of the product effectiveness test on 40 students used with the results of the study stated that the interactive multimedia volleyball-based exercise model is suitable to be used to help improve volleyball skills both for training and learning. Because with the media can increase cognitive, affective, and give birth to the automation movement. Most students are very positive with the use of interactive multimedia in learning [18]. This research and development produces multimedia products Volleyball learning is suitable for use in the process of training, learning and teaching [7]. The skill model of playing volleyball with technology with the help of media allows students, athletes, to be able to effectively and efficiently improve the skills of playing volleyball.

5 Conclusion

Based on the data obtained, from the results of field trials and discussion of the results of the study it can be concluded that SMASH's skills in playing volleyball in athletes can be mastered faster by using an exercise model that uses interactive multimedia volleyball-based VCD media. Because with VCD media, athletes can see a series of movements on smash skills outside of repeated training time at each stage of the volleyball smash sequence. So as to provide understanding cognitively, affective and give birth to the movement of automation. The practice model of volleyball playing skills with a touch of VCD technology enables students, athletes, to be able to

learn and do exercises effectively and efficiently which is used as a literacy enhancer, reference, in an effort to improve volleyball playing skills.

6 Acknowledgment

The researchers would like to address their gratitude to Health and Recreation Physical Education Study Program IKIP PGRI Pontianak. Ristek Dikti support and finance Research Doctoral Dissertation. Decree of Strengthening Research and Development Number 3 / E / KPT / 2018.

7 References

[1] T. Lvhua, "Multimedia application research in sport education," Procedia Eng., vol. 15, pp. 4246–4250, 2011. https://doi.org/10.1016/j.proeng.2011.08.796

[2] N. Vernadakis, P. Antoniou, E. Zetou, M. Giannousi, and E. Kioumourtzoglou, "Comparison of Multimedia Computer-Assisted Instruction, Traditional Instruction and Combined Instruction on Knowledge Acquisition and Retention of Setting Skill in Volleyball," Comput. Teach. New Dev., pp. 133–149, 2010. https://doi.org/10.1007/978-0-387-45951-6_40

[3] G. Shabiralyani, K. S. Hasan, N. Hamad, and N. Iqbal, "Impact of Visual Aids in Enhancing the Learning Process Case Research: District Dera Ghazi Khan.," J. Educ. Pract., vol. 6, no. 19, pp. 226–233, 2015.

[4] M. Al-Asadi, "Soccer Players Skill Development with Multimedia Aid," Futur. Prospect. Educ., vol. 6, no. 5, p. 4, 2006.

[5] Y. Wang, A. Qi, and F. Cui, "Application of the Multimedia Teaching System Based on Real-time Shooting and Production in Martial Art Course," Int. J. Emerg. Technol. Learn., vol. 11, no. 03, pp. 37–41, 2016. https://doi.org/10.3991/ijet.v11i03.5347

[6] Y. N., "Making Of Purchase Media About Sports and Sports Education for The First Medium School Based on Multimedia.," Yogyakarta High Sch. Informatics Manag. Amikom Comput. Yogyakarta, 2011.

[7] L. S. S. P, "Multimedia Development of Volley Ball Material Learning in Corporate Teaching Students For High School Students in Bantul District, Yogyakarta Private Vocational School.," J. Phys. Educ. Sport., vol. 3, no. 2, 2014.

[8] G. Sadam Husein LH, "He Effect Of Interactive Multimedia Use On The Concept Of Skills and Calor Materials Concept And Skills Of Students.," J. Phys. Technol. Educ., vol. 1, no. 3, p. 6, 2015.

[9] S. E., S. DLL, and C. Mims., "Instructional Technology and Media for Learning.," Bost. Pearson Educ. Inc., 2018.

[10] J. M. Palao and D. Valadés, "Validity of the standing spike test as a monitoring protocol for female volleyball players," Biol. Sport, vol. 29, no. 4, p. 281, 2012. https://doi.org/10.5604/20831862.1019666

[11] W. R. Borg and M. D. Gall, "Educational research: An introduction," 1984.

[12] J. W. Jad., "Special Issue for IETC 2017 Turkish Online Journal of Educational Technology.," Publ. Turkey Turkish Online J. Educ. Technol., 2017.

[13] E. H. Fahmi Arif Ashfahany SA, "Teaching And Health Education Teaching Teaching Materials In Interactive Multimedia For Class Students VII.," J. Educ. Theory, Res. Dev., vol. 2, no. 2, p. 7, 2017.

[14] M. A., "Research Methodology in Sports.," 2018.
[15] T. J., "Kinds of Research Methodology: Descriptions and Examples.," Lensa Media Pustaka Indones., 2016.
[16] H. FT., "Multimedia Literacy In: Arnold A, editor.," Multimed. Lit. North Am. McGraw-Hill Companies, Inc., 2001.
[17] M. Muflihah and H. Aziz, "Developing Interactive Multimedia CD-based Teaching Materials for Teaching Arabic Skill at Arabic Education Department of Islamic State University Sunan Ampel Surabaya," Din. Ilmu, vol. 18, no. 2, pp. 195–210, 2018. https://doi.org/10.21093/di.v18i2.1158
[18] K. Komalasari, "Living Values Based Interactive Multimedia in Civic Education Learning.," Int. J. Instr., vol. 12, no. 1, pp. 113–126, 2019.
[19] S. AH., "Interactive Multimedia with Flash. Sutopo A, editor.," Yogyakarta Graha Ilmu, 2003.
[20] M. E. W. AT, I. Sugiono, and D. Shandy, "Basic Techniques for Playing Volleyball.," Malang Malang State Univ. Indones., 2013.
[21] A. H. Sutopo., "Information and Communication Technology in Education. In: Sutopo AH, editor. Information and Communication Technology in Education.," Yogyakarta Graha Ilmu, 2012.
[22] S. Try Sevita Haryanto WDD, "Development Of Bolavoly Game Learning Using Interactive Media In State 6 State Smp In Situbondo District.," vol. 25, no. 1, p. 6, 2015.
[23] G. P., "Application Research on Multimedia Information Technology in the Universities Physical Teaching.," Open Cybern. Syst. Journal., vol. 9, p. 6, 2015.

8 Authors

Muhammad Suhairi Graduate State of Physical Education, Universitas Negeri Jakarta, Indonesia Health and Recreation Physical Education, IKIP PGRI Pontianak, Kalimantan Barat, Indonesia. suhairims27@gmail.com

Moch. Asmawi works in Physical Education Dept at Universitas Negeri Jakarta, Indonesia. asmawi.moch1@gmail.com

James Tangkudung works in Physical Education Dept at Universitas Negeri Jakarta, Indonesia. james24061952@gmail.com

Achmad Sofyan Hanif works in Physical Education Dept at Universitas Negeri Jakarta, Indonesia. sofyan_dean@yahoo.com

Firmansyah Dlis Works in Physical Education Dept at Universitas Negeri Jakarta, Indonesia. firmansyahdlis.unj@gmail.com

Article submitted 2020-01-30. Resubmitted 2020-02-29. Final acceptance 2020-03-01. Final version published as submitted by the authors.

A Systematic Review of Past Decade of Mobile Learning: What we Learned and Where to Go

https://doi.org/10.3991/ijim.v14i06.13479

Muhammad Imran Qureshi (✉)
Universiti Teknikal Malaysia Melaka, Melaka, Malaysia
qureshi@utem.edu.my

Nohman Khan
University of Kuala Lumpur, Kuala Lumpur, Malaysia

Syed Muhammad Ahmad Hassan Gillani, Hamad Raza
University Teknologi Malaysia, Kuala Lampur, Malaysia

Abstract—The increasing growth of mobile technology in our Society has become a reality. Outdoor learning is one of the very revolutionary developments in modern ages without huge infrastructure and resources. This study is focusing the area of mobile learning in year 2009 to 2018 about the areas and working done by the researchers. Mobile learning is relatively a new platform of learning through the mobile technologies, and penetration of smartphones and digital devices is globally increased in a short interval of time. The Scopus database is used to find the literature with the keyword used in search button mobile learning. The PRISMA diagram 2009 shows that the subjects of Social Sciences area to include the literature articles for the review. The final 54 articles with more than 20 citations for the review are selected to analyze the literature to find the gap and direction of mobile learning. Literature is divided in different classifications to find the results.

Keywords—Mobile learning, Ubiquitous Learning Environments, pedagogical

1 Introduction

Outdoor learning is one of the very revolutionary developments in modern ages without huge infrastructure and resources. The traditional concept of education and learning is about to change, technological advancement and IR 0.4 enhance the structure of learning through devices such as laptops, tablets, and smartphones. The devices have not inside the classroom but outside have great potential for learning [1]–[17]

[18]. Relatively mobile learning is new phenomenon, but the effectiveness of the tool is countless in terms of high-quality education and learning process. A smartphone is not only a phone but a device that can educate you with your willingness and timing that is conveniently available for the user [19]. Digital mobile technology using in educational purposes is the core function of vibrant and expanding

streams of mobile learning research and that is called ubiquitous learning. With the ubiquitous learning teachers are looking and exploring the technologies that are combining mobile devices with collaborative learning environment in process to enhance learning [20].With the period mobile learning is growing more and technological advancement opening create opportunity for students to educate in every field. This study will review the mobile learning approaches direction and significance in distance learning and classify the fields in which mobile learning is contributing effectively with high performance. Mobile learning is a greater solution for the developing and under-developing countries to educate large masses without the giant infrastructure development and only manage the techniques and applications with smartphones and other mobile devices that can assist students in distance areas [21]. Educating the outdoor student specifically online courses are more effective for different corners and learning new technologies, new languages and mathematical tools, mobile learning is very effective [21].

Educational techniques are changing very quickly, and another form of mobile learning is moving forward toward the e-learning applications that make possible much easier for students to approach desire text and solution of problem [22]. Mobile learning makes possible for students to learn, collaborate, and share ideas through the internet and m-learning system. M-learning modified form of learning in which mobile applications are making more diverse and accurate information available according to the need of students [23]. That is more comfortable for the learners to download the app and use that according to the need and share the ideas and views with the other users about the applications. But some of the characteristics of m-learning applications can also contribute for the teachers the way they teach to students and an important feature of m-learning is the traditional transfer of knowledge from teacher to student is changed and students can actively participate in the learning process [24]. Before that the educational structure was teacher-centered and after the mobile technology's developments make this to student-centered. Researchers of m-health are believing in maximize the use of mobile technologies in the higher education level while going with the educational mission. Many researchers argued that in higher education levels, students and teachers are ambition in learning mobile technologies [25-27]

This study is focusing the area of mobile learning in year 2009 to 2018 about the areas and working done by the researchers. Mobile learning is relatively a new platform of learning through the mobile technologies, and penetration of smartphones and digital devices is globally increased in a short interval of time. We will overview the literature, how researchers contributed the area of mobile learning during the 10 years of time. We will classify the broad areas of research and look deeply the recommendations and findings of the literature in the field mobile learning. Study is conducted due to importance and effectiveness of mobile learning from educational point of view. The significance of the study is to evaluate the researchers work during the 10 years and direction of researchers. In the first step quality screening process will be complete through the PRISMA statement and inclusion and exclusion of literature will be done through the quality process of PRISMA statement. Second step will

overview the classification of literature. The recommendations and conclusion will discuss in the last after the detail review process.

2 Methodology

The most recent attention of mobile learning is motivated researchers to work on the development of mobile learning in the recent years and this study will overview the literature towards the direction and missing areas of mobile learning for the educational development. The study analysis the past literature to a systematic literature review (SLR). The PRISMA statement templet is used to explain the overall process of selection and rejections of articles for the review of mobile learning. The PRISMA statement helps the researcher to improve the reporting of the review paper. The review is limited to published literature.

3 Literature Research

The Scopus database is used to find the literature with the keyword used in search button mobile learning. The total number of articles is shown by database 38772, but when the research is limited to the year 2009 to 2018 the number is decreased to 27398. The process is needed to filter more for the quality of the review, the language is selected only English and subject are selected social sciences for assessment and numbers are reached to 7547. After this the other options used from Scopus database of only published articles the results are automatically limited to 33320. There are other options like conference papers, review papers and submitted papers but for the reliability and quality of the study only published articles are included for the study. The PRISMA diagram 2009 shows that the subjects of Social Sciences area to include the literature articles for the review. For PRISMA diagram only open access articles of Scopus database is used for review and record are limited to 489 papers that were available in open access in Scopus database. The data is imported to excel sheets for further assessment of the literature. The excel sheets are extended into more sheets to find out the highest citations and for more batter and purified analysis, more than 20 citations papers are used for the study. after this the results are limited to 56 studies. The four studies are also excluded after the detail studies of the article's due irrelevancy with the subject. The final 54 articles for the review are selected to analyze the literature to find the gap and direction of mobile learning.

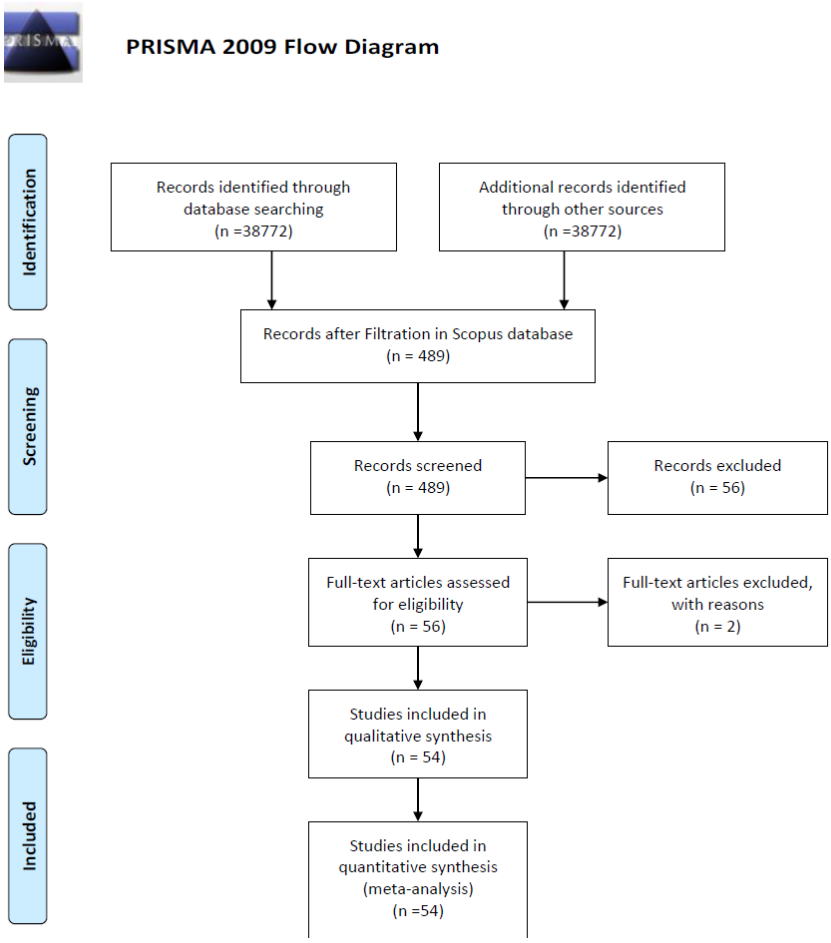


Fig. 1. PRISMA 2009 diagram of selection and screening process

4 Eligibility and Inclusion Criteria

The eligibility and inclusion of articles one of very critical and absolute observation way to include the best possible articles for the study. Generally, the language is selected for the articles is English and due to universal acceptability and maximum literature is published in English, so the articles are selected only in English language. The research article from the database is selected only from one subject social science. But also make sure the papers from all journals of the database must be considered for more batter and quality results. The open-access articles are considered for the review.

5 Studies Included in Qualitative Synthesis

The final 54 studies are used for the final process and find the direction and research done by the researcher in the year 2009 to 2018. The year base analysis is done to find out the annual publications and most cited papers are also be explained through the graph. the subject wise research is also explained in the graph to show the number of papers is include and exclude for the review. The journal base and most cited papers are also discussed

6 Most Cited

Minimum citation report of a paper in the study is 20 times and highest is 251 time of a paper. The effects of integrating mobile devices with teaching and learning on students' learning performance: A meta-analysis and research synthesis is cited 251 times which is a good number and other study with high citations number is Viewing mobile learning from a pedagogical perspective with the 232 times by the other studies. The citation criteria are making the study more valuable due to the other research's citations. Using mobile phones to improve educational outcomes: An analysis of evidence from Asia is the study 3rd number in the citation list with 150 times citation. Figure 1.2 is showing the details of citations report for more times and selected for the study.

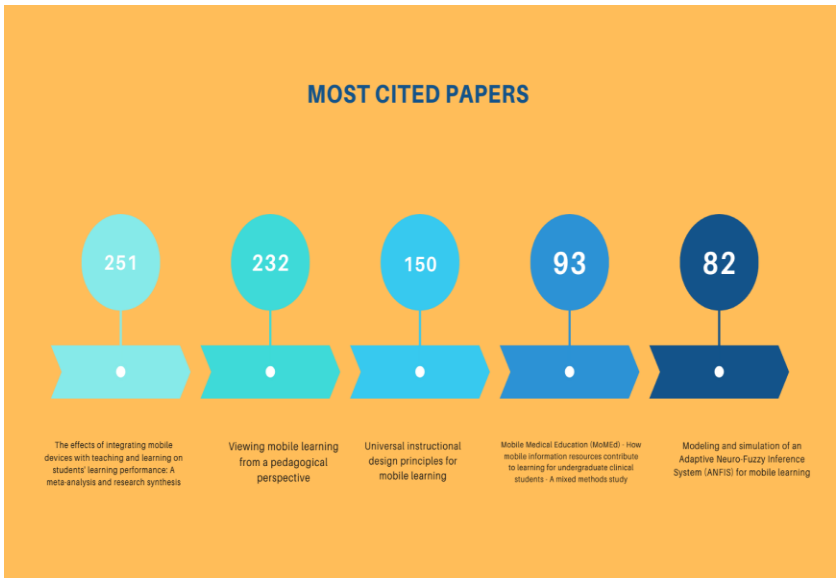


Fig. 2. most cited papers

7 Year Wise Publications

The study is limited from year 2009 to 2018 and every year publications are different and selected papers are due to the characteristics of most citations. Year 2010 and 2015 is the top on the list with 11 studies elected for the review and minimum number of the studies are choose from year 2018 and 2017 with 1 paper each from every year. While year's 2014,2012 and 2011 are having 9,6 and 5 studies from each year with high citation report. Figure 1.3 is showing the complete number and results of 10-year publications record selected for the study.

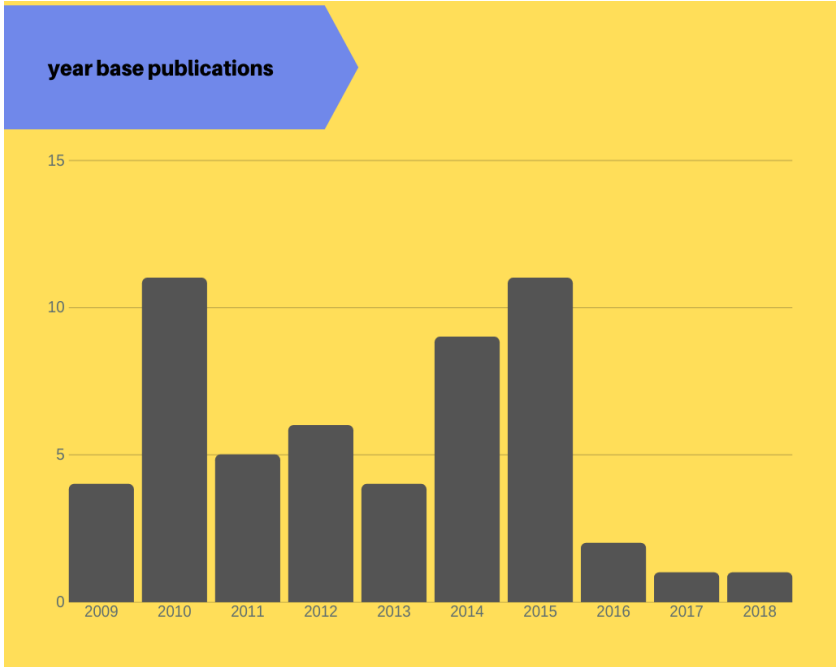


Fig. 3. Year base publications

8 Journal Base Publications

IEEE Transactions on Learning Technologies is journal that is top rank in selection criteria with 19 studies are selected from the journal. All studies are citation report more then 20 times and no other journal is near around the number of articles selected for this study. International Review of Research in Open and Distance Learning is the second in the list with the 6 studies choose for the review paper and citation report is more then times in other studies cited. Figure 1.4 is showing the highest number of papers selected from the different journals. BMC Medical Education is 3rd in the list with 4 articles selected through the screening process and citation is more than 20 times.

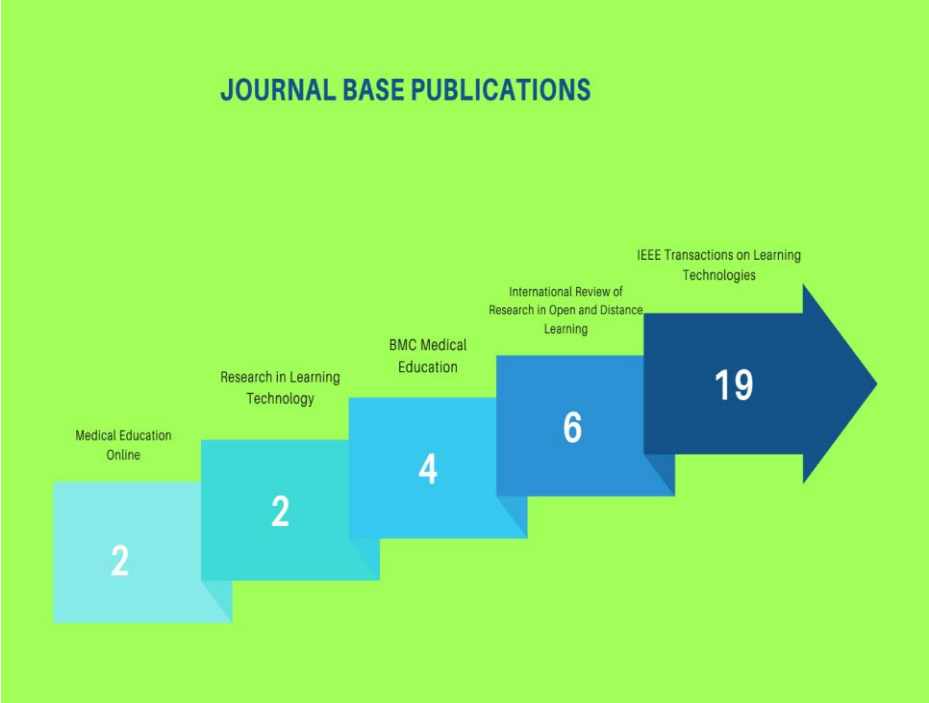


Fig. 4. Journal base publications

9 Classifications

Literature is classified in different areas according to the work done by the researchers and table 1.1 is showing the results of classifications.

9.1 Mobile learning students and teachers

The mobile learning classification process on excel sheet shows more contribution of the researcher is on student learning and teachers' responsibilities in distance learning and adjustable time frame according to the availability of students and teachers. Collaborative learning: Group interaction in an intelligent mobile-assisted multiple language learning system is the study that discuss the tutoring through the mobile phones and developing an effective intelligent tutoring system [28]. The findings of the study show that the learning through the mobile tutoring is effective and students can take advantage of the applications using mobile phones. Mobile learning environment is very important for students and teachers, in the environment students and teachers can work together in collaborative environment for user feature and context [29]. Supporting the Development of Mobile Adaptive Learning Environments: A Case Study recommended that the students and teachers work together for mobile learning environment development for the future prospectus. The effects of learning

styles and meaningful learning on the learning achievement of gamification health education curriculum study is also talks about the procedures about the learning styles, meaning full learning and learning achievement. The study agenda was towards the junior high school learning students through the digital mobile game learning. The findings of the study are divergence in mobile game-based students are highly regarded the curriculum [30]. Another study explains the importance of the distance learning and suggest distance learning is opening new opportunities for away students and they are able to educate them through the mobile phones and Mobile learning: Moving past the myths and embracing the opportunities study also talks about the challenges and risks related to the mobile learning in the future [31]. Academic mobility and migration: What we know and what we do not know is the study that talks about the higher education and research base scholarly education for the teachers. The suggested that to use the mobile learning about the international techniques and research opportunities through the mobile technologies and make the research more valuable in other parts of world [32].

The mobile learning in students and teacher's classification is mostly literature is talking about the environment that helpful for learning. Future of mobile learning is very important in distance

Table 1. Classification of literature

Authors	Variables	Findings
(Troussas, Virvou, & Alepis, 2014) [28]	Mobile Learning Students and Teachers	Environments rich in opportunity for self-regulated learning
(Teichler, 2015) [32]	Ubiquitous Learning Environments (ULEs)	Education beyond the traditional classroom, creating so-called Ubiquitous Learning Environments
(Kenny, Park, C Van Neste-Kenny, Burton, & Qayyum, [30], Medhanyie et al., [31]	Mobile health (mHealth) applications and Mobile Learning in Patient Care	M-Learning seek to provide an overview of what mobile learning entails, recognize the achievements of mobile learning to date, and stimulate
(G Sun, Technologies, 2014[32], Boticki, Wong, Learning, & 2012[39]	Collaborative Learning	Collaborative learning brought by TaaS in real university level courses
(Yang, Learning, 2014, [35]	Foreign Language Learning	Make cultural and language learning appealing, improve cultural learning effectiveness, and enhance interpersonal communication between teachers and students
(Bower, Education, 2015 [36] Kearney, Schuck, Burden, & Aubusson, 2012)[19]	Wearable Technologies & robot technologies	Future of wearable technology learning design is also discussed
(Cochrane & Antonczak, 2014, Soep, 2012) [37]	Mobile Social Media	Mobile social media framework is potentially transferable to a range of educational contexts,

Learning and students can learn about the technology and other segments related to the mobile learning very conveniently using the mobile phones.

9.2 Ubiquitous Learning Environments (ULEs)

Second classification of the literature is about the ubiquitous learning environment, that is basically explains the penetration and accessibility of mobile learning in the last decade. Traditional classrooms and educational scope are completely changed into complex technologies and mobile devices. Supporting teacher orchestration in ubiquitous learning environments: A study in primary education discuss the ubiquitous learning environment in detail, Teichler [32] suggested that the resources and energies must be utilize to support for the primary level teachers that are performing in the complex model ubiquitous learning environment. Teachers able to perfume in more batter way. Another study Context-aware services for smart learning spaces suggested that in the literature about the removal of the traditional classrooms, labs, meeting rooms and halls into services centers that provide more effective and efficient learning opportunities to the students and curriculum should be design according to the mobile learning situations [38]. According to the author due to this system learners and instructors are easily communicate with each other on mobiles and all students can learn very effectively. Mobile learning is more effective in the mobile integrated and individualize course in an application. Individualization for education at Scale: MIIC design and preliminary evaluation is study that suggested the idea about the one application for the students learning through the ubiquitous learning environment and convert the course into the integrate lecture videos, text, assessment and social learning into application. That can update the student learning model and also measurement of the student behavioral measurement [38].

Mobile learning environment needs to improve the learning structure and content of the students and provide a batter learning environment for both instructors and learners. Mobile applications are more reliable and effective tools for mobile learning during the current times.

9.3 Mobile health (mHealth) applications and mobile Learning in patient care

A good number of literatures in year is discussing the patient care using the mobile learning care and more developed form of the mobile health in mHealth applications. Mobile Medical Education (MoMEd) - How mobile information resources contribute to learning for undergraduate clinical students - A mixed methods study talks about the students use mobile learning for the improvement of learning and experience of clinical area of patient care. Clinicians are rise the use of mobile technology for more updated knowledge for patient care this study suggested that healthcare other departments must adopt the mobile technologies for the improvement and development of the patientcare[38] . Medhanyie et al. [31] believes that health applications are very much important for the healthcare, specially the developing countries health sector could be improve using the mHealth applications. Author also recommended that healthcare workers in developing countries must be provide smartphones and technological advancement to use the mHealth applications for learning and personal development. International Review of Research in Open and Distance Learning study also suggested the mobile learning importance in nursing students and faculty. The study

based on the survey and results of the suggested that the mobile learning improves the performance of the nursing students and faculty. Study also indicates that 75 out of 100 nursing students and faculty members are engage with the mobile learning [30]. Mobile learning is very much effective, and importance of healthcare is based on mobile learning. Medical students, doctors and nursing staff also must be equipped with the mobile learning due to the importance of mobile technologies.

9.4 Collaborative learning

In mobile learning that is very important to collaborate about the learning with the teams and individual for more development and penetration. Mobile learning is one of top emerging tend that is bringing many advantages for disturb learners. Collaborative learning is together the multiple learners together towards the pedagogical in online courses[32]. Designing technology for content-independent collaborative mobile learning study talks about the collaborative mobile learning opportunities and design the technology platform for motivating content mobile learning in the classroom. Technical architecture is assigning different materials to student and then guide all groups to achieve the preassign goals. Results of study recommended that the groups and teams are more batter in the mobile learning [39]. Collaborative learning is empowering the mobile learning and mobile applications are more strengthen the teams and goals of teams in mobile learning. Students are more learning in collaborative environment and mobile phones are more powerful tools for collaborative learning.

9.5 Foreign language learning

Mobile learning most attractive and easy tool to learn the foreign languages, Successful learning of academic word list via MALL: Mobile assisted language learning article discuss the importance of foreign languages learning in mobile learning. Study discuss that mobiles phones are a new addition in information and communication field for learners in the process of foreign languages learning. Results of the study recommended that teachers must send text messages to student about the language learning and they must in contact with each other [40] . mobile learning is also very helpful in cultural and language learning according to the Computer-assisted culture learning in an online augmented reality environment based on free-hand gesture interaction research article included in the study. Study objectives were about the improve cultural learning effectiveness and strengthen the interpersonal communication language between the students and teachers [35]. Mobile applications are a very effective and powerful tool of language learning due to the large number of videos, images and tutorial are available in different languages, that can help and guide in wright direction in learning the languages. Foreign language institutes are using the same techniques with students and courses they offer in foreign languages learning, they just collect videos and images to teach students through the mobile phones.

10 Wearable Technologies and Robot Technologies

Wearable technologies are a new phenomenon of technology development and many educationalists are harness pedagogical opportunities to understanding their potentials. What are the educational affordances of wearable technologies? Article that is cited 74 times suggested that three emergent themes; 'pedagogical uses', 'educational quality' and 'logistical' in the research paper. Data is collected from educationalists and find that wearable technologies are more effective and important in the mobile learning and this is updated version of mobile learning in context of emails, reminders, massages and many other futures related with wearable devices [36]. Viewing mobile learning from a pedagogical perspective is study discuss the feature of mobile learning and devices used in mobile learning. Basically, mobile learning has three main features: authenticity, collaboration and personalization, for the mobile learning [19]. A mobile mixed-reality environment for children's storytelling using a handheld projector and a robot article describe the robot's technologies for storytelling to children's using robots. Findings of the study are robots enhance children's embodied participation in, and their level of engagement with, their storytelling activities, and can support children in designing and expressing creative and original stories.

11 Mobile Social Media

Social media provides a unique and creative opportunities for learning environment. Case studies literature is emerging from the mobile learning and social media, for confirmation of the literature a study "Implementing a mobile social media framework for designing creative pedagogies" conducted number of social media projects. Findings of the study are social media project is potentially transferable in context of mobile learning and new pedagogies [37]. Social media medium to educate and learn new information to educate and update. Distance areas are now connected with the social media very easily through the mobile networks. Mobile penetration is growing rapidly and now students are almost on every social media medium that can educate them. Languages learning students are comfortably contact with the other native language speakers and get feedback. Digital era of technology shaped the traditional institutional structure and mobile learning is premium tool in the learning process. The digital afterlife of youth-made media: Implications for media literacy education is article included in the study and describe the youth media importance for mobile learning process. paper conclude that youth is deliberate to contribute through the mediums of social and mobile media. They are highly interested in discovery, analytics, networking mobilization and platform program [42].

12 Conclusion

Education process is very much dependent on mobile learning and numerous of fields are growing the development of mobile learning. Literature discusses many prime fields and importance of mobile learning within the fields for improving the ability of students in learning process. mobile applications are now the new advancement of era in learning skills in every field and social media platform are strengthen the process. mobile applications are not only text and videos but also tutorials that are showing the actual processes. Study find that literature is directing quality of work in every field during the year 2009 to 2018 but literature is very limited about social media and mobile applications learning. Results are also indicating that researchers must work about mobile applications importance and value in mobile learning that will helpful for student and for teachers. Literature is contributing more about the teachers learning and development but missing the link about teachers training and teaching skills importance in mobile learning process. literature linking very few studies in sciences subjects and visual arts subjects in past years. The subjects are very important to teach and offer through the mobile learning and researchers need to identify the importance of the subjects.

13 References

[1] M. I. Qureshi et al., "Measuring the ecological footprint of inbound and outbound tourists: evidence from a panel of 35 countries," Clean Technol. Environ. Policy, 2019. https://doi.org/10.1007/s10098-019-01720-1

[2] M. I. Qureshi, S. Qayyum, A. A. Nassani, A. M. Aldakhil, M. M. Q. Abro, and K. Zaman, "Management of various socio-economic factors under the United Nations sustainable development agenda," Resour. Policy, vol. 64, p. 101515, 2019. https://doi.org/10.1016/j.resourpol.2019.101515

[3] M. I. Qureshi, N. U. Khan, A. M. Rasli, and K. Zaman, "The battle of health with environmental evils of Asian countries: promises to keep," Environ. Sci. Pollut. Res., vol. 22, no. 15, pp. 11708–11715, 2015. https://doi.org/10.1007/s11356-015-4440-8

[4] M. I. Qureshi et al., "Environment and air pollution: health services bequeath to grotesque menace," Environ. Sci. Pollut. Res., vol. 22, no. 5, pp. 3467–3476, 2015. https://doi.org/10.1007/s11356-014-3584-2

[5] M. I. Qureshi, A. Md. Rasli, A. Jusoh, and T. O. Kowang, "Sustainability: A new manufacturing paradigm," J. Teknol., vol. 77, no. 22, pp. 47–53, 2015. https://doi.org/10.11113/jt.v77.6661

[6] A. M. Rasli, N. Norhalim, T. O. Kowang, and M. I. Qureshi, "Applying managerial competencies to overcome business constraints and create values: Evidence from small technology-based firms in Malaysia," J. Manag. Info, vol. 2, no. 2, pp. 22–28, 2015. https://doi.org/10.31580/jmi.v3i1.15

[7] M. I. Qureshi, M. Iftikhar, S. Y. Janjua, K. Zaman, U. M. Raja, and Y. Javed, "Empirical investigation of mobbing, stress and employees' behavior at work place: quantitatively refining a qualitative model," Qual. Quant., vol. 49, no. 1, pp. 93–113, 2015. https://doi.org/10.1007/s11135-013-9976-4

[8] I. Q. Muhammad, B. Mansoor, K. Aamir, and Z. Khalid, "Measuring queuing system and time standards: A case study of student affairs in universities," African J. Bus. Manag., vol. 8, no. 2, pp. 80–88, 2014. https://doi.org/10.5897/ajbm2013.7247x

[9] M. I. Qureshi, M. N. Bhatti, A. M. Rasli, M. Yasir, and K. Zaman, "The Delphi method for internationalization of higher education in Pakistan: Integrating theory of constraints and quality function deployment," Mediterr. J. Soc. Sci., vol. 5, no. 20, pp. 2702–2710, 2014. https://doi.org/10.5901/mjss.2014.v5n20p2702

[10] M. I. Qureshi, R. M. Yusoff, S. S. Hishan, A. F. Alam, K. Zaman, and A. M. Rasli, "Natural disasters and Malaysian economic growth: policy reforms for disasters management," Environ. Sci. Pollut. Res., vol. 26, no. 15, pp. 15496–15509, May 2019. https://doi.org/10.1007/s11356-019-04866-z

[11] M. I. Qureshi et al., "Modeling Work Practices under Socio-Technical Systems for Sustainable Manufacturing Performance," Sustainability, vol. 11, no. 16, p. 4294, Aug. 2019. https://doi.org/10.3390/su11164294

[12] M. Shahverdi, K. Ismail, and M. I. Qureshi, "The effect of perceived barriers on social entrepreneurship intention in Malaysian universities: The moderating role of education," Manag. Sci. Lett., vol. 8, no. 5, pp. 341–352, 2018. https://doi.org/10.5267/j.msl.2018.4.014

[13] Q. M. I. & R. A. Harasis A. A., "Development of research continuous usage intention of e-commerce. A systematic review of literature from 2009 to 2015.," Int. J. Eng. Technol., vol. 7, no. 2.29 (2018), pp. 73–78, 2018. https://doi.org/10.14419/ijet.v7i2.29.13133

[14] M. I. Qureshi, R. M. Yusoff, A. R. Ahmed, K. Isa, and A. Imran, "Linking quality of work life with sustainable manufacturing performance," Adv. Sci. Lett., vol. 23, no. 9, pp. 8232–8235, 2017. https://doi.org/10.1166/asl.2017.9867

[15] M. I. Qureshi, M. A. Hassan, S. S. Hishan, A. M. Rasli, and K. Zaman, "Dynamic linkages between sustainable tourism, energy, health and wealth: Evidence from top 80 international tourist destination cities in 37 countries," J. Clean. Prod., vol. 158, pp. 143–155, 2017. https://doi.org/10.1016/j.jclepro.2017.05.001

[16] M. I. Qureshi, U. Awan, Z. Arshad, A. M. Rasli, K. Zaman, and F. Khan, "Dynamic linkages among energy consumption, air pollution, greenhouse gas emissions and agricultural production in Pakistan: sustainable agriculture key to policy success," Nat. Hazards, vol. 84, no. 1, pp. 367–381, 2016. https://doi.org/10.1007/s11069-016-2423-9

[17] M. I. Qureshi, A. M. Rasli, and K. Zaman, "Energy crisis, greenhouse gas emissions and sectoral growth reforms: Repairing the fabricated mosaic," J. Clean. Prod., vol. 112, pp. 3657–3666, 2016. https://doi.org/10.1016/j.jclepro.2015.08.017

[18] Y. T. Sung, K. E. Chang, and T. C. Liu, "The effects of integrating mobile devices with teaching and learning on students' learning performance: A meta-analysis and research synthesis," Comput. Educ., vol. 94, pp. 252–275, Mar. 2016. https://doi.org/10.1016/j.compedu.2015.11.008

[19] M. Kearney, S. Schuck, K. Burden, and P. Aubusson, "Viewing mobile learning from a pedagogical perspective," Res. Learn. Technol., vol. 20, no. 1, 2012. https://doi.org/10.3402/rlt.v20i0.14406

[20] H. Heflin, J. Shewmaker, and J. Nguyen, "Impact of mobile technology on student attitudes, engagement, and learning," Comput. Educ., vol. 107, pp. 91–99, Apr. 2017. https://doi.org/10.1016/j.compedu.2017.01.006

[21] A. Lepp, J. E. Barkley, and A. C. Karpinski, "The relationship between cell phone use and academic performance in a sample of U.S. college students," SAGE Open, vol. 5, no. 1, Jan. 2015. https://doi.org/10.1177/2158244015573169

[22] G. Sun and J. Shen, "Facilitating social collaboration in mobile cloud-based learning: A teamworkas a service (TaaS) approach," IEEE Trans. Learn. Technol., vol. 7, no. 3, pp. 207–220, Jul. 2014. https://doi.org/10.1109/tlt.2014.2340402

[23] J. M. Zydney and Z. Warner, "Mobile apps for science learning: Review of research," Comput. Educ., vol. 94, pp. 1–17, Mar. 2016.

[24] C. X. Navarro, A. I. Molina, M. A. Redondo, and R. Juárez-Ramírez, "Framework to Evaluate M-Learning Systems: A Technological and Pedagogical Approach," Rev. Iberoam. Tecnol. del Aprendiz., vol. 11, no. 1, pp. 33–40, Feb. 2016.

[25] M. I. Qureshi, A. M. Rasli, and K. Zaman, "A New Trilogy to Understand the Relationship among Organizational Climate, Workplace Bullying and Employee Health," Arab Econ. Bus. J., vol. 9, no. 2, pp. 133–146, 2014. https://doi.org/10.1016/j.aebj.2014.05.009

[26] M. I. Qureshi, A. Khan, K. Zaman, and N. Khaqan, "Structural investigation of service quality in conventional and islamic banking in pakistan," Int. J. Manag. Innov., vol. 6, no. 1, p. 84, 2014.

[27] M. I. Qureshi, S. Y. Janjua, K. Zaman, M. S. Lodhi, and Y. Bin Tariq, "Internationalization of higher education institutions: Implementation of DMAIC cycle," Scientometrics, vol. 98, no. 3, pp. 2295–2310, 2014. https://doi.org/10.1007/s11192-013-1163-9

[28] C. Troussas, M. Virvou, and E. Alepis, "Collaborative learning: Group interaction in an intelligent mobile-assisted multiple language learning system," Informatics Educ., vol. 13, no. 2, pp. 279–292, 2014. https://doi.org/10.15388/infedu.2014.08

[29] E. Martín and R. M. Carro, "Supporting the Development of Mobile Adaptive Learning Environments: A Case Study," IEEE Trans. Learn. Technol., vol. 2, no. 1, pp. 23–36, 2009. https://doi.org/10.1109/tlt.2008.24

[30] K. K. Fan, P. wei Xiao, and C. H. Su, "The effects of learning styles and meaningful learning on the learning achievement of gamification health education curriculum," Eurasia J. Math. Sci. Technol. Educ., vol. 11, no. 5, pp. 1211–1229, 2015. https://doi.org/10.12973/eurasia.2015.1413a

[31] T. H. Brown and L. S. Mbati, "Mobile learning: Moving past the myths and embracing the opportunities," Int. Rev. Res. Open Distance Learn., vol. 16, no. 2, pp. 115–135, 2015. https://doi.org/10.19173/irrodl.v16i2.2071

[32] U. Teichler, "Academic mobility and migration: What we know and what we do not know," Eur. Rev., vol. 23, pp. S6–S37, 2015. https://doi.org/10.1017/s1062798714000787

[33] R. F. Kenny, C. L. Park, J. M. C. Van Neste-Kenny, P. Burton, and A. Qayyum, "Using self-efficacy to assess the readiness of nursing educators and students for mobile learning," Int. Rev. Res. Open Distance Learn., vol. 13, no. 3, pp. 277–296, 2012. https://doi.org/10.19173/irrodl.v13i3.1221

[34] A. A. Medhanyie et al., "Health workers' experiences, barriers, preferences and motivating factors in using mHealth forms in Ethiopia," Hum. Resour. Health, vol. 13, no. 1, Jan. 2015. https://doi.org/10.1186/1478-4491-13-2

[35] M. T. Yang and W. C. Liao, "Computer-assisted culture learning in an online augmented reality environment based on free-hand gesture interaction," IEEE Trans. Learn. Technol., vol. 7, no. 2, pp. 107–117, 2014. https://doi.org/10.1109/tlt.2014.2307297

[36] M. Bower and D. Sturman, "What are the educational affordances of wearable technologies?," Comput. Educ., vol. 88, pp. 343–353, 2015. https://doi.org/10.1016/j.compedu.2015.07.013

[37] T. Cochrane and L. Antonczak, "Implementing a mobile social media framework for designing creative pedagogies," Soc. Sci., vol. 3, no. 3, pp. 359–377, 2014. https://doi.org/10.3390/socsci3030359

[38] K. Scott and R. Benlamri, "Context-aware services for smart learning spaces," IEEE Trans. Learn. Technol., vol. 3, no. 3, pp. 214–227, 2010. https://doi.org/10.1109/tlt.2010.12
[39] I. Boticki, L. H. Wong, and C. K. Looi, "Designing technology for content-independent collaborative mobile learning," IEEE Trans. Learn. Technol., vol. 6, no. 1, pp. 14–24, 2013. https://doi.org/10.1109/tlt.2012.8
[40] M. Alemi, M. R. A. Sarab, and Z. Lari, "Successful learning of academic word list via MALL: Mobile assisted language learning," Int. Educ. Stud., vol. 5, no. 6, pp. 99–109, 2012. https://doi.org/10.5539/ies.v5n6p99
[41] M. Sugimoto, "A mobile mixed-reality environment for children's storytelling using a handheld projector and a robot," IEEE Trans. Learn. Technol., vol. 4, no. 3, pp. 249–260, 2011. https://doi.org/10.1109/tlt.2011.13
[42] E. Soep, "The digital afterlife of youth-made media: Implications for media literacy education," Comunicar, vol. 19, no. 38, pp. 93–100, 2012. https://doi.org/10.3916/c38-2012-02-10

14 Authors

Nohman Khan Is a PhD student in UNIKL Business School, University of Kuala Lumpur, Malaysia. Author has interest in digital marketing area and has many research articles related to the field. For more detail contact him at nohman.khan@s.unikl.edu.my

Muhammad Imran Qureshi Is currently affiliated with Faculty of Technology Management and Technopreneurship, Universiti Teknikal Malaysia Melaka, Malaysia. Muhammad Imran Qureshi has interest in area of operations management and open innovation field. For more details contact him at.qureshi@utem.edu.my

Syed Muhammad Ahmad Hassan Gillani is currently a PhD candidate at Azman Hashim International Business School, University Teknologi Malaysia, Malaysia. He is also serving as lecturer at GC university Faisalabad Pakistan.

Hamad Raza currently a PhD candidate at Azman Hashim International Business School, University Teknologi Malaysia, Malaysia. He is also serving as lecturer at GC university Faisalabad Pakistan.

Article submitted 2020-01-30. Resubmitted 2020-03-02. Final acceptance 2020-03-03. Final version published as submitted by the authors.

Using Modern Education Technique in Wasit University

https://doi.org/10.3991/ijim.v14i06.11539

Abdul Hadi M. Alaidi
University of Wasit, Wasit, Iraq

Omar Hashim Yahya
Northern Technical University, Mosul, Iraq

Haider Th. Salim AlRikabi (✉)
University of Wasit, Wasit, Iraq
hdhiyab@uowasit.edu.iq

Abstract—This New learning educational methods, which depending on Learning Management System (LMS), have been used by universities in the top education universities in the world. However, most of the Iraqi universities use the traditional education methods in the classroom. The purpose of this study was to examine the benefit of using LMS in higher education. This study shows how to implement and use modern educational techniques in Engineering College of Wasit University. This paper shows that using modern education tools in the class lead to increase the productivity of student, save time with less effort for instructors with high accuracy of exam results. In addition, using LMS system allows students to obtain more information in a short time. Moreover, this system gives students an opportunity to interact with the instructor and among themselves. The findings show the benefits of integrating LMS in higher education and recommend other institutions to implement it.

Keywords—Higher Education; Learning Management System; Information and Communication Technology; Canvas

1 Introduction

It is very difficult for students to learn and understand engineering classes like mathematics without using classical education material as chalkboard or other educational material. It's an unthinkable mission for instructors to clarify without utilizing any instructive apparatuses. In the last decade, the educational methods have evolved dramatically. Firstly, instructors were using blackboard and chalk for leaning students then white boards. Finally, in the present time the instructors are using smart of whiteboards in their lecturers. According to[1], “Educational change depends on what teachers do and think – it is as simple and as complex as that.” We believe that the instructor is the main key to the development of students' mental skills and success. Using of technological education within colleges by instructors has three main advantages. Firstly, the use of technological education saves time and gives an oppor-

tunity for discussion between the student and the professor within the classroom. It is known that the time is money. California Department of Education ("Education Technology Planning," 2001) defines time as "Time is the greatest stumbling block" to provide significant and a high quality educational opportunities for teachers "to plan, reflect, design lessons together, and examine and make meaning of content and teaching standards." The use of educational technology in classroom reduces the stress of the professor and makes the teacher teach the students effectively and actively. Moreover, In-class technological education gives the student an incentive to continue learning. One of the biggest problems that confronted lecturers to teach huge number of students and it needs much of time while the technological education save time with high efficiency. For instance, some colleges have halls of lectures, and that will be tough to lecturers in additions to students[2]. California University, San Diego University, and Temple University solved this problem by using Room Control System (Goral, 2008).

Educators utilize innovation education in the classroom to enhance execution and utilize time viably. As of late, modern education technology has been created and utilized present day advancements to enable educators to decrease time utilization in instructing. According to[3] instructors can save lessen time essentially by creating a new technique to enhance the students for overcoming the difficulties that may face in composing or perusing. In fact, one of the best techniques way, according to[4], is utilizing media in the classroom. Utilizing sight and sound in class can support the achievement of success from 10% to 20% over customary adapting way and 33% sparing time on the undertaking[5]. For instance[6], announced that "Owing to the lack of time," he utilized the Interactive Whiteboards as an apparatus to show understudies and answer their inquiries concerning "heat and the process of floating." Dodd's and Fletcher[7] detailed that utilizing intuitive advances can decrease time by approximately 33%. Also [8], said that sparing time is the undeniable outcome when we contrasting ordinary guideline and innovation direction. Table 1 clarifies the sparing time that[8] announced:

Table 1. Percent time saving for technology-based instruction

Study (reference)	Number of studies reviewed	Average Time saved (%)
Orlansky and string (1977) (Military training)	13	54
Fletcher (1991) (higher Education)	8	31
Kulik (1994) (higher Education)	17	34
Kulik (1994) (Adult Education)	15	24

This table is considered as significant proof to demonstrate that reliance on modern technology in the classroom can both save and utilize time successfully.

The second reason educators rely upon instructive innovation in the classroom is to lessen the workload utilizing less push to give a more noteworthy impact when they educate. All educators are human and when they work they feel weariness that decreases their execution.

Information and Communication Technologies (ICT) and Virtual Teaching Assistants (VTA) are modern educational tools that may assist lecturers to reduce the ef-

forts and enhancement their achievements. However, this could not happen without changing the role of professors and instructors toward the use of ICT. So, to reach their full potential "staff and student should receive appropriate training and support" [16]. Bordbar[9] reported that (ICT) is one characteristic of using development technologies tools like computer in the classroom to decrease the workload on the lecturer. One of big problems that face lecturers is the grading of student's test especially huge class, which is one of Wasit University example that can do multiple-choice exam in the electrical engineering department. The lecturers do not take time the correct papers exam, and the student can get his grade automatically after finish his exam. The huge number of papers exam may due to mistake the question correction or in the summation grade of questions. The modern technology exams tools show the results without any mistake and without spending much time. Chou, Huang and Lin[10] reported that (VTA), which are using modern ways to enhance the student for learning, can decrease the lecturer workload. Lecturers take much time to correct paper quizzes, exams, grade exams, or even the explanation in the classroom.

Modern educational technologies tools can decrease a lot of management paperwork and save workload of lecturer.one of the best ways, for instance, by utilization smart whiteboards. According to[11], smart Whiteboards can decrease the time of lecture preparation because it gives the instructor more option like searching on the internet. Moreover, using smart Whiteboards (IWB) can decrease instructor effort and the student remain interactive[12]. Morgan[11] prove the practice of Forrest, who responsible on mathematical class by using IWB, he shows that the using of smart board is a simple way for learning students because they will have more than one option for learning by using pin and manipulate text. Arias[13] did study and established that fifty percent of lecturers use modern technology tools "as a medium for curriculum" (p.11); in addition, they show 4 out of 6 lecturers consider the modern technology way assist them to qualify their load.

Another part of educational technologies is managing eLearning courses through learning management system "LMS", which this paper covers. The major concern in this paper is to support traditional educational method through LMS, which is not only to save time and money but also to deliver effective instruction that enhances interactive learning environment between students and faculties. However, creating effective courses and interactive learning environment through LMS would be great challenges that instructors should be aware of [14]. Can faculties face these challenges and increase students' performance and create interactive learning environment? Are designing Engineering courses through LMS would be applicable in all courses? This study answers these questions by presenting instructive case of how to implement and use modern educational techniques in Engineering College of Wasit University.

2 The Need of LMS in Higher Education

The emerging of LMS was at Illinois University in1960 [19]; it has gradually developed by the scholars to be integrated into academic organizations. Regards of the

limitation of time and distance LMS is designed to face these obstacles by delivering asynchronous or synchronous eLearning and online classes and to support traditional teaching methods [18]. Nowadays LMS is a supportive tool for boosting learning process. The purpose of LMS is for enhancing communication among students and between instructors and students, share materials and communicate online. Delivering courses to a large number of dispersed students globally in a limited time would be demanding task through traditional teaching [14]. LMS which is web-based technology could meet these demands and delivering eLearning courses, virtual classes or online classes and supporting traditional teaching [24]. LMS, virtual learning environment or course management system are used interchangeably in e-learning environment to support student-centered learning, make learning content easily accessible and supportive with a variety of learning materials [23].

Recently, LMS has used among corporate and government organizations to academic universities and K-12. It helped to administrate, document, track, report and evaluate the whole learning process effectively [16]. Unquestionably, LMS has widely and commonly used among higher education in UK, Canada, USA and Australia and recently in developing country such as Iraq, Saudi Arabia and Jordan. For example, The National Centre for E-learning and Distance Learning (NCEL) in Saudi Arabia designed its own LMS called JUSUR which designed with "17 interactive tools" and they collaborate with Meteor Group of Companies in Malaysia [26].

With LMS professor or instructors can administrate, track and evaluate the whole learning process and see the progress of their students digitally. Students can do their test or deliver their assignments, view their grades, evaluate their progress and involved in group discussion through LMS which increase the theory of student-centered [24]. Stakeholders in any learning community had studied all the possibilities to improve teaching strategies through pedagogical concept and to achieve effective learning outcomes, but they have faced challenges of accessibility and flexibility of teaching through e-Learning environment [27]. LMS had faced those challenges in addition to meeting learners' needs with various characteristics and meeting diverse learning style [27].

3 What Can an LMS do in Higher Education?

LMS is a better future of learning for higher education. LMS gives instructors opportunities to create tailored learning experience that fit every student's needs and give the ability to manage multiple classes worldwide [23]. Its system of creating interactive website and modules, built-in rubrics, assessment, grading, reporting, trucking students' progress, participation and attendance, and communication system make it the better supporting tool for creating desirable interactive learning environment[28]. LMS helps in planning, implementing and delivering instructions in multiple learning contexts and extend beyond traditional campus because it is organized around the learners' needs. LMS gives opportunity to apply different learning models such as blended learning - synchronous and asynchronous, storytelling, gamification, rapid learning etc [29]. Obviously, the variety of learning models could meet diverse

learners' needs and they can be self-directed and self-paced and meet their individual progress. They can also get immediate feedback, be involved in valuable discussion groups. Undoubtedly, with traditional teaching method which is based on teacher-centered, students would not be able to achieve the desirable learning outcome [22]. LMS replaced the traditional design of teaching to learner-centered design and replaced traditional methods of getting information, submitting assignment or doing a test. For example, students can view several supported links and resources for their interested subject that support their educational attainment [20].

Stakeholders and professors can administrate, document, organize and manage modules and the status of the course, distribute materials, upload online resources or share MOOCs that support their main course, post immediate feedback with grades, track students' progress and assess and view statistical data about the learning outcome and LMS quality [19]. When a new course is introduced it could be no access for students to view a course syllabus before signing up for a course, but with LMS student can view the introduction of the course and the instructor teaching method and the announcement in its calendar [19][20]. Without LMS it would be most difficult to support the theory of learner-centered approach and deliver instructions in different learning style and create the interactive environment between students and professors in an effective way and with cost-effectiveness. So, it is obvious that LMS has been suggested for higher education by scholars and stakeholders to integrate it into their classes to achieve the desirable learning outcome.

4 Features of LMS in Higher Education

The functional LMS was built on pedagogical theory and learning theories such as "behaviorism, cognitive theory, and constructivism" to achieve the desired learning outcomes and meet organizations' goal [15]. As [14], [15], [29] and [16] detailed some features to state the fit LMS that meet individual needs. LMS should be adapting to learners' and instructors' needs such as the ability to choose from the variety of the learning models. Instructors' should be able to create interactive modules, delete or add new course independently. Most LMS has been integrated with registration portal to give access to their students to register for a class.

User friendly is another feature makes stakeholders interested in LMS. The friendly interface to navigate and accessing information and activities easily and quickly was faster their work to be done. LMS is an organized system so instructors can easily create organized modules with relevant contents and online readily available materials, create online quizzes and syllabus and upload varieties of files and online resources.

Easy access: That is accessible with the whole functionality from any mobile device - laptop, smartphone or tablet anytime. This has helped students to complete their assignment and upload it from anywhere, collaborate together in a discussion group, and get feedback from their peers and teachers [14].

Interactive learning and communication: Creating interactive modules in the form of PDFs, video clips, audio, or online resource and encouraging students to pre-

pare for the class prior to class time can support traditional class. That is instructors made substantial discussion in the class time and decrease the workload and save time. Instructors need to engaging students in discussion forums which facilitate communication between them [[16] about class. When students post questions online and get responses and critical ongoing feedback from their peers and instructor, they learn from each other and promote learning process [29]. Also, motivation is part of interactive learning experience. Students need to feel motivated i.e. their names are on the leaderboard and to enhance motivation instructors can utilize the feature of gamification – another learning strategy within LMS [25]. Gamification helps students to remember what they have learned through "game mechanics" which is tailored to meet course learning objectives [30].

Trucking Data for learners' progress: Collecting data to analyze learners' performance and close their gaps can be in many forms in LMS. The build-in rubrics help instructors to grade students' assignments effectively and measure their progress. Students can do their quizzes online and view their score immediately. Instructors' feedback, grade statistics and other learning activities are help instructors to collect data about students' proficiency, truck their progress and close any gap in teaching [28]. Trucking data is not just help instructors to close learns' gap, but also help students to focus on what they need to learn [28].

5 Design and Implementation of LMS

The proposed method for implementing the system is to use three servers with main router and four switches. The servers are one of the most important part of the system because they provide the services for all users, which will be responsible for storing all data and information, including database and archiving, in a manner that ensures that this information is not lost. In addition, these servers provide the transfer of information between large numbers of users simultaneously with high efficiently. Therefore, our College provides three high-performance servers. The first one is HP ProLiant DL380p Gen8 E5-2620 with 24 processor and random memory capacity of 48 Gigabyte. The others are HP ProLiant DL380 G7 type with specification of two processors (Intel Xeon E5640), random memory capacity of 16 Gigabyte, and large storage capacity (2 terabytes) with RAID 5 data storage for four parallel hard drives, to ensure that data will not lost even if one of these discs' malefaction. The fiber optics is used for connection between the main router and branches of switches. The switches are distributed for four engineering departments (Electrical, Civil, Mechanical, and Architecture). There are two types of Wi-Fi devices in each department. The first type which has more capability to serve more crowded places like student classes, Laboratories, Workshops, and student club while the other Wi-Fi types serve less crowded places like faculty, management, and control rooms. Figure 1 shows the Architecture of engineering college network and figure 2,3 show the installation of Wi-Fi and Fiber optic.

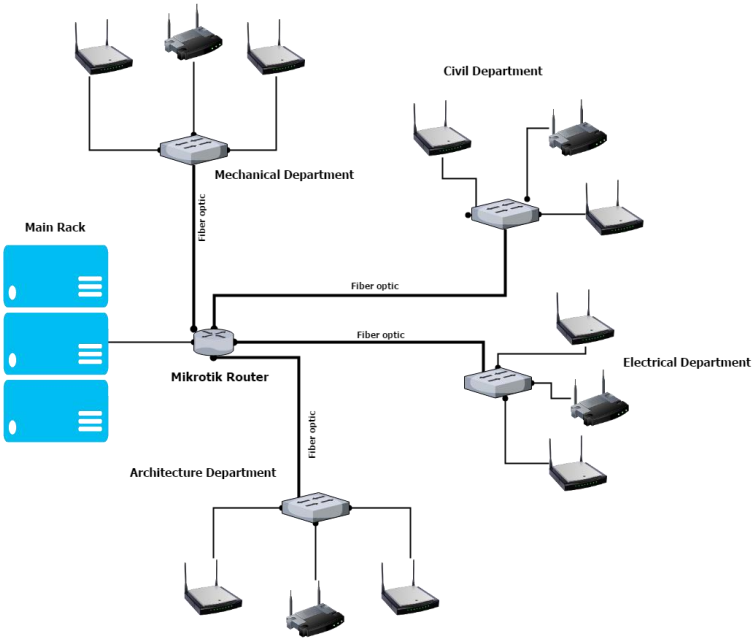


Fig. 1. Architecture of engineering college network.

Fig. 2. Fiber optic and Wi-Fi installation.

6 Conducting Workshops

The support team and instructional design team conducts general workshops on how to use LMS particularly Canvas platform. During the workshops, they discussed generally faculty's technological barriers of integrated educational technology into instructions and learners characteristics to implement LMS effectively. The team encouraged interaction, provided live examples and interactive activities. Also, the support team worked with different Engineering departments – civil, mechanical and electrical - to develop multimedia materials that beneficial for students' learning.

7 Why Canvas

7.1 Features of canvas platform

Finding LMS application that fit into any learning environment and meets all parties' needs – organization, learners, and faculty -would be very challenging [27] and [28]. Most functional LMS has easy access feature, helping students to access course material and assignment anytime. Because of accessibility, students are able to submit their assignments from any mobile device. The user-friendly interface makes it easier for both instructors and learners to easy engage with course materials and communicate with peers and instructors easily. With LMS instructors are able to manage enrollments, share documents, trucking data – assignment and test assessments and grading – share course materials, upload course syllabus and varieties of files. In addition of these features students also have the ability to be engaged in online environment and in discussion group and find additional educational resources. Other tools such as a quiz grading book, a dashboard page, and customizable notifications, quizzes tool for practicing or doing quiz are effective features that support learning process. Meeting those features depends on the organization's needs and goal [14] and some of e-Learning LMS software that has those features is Moodle, Canvas, Edmodo and Blackboard.

Canvas LMS is an open source learning management system developed by Instructure. It provides much functionality depending on web 2.0 technologies. Free version of Canvas distribution has many features: assignments, quizzes, curriculum and polls supported by specialized grading tool. Moreover, Canvas LMS offers file sharing where users have their own file repositories, wiki pages', discussions and messaging system. Announcements, scheduling and presentation tools are also supported by Canvas. A specialized tool is using to create user's portfolios and web pages. In another hand, Canvas offers many tools for system admin: accounts, group with different permissions membership where only enrolled use can access a course organization. Canvas gives the admin ability to customize course organization and navigation. System monitoring is another tool provide by canvas where automatized tasks such as message exchange can be monitored. Third-party tools can be added to extend canvas feature. So far, there are numerous external applications and plug-ins for Canvas.

In order to keep up with what student doing and what expected from them Canvas offers an "Observer" role. Observer user can read documents and pages, check the calendar, assignments, announcements, and see quizzes. However, Observers cannot read quiz content, submit any quizzes or assignments, and send messages to students. In case of link an observer to a student the observer can see the student's grades and course interactions.

Because of all of those features of Canvas and more, many educators in USA has established their free online courses known as massive open online course "MOOC" for academic support and they also extended it to professional development.

8 Result

The modern education method which concerned in this study has been applied in Engineering college / Wasit University for master comprehensive exam for electrical engineering departments and compared the result with others departments which used traditional method for same exam and the result reported in table II.

Table 2. Saving time, number of monitors and objection for comprehensive exam

Department	Student Number	Exam time	No. of objection on result	No. monitors exam	Time of announce the results
Civil	21	3hr	2	4	24Hr
Mechanical	20	3hr	1	4	24Hr
Electrical	16	3hr	0	2	0hr

Depending on the results which shown in the above table, we conclude that there is no needing for time to announce the result of the comprehensive exam of electrical engineering results because the results are shown directly to the students. Moreover, the number of monitors in examination hall was reducing by 50%. Furthermore, there is no objection from any student on the grade.

The result of the survey has shown that most of the instructors who participated in the integration of LMS Canvas have shown initiative to build web-based course materials. The majority of them agreed Canvas was easy to use and easy to create the complete course with multimedia materials which made course enrich. They acknowledged that their teaching strategies had changed and supported their face to face "F/F" classes. The in-service instructors who worked with their peers indicated that some instructors continue in creating engaging activities that encourage interaction among students and their peers and instructors. Indeed, stakeholders will work together to expand the integration of LMS into higher education in Wasit university.

9 Conclusion

The studied in this paper focused on special program (Canvas) to help instructors for teaching. Using this method of modern technology can decrease a workload, notwithstanding sparing time, and save money with high efficiency. The instructors rely

upon instructive innovation in the classroom is to give understudies inspiration to proceed with the learning. The implementation of modern education tools in our college gave excellent results by applying in comprehensive exam of master students. In addition, this study proves that using modern method of education in classroom avoid the mistakes that instructor may face by correction of exam paper or transfer grades from students' paper to master sheet. Even though this study examined the benefit of integrating LMS into higher education and encouraged similar academic institutions to integrate e-learning to support F/F classes to reach the desirable learning outcomes, they did not cover the barriers of using LMS in higher education. It would be very challenging to create interactive class and engaging activities that make students more involved in and build interactive ongoing efficient communication[27].So this study could be extend to examine the key factors that influence the diffusion and infusion of LMS to be adopted by higher education and making successful integration.

10 References

[1] M. Fullan, "with Stiegelbauer, S.(1991)," *The new meaning of educational change,* vol. 2, 1991.

[2] M. Brandsteidl, K. Wieland, and C. Huemer, "Novel Communication Channels in Software Modeling Education," in *MoDELS Workshops*, 2010, vol. 6627, pp. 40-54: Springer. https://doi.org/10.1007/978-3-642-21210-9_5

[3] C. Farivar, "Library shuffles its collection," ed: Wired, 2005.

[4] E. C. Schmid, "Potential pedagogical benefits and drawbacks of multimedia use in the English language classroom equipped with interactive whiteboard technology," *Computers & Education,* vol. 51, no. 4, pp. 1553-1568, 2008. https://doi.org/10.1016/j.compedu.2008.02.005

[5] A. M. Eskicioglu and D. Kopec, "The ideal multimedia-enabled classroom: Perspectives from psychology, education, and information science," *Journal of Educational Multimedia and Hypermedia,* vol. 12, no. 2, pp. 199-221, 2003.

[6] S.-J. Jang, "Integrating the interactive whiteboard and peer coaching to develop the TPACK of secondary science teachers," *Computers & Education,* vol. 55, no. 4, pp. 1744-1751, 2010. https://doi.org/10.1016/j.compedu.2010.07.020

[7] P. Dodds and J. Fletcher, "Opportunities for new" smart" learning environments enabled by next generation Web capabilities," INSTITUTE FOR DEFENSE ANALYSES ALEXANDRIA VA2004.

[8] J. Fletcher, "Does this stuff work? A review of technology used to teach," *TechKnowlogia, Jan-Mar,* 2003.

[9] A. J. J. o. I. T. E. R. Tella, "Reliability and factor analysis of a blackboard course management system success: A scale development and validation in an educational context," vol. 10, no. 1, pp. 55-80, 2011. https://doi.org/10.28945/1368

[10] B. K. Mohammed, R. F. Chisab, and H. J. I. J. o. I. M. T. Alrikabi, "Efficient RTS and CTS Mechanism Which Save Time and System Resources," vol. 14, no. 04, pp. 204-211, 2020. https://doi.org/10.3991/ijim.v14i04.13243

[11] F. Bordbar, "English teachers' attitudes toward computer-assisted language learning," *International Journal of Language Studies,* vol. 4, no. 3, 2010.

[12] C.-Y. Chou, B.-H. Huang, and C.-J. Lin, "Complementary machine intelligence and human intelligence in virtual teaching assistant for tutoring program tracing," *Computers & Education*, vol. 57, no. 4, pp. 2303-2312, 2011. https://doi.org/10.1016/j.compedu.2011.06.005
[13] H. Morgan, "Teaching with the interactive whiteboard: An engaging way to provide instruction," *Focus on Elementary*, vol. 22, no. 3, pp. 3-7, 2010.
[14] N. Selwyn, Education and technology: Key issues and debates. Bloomsbury Publishing, 2016.
[15] O. H. Yahya, H. Alrikabi, I. A. J. I. J. o. O. Aljazaery, and B. Engineering, "Reducing the Data Rate in Internet of Things Applications by Using Wireless Sensor Network," vol. 16, no. 03, pp. 107-116, 2020. https://doi.org/10.3991/ijoe.v16i03.13021
[16] C. Arias, L. Baker, C. Degano, R. Mercado, N. Reynolds, and M. Smith, "EDUC 607 Professor Murillo March 18, 2009."
[17] D. Peraya *et al.*, "Between what we say and what we think: Where is mediatization?" 2019.
[18] R. J. J. o. L. D. Epping, "Innovative use of Blackboard® to assess laboratory skills," vol. 3, no. 3, pp. 32-36, 2010.
[19] N. A. Alias and A. M. J. M. o. j. o. i. t. Zainuddin, "Innovation for better teaching and learning: Adopting the learning management system," vol. 2, no. 2, pp. 27-40, 2005.
[20] D. A. Falvo and B. F. J. T. Johnson, "The use of learning management systems in the United States," vol. 51, no. 2, pp. 40-45, 2007.
[21] W. Watson and S. L. Watson, "An argument for clarity: What are learning management systems, what are they not, and what should they become," 2007.
[22] M. J. S. J. H. E. S. Asiri, "Factors influencing the use of learning management system in Saudi Arabian higher education: A theoretical framework," vol. 2, no. 2, pp. 125-137, 2012.
[23] M. K. Kim, S. M. Kim, O. Khera, J. J. T. I. Getman, and H. Education, "The experience of three flipped classrooms in an urban university: an exploration of design principles," vol. 22, pp. 37-50, 2014. https://doi.org/10.1016/j.iheduc.2014.04.003
[24] P. A. J. E. t. r. Ertmer and development, "Teacher pedagogical beliefs: The final frontier in our quest for technology integration?" vol. 53, no. 4, pp. 25-39, 2005. https://doi.org/10.1007/bf02504683
[25] D. S. Walker, J. R. Lindner, T. P. Murphrey, and K. J. Q. R. o. D. E. Dooley, "Learning management system usage," vol. 17, no. 2, pp. 41-50, 2016.
[26] M. Abdel-Basset, G. Manogaran, M. Mohamed, E. J. C. Rushdy, C. Practice, and Experience, "Internet of things in smart education environment: Supportive framework in the decision-making process," vol. 31, no. 10, p. e4515, 2019. https://doi.org/10.1002/cpe.4515
[27] A. Raman and M. Rathakrishnan, "Blended Learning in Higher Education 4.0: A Brief Review," in *Redesigning Higher Education Initiatives for Industry 4.0*: IGI Global, 2019, pp. 70-84. https://doi.org/10.4018/978-1-5225-7832-1.ch005
[28] R. W. Lancaster, A comparison of student-centered and teacher-centered learning approaches in one alternative learning classroom environment. Arkansas State University, 2017.
[29] H. T. S. ALRikabi, Alaidi, Abdul Hadi M,Abed, Faisal Theyab "Attendance System Design And Implementation Based On Radio Frequency Identification (RFID) And Arduino," *Journal of Advanced Research in Dynamical Control Systems*, vol. SI 10, no. 4, p. 6, 2018.
[30] N. A. Hussien, I. K. Ajlan, M. F. M. Firdhous, and H. T. S. J. I. J. o. I. M. T. Alrikabi, "Smart Shopping System with RFID Technology Based on Internet of Things," vol. 14, no. 04, pp. 17-29, 2020. https://doi.org/10.3991/ijim.v14i04.13511
[31] S. Ko and S. Rossen, *Teaching online: A practical guide*. Taylor & Francis, 2017.

[32] C. L. Chang, "Faculty perceptions and utilization of a learning management system in higher education," Ohio University, 2008.
[33] R. M. Palloff and K. Pratt, *Building learning communities in cyberspace*. San Francisco: Jossey-Bass, 1999.
[34] H. T. Alrikabi, A. H. M. Alaidi, A. S. Abdalrada, and F. T. J. I. J. o. E. T. i. L. Abed, "Analysis the Efficient Energy Prediction for 5G Wireless Communication Technologies," vol. 14, no. 08, pp. 23-37, 2019. https://doi.org/10.3991/ijet.v14i08.10485
[35] W. H.-Y. Huang and D. J. R. R. S. B. E. i. A. Soman, Rotman School of Management, University of Toronto, "Gamification of education," 2013.
[36] J. H. Stronge, *Qualities of effective teachers*. ASCD, 2018.
[37] T. H. J. J. o. E. T. Spotts and Society, "Discriminating factors in faculty use of instructional technology in higher education," vol. 2, no. 4, pp. 92-99, 1999.
[38] Y. Zhao, K. Pugh, S. Sheldon, and J. L. J. T. c. r. Byers, "Conditions for classroom technology innovations," vol. 104, no. 3, pp. 482-515, 2002.

11 Authors

Abdul Hadi M. Alaidi is presently one of the faculty college of Electrical Engineering Department, College of Engineering, Wasit University Wasit,Iraq. He received his B.Sc. degree in computer Science from Al Mustansiriya University in Baghdad, in 2007. His M.Sc. degree (2014) in Computer Science and Engineering from University of Bridgeport, CT, USA. He interested in research areas such as Remote-Control systems and the applications of IOT, signal processing, Digital Communications systems, Embedded systems. Contact: -+964 7724903292. The number of articles in national databases – .4 The number of articles in international databases – 4. E-mail: - alaidi@uowasit.edu.iq

Omar Hashim Yahya is presently one of the faculty college of the computer technology engineering department in the technical College of Mosul, Northern technical University, Mosul, Iraq. Also he is the Director of the Career development Center in The Northern Technical University. He received his B.Sc. degree in computer technology Engineering in 2006 from the technical College of Mosul, Mosul, iraq. his M.Sc. degree (2014) in Computer Science and Engineering from University of Bridgeport, CT, USA. He interested in research areas such as Remote Control systems and the applications of IOT, signal processing, Digital Communications systems, Embedded systems. Northern Technical University, Mosul, Iraq. Contact: -+964 7722118786. The number of articles in national databases – 1. The number of articles in international databases – 3. E-mail: - omer_h_yahya@ntu.edu.iq.

Haider Th. Salim ALRikabi is presently one of the faculty College of Engineering, Electrical EngineeringDepartment, Wasit University in Al Kut, Wasit, Iraq. He received his B.Sc. degree in Electrical Engineering in 2006 from the Al Mustansiriya University in Baghdad, Iraq. His M.Sc. degree in Electrical Engineering focusing on Communications Systems from California state university/Fullerton, USA in 2014. His current research interestsinclude Communications systems with mobile generation, Control systems, intelligent technologies, smart cities, and Internet of Things (IoT). Al Kut city – Hay ALRabee, Wasit, Iraq. Contact: - +9647732212637. The

number of articles in national databases – 8. The number of articles in international databases – 10. E-mail: - hdhiyab@uowasit.edu.iq

Article submitted 2019-08-18. Resubmitted 2020-02-09. Final acceptance 2020-02-23. Final version published as submitted by the authors.

DSDV Extension to Enhance the Performance of Ad Hoc Networks in High Diverse-Velocity Environments

https://doi.org/10.3991/ijim.v14i06.11889

Mada' Abdel Jawad, Saeed Salah (✉), Raid Zaghal
Al-Quds University, Jerusalem, Palestine
sasalah@staff.alquds.edu

Abstract—Mobile Ad-Hoc Networks (MANETs) are characterized as decentralized control networks. The mobile nodes route and forward data based on their routing information without the need for routing devices. In this type of networks, nodes move in an unstructured environment where some nodes are still fixed, others are moving in a constant velocity, and others move with diverse velocities; and thus, they need special protocols to keep track of network changes and velocity changes among the nodes. Destination Sequenced Distance-Vector (DSDV) routing protocol is one of the most popular proactive routing protocols for wireless networks. This protocol has a good performance in general, but with high speed nodes and congested networks its performance degrades quickly.

In this paper we propose an extension to the DSDV (we call it Diverse-Velocity DSDV) to address this problem. The main idea is to modify the protocol to include node speed, determine update intervals and the duration of settling time. To evaluate the performance of the new protocol, we have carried a number of simulation scenarios using the Network Simulator tool (NS-3) and measured relevant parameters such as: packet delivery ratio, throughput, end-to-end delay, and routing overhead. We have compared our results with the original DSDV and some of its new variants. The new protocol has demonstrated a noticeable improvement of performance in all scenarios, and the measured performance metrics outperform the others except the average delay where the performance of the new protocol was modest.

Keywords—MANET, DSDV, I-DSDV; E-DSDV, O-DSDV, Simulation Network Performance, NS3;

1 Introduction

Mobile Ad-hoc Networks (MANETs) are special types of Wireless Sensor Networks (WSNs) where the nodes (computers, laptops, smart phones, etc.) are connected without a predetermined infrastructure. The topology and routing information keep changing frequently. This means that there is no need to use dedicated routers or access points to connect any two nodes; a node can act as a router to forward traffic to other nodes. All nodes are working collaboratively in a distributed fashion to keep the network alive. Normally, nodes belonging to this type of network have a small

memory and limited battery capacity. Furthermore, links between nodes are wireless making them subjected to path disconnections and frequent packet losses. The mobility nature of the nodes makes it difficult to build routing information in a coherent way. MANETs are currently being deployed in many disciplines. For example, in the military arena they can be used to exchange information between the vehicles, soldiers and headquarters. On a more personal level, MANETs can simplify the interconnection between lightweight devices such as laptops, smartphones, and tablets. They can also be helpful in disaster situations when the network infrastructure is subjected to sudden and catastrophic damages that might affect the stability and lifetime of the network. MANETs face several challenges such as: transmission range is very limited; security issues due to the wireless environments; the power and processing resources are very limited. Furthermore, the mobility nature of a MANET makes its topology highly dynamic which leads to an increase the packets' loss and route changes.

Many networking protocols were proposed to deal with these challenges. Routing protocols are special algorithms and mechanisms used by wireless devices to find the best path (route) for forwarding data between two (or more) nodes. Many of them were proposed in the literature, and enhanced versions continue to appear. Efficient routing protocols usually try to optimize several performance metrics such as: control overhead, bandwidth consumption), throughput, end-to-end delay, security, fault tolerance and energy efficiency. The proposed routing protocols usually focus on some of these performance aspects and ignore the others based on their target applications and usage purposes. There are different classifications for routing protocols suggested by the research community; one of these main classifications is the work done by [3]. In this work, the authors classified existing routing protocols into three many categories:

1. The proactive or table-driven routing protocols
2. The reactive or on-demand routing protocols
3. The hybrid protocols which merge concepts from both the proactive and reactive methods

In the proactive routing method, every node maintains one or more routing tables, these tables contain routing information about all the nodes within the network. These protocols update the table(s) periodically which might lead to increasing network overhead, bandwidth and power consumptions, but it minimizes the end-to-end delay and keeps the routing information up to date. Examples of such category of protocols are Optimized Link State Routing Protocol (OLSR) [17], Destination Sequenced Distance Vector (DSDV [4], and Wireless Routing Protocol (WRP) [19]. In the reactive routing method, the node's routing information will not be maintained frequently or periodically. If a node needs to communicate with another node, it will first send a request (broadcast) to the whole network, every node will pass the request until it reaches the destination node. Next, the destination node will reply using the same path which was used for the request message. In this case, the source node will not have the routing information until it receives the reply message. This process increases the end-to-end delay, but it saves both thee bandwidth and power consumption. Examples

of this category are: AODV Ad Hoc On-demand Distance Vector (AODV) [5] and DSR Dynamic Source Routing (DSR) [7], among others.

Finally, the hybrid routing protocols were built to use concepts from methods to get the maximum performance. These protocols will maintain a routing table for nodes within some ranges and will send routing requests for the nodes located outside this specified range. Examples of this routing method are: ZRP Zone Routing Protocol (ZRP) [29] and Order One Routing Protocol (TORA) [26], among others. We implemented several simulation scenarios using NS3 simulator and compared the results of the new protocol protocols with four other routing protocols which have provided an improvement to the DSDV protocol and relevant to our protocol. The names of these protocols are: DSDV, I-DSDV, E-DSDV and the Optimized DSDV routing protocols (O-DSDV). The comparative study was done based on four performance metrics: packets delivery ratio, throughput, End-to-End delay and routing overheard.

2 Related Work

In this section, we present a brief description of several protocols that have been proposed by the research community, and mainly we focus on the DSDV and its variants since these are relevant to the work suggested in this paper. They are: the generic DSDV, I-DSDV, E-DSDV and the Optimized DSDV. In the following subsections we give a brief overview of these protocols.

2.1 Destination sequenced distance vector

DSDV routing protocol [4] is an Ad-Hoc network proactive loop free distance routing protocol. In this protocol, the nodes periodically broadcast packets with routing information about themselves. These packets contain fields such as: destination, hop-count, and sequence number, among others. The neighbors receive these messages and update their routing tables accordingly. In this case, the updates will be added to the routing table in certain situations, e.g., when there is no routing information about the destination in the routing table, or the updated message has a higher sequence number, or it has the same sequence number but with a shorter path (smaller hop count). New updates in the routing table will be immediately broadcasted after increasing the metric parameter in the records by one. The routing information in the routing table will periodically be rebroadcasted as well. Fig 1 illustrates the broadcasting mechanism used by this protocol.

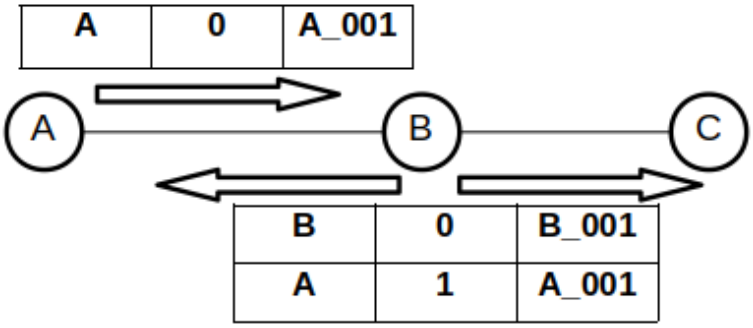


Fig. 1. An example of a routing message exchange used by the DSDV routing protocol

The DSDV routing table mainly contains the following fields:

- **Next hop:** It mainly represents the first node (the closest node's neighbor) to be visited to reach the destination.
- **Metric:** It is a measured value that represents the number of nodes which the data packet will visit before reaching the destination.
- **Sequence number:** It is a sequential number to distinguish old updates from new ones.
- **Settling time:** This metric represents the time that a node will wait before broadcasting the incoming updates (any update for the record will reset the timer).
- **Hold down time:** It is the time that a node will wait before considering the record is expired (i.e., broken connection).

2.2 Efficient DSDV routing protocol E-DSDV

E-DSDV [11] was presented as an extension to the DSDV. The main purpose of this protocol is to reduce network congestion. DSDV routing protocol is designed to choose the shortest path to reach any node within the network, but this principle does not apply to the E-DSDV protocol, which was mainly proposed to deliver routing data updates as quickly as possible, even if this is done by choosing non-optimal paths. The purpose of this mechanism is to avoid network bottlenecks by eliminating settling time that was used in the DSDV protocol to reduce oscillation and replacing it with a new mechanism. The nodes in this protocol always consider the updates only when they have higher sequence numbers. In case a node receives a route advertisement message with higher sequence number, it will advertise the message immediately. The node will discard the new route advertisement messages having the same sequence number or smaller hop-count.

This protocol does not give importance to the length of the path; yet is concentrates on paths that do not contain network congestion. The use of this protocol increases the end-to-end delay; i.e., passing data over longer paths increases the time required to move from source to destination. Improved DSDV Routing Protocol (I-DSDV) I-

DSDV [22] improves the packets' delivery ratio of the DSDV in high mobility scenarios. A new field was added to the DSDV routing message. In some cases, routing tables contain broken links and these links are usually fixed when the data updates arrive from the source. This process takes time to be able to reuse the path. I-DSDV proposed a new approach to repair broken links without having to wait for the source. The new message has four fields: destination, type, hop-count and sequence number. Nodes with stale routes will send a routing message and will set the message type as INVALID. The neighbors of the sender will deal with this message as a route request. If these neighbors have a VALID route information with a better or an equal sequence number and smaller or equal hop-count, they will broadcast the VALID routing information. On the other hand, if the neighbors do not have a valid routing information, they will rebroadcast the received INVALID routing message in case they need this route. Otherwise, they will remove the route from their table only.

The repairing process of broken links in this protocol requires an effective link with the same length as the broken link or less. The existence of this condition reduced the possibility of using the available paths only because it is longer. In our point of view, it is better to use any available path – even if it is a bit longer than the optimal path – as a temporary solution until the next updates arrive.

2.3 Optimized DSDV routing protocol

O-DSDV [28] is a modified version of the DSDV, which was mainly presented as a new approach to reduce end-to-end delay, increase throughput, and maximize packet delivery ratio in VANETS' applications. The authors analyzed the performance of the DSDV protocol and noticed that its performance is low, especially in high-traffic environments, and thus they made several modifications to suit these conditions; The O-DSDV suggests two modes, high velocity mode and low velocity mode. While the protocol will act like the original DSDV in low velocity modes, it reduces its update interval and sets its settling time equal to zero for the incoming updates in high velocity scenarios. When the speed of the node exceeds 25 m/s, the protocol gradually reduces the update period until the speed reaches 40 m/s. The update period is settled at a predefined low value. For settling time, it has two values one for high speeds and the other for low speeds. In this way, the received updates will be sent immediately, and the interval between nodes' updates will be shorter in high mobility environments.

This approach enhanced the DSDV performance, but it does not behave well in highly diverse velocity environments. The neighbors of the high-speed node will not be informed about this node's speed, and consequently, they will deal with the updates from such nodes as any other node. This will lead to delays when the updates advertise the high-speed nodes. Processing updates coming from high-speed nodes quickly is necessary because such updates lose their value quickly.

3 Proposed DSDV Extension

This section describes the new settings and changes that we have made on the DSDV protocol. We also include a discussion on the justification of making these modifications, our methodology to implement them and the assumptions that we have considered.

3.1 Assumptions

We assume that all nodes in the network are using this new protocol and are equipped with location and velocity determination devices like Global Positioning System (GPS). As the information received from these devices will be used for controlling several parameters in the DSDV such as periodic update time, hold-down time, and settling time.

3.2 Methodology

As previously mentioned, several techniques have been proposed to enhance DSDV's stability. However, these mechanisms sometimes actually degraded the performance of the protocol, especially in the highly-diverse velocity environments. Therefore, in this work, we suggest a new approach that is specially designed to increase the performance the DSDV algorithm in the high mobility environments. We followed the scientific methodology in which we propose the theoretical part first, and then validate it using simulations. Our methodology consists of five procedures:

- The nodes that receive routing information updates about their neighbors within the scope or two hops away, should advertise the received updates immediately without any delay.
- High speed nodes should gradually reduce the update intervals and settling time according to the speed.
- High speed nodes should inform other nodes about their speed mode to help them calculate "Settling" and "Hold Down" times.
- The nodes that detect a broken connection should try to recover it by sending a route request to the neighbors only.
- The nodes will prefer the routes through the lowest velocity nodes when they receive several route suggestions to a specific destination with the same hops-count.

In the DSDV internal operation, the goal of the "settling time" is to ensure that the node has the shortest path to every other node in the network. We found that the "settling time" should not be applied to all types of routes. For example, as illustrated in Fig 2, when node (A) receives a routing information about one of its neighbors, it will wait for the specified "settling time" before rebroadcasting it to the other neighbors. Although node (A) will wait for the specified "settling time", it will not get a shorter path to these neighbors because it has the best path already. The shortest path in this

case is only between the node and itself. This is how we applied the first step in our methodology.

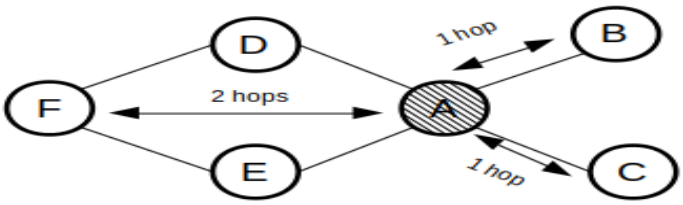


Fig. 2. Applying settling time to one-hop or two-hops neighbors will not guarantee a shorter route.

The second and third steps in our methodology will affect nodes with high velocity. The update period in the DSDV is fixed, and in most applications its value is fixed to 15 seconds. This time is considered very long in high diverse velocity situations. For example, Fig 3 illustrates a scenario where node M is moving in high velocity and the other nodes are either stationary or moving very slowly. An intermittent line represents M's signal range. At some points, node M will send its update to all nodes through its neighbors (E and F, in this case), then it will leave the area and its neighbors will change few seconds later. The nodes in the network will lose the route to node M quickly, and node M will have to resend a new update after the update period expires. In our approach, we will take care of this problem by:

1. Forcing the update time to be variable
2. By making it proportional to the node's velocity. The position of a high velocity node changes rapidly, and thus it sends its updates more frequently to its new neighbors, and remain connected with the rest of the network.

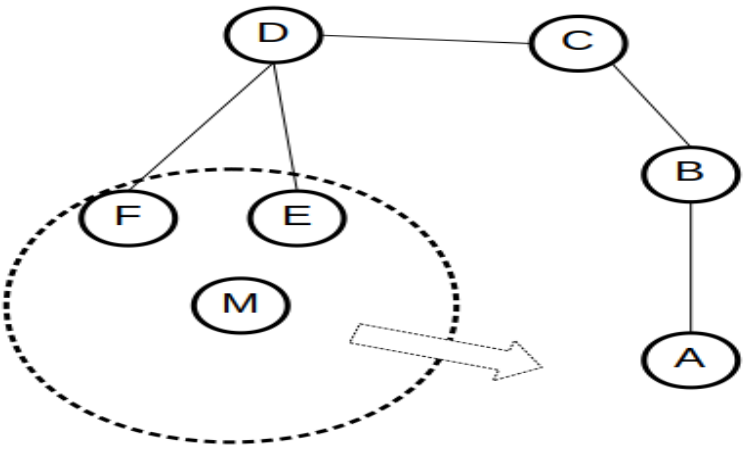


Fig. 3. Example of high mobility scenario.

To consider the node's velocity in the DSDV calculations, we have modified the update time by including another parameter, i.e., the speed of the node. The new suggested formula of the update time is as follows:

$$Updatetime = T_d - \frac{V_n}{V_{max}} \times (T_d - T_{min}) \tag{1}$$

where:

- Td represents the default update time.
- Vn represents the actual node velocity.
- Vmax is the maximum node velocity.
- Tmin is the least update time period.

In case the node's velocity is very low, or if the node is stationary, then Vn = 0, and this means that the value of the update time equals Td which is the default value in this case. Furthermore, when the velocity of the node is increased, the value of the update time will be decreased accordingly. To keep the update time above zero the lower limit to the Tmin value has been added.

Back to Fig 3, when nodes E and F receive routing information update about node M, they will wait for the expiry of the "settling time" before resending this update to the other nodes. For every node which receives this update, it will apply the same policy which will lead to a considerable delay of these updates by the remote nodes. This type of delay can significantly affect the performance of DSDV protocol, especially when nodes move in high velocity. In Fig 4, the routing information of node M will reach node A after node M leaves the area, and its neighbor nodes are changed. Thus, we suggest that every node should inform every other node about its velocity. The nodes that receive the routing updates should set their own "settling" and "hold down" times based on the velocity of the source node. We suggest the following formula to calculate the adjusted "settling time":

$$SettlingTime = T_s - \frac{V_s \times T_s}{V_{max}} \tag{2}$$

where:

- Ts represents the default settling time
- Vs represents the velocity of the sender.
- Vmax is the maximum velocity.

The above equation (Eq. 2) estimates the settling time as inversely proportional to the velocity of the source node. In this way, we can improve the availability of the routing information about high velocity nodes through the network for a shorter time. Furthermore, the velocity of the source nodes can be used for tuning the hold down time interval. We note that the routing information about the fast points will expire

early. The following equation is suggested to set the holding down timer for the received routing records:

$$HoldsTime = \frac{T_d \times V_n}{V_{max}} \times (\alpha - \gamma) \tag{3}$$

Where γ is the minimum limit and α is a constant value which has the default value of 3.

We can also use the added node's velocity to optimally select the most stable paths. For example, as illustrated in Fig 5, node A has two paths to node D, and the two paths have the same hop-count. In this case, node A will use only one path to send data to node D. When node A receives routing information about node D through node C first, it will use this path to send data to node D. In this case, we argue that this node (which has two paths to the same destination and they both have the same hop-count) will select the neighbor with the slower velocity since it has more updated and correct entries.

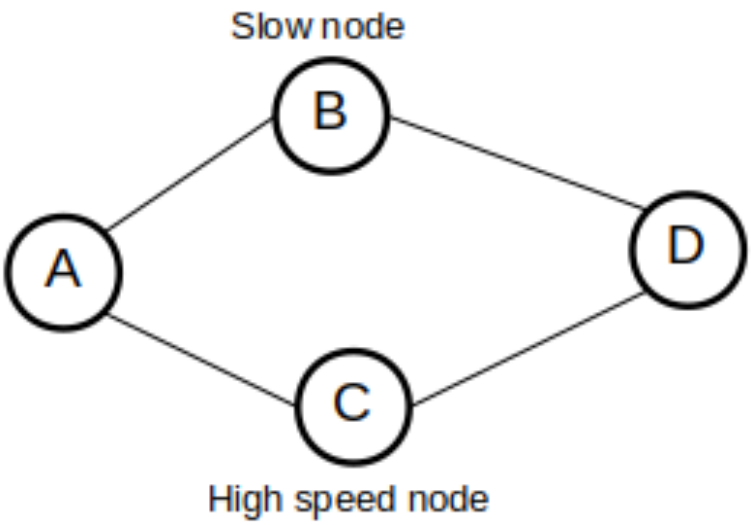


Fig. 4. An example of selecting a stable path among several ones.

The last enhancement to be considered in this study is the ability to recover the broken connections. When a connection between two nodes is broken, this connection will not be recovered until receiving a new routing information, even though it is possible to recover this connection in a shorter time. For example, as illustrated in Fig 5 the connection between nodes A and D is broken because of node's A movement, node A has two other paths to node D, but it will not know about these paths until node D sends its next periodic update. To overcome this situation, we suggest a new mechanism to send a recovery request to other neighbors to keep the link between the two nodes alive if possible. Thus, in Fig 6 node A will send requests to both nodes B

and C. In case node B or C has a connection to node D it will reply to the request otherwise it will do nothing.

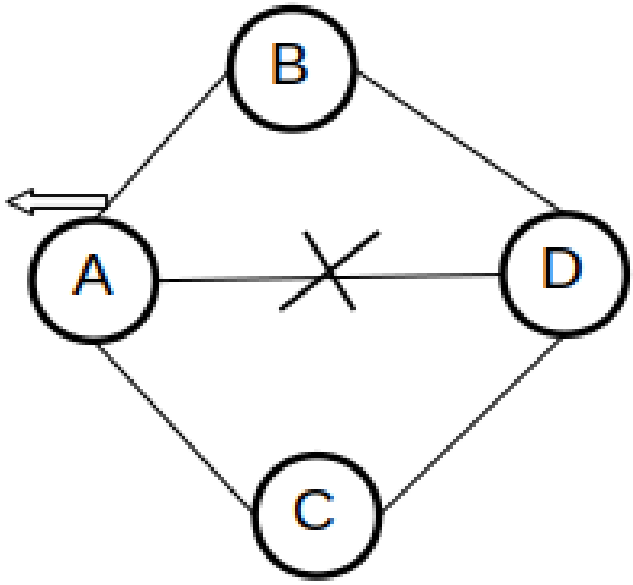


Fig. 5. An example of recovering a broken connection.

To consider all these modifications, we have modified the generic DSDV message header format by including two new parameters: node speed and message type. The node's speed parameter will register the node's current velocity, and the message type parameter which will identify the message type (normal update or recover connection request). Both parameters will be added by the source node in every message update.

It is worth noting (as illustrated in Fig 6) that the size of the header remains constant. After studying the generic DSDV header, we found that 4 Bytes (32 bits) have been allocated to the hop-count parameter which is considered extremely big when compared to the hop-count size of other routing protocols like the OLSR and AODV, where the hop-count size is 1 Byte in both of them. Therefore, we found a good opportunity to re-use half of the space allocated to the hop-count parameter in DSDV (16 bits) to serve us to achieve the goals of this work. In the new modification, we argue that 16 bits, which can represent more than 65000 hops should be more than enough for the hop-count counter. We use the remaining 16 bits to store the new parameters (speed and type) and thus we can expand the functionality and add new features without increasing the header size. The new header layout is shown in Fig 6.

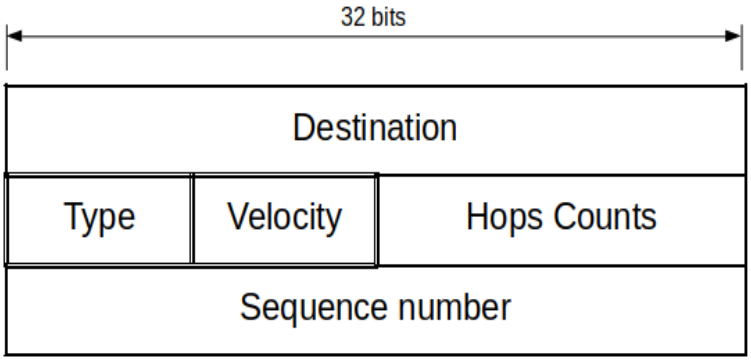


Fig. 6. The new proposed structure of the DSDV header.

As shown in Fig 6, the size of the new update message is still the same (12 Bytes) with two new parameters: type and speed. The type parameter can have two states: UPDATE or REQUEST. The same message will be used for sending updates or sending a route request. The second parameter (speed) will be used to inform other nodes about the current speed of the source node.

4 Performance Evaluation

In this section, we provide a description of the quantitative metrics that will be used to evaluate the performance of the new modifications. We mainly use the following four metrics:

- Packet Delivery Ratio (PDR): It is defined as the ratio of data packets delivered to the destinations to those generated by the Constant Bit Rate (CBR) sources.
- Throughput: It is the total number of bits that are successfully delivered to the destination in a given time period.
- End-to-End Delay: It is defined as the average time delay for data packets to reach from the source node to the destination node. This includes all possible delays that were caused by buffering, interface queuing and data retransmission.
- Normalized Routing Overhead: It is defined as the total number/size of routing packets transmitted per data packets.

We evaluated the extended version based on the Network Simulator tool (NS3) which is extensively used by the research community to evaluate routing protocols and their variants. NS3 is an enhanced version of NS2; It is an open source software and a discrete-event network simulator. It is implemented using C++ and its scripts also can be implemented using C++. It has also better performance and enhanced memory management when compared to NS2. The simulator also includes many tracing models which makes it easy to measure the modified protocol's performance.

5 Simulation Results

We have built three different simulation scenarios to measure the performance of the modified version of the DSDV protocol and compare the results with four routing protocols considered in this study. The first scenario was built to measure the performance in diverse load environments. We repeated every experiment twelve times using different number of nodes. The second scenario was built to measure the performance in diverse velocity environments where every node has a different speed. The scenario was repeated multiple times with different pause time. The last scenario was carried out to compare the performance among the routing protocols based on different speed environments. All the nodes in this scenario have the same speed. The experiment was repeated several times with a new speed value for all nodes in each iteration. The simulation area in the three scenarios is fixed to 750m x 750m. The transmission range of each node is set to 250m. The duration of each scenario is fixed to 100s. Nodes mobility was based on random waypoint model. Table 1 summarizes these parameters along with their values.

Table 1. Simulation Parameters and their values.

Parameter	Value
Area	750mx750m
Transmission range	250m
Duration	100s
Traffic sources	CBR (512 bytes)
Mobility Model	Random waypoint
Transport protocol	UDP

The results of our study were split into three scenarios as follows:

5.1 Dense vs. Sparse mobile ad hoc networks

In this scenario, the number of nodes varied from 10 to 60 with an increment of 10 nodes per each experiment run. The pause time is initially set to zero and node's speed is fixed at 30 m/s). The rest of the parameters remained unchanged and given values as described in Table 1. The simulation results of this experiment are shown in Fig 7 where Part (a) illustrates the effect of increasing the number of nodes on the Packet Delivery Ratio (PDR); Part (b) shows the effect of increasing the number of nodes on the network Throughput; Part (c) displays the relationship between increasing number of nodes and the average End- to-End delay; And finally, part (d) presents the relationship between increasing the number of nodes and the routing overhead.

Based on Fig 7 we conclude the following findings:

1. The new DSDV version has the same behavior as the other protocols, but it showed a noticeable improvement in terms of PDR

2. The overall performance of the new modification is better in sparse networks compared to dense networks, whereas the difference in packets delivery ratio was about 10% when the number of nodes number was fixed to 30
3. In terms of throughput, the new protocol outperforms the others in all cases, but the results were close to the others when there are very few or very high number of nodes
4. The average End-to-End delay in the new protocol was not improved since the average delay was close to other protocols, but when the number of nodes was increased, the average delay was also increased significantly compared to the others
5. The routing overhead analysis showed that the new protocol outperforms the others except for the protocol E-DSDV which showed a low level of routing overload.

In summary, the performance of all the protocols was better in the sparse networks than in the dense ones. The new protocol also showed a remarkable improvement in all the performance metrics except for the average delay which was close to the other protocols.

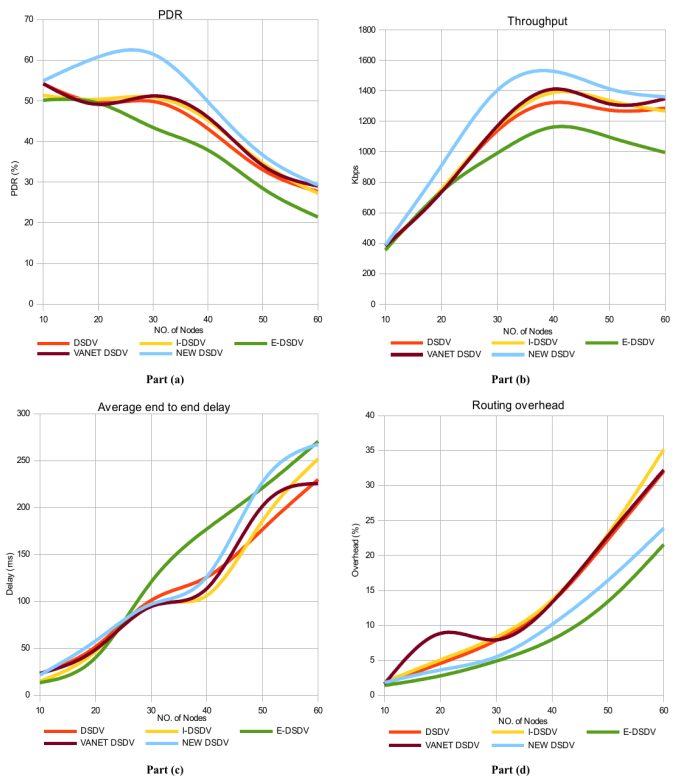


Fig. 7. Performance comparative charts, Part (a) Packet delivery ratio vs. number of nodes, Part (b) Throughput vs. number of nodes, Part(c) End to end delay vs. number of nodes, and Part (d) Routing overhead vs. number of nodes.

5.2 Continuous vs. Discrete mobility mobile ad hoc networks

In this scenario the pause time was varied from 0 to 100 seconds with an increment of 20 seconds by each run. All the nodes in this scenario are moving in a fixed speed (30 m/s). The nodes stop moving at several random locations for the specified pause time. When the pause time is set to zero, the nodes move without stopping. This scenario has a duration of 100s, which means that when the pause time was set to 100s, the nodes will stay in fixed places. The rest of the parameters are unchanged. The results are shown in Fig 8, where Part (a) illustrates the effect of increasing pause time on the (PDR); Part (b) shows the effect of increasing pause time on the network Throughput; Part (c) displays the relationship between increasing pause time and the average End-to-End delay; And finally, part (d) presents the relationship between increasing pause and the routing overhead.

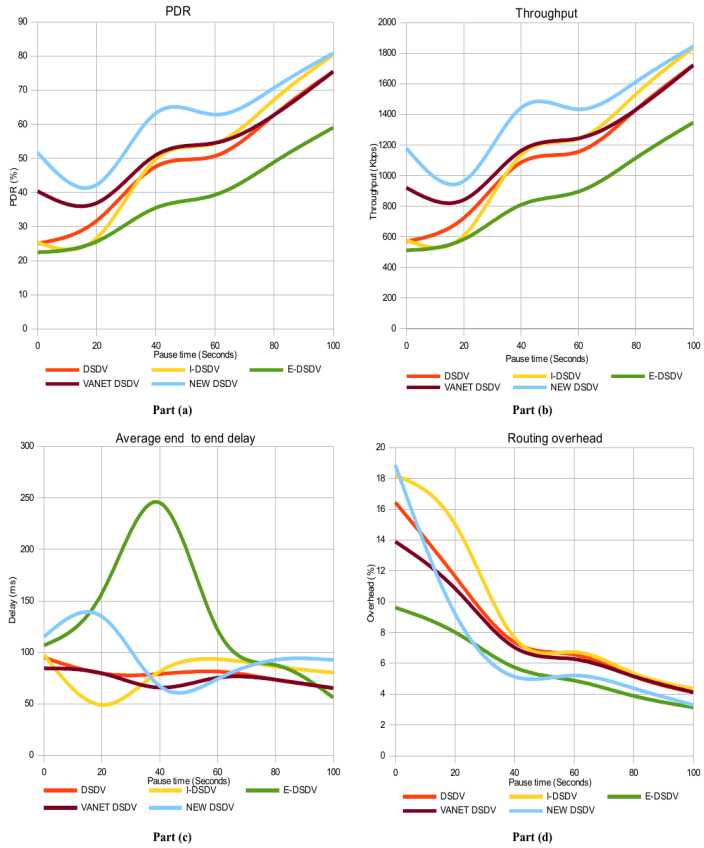


Fig. 8. Performance comparative charts, Part (a) Packet delivery ratio vs. pause time, Part (b) Throughput vs. pause time, Part(c) End to end delay vs. pause time, & Part (d) Routing overhead vs. pause time.

In this scenario, the nodes move in a continuous movement intercepted with random stops. Their duration is shown in the graph. Increased paused time intervals means greater stability of data transmission paths, which improves the performance of the routing protocols. Furthermore, the performance of all the protocols is improved with increasing the pause time's period. The charts also show an increasing in the PDR, especially in the new modified version, where performance outperforms the others in all stages. The same applies to throughput as its value is directly proportional to the pause time interval, but it is noted that the performance of the protocol I-DSDV is approaching the performance of the new protocol with the increase of the pause time interval.

For the average End-to-End delay, it was almost constant regardless of using various paused time intervals for all protocols except for the E-DSDV protocol. For the new modified version, a high average delay was observed when the stopping periods were short. The performance is similar to the other protocols after increasing pause time interval. Routing overload is inversely proportional with increasing pause time, because data the lifetime of transmission paths become longer. Therefore, the routing overhead has decreased for all protocols with increasing the pause time interval. The new protocol showed a considerable improvement with increased pause time and was better than the others.

5.3 Low vs. High Mobility Networks

In this scenario the speed of nodes varied from 5 to 30 with an increment of 5 m/s. The scenario has 30 nodes in all cases. The pause time is zero for all nodes. The rest of the parameters are described in the Table 1. After applying this scenario, we got the results shown in Fig 9. The same analysis is also applied here, but in this case, we study the effect of varying node's velocity on the four measured parameters.

As in the previous scenarios, the new protocol showed a significant improvement in the PDR compared to the others, and this enhancement clearly appears as the node's speed gets higher. It is also noted from Fig 9 that the performance of the protocols in general was less than the new modified version when the movement included different pause time periods. For the delay rate, all protocols showed a noticeable increase, especially in continuous movement environments. The new protocol showed a higher average delay compared to the others. This can be explained by the fact that the new protocol fixes the broken links with other nodes even if they present longer paths, which increases the required data arrival time. For the routing overhead, it increased for all protocols. The new protocol showed better performance than the others except for E-DSDV protocol.

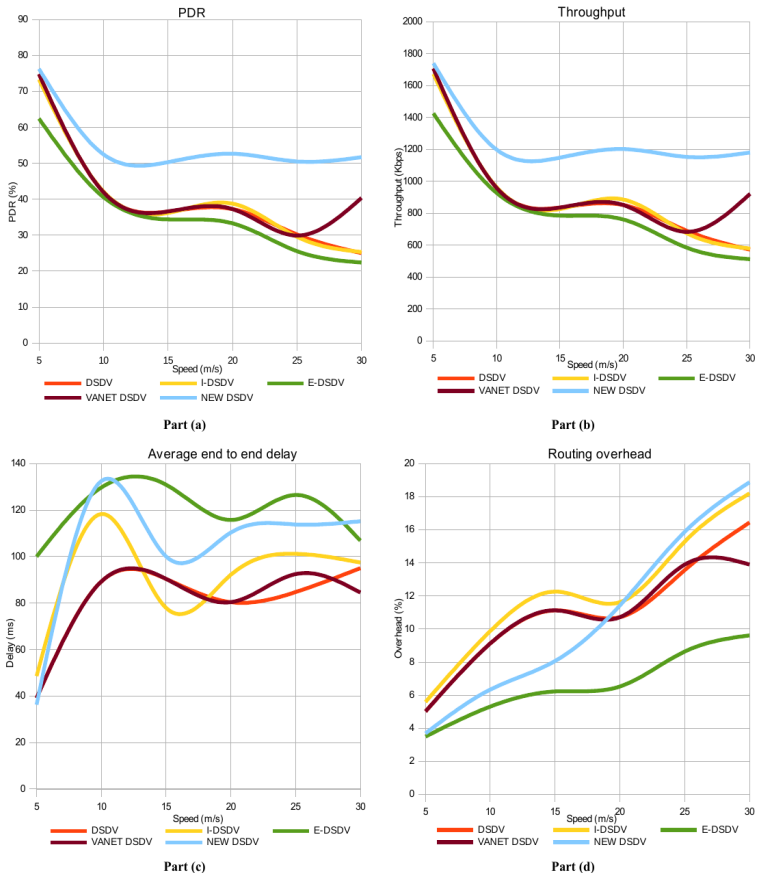


Fig. 9. Performance comparative charts, Part (a) Packet delivery ratio vs. speed, Part (b) Throughput vs. speed, Part(c) End to end delay vs. speed, Part (d) Routing overhead vs. speed.

6 Conclusion and Future Work

ODSDV protocol is one of the most popular routing protocols in Ad hoc networks. It is extensively used by the research community with many variants proposed in the past and still appearing. In this paper, we propose a novel extend version of this protocol by modifying the messages header formats and its internal operations. One of these modifications is to add two new parameters to the message header, namely: node speed and message type; these two parameters had enabled us to fine-tune the measured update and settling time intervals which are considered crucial to the internal operations of this protocol. To study the effect of these modifications, we have implemented several scenarios: using variable number of nodes (Dense vs. Sparse network), using different pause time intervals (Continuous vs. Discrete Mobility Pat-

terns), and finally, testing the protocols using different values of nodes' speeds (Low vs. High Mobility Networks).

The simulation results had shown that the new protocol can provide significant improvements in all scenarios. In terms of packet delivery ratio, the new protocol was the best in all cases. The new protocol outperforms the others regarding the throughput. However, it did not show any improvement in the average End-to-End delay due to the broken link repair mechanisms. Nevertheless, we think this issue is already compensated by the fact that the protocol can fix broken links (even with non-optimal paths) to keep the nodes connected and we believe this is a good compromise. Finally, as all proactive routing protocols considered in this study have demonstrated high routing overhead relative to the actual data that was transmitted, our protocol has actually reduced the overhead compared to these protocols.

As a future work, we intend to expand the proposed protocol by adding the node's coordinates and its direction of movement. Obviously, this will increase the header size and thus increase the overhead of routing updates, but we believe that having this new information at hand will enable each node to take smarter decisions which can impact other performance metrics.

7 Acknowledgement

The authors would like to express their highest gratitude to AL-Quds University for the funding of this research.

8 References

[1] Abd Rahman, A., Ahmad Zukarnain, Z. (2009). Performance Comparison of AODV, DSDV and I-DSDV Routing Protocols in Mobile Ad Hoc Networks. European Journal of Scientific Research. 31(4), 566-576. https://doi.org/10.31142/ijtsrd158

[2] Kumar, A., Yadav S., Maurya, K. (2013). An Overview of Mobile Ad-Hoc Networks: Architecture, Routing and Challenges. International Journal for Advance Research in Engineering and Technology. 1 (1), 47-51.

[3] Maqbool, B., Peer, M. (2010) Classification of Current Routing Protocols for Ad Hoc Networks - A Review. International Journal of Computer Applications, 7(8).

[4] Perkins, C., Bhagwat, P. (1994). Highly dynamic Destination sequenced distance vector routing (DSDV) for mobile computers. Proceeding of ACM SIGCOMM. 234-244. https://doi.org/10.1145/190809.190336

[5] Perkins, C., Belding-Royer, E., Das., S. (2003). Ad hoc On-Demand Distance Vector (AODV) Routing. IETF. RFC 3561. https://doi.org/10.17487/rfc3561

[6] Bhatia, D., Sharma, D. (2016). A Comparative Analysis of Proactive, Reactive and Hybrid Routing Protocols over open Source Network Simulator in Mobile Ad Hoc Network. International Journal of Applied Engineering Research. 11(6), 3885-3896.

[7] Johnson, D., Maltz, D. (1996). Dynamic Source Routing in Ad Hoc Wireless Networks. Mobile Computing Journal. 5, 153–181. https://doi.org/10.1007/978-0-585-29603-6_5

[8] Ahmeda, G., Barskarb, R., Barskarc, N. (2012). An Improved DSDV Routing Protocol for Wireless Ad Hoc Networks. International Conference on Communication, Computing & Security (ICCCS-2012). 6, 822 – 831. https://doi.org/10.1016/j.protcy.2012.10.100

[9] Agarkhed, J. (2017). A Survey on DSDV Routing Protocol in Ad hoc Network. International Journal of Emerging Trends & Technology in Computer Science. 6(5), 114-117.

[10] Loo, J., Mauri, J., Ortiz, J. (2012) Mobile Ad Hoc Networks Current Status and Future Trends. CRC Press. https://doi.org/10.1201/b11447

[11] Khan, K., Reddy, A., Zaman, R. (2008). An Efficient DSDV Routing Protocol for Wireless Mobile Ad Hoc Networks and its Performance Comparison. IEEE. 506-511. https://doi.org/10.1109/ems.2008.11

[12] Khan, K., Zaman, R., and Reddy, A. (2009) The Performance of the Extended DSDV (eDSDV) MANET Routing Protocol and its Suitability in Integrated Internet-MANET. International Journal of Simulation Systems, Science & Technology. 10(2), 38-46.

[13] Gorantala, K. (2006). Routing Protocols in Mobile Ad-hoc Networks. MSc. Dissertation, Dept. Of Computer Science, Umeå University, SE-901 87 UMEÅ SWEDEN.

[14] Naseem, M., Kumar, C. (2013). EDSDV: Efficient DSDV Routing Protocol for MANET. International Conference on Computational Intelligence and Computing Research, IEEE. 1-4. https://doi.org/10.1109/iccic.2013.6724265

[15] Elias, M., Campista, M., Rubinstein G. (2014). Advanced Routing Protocols for Wireless Networks. ISTE Ltd and John Wiley. https://doi.org/10.1002/9781118984949.ch6

[16] Gulati, M., Kumar, K. (2014). Performance Comparison of Mobile Ad hoc Network Routing Protocols. International Journal of Computer Networks & Communications. 6(2). https://doi.org/10.5121/ijcnc.2014.6211

[17] Jacquet, P., Muhlethaler, P., Clausen, T., Laouiti, A., Qayyum, A., Viennot, L. (2001). Optimized link state routing protocol for ad hoc networks. in Proceedings of the 5th IEEE Multi Topic Conference, INMIC 200I. 62-68. https://doi.org/10.1109/inmic.2001.995315

[18] Rehman, S., Khan, M., Zia, T., Zheng, L. (2013). Vehicular Ad-Hoc Networks (VANETs) - An Overview and Challenges. Journal of Wireless Networking and Communications. 3, 29-38.

[19] Murthy, S., and Garcia-Luna-Aceves, J. (1996). An Efficient Routing Protocol for Wireless Networks. ACM Mobile Networks and App., Special Issue on Routing in Mobile Communication Networks. 183–97. https://doi.org/10.1007/bf01193336

[20] Shelja, S., Suresh, K., K., R. (2011). Study of Route Reconstruction Mechanism in DSDV Based Routing Protocols. International Journal of Computer Engineering Science. 1(2), 34-46.

[21] Ahn, S., Shankar, A. (2001). Adapting to route-demand and mobility in ad hoc network routing. Proceedings Ninth International Conference on Network Protocols, IEEE. 44 – 52. https://doi.org/10.1109/icnp.2001.992759

[22] Liu, T., Liu, K. (2007). Improvements on DSDV in Mobile Ad Hoc Networks. International Conference on Wireless Communications, Networking and Mobile Computing, IEEE. 1637 – 1640. https://doi.org/10.1109/wicom.2007.412

[23] Larsson, T., Hedman, N. (1998). Routing Protocols in Wireless Ad-hoc Networks - A Simulation Study. MSc. Dissertation, Dept. Of Computer Science, Luleå University of Technology, Stockholm, Sweden.

[24] Prasan, U., Murugappan, S. (2016). An Analysis on Vehicular Ad-Hoc Networks: Research Issues, Challenges and Applications. International Journal of Applied Engineering Research. 11(6), 4569-4575.
[25] Lee, U., Midkiff, S. Park, J. (2005). A proactive routing protocol for multi-channel wireless ad-hoc networks (DSDV-MC). International Conference on Information Technology: Coding and Computing (ITCC'05). 2,710 – 715. https://doi.org/10.1109/itcc.2005.26
[26] Park, V., Corson, M. (1997). A highly adaptive distributed routing algorithm for mobile wireless networks INFOCOM '97. Sixteenth Annual Joint Conference of the IEEE Computer and Communications Societies. Driving the Information Revolution, Proceedings IEEE. 3, 405 – 1413. https://doi.org/10.1109/infcom.1997.631180
[27] Kai, W., Yang-yang, G., Jian-feng, G., Ya-juan, Q. (2011). MDSDV: a modified DSDV routing mechanism for wireless mesh networks. The Journal of China Universities of Posts and Telecommunications, Elsevier. 18(2), 34-39. https://doi.org/10.1016/s1005-8885(10)60142-2
[28] Yang, X., Sun, Z., Miao, Y., Kang, N. Yang, Y. (2015). Performance Optimization for DSDV in VANETs. 17th UKSim-AMSS International Conference on Modelling and Simulation (UKSim), IEEE. 514-519. https://doi.org/10.1109/uksim.2015.29
[29] Haas, Z. (1997). A new routing protocol for the reconfigurable wireless networks. Proceedings of ICUPC 97 - 6th International Conference on Universal Personal Communications, San Diego, CA. 2, 562 – 566. https://doi.org/10.1109/icupc.1997.627227

9 Authors

Mada' Abdel Jawad is a vocational teacher in the Computer Workshop at Salfit Industrial School in Palestine. He is currently a Master student in Computer Science at Al-Quds university in Jerusalem. He is working on his Master's Thesis on Routing Protocols in MANETs. He received his B.Sc. in Computer Engineering at Philadelphia University in Jordan. He is also interested in Open Source Software development and Operating Systems.

Saeed Salah is an Assistant Professor at the Department of Computer Science at Al-Quds University in Jerusalem. He received his B.Sc. in Electrical Engineering from Al-Najah National University in Palestine in 2003, his M.Sc. degree in Computer Science from Al-Quds University in 2009, and his Ph.D. from the Department of Signal Theory, Telematics and Communications of the University of Granada, Spain. His research interests are mainly focused on Network Management, Routing Protocols, Information and Network Security, Machine Learning, knowledge-based Systems, and Blockchain. Dr. Salah published many peer-reviewed research papers in recognized international Journals and Conferences. Moreover, he acts as a reviewer for a number of international journals and conferences.

Raid Zaghal is an Assistant Professor at the Department of Computer Science at Al-Quds University in Jerusalem. Dr. Zaghal received his Ph.D. in Computer Science from Kent State University in Ohio, USA in 2005, and his Master in Computer Science from the American University in Washington DC in 1996. Currently he is an Assistant Professor, lecturer and researcher at the Computer Science Dept at Al-Quds

University (since 1996). His research interests are in Network Theories and Protocols' Design, Routing Protocols, MANETs, Cloud-Computing, and Mobile Applications. In the past 13years, he has advised more than 20 Master students on a number of research projects in these fields and published many articles in International Conferences and Journals.

Article submitted 2019-10-17. Resubmitted 2019-12-09. Final acceptance 2019-12-10. Final version published as submitted by the authors.

An Integrated Conceptual Model for m-Government Acceptance in Developing Countries:

The Case Study of Jordan

https://doi.org/10.3991/ijim.v14i06.11449

Dr. Bassam A. Y. Alqaralleh (✉)
Al-Hussein Bin Talal University (AHU), Ma'an, Jordan
alqaralleh@ahu.edu.jo

Dr. Ahmad H. Al-Omari
Northern Border University, Arar, Saudi Arabia

Dr. Malek Zakarya Alksasbeh
Al Hussein Bin Talal University, Ma'an, Jordan

Abstract—Mobile government services have changed how people and businesses can benefit from government public services at any time and from anyplace. The success of these services is becoming more dependent on satisfying the needs and the expectations of both citizens and business organizations. The current study aims to propose a new integrated conceptual model for examining some important key factors that may affect m-Government acceptance in Jordan from user perspective. It also aims to explore the effect of the following factors: trust in mobile technology, trust in government, perceived usefulness, perceived ease of use, compatibility, service quality and user satisfaction on the behavioral intention to use mobile government applications. A survey method was applied through self-administrated questionnaire that were distributed randomly to 500 citizens who have used mobile government services. Empirical tests were conducted to analyze the collected primary data. Results showed that Jordanian citizens intention to use m-Government services increases if they have high level of positive trust toward Internet and the technologies used to access m-Government services. Perceived ease of use and perceived usefulness were the original constructs in Technology Acceptance Model. Failures to reveal the advantages of m-Government services to potential users will most likely result in low rate of satisfaction. Thus, both perceived ease of use and perceived usefulness were found to have a significant effect on citizen satisfaction. Results indicated the appropriateness of the fundamental elements of Technology Acceptance Model in the Jordanian m-Government context. The higher levels of satisfaction lead to more usage and acceptance of modern mobile service.

Keywords—M-Government, e-Government, technology acceptance, success factors, mobile network

1 Introduction

Globally, Information and Communication technology (ICT) is gradually becoming more important part of our daily life. Mobile services has emerged as a result of the significant growth in ICT such as mobile technology (i.e. WAP and Satellite), mobile devices (i.e. smart phones, handheld and laptop computers) along with instant messaging (i.e. SMS and MMS), other Internet services and web applications [1]. These technologies presented many new opportunities for mobilizing the collaboration and interaction between humans, firms and organizations by employing the power of mobile networks to close the connectivity gap between them and provide access to innovative mobile services from anywhere at any time.

Most recently, several researchers highlighted the advantages of the integration of mobile technology and various important fields such as education, government, healthcare, etc. For example, some researchers [2-5] stated that education institutions must follow the fast propagation of mobile technology and incorporate mobile digital devices in their classrooms since mobile devices have been recognized as the new media for the delivery of education materials and the collaboration between the members of the educational community, at various levels of education.

On the other hand, governments worldwide seek for new and advanced technologies to link government to citizens and firms and to facilitate online information sharing. Due to the massive penetration rate of mobile devices among public citizens, these governments moved from electronic government (e-Government) to mobile government (m-Government) to develop the social life in their countries via facilitating the delivery of government public services and information to citizens and firms [6].

A successful m-Government has two key elements. The first is a successful design and implementation. The second is an effective user engagement and acceptance of its services. Developing new mobile services that are not accepted by the users will increase the failure rate for these services and will waste the design and implementation efforts [7]. In order to prevent this waste, the acceptance of new services and technologies should be an important concern of government institutions and the developers of mobile systems worldwide and must be assessed beforehand.

Within the context of Jordan as an example of developing countries, it seems that Jordanian citizens are not fully interested in accepting the increasing amount of new innovations at the service level such as m-Government services. Many research studies [8, 9] argue that in spite of the growing investment of the governments in e-services at different government levels such as national and local levels, the research results revealed evidence of poor citizen adoption of e-government. So do the authors in [10] claimed that the acceptance of m-Government services in Jordan is still in infancy stage in contrast to other mobile applications. Therefore, it is important to highlight the factors that affect Jordanian citizens' acceptance of m-Government services to be able to predict their reaction towards new technologies.

Therefore, this study proposes a theoretical conceptual model for m-Government acceptance to analyze the most influential factors that affect the behavior of Jordanian citizens towards accepting m-Government services. Identifying these factors can help

to develop m-Government applications and avoid the possibility of its failure. The aim of this study is to help us to provide a conceptual model that may suit the Jordanian context and develop a potential efficient strategy to raise the participation of Jordanian citizens as end users of m-government services. A better understanding of these factors is significant for policy making in Jordan. Therefore, it can be argued that although this paper focuses on Jordan, the key findings provided may have important implications for other Arab countries and other developing countries which have similar circumstances as Jordan.

2 Literature Review

M-government is defined as the utilization of mobile technologies, applications and devices in changing government procedures, and enhancing the delivery of government services to the main parties who are involved in m-Government including public citizens and business firms [11, 12]. M-Government can support the mobility of citizens, and provide them with customized, real-time and location-based information and services. Also, it can be considered as another channel to deliver government services to citizens in rural and urban areas and to extend the delivery of government services to those who simply prefer to use mobile devices [13].

Successful design and implementation of m-Government can be considered an important factor for increasing the success rate of m-Government projects. Therefore, it is important to highlight some of the technical challenges and barriers that may affect m-Government development and dissemination efforts in developing countries such as lack of infrastructure, compatibility and security threats [14]. Moreover, the authors in [15] argued that regardless some success, the e-government program in Jordan still face key challenges such as lack of citizens' awareness, limited ICT skills among the government employees, integration problems, financial issues.

2.1 M-Government acceptance in developing countries

Most of the previous studies regarding various issues of m-Government has concentrated on developed countries (i.e. Hong Kong, Germany and Singapore) where m-Government has already become more important for the provision of public government services. On the other hand, m-Government in developing countries is still in its early stage and its actual acceptance rate is still below the expectations due to some important factors such as the government support and the level of ICT infrastructure.

Jordan is a good example of developing countries which have a good opportunity to offer a new era for m-Government adoption since the mobile devices penetration rate was 118.2 per cent in December 2011 [16]. Also, SMS service has become hugely popular recently, particularly with younger generation. In 2008, Jordanian government has started a new SMS gateway project to provide some of its services via mobile phones to improve government-to-citizen communications using SMS services. This project has shown to be effective in reaching people living in rural areas. The Jordanian government has invested a large amount of money in e and m-Government

projects to solve many problems such as the shortages of resources (i.e. human resources). As mentioned earlier, m-Government projects may not succeed if the number of people that are keen to accept its services is not enough even if it is sufficiently funded and well designed. Also, this will increase the risk of wasting the invested human, financial, and technical resources [17]. Factors such as trust, satisfaction, and PEOU, PU, and quality of service are other important related factors that may affect citizen's acceptance of m-Government.

2.2 Previous studies

In order to support the success of innovative services, it is important to observe the important determinants of IT services usage which are essential to illustrate the acceptance of m-Government services. Thus, various Information System (IS) theories/models (i.e. Theory of Reasoned Action (TRA), Technology Acceptance Model (TAM), Diffusion of Innovations (DOI)) have been globally tested, modified and developed over the years. Each of these theories/models was created using different set of constructs in order to predict, understand and explain individuals' behavior towards the acceptance of technology and information systems. There are a plenty of studies in the literature that have used these theories as a theoretical basis for their research models.

In the context of Jordan, Abu-Shanab [18] proposed a conceptual model based on TAM to investigate the factors that may affect the intention to use some m-Government services (i.e. SMS based services). The study has recognized six factors that are closely related to the intention to accept m-Government in Jordan. These factors are Social influence, perceived usefulness (PU), perceived ease of use (PEOU), perceived compatibility, perceived cost and perceived responsiveness. An empirical test was conducted utilizing surveys. The correlations and regression analyses indicated that all factors except for perceived cost of service have significant relationship with the user's intention to use m-Government services. Similarly, Althunibat et al. [19] examined the influence of PU and PEOU which are the main constructs in TAM. Their study stated that these two constructs can influence citizen’s acceptance of m-Government services in Jordan.

In the context of other developing countries, Almuraqab and Jasimuddin [20] have identified ten factors that may influence end-user acceptance of m-Government services in UAE. These factors are social influence, PU, PEOU, awareness, facilitating conditions, perceived cost, perceived trust in government, perceived trust in technology, perceived risk and perceived compatibility. Alotaibi et al. [21] also examined some potential factors that may affect m-Government acceptance in Saudi Arabia. These factors include perceived trustworthiness, enjoyment, user experience, awareness and security. This study found that these factors except enjoyment may have significant effect on m-Government acceptance in Saudi context. Also, Babullah et al. [22] in their study adopted some factors from the UTAUT2 model along with other variables such as perceived risk and innovativeness. The findings stated that these factors can play some role in influencing the participants' behavioural intention to use m-Government in Saudi Arabia.

Based on the former literature revision, it can be argued that it is obvious that TAM is the most influential theory that clarifies user satisfaction and technology acceptance factors due to its predictive power [23, 24]. Paul and John [25] stated that TAM model must be combined with a wider set of variables which are related to both social and human factors to enhance its predictive power. In line with their suggestion, this study has proposed an extended conceptual framework which adopts the key factors of TAM and incorporates the key factors of TRUST model, Diffusion of innovation theory (DOI), service quality and user satisfaction. These factors were carefully chosen according to the previous literature that demonstrated the important role that these factors play in influencing the user's acceptance of mobile services.

3 Research Model and Hypotheses Development

There are five aspects to our model: first, TAM which has roots in direct and indirect prediction of user's satisfaction and his behavioral intention to use new technologies and information systems; second, DOI theory which seeks to explain the process through which innovations are disseminated in the society; Trust model which is essential to understand the degree of confidence that the services will be provided to the users according to their expectations; Service quality which seeks to explain the antecedents that affect user behavior and satisfaction; Finally, user satisfaction which may lead to a greater level of acceptance. These theories/models were presented as a suitable theoretical background to examine the key factors that may affect m-Government acceptance in Jordan.

This section presents our research model and hypotheses. Based on the objectives and the theoretical perspectives specified earlier and according to the related literature regarding m-Government acceptance key success factors, the main constructs of used variables were derived, and the theoretical model was established as shown in Figure 1. Seven hypotheses were proposed, one for each variable in the model. The independent variables are proposed to have direct and indirect relationships with the main dependent variable which is m-Government acceptance. The social factors are represented by citizens' trust in government and trust in mobile technology. Compatibility is the main element of the DOI. PEOU and PU are the main determinants in TAM. Finally, the last factor was the quality of service. It is important to mention that PEOU, PU, and quality of service are proposed to have direct relationships with the variable, citizen satisfaction, which in turn influences the dependent variable (m-Government acceptance).

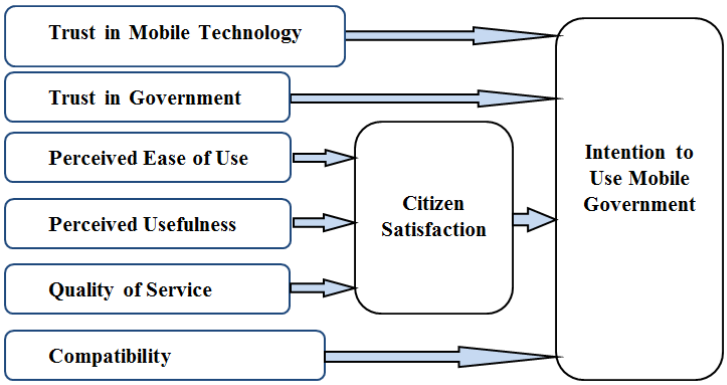


Fig. 1. The Proposed Research Model

3.1 Trust

Trust has received significant attention in recent research since it is crucial for the success of a broad range of public services including e and m-services that depend on behavioral responses from the public citizens. Warkentin et al. [26] defines trust as a willingness to believe that others will act in a predictable and consistent manner.

Trust is essential in building relationships and increasing the confidence. The negative consequences that can stem from the absence of trust in online services can obstruct the success of the service level of e & m-Government [27]. Lack of trust compromises the willingness of mobile users to perform their transactions and to exchange sensitive and personal information online [28]. Trust has different definitions emerged from many disciplines which have examined it. These definitions can be roughly divided in two major streams:

Trust in mobile technology: M-Government transactions involve people, government organizations, and the technologies applied by them through their interactions with each other [29]. These applied technologies rely on mobile devices and telecommunication networks which offer some features that are exclusive to mobile contexts such as mobility, ubiquity, and contextual offers [30]. M-Government trust is built when public citizens form more positive impressions of their online interactions with the government organizations regarding their concerns for security and privacy of their information, and when they agree to accept vulnerability in dealing with it [31]. Using Lee's [30] definition, this study defines trust in mobile technology in the context of m-Government as citizen's willingness to be vulnerable while interacting with the government through a mobile device given existing expectations regarding intentions and behavior of the other party. According to these arguments, the authors make the following hypothesis:

H1: *Higher levels of trust in mobile technology will positively affect the m-Government acceptance in Jordan*.

Trust in government: this research stream treats trust as an aspect of expectation regarding the behaviour of the government as an interaction partner [32]. Trust in

government has received much discussion in the political science literature since it is crucial to enhance the relationship between public citizens and their government. Trust plays a significant role in enabling public citizens to become willing to interact with m-Government services and have confidence that the government will make the right decisions regarding protecting and providing its services [33]. Trust in government can be affected by citizen's experience of using its public services. Therefore, the ability of the government to provide services that is tailored to the citizens' needs and the proper planning and performing of these services can ensure the success of m-Government services. Based on these arguments, the authors make the following hypothesis:

H2: *Higher levels of trust in government will positively affect the m-Government acceptance in Jordan*.

3.2 Technology acceptance model

TAM model was proposed by Davis [34] to determine the potential user's behavioral intention when using a new innovated technology. Some studies [35, 36] have stated that TAM is extensively used to measure the acceptance of new IT innovations. Also, Mather et al. [37] in their study did confirm that the main TAM constructs, PU and PEOU, were suitable to predict user satisfaction which leads to greater level of acceptance. TAM adapts Theory of Reasoned Action (TRA) to explain why users accept or discard new system or new technology [38]. According to TAM, the consumer's attitudes toward his intention to use the system are influenced by two perceptions, usefulness and ease of use [34]. This study examines the role of PU and PEOU in influencing the user's satisfaction and user's intention to accept m-Government services in Jordan.

Perceived Usefulness: can be defined as the degree to which citizens believes that the use of m-Government services can improve their job performance and enhance their life and make it stress-free [34]. Moreover, the related literature has stated that PU has an important influence on the acceptance of both e and m-Government services [18] [23]. In the context of Jordan, the authors in [19, 39] reported that a higher level of PU lead to higher levels of intention to use e-Government services in Jordan. This finding indicates that citizens will be satisfied when they receive more useful m-Government services, and as a result, they will be keen to accept m-Government. According to the above arguments, the authors make the following hypothesis:

H3: *Higher levels of PU will positively affect the citizen satisfaction*.

Perceived Ease of Use: is defined as "the degree to which a person believes that using a particular system would be free of effort" [34]. This construct has been used in prior mobile technology acceptance studies. Some scholars [19, 18] declared that end-users will be motivated to use a service if it is simple, practical, less hassle, easy to access and easy to use. Further recent studies [19, 23] have also stated that PEOU has a significant influence on user satisfaction and his acceptance of m-Government services. Based on these arguments, the authors make the following hypothesis:

H4: *Higher levels of PEOU will positively affect the citizen satisfaction*.

3.3 Diffusion of innovation theory (DOI)

Diffusion of Innovation theory [40] became one of the most popular models that can be used in a broad variety of disciplines (i.e. information systems) research to explain user acceptance of new ideas and new technologies. Rogers [40] defines an innovation as "an idea or object that is perceived to be new". Also, he defines diffusion as "the process by which an innovation is communicated through certain channels over time among the members of a social society". According to DOI, the individual's decision to accept the innovated technology is affected by its following attributes: relative advantage, compatibility, complexity, trialability and observability [41]. After a literature review, the authors in [42] stated that relative advantage, complexity and compatibility were found to be the most relevant constructs to acceptance and adoption research. However, Moore and Benbasat [43] revealed that there is a conceptual overlapping between relative advantage and complexity with TAM's PU and PEOU, respectively. Therefore, this study excluded these two innovation attributes from the proposed research model and presented compatibility as an important key factor affecting the acceptance of m-Government in Jordan. Compatibility is defined as "the degree to which an innovation is seen to be compatible and consistent with existing values, beliefs, past experiences and needs of the potential users" [44]. Thus, the following hypothesis is tested:

H5: *Higher levels of compatibility will positively affect the m-Government acceptance in Jordan*

3.4 Quality of service

In the context of online services, quality of Service and its influence on user's satisfaction has received considerable academic attention in the past few years [45]. Every service must fulfill a list of requirements in order to improve its quality. In fact, some unclear and contradictory objectives may be introduced when we face various users' needs and requirements to fulfill simultaneously along with having those requirements unclear, incompatible or inaccurate. The authors in [46] defined the quality of service as a measure of the difference of service performance between the customers' expectations and the delivered service. Based on the literature [47, 48], the selected measures of service quality elements that have been used in this study are: awareness, accessibility, availability, reliability, accuracy, responsiveness, courtesy and helpfulness. In the light of the above arguments, the authors make the following hypothesis:

H6: *Higher levels of quality of service will positively affect the citizen satisfaction*

3.5 Citizen satisfaction

User satisfaction can be viewed as the core of successful e-government adoption [49]. The success and survival in online environment of electronic and mobile services depends directly on user satisfaction and indirectly on the quality of delivered service [50]. Also, Udo et al. [51] claimed that quality of service is a predecessor of

customer satisfaction. As mentioned earlier, Mather et al. [37] stated that the main TAM constructs, PU and PEOU, were suitable to predict user satisfaction which leads to greater level of acceptance. Also, Westbrook [52] stated that customer satisfaction is a valid measure of subjective evaluation of any outcome or experience related to purchasing a product/service. However, Shankar et al. [53] claimed that customer satisfaction can be measured through transactional satisfaction and overall satisfaction. Transactional satisfaction can be derived from specific individual transactions and leads to overall satisfaction of the customer which can encourage service acceptance. Thus, the following hypothesis is tested:

H7: *Higher levels of citizen satisfaction will positively affect the m-Government acceptance in Jordan*.

4 Research Methodology

The research methodology explains a few aspects about the survey method, sampling technique, survey design, pilot study and data collection procedure. Also, in this section the authors discuss the details of sample profile.

4.1 Survey design and pilot study

A survey method was applied for this study which adapted a set of questionnaires raised by previous studies [47, 54-59]. The survey questions were considered and developed to be short and simple. Also, back translation technique [60] was used to translate the questionnaire into Arabic language since the participants are native Arabic speakers. The questionnaire was reviewed by two bilingual experts to guarantee successful translation. The survey items were rated using 5 point-Likert-scales ranging from strongly disagree to strongly agree.

A pilot study was conducted at some Jordanian government Universities. 35 faculty staff and students were asked to complete the questionnaire and to give written and verbal feedback. On the other hand, the researchers applied reliability tests for each construct to measure the goodness of measuring instrument and ensure more accuracy in the results. The instrument was finalized after making some minor changes based on the provided feedbacks. The questionnaire consisted of 9 sections. The first section was designed to obtain the demographic data whereas the following 8 sections were designed to obtain information about the factors used in the research model.

4.2 Data collection procedure

The research team personally distributed the questionnaires to the participants to be able to respond to any question immediately, introduce the research topic, reduce ambiguity and encourage the participants to give accurate and full answers while filling in the questionnaire [61]. The data collection for this study started in February 2018 in the city of Amman in Jordan. The data were collected randomly from 500 citizens who have used mobile government services. The survey response rate (85 per

cent) was high and acceptable since 425 questionnaires were returned. However, 45 incomplete questionnaires were excluded. Finally, 380 responses were accepted for final analysis. Therefore, the usable response rate was 76 per cent.

4.3 Sample profile

A purposive sampling was employed as sampling technique where a specific predefined group of participants that suit the purpose of the study is selected. Moreover, it was decided that the suitable randomly selected respondents must fit in the age groups, and preferably should be aware of mobile services. Sekaran [62] stated that purposive sampling is appropriate since it involves the choice of the ideal subjects who can provide the required information.

As shown in Table 1, the analysis results of the demographic data of the respondents are as follows: 66.3 per cent were males and 33.7 per cent were females. These results demonstrate the sufficiency of the variety of responses in generalizing research findings to both genders. Moreover, this study includes 5 age groups, ranging from under the age of 18 to the age of 65 years old. Table 1 shows that the age group of 18 – 34 years old represents the major ages of this study since the majority (68 percent) of the survey respondents were in this group. Also, more than half of the respondents (53.2 percent) had a bachelor's degree and above.

Table 1. Demographic Profile of Respondents – Age, Gender and Education level

Attribute	Demographic Distribution	
	Frequency	***Percent (%)***
Gender		
Male	252	66.3
Female	128	33.7
Age		
Under 18	6	1.7
18-24	152	40.0
25-34	107	28.0
35-49	95	25.0
50-65	20	5.3
Education Level		
Primary School	11	2.8
Secondary School	70	18.4
Diploma	97	25.6
Degree and Above	202	53.2

5 Data Analysis and Research Results

In this study, different data analysis techniques were applied. These techniques include descriptive, reliability, exploratory factor, correlation, and regression analysis. As recommended by [63], the measurement model was first examined for reliability and validity of the research constructs to test the goodness of the measurements, fol-

lowed by an analysis of the correlation and multiple linear regression for testing the research hypotheses in the research model. In this section, correlation analysis using Pearson correlation matrix was applied to test the direct relationship between the hypothesized variables and measure the strength of these relationships. On top of that, multiple regression analysis was performed in order to investigate the influences of independents variables (IVs) on the dependent variables (DVs).

5.1 Descriptive analysis

Descriptive statistics analysis is performed for all questionnaire items. The values of mean, standard deviation, and skewness and kurtosis were examined for testing the normality of data. Most of the respondents were satisfied with the items in this study since the results showed that the values of mean ranged from (3.5467) to (4.2133) on a five-point scale. Also, the standard deviations ranged from (.9035) to (.9879). The descriptive statistics which are shown in Table 2 indicate that the analysis results were acceptable. Moreover, the normality distribution ranged from -1 to +1 according to skewness and kurtosis assumptions which shows sufficient results [64].

Table 2. Descriptive analysis

Constructs	Items	Mean	Std. Deviation	Skewness	Kurtosis
Trust in Mobile Technology (TMT)	TMT 1	3.7913	0.908	-.743	.229
	TMT2	3.8795	.9590	-.767	.541
Trust in Government (TG)	TG1	3.8469	.9561	-.870	.756
	TG2	3.9231	.9553	-.597	.783
	TG3	3.9427	.9554	-895	.786
Perceived ease of use (PEOU)	PEOU1	3.8428	.9551	-.775	.791
	PEOU2	4.0424	.9543	-.985	.764
	PEOU3	3.5467	.9474	-.074	.969
	PEOU4	4.1464	.9336	-.748	.488
	PEOU5	4.0264	.9336	-.754	.567
Perceived Usefulness (PU)	PU1	3.9272	.9314	-.435	.423
	PU2	4.1542	.9284	-.635	.734
	PU3	4.1953	.9122	-.465	.544
	PU4	4.0133	.9848	-.543	.529
Quality of service (QS)	QS1	4.1543	.9581	-.632	.759
	QS2	4.1936	.9847	-.453	.522
	QS3	4.2104	.9858	-.541	.579
	QS4	4.0232	.9879	-.653	.722
	QS5	4.0519	.9760	-.726	.659
	QS6	3.9472	.9394	-.485	.375
	QS7	4.1552	.9484	-.635	.759
	QS8	4.1953	.9821	-.455	.522
	QS9	4.2133	.9848	-.541	.579
	QS10	4.0243	.9849	-.653	.722

	QS11	4.0514	.9732	-.725	.659
	QS12	3.9463	.9845	-.486	.375
	QS13	4.1524	.9541	-.632	.759
	QS14	4.1923	.9542	-.466	.522
	QS15	4.2124	.9358	-.533	.579
	QS16	4.1912	.9447	-.444	.622
Compatibility (C)	C1	3.8187	.9035	-.135	.465
	C2	3.8042	.9207	-.146	.538
	C3	3.8164	.9785	-.626	.718
	C4	3.8288	.9670	-.782	.824
Customer Satisfaction (CS)	CS1	3.8238	.9373	-.763	.714
	CS2	3.8342	.9613	-.774	.630
	CS3	3.8263	.9432	-.785	.622
Behavioral Intention (BI)	BI1	3.8181	.9170	-.723	.713
	BI2	3.8032	.9200	-.734	.614
	BI3	3.8223	.9330	-.745	.735

5.2 Goodness of measurement: Reliability and validity

The reliability and the validity were tested to ensure the goodness of measurement. The reliability test in this study is assessed using Cronbach's alpha [65] which is considered the most popular method used for calculating internal consistency of all variables [66]. According to Hair et al. [63], the coefficient of reliability (Cronbach's Alpha) needs to be more than 0.7 to be acceptable. As shown in Table 3, the reliability test shows values above 0.70, ranging from 0.77 to 0.92, for all constructs. These results show well-structured model which have a good level of internal consistency and indicates satisfactory reliability for all variables.

Table 3. Results of Reliability analysis

Constructs	# Items	Cronbach's Alpha ($\alpha \geq 0.7$)
TMT	2	0.92
TG	3	0.89
PEOU	5	0.91
PU	4	0.88
QS	16	0.77
C	4	0.84
CS	3	0.87
BI	3	0.86

In order to establish construct validity test, convergent and discriminant validity tests were applied. Convergent validity was evaluated based on Confirmatory Factor Analysis by investigating the factor loadings that should be above the threshold of (0.7) as recommended by [67]. The results in Table 4 indicates that all items have loadings above 0.7 which indicate agreeable factors loading for all variables.

Table 4. Confirmatory Factor Analysis

TMT	TG	PEOU	PU	QS	C	CS	BI
.798	.865	.866	.856	.902	0.88	.903	0.83
.802	.871	.867	.842	.903	0.85	.898	0.81
	.863	.878	.858	.898	0.89	.896	0.82
		.884	.855	.896	0.83		
		.889		0.83			
				0.81			
				0.82			
				0.79			
				0.84			
				0.71			
				0.73			
				0.75			
				0.72			
				0.76			
				0.78			
				0.80			

Discriminant validity test was conducted to determine the degree of correlation between the various variables [68]. This test was conducted using the correlation matrix approach. The results in Table 5 showed that all the off-diagonal values for all variables are less than 0.85 as suggested by [69], thus indicating that discriminant and convergent validity of the measures are reasonable.

Table 5. Assessment of discriminant validity

Variables	TMT	TG	PEOU	PU	QS	C	CS	BI
TMT	1							
TG	0.582	1						
PEOU	0.472	0.493	1					
PU	0. 563	0. 454	0. 559	1				
QS	0. 534	0. 424	0. 458	0.466	1			
C	0.543	0.491	0.543	0.447	0.473	1		
CS	0.465	0.471	0.473	0.465	0.435	0.579	1	
BI (m-Gov Acceptance)	0.468	0.429	0.293	0. 473	0. 429	0.565	0.561	1

These results support the reliability and the validity of the variables, and show that the proposed measurement model exhibit a good fit with the obtained data. As a result, the proposed structural model is close enough to contribute to the citizens acceptance of m-Government services in Jordan.

5.3 Hypotheses testing: Correlation analysis

In this section, Pearson's correlation analysis was conducted to quantify the strength of linear relationship between every pair of variables in the hypotheses. The correlations between the independents variables (IVs) and the dependent variables (DVs) in the research model are shown in Table 6. The correlation analysis supports the seven hypotheses since the results demonstrated a significant positive relationship between the variables, thereby, confirming the hypothesis.

Table 6. Summary of correlation analysis results

Hypotheses	IV	DV	Results	Support or not
H1	TMT	BI	0.453	Support
H2	TG	BI	0.522	Support
H3	PEOU	CS	0.468	Support
H4	PU	CS	0.593	Support
H5	QS	CS	0.654	Support
H6	C	BI	0.659	Support
H7	CS	BI	0.711	Support

5.4 Hypotheses testing: Regression analysis

In this study, seven hypotheses were proposed to test the impacts of PEOU, PU and quality of service on the citizen's satisfaction that can together with trust in mobile technology, trust in government and compatibility affect the citizens' behavioral intention to use of m-Government services. Therefore, there are two DVs in this study. The proposed hypotheses were tested by multiple regression analysis. The summary of regression hypotheses test is presented in Table 7.

The first regression model was tested by multiple regression analysis between citizen satisfaction as a DV and PEOU, PU and quality of service. As shown in Table 7, the results show that citizen satisfaction was significantly impacted by perceived ease of use (H3, $\beta = 0.381$, $p < 0.001$), perceived usefulness (H4, $\beta = 0.373$, $p < 0.001$), and quality of service (H5, $\beta = 0.494$, $p < 0.001$). Furthermore, the value of R2 for the citizen satisfaction as a DV is 0.734; this means that perceived ease of use, perceived usefulness, and quality of service within the proposed model can explain 73.4% of the variance in the citizen satisfaction of m-Government services. Therefore, the first regression model supports the following hypotheses: H3, H4 and H5.

In the second regression model, the citizen's behavioral intention to use m-Government applications was significantly affected by four determinants including trust in mobile technology (H1, $\beta = 0.351$, $p < 0.001$), trust in government (H2, $\beta = 0.173$, $p < 0.01$), compatibility (H6, $\beta = 0.121$, $p < 0.05$) and citizen satisfaction (H7, $\beta = 0.517$, $p < 0.001$) as shown in Table 6. The value of R2 for the dependent variable behavioral intention to use is 0.875; this means that the trust in mobile technology, trust in government, compatibility and citizen satisfaction can explain 87.5% of the variance in the behavioral intention to use m-Government. Also, this value is consid-

ered high and indicates that the power of the regression model is very good. Thus, the second regression model supports the following hypotheses: H1, H2, H6 and H7.

Table 7. Summary of regression analysis results

Hypotheses	IV	DV	Beta (β)	Sig. (ρ<0.05)	Support or not
H1	TMT	BI	0.351	0.001	Support
H2	TG	BI	0.173	0.01	Support
H3	PEOU	CS	0.381	0.001	Support
H4	PU	CS	0.373	0.001	Support
H5	QS	CS	0.494	0.001	Support
H6	C	BI	0.121	0.05	Support
H7	CS	BI	0.517	0.001	Support

6 Discussion and Implications

This section provides a discussion for the significant results of multiple regression analysis. This study has revealed several key findings. Firstly, trust in mobile technology and trust in government are very important elements which have been found to influence user acceptance of technology-enabled government services by many prior studies. Consequently, it is not surprising to find that, those two factors also affect the citizens acceptance of m-Government services.

The latest mobile technologies and mobile devices are exposed to various security threats such as cybercrime, malware and viruses which may cause people to be worried about the security and the privacy of their sensitive data and, as a result, hesitate before using mobile applications for transactions. The outcomes of this research are consistent with some previous studies [20, 70], these results specified that Jordanian citizens intention to use m-Government services increases if they have high level of positive trust towards Internet and the technologies used to access m-Government services. Therefore, the Jordanian government agencies should ensure that their mobile services are accessible by all users and should maintain the privacy and the security of the citizens' sensitive information while dealing with the government departments via smart phones using Internet.

Also, the findings confirmed that citizens' intention to use m-Government increases if the citizens have a high level of positive trust toward government. These findings are in line with some previous studies such as [20, 70]. Therefore, the government has the responsibility to put a strong government-wide integrity in place and should be capable to provide m-Government services according to the expectations of the citizens.

Secondly, the results of this study stated that when m-Government services are presented to be useful and easy to use, the Jordanian citizens will be more satisfied. However, these results agree with previous studies [71] and indicate the appropriateness of the fundamental elements of TAM, PEOU and PU, in the Jordanian m-Government context. Therefore, the Jordanian government should introduce its services in an easy, clear and understandable way via ensuring the simplicity of perform-

ing diverse transactions by having clear instructions to perform these transactions using a small number of clicks (i.e. passport renewal). On the other hand, the government should provide information and services in a manner that is useful for the people.

Thirdly, this study has responded to the findings of some research studies [51] which indicated that quality of service is also an antecedent of citizens' satisfaction. In this study, the quality of service has been considered in order to achieve citizens' satisfaction. The quality of service was found to have the strongest impact on citizens' satisfaction among all IVs. These outcomes are consistent with previous studies [71, 72]. Therefore, the Jordanian government should enhance the performance of the delivered services to meet the expectations of Jordanian citizens and increase their satisfaction.

Also, some prior studies found that compatibility is consistently significant in technology adoption [42]. The fourth finding of this study highlighted the significant impact of compatibility on citizens' intention to use m-Government services. These outcomes are consistent with some previous studies [70].

Finally, the emergence and the growth of new innovations in information technology highlighted the importance of satisfying the citizens. This research contributes more knowledge to the acceptance of m-Government services by investigating citizens' satisfaction with the new installed mobile-government systems. This empirical study shows that citizens' satisfaction is one of the most influential factors in its success and acceptance. However, the results indicated that higher levels of acceptance of m-Government services by citizens in Jordan are associated with increased satisfaction with these services. These outcomes are in line with previous studies [73, 74].

7 Conclusion

However, since m-Government services in Jordan are facing some important challenges such as remaining unknown to and underutilized by the public citizens, one of the most important contributions of this study is to detect and understand the main factors that can promote and inhibit the acceptance and the diffusion of m-Government services as perceived by Jordanian citizens.

This study explored the architecture of the conceptual model that has been proposed and introduced many variables that commonly play important role in heavily influencing the individual's behavior of accepting new technologies. These variables have a large share among technology acceptance studies. Overall, citizen satisfaction, compatibility and other user requirements such as trust in mobile technology, trust in government are considered the gateway to accept m-Government services and increase the behavioral intention to use it. Moreover, in order to increase the citizen satisfaction, the government should demonstrate the benefits of the m-Government services, maintain the easiness in accessing and using these services and enhance its quality.

The consideration of the factors identified in this study can significantly enhance the understanding of technology acceptance of m-Government services in Jordan, and as a result, it should lead to more successful acceptance of these services.

8 Limitations and Future Work

This study demonstrates strong evidence concerning some important factors that affect the Jordanian citizens' acceptance of m-Government services. One of the main limitations of this study was that this research did not cover all the factors that may influence the citizens' acceptance of m-Government services in Jordan. However, in future studies, the authors may conduct further studies to explore more useful dimensions based on the research goals. Also, this study has only focused on the issues related to citizen acceptance in the domain of Government-to-Citizen. Therefore, similar research efforts can be applied to the domain of Government-to-Business in developing countries. Finally, the door is open for future research to perform further assessment and analyzation of the acceptance of m-Government services from a larger perspective based on the classification of m-Government products and services into different categories.

9 References

[1] P. Germanakos, G. Samaras and E. Christodoulou, "Multi-channel Delivery of Services–the Road from eGovernment to mGovernment: Further Technological Challenges and Implications," in Proceedings of the First European Conference on Mobile Government, EURO mGOV, 2005.

[2] M. Kalogiannakis and S. Papadakis, "Evaluating pre-service kindergarten teachers' intention to adopt and use tablets into teaching practice for natural sciences," International Journal of Mobile Learning and Organization, 13(1), pp. 113-127, 2019. https://doi.org/10.1504/ijmlo.2019.10016617

[3] S. Papadakis, "Evaluating pre-service teachers' acceptance of mobile devices with regards to their age and gender: a case study in Greece," International Journal of Mobile Learning and Organisation, 12(4), pp. 336-352, 2018. https://doi.org/10.1504/ijmlo.2018.095130

[4] S. Papadakis and M. Kalogiannakis, "Mobile educational applications for children. What educators and parents need to know," International Journal of Mobile Learning and Organisation (Special Issue on Mobile Learning Applications and Strategies), 11(3), pp. 256-277, 2017. https://doi.org/10.1504/ijmlo.2017.085338

[5] S. Papadakis, M. Kalogiannakis, E. Sifaki and N. Vidakis, "Evaluating Moodle use via Smart Mobile Phones. A case study in a Greek University," EAI (European Alliance for Innovation) Endorsed Transactions on Creative Technologies, 5(16), e1, 1-12, pp. 1 - 12, 2018. https://doi.org/10.4108/eai.10-4-2018.156382

[6] O. Östberg, "A Swedish View on Mobile Government," in Paper presented at the International Symposium on E & M-Government, Seoul, Korea, 2003.

[7] E. Kaasinen, " User acceptance of mobile services–Value, Ease of use, Trust and Ease of Adoption," VTT-Pulblications 566, Espoo, Finland, 2005.

[8] M. Hamner and F. Al-Qahtani, "Enhancing the case for Electronic Government in developing nations: A people-centric study focused in Saudi Arabia," Government Information Quarterly, 26, no. 137–143, 2009. https://doi.org/10.1016/j.giq.2007.08.008
[9] F. F. S. Lin and D. Liang, "Assessing citizen adoption of e-Government initiatives in Gambia: A validation of the technology acceptance model in information systems success," Government Information Quarterly, 28(2), pp. 271-279, 2011. https://doi.org/10.1016/j.giq.2010.09.004
[10] M. Gharaibeh and M. Arshad, "Current Status of Mobile Banking Services in Jordan," World Applied Sciences Journal, 34(7), pp. 931-935, 2016.
[11] J. Schlaeger, "The role of m-government in Western China development," in Mobile Information Communication Technologies Adoption in Developing Countries: Effects and Implications, 2012, pp. 364-381. https://doi.org/10.4018/978-1-61692-818-6.ch009
[12] A. Bassara, M. Wisniewski and P. Zebrowski, "USE-ME.GOV- Usabilitydriven open platform for mobile government," in In Proc. Business Information Systems (BIS), Poznan, Poland, 2005.
[13] M. Deep and G. Sahoo, "M-governance for better G2C service," Journal of Internet Banking and Commerce, 16(1), p. 1–5, 2011.
[14] G. N. L. Stowers, "The State of Federal Websites: The Pursuit of Excellence," in E-Government, USA, Rowman & Littlefield Publishers Inc., 2003.
[15] O. Al Hujran, A. Aloudat and I. Altarawneh, " Factors Influencing Citizen Adoption of E-Government in Developing Countries: The Case of Jordan," International Journal of Technology and Human Interaction, 9, pp. 1-19, 2013. https://doi.org/10.4018/jthi.2013040101
[16] ITU, "Key Global Telecom Indicators for the World Telecommunication Service Sector," 2011. [Online]. [Accessed 12 Oct 2011].
[17] G. Colclough, "The user challenge benchmarking the supply of online public services-7th measurement," Capgemini, European Commission Directorate General for Information Society and Media, Bruxelles, 2007.
[18] E. Abu-Shanab, "Major factors influencing the adoption of m-government in Jordan.," Electronic Government An International Journal, 11(4), pp. 223-240, 2015. https://doi.org/10.1504/eg.2015.071394
[19] A. Althunibat, T. Alrawashdeh and M. Muhairat, "The acceptance of using m-government services in Jordan," Journal of Theoretical and Applied Information Technology, 63(3), pp. 733-740, 2014. https://doi.org/10.1109/itng.2014.65
[20] N. Almuraqab and S. Jasimuddin, "Factors that Influence End-Users' Adoption of Smart Government Services in the UAE: A Conceptual Framework," The Electronic Journal Information Systems Evaluation, 20(1), pp. 11-23, 2017.
[21] R. Alotaibi, L. Houghton and K. Sandhu, "Exploring the Potential Factors Influencing the Adoption of M-Government Services in Saudi Arabia: A Qualitative Analysis," International Journal of Business and Management, 11(8), 2016. https://doi.org/10.5539/ijbm.v11n8p56
[22] A. Babullah, Y. Dwivedi and M. Williams, "Saudi Citizens' Perceptions on Mobile Government (mGov) Adoption Factors," in Proceedings of UK Academy for information systems conference , 2015.
[23] M. Dahi and Z. Ezziane, "Measuring e-government adoption in Abu Dhabi with technology acceptance model (TAM)," International Journal of Electronic Governance, 7(3), pp. 206-231, 2015. https://doi.org/10.1504/ijeg.2015.071564
[24] P. Luarn and H. H. Lin, "Toward an understanding of the behavioral intention to use mobile banking," Computers in Human Behavior 21(6), pp. 873-891, 2005. https://doi.org/10.1016/j.chb.2004.03.003

[25] L. Paul and I. John, "Why do people use information technology? A critical review of the technology acceptance model," Information and Management, 40, p. 191–204, 2003. https://doi.org/10.1016/s0378-7206(01)00143-4
[26] M. Warkentin, D. Gefen, P. A. Pavlou and G. M. Rose, "Encouraging Citizen Adoption of e-Government by Building Trust," Electronic Markets, 12(3), p. 157 – 162, 2002. https://doi.org/10.1080/101967802320245929
[27] L. Carter and F. Bélanger, "The utilization of e-government services: citizen trust, innovation and acceptance factors," Information Systems Journal, 15, pp. 5-25, 2005. https://doi.org/10.1111/j.1365-2575.2005.00183.x
[28] A. Beldad, M. Jong and M. Steehouder, "How shall I trust the faceless and the intangible? A literature review on the antecedents of online trust," Computers in Human Behavior, 26, p. 857–869, 2010. https://doi.org/10.1016/j.chb.2010.03.013
[29] J. Boyd, "The rhetorical construction of trust online," Communication Theory, 13(4), pp. 392-410, 2003.
[30] T. Lee, "The impact of perceptions of interactivity on customer trust and transaction intentions in mobile commerce," Journal of Electronic Commerce Research, 6(3), pp. 165-181, 2005. https://doi.org/10.5465/amr.1995.9508080335
[31] R. C. Mayer, J. H. Davis and F. D. Schoorman, "An Integration Model of Organizational Trust," Academy of Management Review, 20(3), pp. 709-734, 1995.
[32] E. Garbarino and M. S. Johnson, "The different roles of satisfaction, trust, and commitment in customer relationships," Journal of Marketing, 63(2), pp. 70-87, 1999. https://doi.org/10.1177/002224299906300205
[33] J. K. Lee, S. Braynov and R. Rao, "Effects of public emergency on citizens' usage intention toward e-Government: a study in the context of war in Iraq," in in proceedings of ICIS 2003 , 2003.
[34] F. D. Davis, " Perceived Usefulness, Perceived Ease of Use, and user Acceptance of Information Technology," MIS Quarterly, 13, pp. 319-340, 1989. https://doi.org/10.2307/249008
[35] S. Alharbi and S. Drew, "Using the technology acceptance model in understanding academics' behavioural intention to use learning management systems," International Journal of Advanced Computer Science and Applications (IJACSA), 5(1), pp. 143-155, 2014. https://doi.org/10.14569/ijacsa.2014.050120
[36] J. Moon and Y. Kim, "Extending the TAM for a World-Wide-Web context," Information & Management,38(4), pp. 217-230, 2001. https://doi.org/10.1016/s0378-7206(00)00061-6
[37] D. Mather, P. Caputi and R. Jayasuriya, "Is the technology acceptance model a valid model of user satisfaction of information technology in environments where usage is mandatory?," in Enabling organisation, Victoria University, australia, ACIS 2002 School of Information Systems., 2002, pp. 1241-1250.
[38] F. D. Davis, R. P. Bagozzi and P. R. Warshaw, "User acceptance of computer technology: a comparison of two theoretical models," Management science, 35(8), pp. 982-1003, 1989. https://doi.org/10.1287/mnsc.35.8.982
[39] M. Alomari, P. Woods and K. Sandhu, "Predictors for e-government adoption in Jordan," Information Technology & People, 25(2), p. 207 – 234, 2012. https://doi.org/10.1108/09593841211232712
[40] E. M. Rogers, Diffusion of Innovations (4th ed.), New York, USA: The Free Press, 1995.
[41] D. Gilbert, P. Balestrini and D. Littleboy, " Barriers and Benefits in the Adoption of e-Government," The International Journal of Public Sector Management, 17, pp. 286-301, 2004. https://doi.org/10.1108/09513550410539794

[42] L. Tornatzky and K. Klein, " Innovation characteristics and innovation adoption implementation: a metaanalysis of findings," IEEE Transactions on Engineering Management, 29, p. 28–45, 1982. https://doi.org/10.1109/tem.1982.6447463
[43] G. Moore and I. Benbasat, "Development of an instrument to measure the perceptions of adopting an information technology innovation," Information Systems Research, 2, p. 173–191, 1991. https://doi.org/10.1287/isre.2.3.192
[44] E. M. Rogers, Diffusion of innovations (3rd ed.), New York: Free Press of Glencoe, 1983.
[45] M. J. Alsamydai, R. O. Yousif and M. H. AlKhasawneh, "The Factors Influencing Consumers' Satisfaction and Continuity to Deal with E-Banking Services in Jordan," Global Journal of Management And Business Research, 12(14), 2012.
[46] M. Wisniewski and M. Donnelly, "Measuring service quality in the public sector: The potential for SERVQUAL," Total Quality management, 7, pp. 357-364, 1996. https://doi.org/10.1080/09544129650034710
[47] T. El-Kiki and E. Lawrence, "Mobile user satisfaction and usage analysis model of m-government services," in Proceedings of the Second European Conference on Mobile Government, EURO mGOV, United Kingdom, 2007.
[48] Z. Yang and X. Fang, "Online service quality dimensions and their relationships with satisfaction: A content analysis of customer reviews of securities brokerage services," International Journal of Service Industry Management, 15(3), pp. 302-326, 2004. https://doi.org/10.1108/09564230410540953
[49] A. Jamal and K. Naser, "Customer Satisfaction and Retail Banking: An Assessment of Some of the Key Antecedents of Customer Satisfaction in Retail Banking," International Journal of Bank Marketing, 20, pp. 146-160, 2002. https://doi.org/10.1108/02652320210432936
[50] V. Zeithaml, " Service excellence in electronic channels," Managing Service Quality, 12, pp. 135-138, 2002. https://doi.org/10.1108/09604520210429187
[51] G. Udo, K. Bagchi and P. Kirs, "An Assesment of Customers' E-service Quality Perception, Satisfaction and Intention," International Journal of Information Management. 30, p. 481 – 492, 2010. https://doi.org/10.1016/j.ijinfomgt.2010.03.005
[52] R. A. Westbrook, "Intrapersonal Affective Influences on Consumer Satisfaction with Products," Journal of Consumer Research.7, pp. 49-54, 1980. https://doi.org/10.1086/208792
[53] V. Shankar, K. S. Amy and R. Arvind, "Customer Satisfaction and Loyalty in Online and Offline Environment," International Journal of Research in Marketing 20(2), pp. 153-175, 2003. https://doi.org/10.1016/s0167-8116(03)00016-8
[54] K. P. Gupta and P. Bhaskar, "Citizen adoption of e-government: A literature review and conceptual framework," Electronic Government, An International Journal, 12(2), January 2016. https://doi.org/10.1504/eg.2016.076134
[55] A. Rokhman, "E-government adoption in developing countries: The case of Indonesia," Journal of Emerging Trends in Computing and Information sciences 2 (5), pp. 228-326, 2011.
[56] A. Chatfield and J. Alanazi, "Service quality, citizen satisfaction, and loyalty with self-service delivery options to transforming e-government services," in in Proceedings of the 24th Australasian Conference on Information Systems (ACIS), 2013.
[57] V. Venkatesh and F. D. Davis, "A theoretical extension of the technology acceptance model: Four longitudinal field studies," Management Science, 46 (2), p. 186–204, 2000. https://doi.org/10.1287/mnsc.46.2.186.11926

[58] A. Althunibat, M. Azan and N. Sahari, "Modeling the factors that influence mobile government services acceptance," African Journal of Business Management, 5(34), pp. 13030-13043, 2011.
[59] O. Al-Hujran, A. Aloudat and I. Altarawneh, "Factors influencing citizen adoption of e-government in developing countries: The case of Jordan," International Journal of Technology and Human Interaction (IJTHI), 9(2), pp. 1-19, 2013. https://doi.org/10.4018/jthi.2013040101
[60] R. W. Brislin, "Back-translation for cross-cultural research," Journal of cross-cultural psychology, 1(3), pp. 185-216, 1970. https://doi.org/10.1177/135910457000100301
[61] R. Y. Cavana, B. L. Delahaye and U. Sekaran, Applied business research: Qualitative and quantitative methods, Australia: John Wiley & Sons, 2001.
[62] U. Sekaran, Research methods for managers: a skill-building approach, Wiley, 1984.
[63] J. F. Hair, W. C. Black, B. J. Babin, R. E. Anderson and R. L. Tatham, in Multivariate data analysis, 6, Upper Saddle River, NJ: Pearson Prentice Hall., 2006.
[64] R. A. Groeneveld and G. Meeden, "Measuring skewness and kurtosis," The Statistician, vol. 1, no. 4, pp. 391-399, 1984. https://doi.org/10.2307/2987742
[65] L. J. Cronbach, Essentials of Psychological Testing (3rd Ed.), New York: Harper and Row, 1970.
[66] T. P. Hogan, A. Benjamin and K. L. Brezinski, " Reliability methods," Educational and Psychological Measurement, 60, p. 523–531, 2000. https://doi.org/10.1177/00131640021970691
[67] D. Campbell and D. Fiske, "Convergent and discriminant validation by the multitrait-multimethods matrix," Personality, 56, p. 162, 1998.
[68] R. P. Bagozzi, Y. Yi and L. W. Phillips, "Assessing construct validity in organazational research," Adminstration Science Quarterly - Sage Journals, 36, pp. 421-458, 1991. https://doi.org/10.2307/2393203
[69] N. Bontis, "Intellectual capital: an exploratory study that develops measures and models," Management decision, 36(2), pp. 63-76, 1998. https://doi.org/10.1108/00251749810204142
[70] M. Alomari, P. Woods and K. Sandhu, "The Deployment of E-Government in the Hashemite Kingdom of Jordan: factors in E-Government adoption," in Proceedings of the IADIS International Conference WWW/Internet, Rome, Italy, 2009. https://doi.org/10.1109/icitst.2009.5402528
[71] T. Ahmed, N. Alhadi and M. E. Seliaman, "Acceptance of e-Government Services in Sudan: an Empirical Investigation," in Proceedings of 2015 International Conference on Cloud Computing (ICCC), Riyadh, 2015. https://doi.org/10.1109/cloudcomp.2015.7149625
[72] A. Moradi Abadi, A. Moradi Abadi and A. Jafari, "Innovation acceptance and customer satisfaction. A survey on tax information systems," AD-minister, [S.l.], n. 30, pp. 149-171, February 2017. https://doi.org/10.17230/ad-minister.30.8
[73] L. Lee, H. Kim and M. Ahn, "The willingness of e-govemment service adoption by business users: The role of offline service quality and trust in technology," Government Information Quarterly, 28(2), pp. 222-230, Aprill 2011. https://doi.org/10.1016/j.giq.2010.07.007
[74] C. Lai and G. Pires, "Testing of a model evaluating e-govemment portal acceptance and satisfaction," Electron. J. Inform. Syst. Evaluat., 13, pp. 35-46, 2010.

10 Authors

Dr. Bassam A. Y. Alqaralleh is an associate professor in the Department of Computer Science / Faculty of IT at Al-Hussein Bin Talal University (AHU), Ma'an, Jordan.

Dr. Ahmad H. Al-Omari is an associate professor of network security in the Department of Computer Science at Northern Border University, KSA.

Dr. Malek Z. Alksasbeh is an Associate Professor in the Department of Computer Information Systems / Faculty of IT at Al-Hussein Bin Talal University (AHU), Ma'an, Jordan.

Article submitted 2019-08-05. Resubmitted 2019-12-24. Final acceptance 2019-12-24. Final version published as submitted by the authors.

Factors Affecting Indonesian Pre-Service Teachers' Use of m-LMS: A Mix Method Study

https://doi.org/10.3991/ijim.v14i06.12035

Aman, Lantip Diat Prasojo,
Universitas Negeri Yogyakarta, Yogyakarta, Indonesia

Muhammad Sofwan, Amirul Mukminin, Akhmad Habibi (✉),
Universitas Jambi, Jambi, Indonesia
akhmad.habibi@unja.ac.id

Lalu Nurul Yaqin
Universitas Gunung Rinjani, West Nusa Tenggara, Indonesia

Abstract—The purpose of this research is to investigate factors affecting Indonesian pre-service teachers' (PSTs) teachers' use of m-learning management systems (m-LMS) in higher education. The difference regarding the use of m-LMS based on some demographic information namely gender, university, year in university, and age are also reported as well as gaining an in-depth understanding of the use of m-LMS in Indonesian universities. To achieve this, two approaches, quantitative and qualitative, were applied. First, we developed and distributed a survey instrument to 210 PSTs in history education based on the technology acceptance model (TAM). In addition, we interviewed 7 of them to obtain an in-depth understanding of the use of m-learning in their learning. Some statistical calculations were presented such as mean, standard deviation, Cronbach's alpha, t-test, and ANOVA. Findings suggest that PSTs' use m-LMS are related to their perceived usefulness and perceived ease of use, subjective norm and attitudes self-efficacy and supporting condition. From these results, we suggest that teacher educators target these factors within teacher development training programs in preparing PSTs for successful integration of m-LMS.

Keywords—M-LMS, PSTs, learning, TAM

1 Introduction

M-learning is a trend in educational technology enabling a rapid change in learning because of the fast development of mobile technologies [1]. M-learning is defined as a new kind of learning that is encouraged by mobile devices that include the current technology of communication and data sharing [2]. The trend of m-learning helps students enjoy a personal-customized learning on mobile devices. Recently, many new mobile services have been integrated into mobile technologies into educational systems [2].

As m-learning evolves, the establishment of applications that can be integrated with mobile devices including the m-learning system (m-LMS) is widely-used [3]. The m-LMS are defined as a way of m-learning tools providing faculty and student an online platform to courses regardless of time and location. Even though m-LMS facilitate tools for PSTs to link with their mobile devices for learning, limited studies were conducted regarding factors affecting the use of m-LMS, especially in developing countries.

Facilitating university students with m-LMS does not automatically address the actual use. They possibly have various perceptions of the system. Therefore, this study was conducted to investigate factors affecting Indonesian PSTs' use of m-learning in higher education. It also aimed to inform the difference regarding the use of m-LMS based on gender, university, year in university, and age. To support the survey data, we interviewed 7 PSTs to gain an in-depth understanding of the use of m-LMS in Indonesian universities. We chose Indonesia since this developing country is one of the most users of mobile devices with high rate of mobile devices penetration.

2 Literature Review

2.1 Theories of technology adoption

Some frameworks have been established to examine users' intention to use and actual use of new technologies in education such as the Technology Acceptance Model (TAM) [4], theory of planned behavior [5], and innovation diffusion theory [6]. Among the proposed models, TAM has become became a very important model to understand factors predicting human behavior on potential technology acceptance [7]. TAM has its focus on the perceived usefulness and perceived ease of use. It was originally examined the use of technology in some domains of economic business and proved to become reliable to predict such as online shopping [8] or e-commerce [9].

2.2 Technology adoption in educational settings

Even though TAM originally aimed to explain technology adoption by users in economics, it has been further use as an investigation tool for educational purposes [10, 11]. Among several previous studies which have applied TAM or its extended model in adoption of technology in education, many researchers have focused on the adoption of mobile learning in teaching or learning processes [12] and learning management systems [10]. However, the researches facilitate the readers with insights understanding into the factors that may affect the adoption of m-LMS [13, 14]. Moreover, not many of them informed the use of TAM in a descriptive way or reported differences based on demographic information regarding the use of m-LMS in education as well as exhibited qualitative analysis on the TAM application measuring the adoption m-LMS in education.

2.3 Adoption of m-LMS in higher education

Even though many previous studies applied TAM to examine the adoption of e-learning and mobile learning; few studies were conducted to examine the adoption of m-LMS in higher education. M-LMS which is defined as a software application to set administration, documenting, tracking, reporting, and addressing educational courses and training programs [13, 14]. The learning management system is established directly from e-Learning. The m-LMS in this study are Moodle to Edmodo which used by PSTs in two Indonesian universities.

3 Method

In this study, we informed the descriptive statistics of a survey investigating factors affecting Indonesian PSTs' use of m-LMS in higher education. We also informed the difference regarding the use of m-LMS based on some demographic information namely gender, university, year in university, and age. To support the survey data, we interviewed 7 PSTs to gain an in-depth understanding of the use of m-LMS in Indonesian universities.

3.1 Instrumentation

Quantitatively, the instrument for the survey includes two sections. Part 1 consists of a nominal scale to recognize respondents' demographic information. Meanwhile, part 2 aims to examine respondents' factors affecting the use of m-LMS. The part 2 instrument was modified from the original scales of TAM [4] and other relevant studies [12, 13]. To make sure that the instrument fits the setting of m-LMS, changes in wordings were made for the easiness of the instrument's interpretation and understanding. Three experts of educational technologies were involved in the discussion as part of content validity in developing the instrument [15]. The instrument was translated involving two sworn translators from English to Indonesian and from Indonesian to English which is also called back translation [16]. To strengthen its validity, the survey instrument was pre-tested to 73 PSTs. The analysis of the pre-test or pilot test was conducted through factor analysis and Cronbach's alpha. From the results, 21 indicators were listed for the main data collection. A 7-point Likert scale, with 1 being the lowest score (strongly disagree) and 7 being the highest (strongly agree), was used to examine respondents' responses.

In the qualitative approach, semi-structured interview questions were developed. Experts in areas of educational technology were invited to discuss the questions first draft to establish the validity [17]. Questions for the interview of the PSTs included 10 items established from the analysis results of the quantitative data. Because the interviews were semi-structured based on the analysis of the quantitative phase and conversational in nature, the wording could be different from one interview to the other interviews, but all respondents were requested to have responses to similar

topics. The questions were translated into Indonesian discussed by the two sworn translators.

3.2 Sampling and data collection

An online survey instrument was shared with PSTs in history education in two public universities in Indonesian from Mei to July 2019. We masked the names of the university to become University 1 and University 2 as part of the research ethic. To determine the sample of the survey, we used *G power that results in minimal numbers of 127 respondents for 6 variables involved in this study. However, we managed to obtain 210 measurable responses (100 males and 110 females). 144 respondents are from University 1 and 66 respondents from University 2. Besides, 74 respondents' ages are from 17 to 19 years old while 50 respondents are from 19 to 22 years old and 86 of them are above 22 years old. From the year in university, 66 PSTs are 1st year students, 86 respondents in the 2nd year, 40 respondents in the 3rd year, and 18 respondents in the 4th year.

Convenience sampling is considered an appropriate method for the descriptive mix method [16]. We chose it by asking the survey respondents who were willing to participate in the interview sessions. Finally, seven participants agreed to participate in this study by filling in the form in the survey questionnaire. They were invited through phone calls and personal messages to attend the interview. Using a smartphone as the recording tool, the interview was conducted in an office room of one of the two universities. We reward the interviewees for their willingness to attend the interview.

3.3 Data analysis

The data that was collected through Google form was transferred to Microsoft excel. The preparation was done by assessing outliers, missing data, and histograms [18]. As the data has been through the process of screening, the analysis was conducted by calculating Mean and Standard deviation for the descriptive analysis. Cronbach's alpha was used to understand the reliability of each variable. Further, t-test, and ANOVA were applied to measure the difference between demographic information regarding the use of m-LMS. SPSS 23 was used for the qualitative data analysis.

In the qualitative phase, the researcher analyzed the data by using within- and across-case analysis [16]. Within-case analysis in qualitative culture is a deep exploration of a case, as a stand-alone object including attachment to a certain case with a particular case to know how the processes happened and revealed in that study meanwhile cross-case analysis is used or implemented in a study as the analysis is a case. We manually transcribed the data and compiled the typed transcription. We read and re-read the transcripts in order to highlight and examine for connections and redundancies using Microsoft word's review feature. The coding process was further done for the highlighted texts through Macros as the coding tool attached in Microsoft word [19]. To establish the trustworthiness of the study, triangulation, member

checking, and reflexivity to strengthen the trustworthiness were taken to ensure the trustworthiness of the data collected [16, 20].

4 Findings

4.1 Quantitative

In elaborating on the results of the study, descriptive statistics in terms of mean (M), standard deviation (SD), and Cronbach's alpha are reported. As seen in Table1 of this study, all variables and indicators have means of above 5 which can be defined as satisfactory which the measurement of the Likert scale range from 1 (strongly disagree) to 7 (strongly agree) attitudes gained the highest mean (M = 5.495; SD = .999). Meanwhile, the lowest variable mean is the use of m-LMS (M = 5.137; SD = 1.062). As per indicator, AT 1 obtains the highest mean (M = 5.571; SD = 1.156) while the lowest means is informed for USE 2 (M = 5.105; SD = 1.213). The Cronbach's alpha values of the final results of the analysis also exceed the threshold value of .70 in which the values range from .874 to .925. The complete report of the statistical descriptive values is shown in Table 1 below.

Table 1. Mean, SD, and Cronbach's alpha

Variables	M	SD	α	Indicators	M	SD
Perceived usefulness	5.416	1.006	.889	PU1	5.314	1.185
				PU2	5.495	1.055
				PU3	5.438	1.097
Perceived ease of use	5.263	1.092	.912	PEU1	5.362	1.116
				PEU2	5.238	1.120
				PEU3	5.191	1.306
Subjective norm	5.349	1.042	.904	SN1	5.391	1.210
				SN2	5.267	1.109
				SN3	5.391	1.094
Attitudes	5.495	.999	.888	AT1	5.571	1.156
				AT2	5.448	1.071
				AT3	5.467	1.090
Supporting condition	5.425	. 983	.865	SC1	5.391	1.049
				SC2	5.438	1.089
				SC3	5.448	1.182
Self-efficacy	5.349	1.029	.925	SE1	5.438	1.062
				SE2	5.314	1.092
				SE3	5.295	1.157
Use of m-LMS	5.137	1.062	.874	USE1	5.133	1.268
				USE2	5.105	1.213
				USE3	5.171	1.076

Besides the descriptive statistics reports, the current study also informs whether the demographic information (gender, university, age, and year in university) differs in

regard to the use of m-LMS. The t-test was used to examine the difference of the use of m-LMS in terms of gender and university while ANOVA was applied to assess the difference regarding years in university and age. Table 2 shows the results of the t-test informing that a significant difference emerges in regard to the use of m-LMS in terms of gender ($t = 2.595$; $p < .05$). However, no significant differences is found for the use of m-LMS based on the university ($t = 1.593$; $p > .05$). The ANOVA test exhibits that no significant difference is found based on years in university ($F = .995$; $p > .005$) in relation to the use of m-LMS. However, a significant difference emerged based on age ($F = 13.846$; $p > .005$).

4.2 Qualitative

Perceived usefulness and perceived ease of use: The interview results reinforced the survey findings. The codes in the interview data were merged to establish three themes for perceived usefulness and perceived ease of use: Value for effective learning and easy to use but difficult to integrate within lessons.

Value for effective learning: The interview informed that the improvement of students' learning was the most frequently cited reason to use m-LMS. All 7 interviewees mentioned that they used m-LMS in their learning due to its benefits. They perceived the use of m-LMS as a suporting way to communicate in the classroom and to have them be more involved into varied learning experiences and extended time for learning. For instance, one of the PSTs had her comment,

> "m-LMS enhances learning by facilitating some types of learning opportunities for us. We can utilize m-LMS to link with friends and lecturers outside the classroom and to have other learning environments into the classroom."

Similarly, another PST stated in the interview that she thinks that m-LMS is a great way to build communication in the classroom and have students more involved. They also highlighted that m-LMS technologies are appropriate tools to help explain learning concepts better and cater to the needs of different learning styles they have. For instance, one of the interviewees mentioned that m-LMS can visually elaborate concepts which would be good for them because they tend to be more visual learners.

Easy to use: Almost all (n =7) of the PSTs felt that m-LMS are easy to operate. They also informed that technology can better the efficiency of their work.

> "I am more than open to using the technology in my learning because these technologies let things be easier and it can save our time in learning, a very efficient way to learn."

Difficult to integrate within lessons: Although the PSTs felt very confident using m-LMS technologies, they believed that it requires more effort for their lecturers or professors to come up with new ideas that have been already available. Most of them believed that it might be challenging for them. One of the PSTs stated that he ever once proposed to his lecturers that a new fresh idea should be implemented for the use of m-LMS in their lectures so that it can decrease the feeling of "bored" for the repeating tasks in the m-LMS.

Subjective norm and attitudes: Two themes associated with subjective norm and attitudes found in the analysis of the interview data: Need to meet the needs of digital age and expectations of lecturers and peers.

Need to meet the needs of the digital age: During the interviews, the influence exerted emerged as an important consideration among the PSTs when describing their use of m-LMS into their learning. All PSTs consider that the ways in learning are influenced by the use of m-LMS they use,

> "I hope more lecturers will use the m-LMS in their teaching. It is very important for us as millennials to get more engaged in technology especially mobile learning. It is expected more applications are utilized in our department."

Most of the interviewees (n = 5) thought that using m-LMS technologies will enable them to be more connected to their peers in the current digital age. One of the participants informed that in the digital age the use of m-LMS or mobile learning cannot be avoided since this could make people more connected.

Expectations of lecturers and peers: The participants indicated that their use of m-LMS is influenced by their lecturers and peers when talking about people's influence on the use of mobile learning in their education. Six of the 7 interviewees believe that their lecturers always expect them to use the technology; one of the interviewees had her opinion,

> "I think that lecturers who are encouraging more m-LMS technology to be used in our courses can be very influential because it is more interesting and helps us learn creatively."

All PSTs felt that their peers' successes with the use of m-LMS in learning to influence their action to use m-LMS. As one of the PSTs stated in the interview that if his peers did well in learning using m-LMS. So he would also use m-LMS in a maximal way.

Self-efficacy and supporting condition: Two themes associated with self-efficacy and supporting conditions emerged from our analysis of data: High self-efficacy for m-LMS and anytime/anywhere access to m-LMS.

High self-efficacy for m-LMS: The interview data informed that all participants felt very comfortable using m-LMS. Therefore, they have high self-efficacy for the use of m-LMS in their learning.

> "In general, m-LMS technologies are easy to use. I have a very high self-efficacy in using m-LMS in my learning."

When discussing their skills and knowledge about mobile technology, the participants mentioned that they are skilled in finding the right applications in their smartphone and have the ability on their use. One of the interviewees said that as a millennial, she had no problems in using mobile phone application including m-LMS. She continued that she was very confidence if her lecturers assigned her to use m-LMS in her learning.

Anytime/anywhere access to m-LMS: The data reported that PSTs perceived m-LMS as useful because of easy and quick access inside and outside of the classroom. Most of the participants believed that m-LMS address them more resources which are

even accessible from outside the classroom as long as they have their smartphone in their hand.

"Using m-LMS allows us to access lessons from anywhere. As long as we have access to the internet and we have our smartphone, we can access the m-LMS from any place."

Many applications in m-LMS would help them learn more effectively. Moreover, some of the PSTs believed that due to the accessibility of m-LMS, the technologies could broaden PSTs' knowledge and provide interaction by sharing ideas with other people. Generally, the participants of the interview seemed to have great motivation in using m-LMS for their learning because they have increased interaction, information, and resource accesses.

5 Discussion

The purpose of this research is to investigate factors affecting Indonesian PSTs' use of m-LMS in higher education. The difference regarding the use of m-LMS based on some demographic information namely gender, university, year in university, and age are also reported. To support the survey data, 7 PSTs were interviewed to gain an in-depth understanding of the use of m-LMS in Indonesian universities.

The findings of the survey inform that the average perception of the students of the TAM factors is moderate that is understood from the mean of each indicator. The quantitative analysis also reports that a significant difference is found in regard to the use of m-LMS based on gender and age. The data analysis of this mix method study revealed that Indonesian PSTs in the two universities believed that the adoption of m-LMS technologies into learning in higher education is very beneficial and has improved their learning. This perceived usefulness of m-LMS technologies was encouraged by the value of m-LMS technology for improving the engagement, communication, and improving the overall learning experiences by incorporating innovative learning tools to which students can have the relationship. These results are similar to that of [13] who noted that m-LMS increases engagement in learning among students because they can be used to develop creativity and critical thinking collaboratively.

Besides, the PSTs in this study believed that m-LMS are very easy to use. As millennials, they use technology especially mobile devices on a daily basis that make the tools to be their daily friends. Some of them even acknowledge that they cannot live without their gadgets. This finding corroborates [14] findings that PSTs found m-LMS easy to use for their own personal needs. These results suggest that m-LMS can create a more engaging environment for PSTs in learning in higher education due to their familiarity with mobile devices.

The PSTs in this study also perceived that the adoption of m-LMS is influenced by their lecturers and peers as part of the subjective norm in the TAM framework. These findings could be comprehended as the influences of the culture of the east that always respect other people and therefore they are always influenced by other peoples' actions. Indonesian tend to respect other people's opinions and have a

tendency to imitate what other people do, including for the PSTs in learning with m-LMS [7]

The reports of this study inform that the PSTs are encouraged to use m-LMS technologies due to their high self-efficacy perception regarding their knowledge and ability to have these technologies used inside and outside classrooms. One certain possible cause for these findings might focus on the fact that the participants in our study involve every day with their gadgets on a daily basis. This belief echoes previous studies' results informing m-LMS self-efficacy as a positive influence on students' use of m-LMS in higher [14]. Besides high self-efficacy, PSTs in this study also believe that learning through m-LMS can be referred to anytime and anywhere access to the technology and become a positive influence on their use of m-LMS in learning. They believed that possessing easy access to more information, resources, and tools not only facilitate motivation to use the technology inside the classroom but will also facilitate them to use the technology outside the classroom.

6 Conclusion

The results indicate that the PSTs' use of m-LMS technologies in history education is affected by perceived usefulness, perceived ease of use, subjective norm, attitudes, supporting condition, and self-efficacy. The findings recommend that teacher education programs should always provide encouragement to make these factors promoted to better prepare PSTs in learning using m-LMS technologies and also use the m-LMS for their future careers as future teachers. Teacher educators or lecturers should target PSTs' beliefs on the values of these technologies in learning and teaching. Providing PSTs more opportunities to use m-LMS reflect on the pedagogical implications of m-LMS technology integration can have a positive influence on their use of m-LMS in their daily learning and their future careers. Success in this term may need the implementation of some progressive steps for the teacher education experience, for instance, to support beliefs progressing about positive use in m-LMS learning. Future studies should determine the specific interventions that align with PSTs' perceived usefulness, perceived ease of use, subjective norm, attitudes, supporting condition, and self-efficacy to help teacher education programs develop a better preparation for their PSTs to integrate m-LMS in higher education. Besides, longitudinal researches may be planned to determine if these perceptions about using m-LMS. A complex statistical analysis such as structural equation modeling should also be an option.

7 Acknowledgement

This research is co funded by Universitas Negeri Yogyakarta and Universitas Jambi.

8 References

[1] Han, I., & Shin, W. S. (2016). The use of a mobile learning management system and academic achievement of online students. Computers & Education, 102, 79–89. https://doi.org/10.1016/j.compedu.2016.07.003

[2] Gao, S., Krogstie, J., & Siau, K. (2014). Adoption of mobile information services: An empirical study. Mobile Information Systems, 10, 147–171. https://doi.org/10.1155/2014/146435

[3] Brantes Ferreira, J., Zanela Klein, A., Freitas, A., & Schlemmer, E. (2013). Mobile learning: definition, uses and challenges. In Increasing student engagement and retention using mobile applications: Smartphones, Skype and texting technologies (pp. 47-82). Emerald Group Publishing Limited. https://doi.org/10.1108/s2044-9968(2013)000006d005

[4] Davis, F. D. (1989). Perceived usefulness, perceived ease of use and user acceptance of information technology. MIS Quarterly, 13, 319–340. https://doi.org/10.2307/249008

[5] Ajzen, I. (1991). The theory of planned behavior. Organizational Behavior and Human Decision Processes, 50, 179–211. https://doi.org/10.1016/0749-5978(91)90020-t

[6] Rogers, E. M. (1995). The diffusion of innovations. New York: Free Press.

[7] Muhaimin, Habibi, A., Mukminin, A., Pratama, R., Asrial, & Harja, H. (2019). Predicting factors affecting intention to use web 2.0 in learning: Evidence from science education. Journal of Baltic Science Education, 18(4), 595-606. https://doi.org/10.33225/jbse/19.18.595

[8] Gefen, D. (2003). TAM or just plain habit: A look at experienced online shoppers. Journal of End User Computing, 15, 1–13. https://doi.org/10.4018/9781591402572.ch001

[9] Pavlou, P. A. (2003). Consumer acceptance of electronic commerce: Integrating trust and risk with the technology acceptance model. International Journal of Electronic Commerce, 7, 101–134. https://doi.org/10.1080/10864415.2003.11044275

[10] Alharbi, S., & Drew, S. (2014). Using the technology acceptance model in understanding academics' behavioural intention to use learning management systems. International Journal of Advanced Computer Science and Applications, 5, 143–155. https://doi.org/10.14569/ijacsa.2014.050120

[11] Hsu, H.-H., & Chang, Y. Y. (2013). Extended TAM model: Impacts of convenience on acceptance and use of Moodle. US-China Education Review, 3, 211–218.

[12] Park, S. Y., Nam, M. W., & Cha, S. B. (2012). University students' behavioral intention to use mobile learning: Evaluating the technology acceptance model. British Journal of Educational Technology, 43: 592–605. https://doi.org/10.1111/j.1467-8535.2011.01229.x

[13] Iqbal, S., & Bhatti, Z. A. (2017). What drives m-learning? An empirical investigation of university student perceptions in Pakistan. Higher Education Research & Development, 36: 730–746. https://doi.org/10.1080/07294360.2016.1236782

[14] Saroia, A. I., & Gao, S. (2018). Investigating university students' intention to use mobile learning management systems in Sweden. Innovations in Education and Teaching International, 1-12. https://doi.org/10.1080/14703297.2018.1557068.

[15] Habibi, A., Yusop, F, D., & Rafiza, A. R. (2019). The dataset for validation of factors affecting pre-service teachers' use of ICT during teaching practices: Indonesian context. Data in Brief, 28. https://doi.org/10.1016/j.dib.2019.104875

[16] Behr, D. (2017). Assessing the use of back translation: The shortcomings of back translation as a quality testing method. International Journal of Social Research Methodology, 20(6): 573-584. https://doi.org/10.1080/13645579.2016.1252188

[17] Luschei, T. F. (2017). 20 Years of TIMSS: Lessons for Indonesia. Indonesian Research Journal in Education| IRJE|, 6-17.

[18] Hair, J. F., Black, W. C., & Babin, B. J. (2010). Multivariate data analysis. New Jersey, Pearson Prentice Hall.
[19] Ryan, G, W. (2004). Using a Word processor to tag and retrieve blocks of text. Field Methods, 16(1): 109–30. https://doi.org/10.1177/1525822x03261269
[20] Prasojo, L. D., Mukminin, A., Habibi, A., Marzulina, L., Muhammad, S., & Harto, K. (2018). Learning to teach in a digital age: ICT integration and EFL student teachers' teaching practices. Teaching English with Technology, 18(3): 18-32.

9 Authors

Aman is an associate Professor of Universitas Negeri Yogyakarta, Faculty of education. Jl. Colombo No.1, Karang Malang, Caturtunggal, Kec. Depok, Kabupaten Sleman, Daerah Istimewa Yogyakarta 55281, Indonesia.

Lantip Diat Prasojo is a full Professor of educational technology at educational management study program of Universitas Negeri Yogyakarta. He is the head of Indonesian educational management teacher educators.

Muhammad Sofwan is a senior lecturer working at Universitas Jambi, Indonesia. Jl. Lintas Sumatera Jl. Jambi - Muara Bulian No.Km. 15, Mendalo Darat, Kec. Jambi Luar Kota, Kabupaten Muaro Jambi, Jambi 36122, Indonesia

Amirul Mukminin is a Faculty member at Faculty of Education/Graduate School, Jambi University, Indonesia. He holds a PhD from Florida State University, USA in Educational Leadership and Policy Studies and MS in educational sciences from Groningen University, the Netherlands.

Akhmad Habibi is an educational researcher working at Universitas Jambi, Indonesia. Focusing on statistics and education, he has published his works in many journals (e.g. Education and Information Technologies, Heliyon, Data in Brief, SageOpen, The Qualitative Report, Electronic Journal of e-Learning, Journal of Baltic of Educational Science, etc.). He is a reviewer for some reputable journals like Heliyon, IEEE Access, SageOpen, Accountability in Research, International Journal of Instruction, etc.

Lalu Nurul Yaqin is lecturer at Universitas Gunung Rinjani, No.KM 59, Jl. Raya Mataram - Labuhan Lombok, Anjani, Selong, Kabupaten Lombok Timur, Nusa Tenggara Bar. 83659, Indonesia.

Article submitted 2019-10-26. Resubmitted 2019-12-17. Final acceptance 2019-12-18. Final version published as submitted by the authors.

Multimedia Learning Modules (MLMs) Based on Local Wisdom in Physics Learning to Improve Student Diagram Representations in Realizing the Nature of Science

https://doi.org/10.3991/ijim.v14i06.11640

Warsono (✉), Puji Iman Nursuhud, Rio Sandhika Darma, Supahar, Danis Alif Oktavia, Ahdika Setiyadi, Mas Aji Kurniawan
Universitas Negeri Yogyakarta, Yogyakarta, Indonesia
warsono@uny.ac.id

Abstract—This research was conducted to determine the feasibility of the instrument diagram representation test and the effectiveness of Multimedia Learning Modules (MLMs) integrated local wisdom in physics learning activities. The study design used a pretest-posttest control group design. The research instrument consisted of tests and non-tests. The test instrument was in the form of five items arranged according to the diagram representation indicators, namely drawing diagrams and their components and performing mathematical calculations according to the diagram explanation. The non-test instrument is a questionnaire study of test instruments. The validation of the test instrument was carried out using Aiken's V. The data analysis techniques used the General Linear Model (GLM) with a significance level of 0.05 to test the effectiveness of integrated local wisdom MLMs in improving student diagram representation. The results showed that the overall item items were declared valid with Aiken's V score in the range of 0.88 to 0.92 and the integrated local wisdom MLMs were effectively used in physics learning activities to improve student diagram representation based on Mean Difference (MD) values of -54,449.

Keywords—Diagrams, test instruments, local wisdom, multimedia learning modules, representations

1 Introduction

Physics learning in 21st century is very closely related to technological development. Rapidly developing technology makes learning activities more dynamic. Learning activities that require representation ability can be integrated with technologies such as interactive multimedia. The application of interactive multimedia has a positive impact as a support for learning to improve students' understanding of concepts [1]. Agreeing with this, interactive multimedia can also be used to improve problem-solving abilities [2]. In addition, the involvement of multimedia in learning

activities can also improve learning achievement, positive attitudes and student motivation compared to conventional learning [3][4]. This indicates that the development of learning is in harmony with the development of technology so that media is needed that can be used to facilitate the delivery of material concepts.

Multimedia Learning Modules (MLMs) are introductory media that aim to motivate students to actively participate and be able to prepare and have preliminary knowledge before learning activities begin [5][6][7]. MLMs are made in the form of multimedia presentations in the form of graphic, text, video, narrative, animation and audio features that are realized with various forms of representation [3][4][7][8][9]. Various forms of representation provided a positive impact in the form of wealth of information from the use of MLMs so as to make learning activities more effective, increase students' understanding and motivation and students can obtain meaningful information and levels of understanding increase if they can link existing representations [3][10][11][12]. MLMs are used as a learning tool to reduce the limitations of the use of less effective textbooks where students only read books without taking more important information [7][13][14][15].

Indonesian Minister of Education and Culture Regulation No. 22 of 2016 concerning the standard process states that learning at primary and secondary levels must be held interactively, inspiratively, fun and can motivate students to actively participate in learning according to their interests and talents. But in reality, the teacher does not understand these aspects so physics tends to be learning that is abstract, difficult to understand and does not motivate students [16]. Learning that is abstract and difficult to understand can lead to negative perceptions related to the learning material. Students' negative perceptions of physics learning come from several factors such as teachers, peers and family, the community environment, and several other internal and external factors [17]. These factors influence the formation of character, attitudes, thought patterns and behavior of students in the development of perception and knowledge into a form of learning experience. This statement agrees with the results of the research by [18] which shows a positive relationship between students' perceptions of physics learning activities. Therefore, physics learning can be carried out well if students have positive perceptions that are able to encourage interactive, inspirational and challenging learning so that it is easier to understand.

Good learning suggests linking the concept of learning with the phenomena of everyday life so that the process of knowledge transfer becomes more meaningful. Meaningful learning can be realized by integrating local wisdom in its implementation [19]. The application of local wisdom to learning activities can make learning conditions more enjoyable. This makes students able to feel their experiences in daily life closer to learning [20]. In addition, learning activities by applying local wisdom also have a positive influence on the character of students and are able to improve academic achievement [21].

Positive influences related to increasing student academic achievement in the abstract and difficult to understand physics learning process can be realized by implementing appropriate problem solving strategies. The process of finding a solution to a problem depends on the solution strategy applied [22]. One strategy that

can be used in solving problems (problem solving) is to use representation [23]. Representation can be used to solve physics problems [24]. A similar sentiment was also conveyed by Kurnaz and Arslan who explained that the use of representations during physics learning activities can make the learning process more meaningful and enhance students' understanding of concepts [25].

Diagrams are a form of representation that is often used to solve physics problems. The use of diagrams is very important to explain and understand phenomena from various kinds of multidisciplinary science [26]. Physics is learning about natural phenomena which are divided into several parts including kinematics and dynamics [23]. Some physical concepts related to kinematics and dynamics include force, motion, momentum and energy [23]. These materials must be understood and mastered by students because they relate in everyday life. But in reality, students still have difficulty understanding material related to the concepts of kinematics and dynamics. This is because these materials use diagrams as a means of representation in their learning [27]. The results of research show that some students still have difficulty in drawing free diagrams [28][29].

Diagrams as a form of representation help students interpret, represent and implement problem solving strategies to solve problems (problem solving) they face [30]. The representation of diagrams known in physics learning includes free-body diagrams, field line diagrams, energy bar charts [31] and among others. The advantages of using diagrams as representations are:

1. Diagrams help to explain scientific phenomena that occur easily
2. Diagrams provide a means to analyze and understand scientific phenomena
3. The diagram can be used as a means to identify cognitive abilities [32]

In addition, several advantages of using diagrams as representations such as:

1. Diagrams showing scientific cases explicitly
2. Diagrams act as bridging representations between real (concrete) and abstract situations
3. Diagrams help to foster intuition [33]

This study aims to test the feasibility of the instrument test the ability to represent diagrams and the effectiveness of Multimedia Learning Modules (MLMs) integrated local wisdom in physics learning activities.

2 Research Methods

This research uses a quantitative approach with a pretest-posttest control group design. Field testing was conducted to draw conclusions related to the implementation of Multimedia Learning Modules (MLMs) in physics learning to improve student diagram representation. Field testing was carried out on three classes of Natural Sciences in SMA 2 Batang chosen randomly using the cluster random sampling technique. Table 1 shows the research design used.

Table 1. Research Design

Group	Pretest		Treatment	Postest	
	Y₁	***Y₂***		***Y₁***	***Y₂***
Experiment	T_1	T_1	X_1	T_2	T_2
Contrast 1	T_1	T_1	X_2	T_2	T_2
Contrast 2	T_1	T_1	X_3	T_2	T_2

Information

T_1 : *Pretest*

T_2 : *Postest*

Y_1 : Diagrammatic representation

Y_2 : Vector Representation

X_1 : Using Multimedia Learning Modules (MLMs) integrated local wisdom

X_2 : Using the integrated local wisdom print module

X_3 : Use common modules used by the teacher

The research instrument was in the form of a cognitive ability test consisting of five items arranged according to indicators. Table 2 shows the item grids based on the diagram representation indicators. The test instrument was validated using Aiken's V based on the number of assessors (rater) and the rating scale used. The test instrument is declared valid if it has a coefficient value of Aiken's V of $V \geq 0.75$ with a number of rater 8 people and a rating scale ranging from 1 to 4 [34].

Table 2. Diagram Representation Capability Test Chart

Grid			
Indicator of Diagram Representation	Problem Indicator	Item Number	Bloom's Taxonomic Aspects
Draw a diagram with its components	Draw a free diagram of the forces acting on a traditional rowing boat that has zero momentum	1	C3
	Depicts the motion diagram of a traditional rowing boat	3	C3
	Draw a contact force diagram between water and rowing in a traditional rowing competition	2	C3
Perform mathematical calculations according to the diagram explanation	Determine the impulsive force based on the concept of the relationship of momentum and impulse	4	C3
	Determine the speed of the boat after the impact based on the law of conservation of momentum	5	C3

(Adapted from [35][36])

Data analysis techniques in the study used the General Linear Model (GLM) to infer an increase in students' diagram representation abilities. Improvement of students' diagram representation skills is seen based on the analysis of the pretest and posttest scores by comparing the value of the Mean Difference results of the output of the General Linear Model (GLM) mixed design [37].

3 Result and Discussion

3.1 Feasibility analysis instrument representation test diagram

The feasibility analysis of the diagram representation test instrument uses Aiken's V. The results of the Aiken V analysis show that the diagram representation test instrument is in the valid category. Table 3 shows the results of the analysis of the instrument assessment test representation diagram. Figure 1 shows the instrument of diagrammatic ability test used in this research.

1. Perahu memiliki massa m mengapung di air dan memiliki momentum sama dengan nol. Gambarkan diagram bebas gaya-gaya yang bekerja pada perahu!

2. Impuls yang dihasilkan ketika dayung bersentuhan dengan air pada lomba dayung tradisional adalah 200 Ns. Interaksi antara dayung dengan air terjadi selama 0,4 detik. Gambarkan diagram gaya kontak antara dayung dengan air!

3. Perahu lomba dayung bermassa 250 kg berada pada kondisi diam pada $t = 0$ detik. Selama 5 detik perahu bergerak sampai kecepatannya $v = 2$ m/s. Gambarkan diagram gerak perahu dari kondisi $t = 0$ sampai $t = 5$ detik! ($g = 10$ m/s)

4. Perahu bermassa 300 kg didayung pada lomba dayung tradisional. Selama 3 detik, gerak perahu seperti pada diagram di bawah ini.Tentukan gaya impulsif yang dikenakan dayung terhadap air!

5. Perahu A dan B memiliki massa sama 300 kg. Perahu A bergerak menumbuk perahu B yang berada pada kondisi diam seperti pada diagram di bawah ini. Setelah bertumbukan, kedua perahu bergerak bersama sebelum akhirnya tenggelam. Tentukan kecepatan kedua perahu sesaat setelah tumbukan!

Fig. 1. The Instrument of Diagrammatic Representation Ability used in Research

Table 3. Assessment Instrument Representation Test Diagram

Representation	Item Question	Aiken's V score	Criteria
Diagram	2,5	0,88	Valid
	1,3,4	0,92	Valid

The assessment of the instrument diagram representation test obtained Aiken's V score in the range of 0.88 to 0.92 which is in the valid criteria. This is in accordance with the validation criteria according to Aiken's V which states that for 8 validators and a rating scale ranging from 1 to 4, items are declared valid if obtaining an Aiken's V score ≥ 0.75 [34].

3.2 Analysis of improvement of student diagram representation

Data analysis to test the increase in student diagram representation is to use the General Linear Model (GLM). The analysis was carried out based on the students' pretest and posttest scores in doing diagram representation tests by interpreting Mean Difference (MD) and significance (Sig.) outputs on pairwise comparisons output. The results of the analysis are presented in Table 4.

Table 4. Pairwise Comparisons of Diagrammatic Representation

Group	Time (I)	Time (J)	Mean Difference (I-J)	Sig.
MLMs integrated local wisdom	Pretes	Postes	-54.449	.000
Integrated local wisdom print module	Pretes	Postes	-15.221	.000
General modules used by the teacher	Pretes	Postes	-13.110	.000

Table 4 shows the GLM output associated with increasing student diagram representation. Conclusions are based on significance (Sig.). Ho is rejected and Ha is accepted if the Sig value < 0.05. Table 4 in the significance column (Sig.) obtained a value of .000 which proves that Ho was rejected and Ha was accepted, meaning that there was a significant increase in the representation of student diagrams in the MLMs class integrated with local wisdom compared to the printed class module in local wisdom and the general modules used by the teacher. Significant improvement is evidenced from the Mean Difference value of -54,449 for the integrated local wisdom class MLMs, -15,221 for the integrated local wisdom module print class and -13,110 for the general module class used by the teacher. The Mean Difference value is used to show how much an increase in the student diagram representation. Mean difference (MD) is obtained from the reduction of the mean pretest score against the posttest score. The increasingly negative MD scores in Table 4 prove that there is a significant increase in the representation of student diagrams based on pretest and posttest scores. The pairwise comparisons output results in Table 4 prove that the MLMs class integrated with local wisdom gives a better score improvement than the printed class integrated local wisdom module and the general module used by the teacher to obtain an MD of -54,449 [37]. MD which has negative value proves that there is an increase in score from pretest to posttest [38].

Improvement of students' diagram representation ability is determined based on the analysis of the pretest and posttest scores displayed by the Estimated Marginal Means plot graph. The plot of increasing student diagram representation is presented in Figure 2. Figure 2 shows that the use of integrated local wisdom MLMs is able to increase student diagram representation. This is in agreement with the research which states that learning by applying MLMs can improve the ability of representation better than traditional learning [6]. In addition, meaningful learning can be realized by integrating local wisdom so that it can improve student academic achievement [19][20][21]. The intersection of lines between MLMs integrated local wisdom classes with print classes integrated local wisdom modules and the general modules used by the teacher in Figure 2 shows the interaction between MLMs integrated local

wisdom classes, print modules integrated with local wisdom, and general modules used by teachers. This shows the influence generated between classes. The causes of the interaction include a number of students in the printed module integrated with local wisdom or the general module used by the teacher asking the experimental class students about the learning material. The effectiveness of MLMs in this study is in accordance with the results of other research which state that MLMs are a solution in overcoming the use of print media that are less effective [7][38].

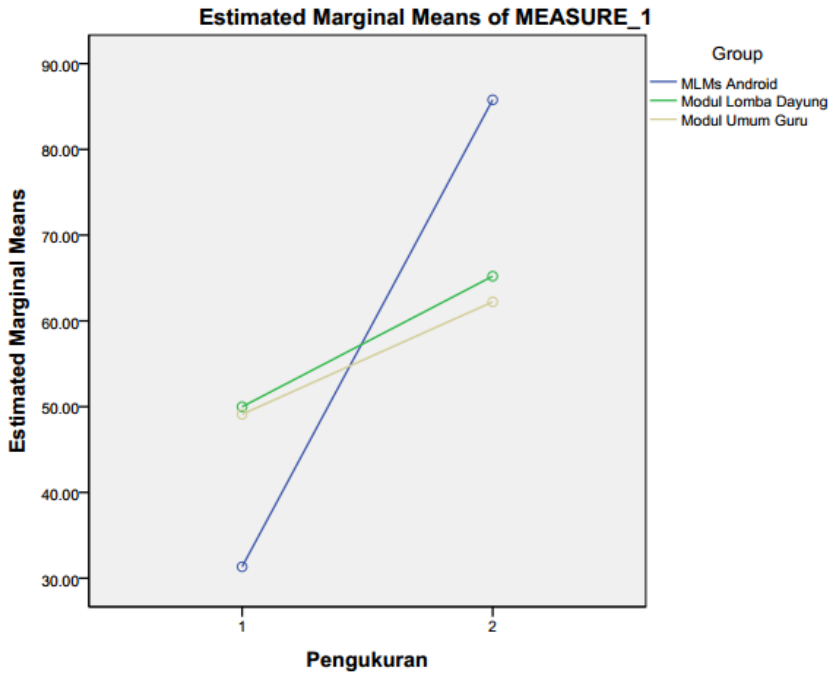


Fig. 2. Estimation Chart for Increased Student Diagram Representation

4 Conclusion and Future Work

In this study, the implementation of the influence of Multimedia Learning Modules (MLMs) integrated local wisdom on physics learning has been carried out to improve the representation ability of student diagrams. The results showed that Multimedia Learning Modules (MLMs) integrated with local wisdom can improve students' diagram representation abilities. Improved student diagram representation ability is obtained based on the analysis of pretest and posttest scores after using Multimedia Learning Modules (MLMs) in physics learning with General Linear Model (GLM) techniques. Analysis technique using GLM proves that the MLMs class integrated with local wisdom gives improved scores better than the paddle race module class and the general teacher module by obtaining a Mean Difference (MD) score of -54,449. This value proves a significant increase related to student diagram representation.

Suggestions for further research can be to develop multimedia learning modules based on local wisdom of other regions in Indonesia to improve the ability of physics representation and high-level thinking of students. In addition, it can be integrated with evaluation questions to measure students' high-level representation and thinking skills.

5 Acknowledgement

Thank you to the Directorate of Research and Community Service of the Ministry of Research and Higher Education, Indonesia for assisting in funding this research.

6 References

[1] Andarini, H. D., Swasty, W., Hidayat, D., & Media, A. L. (2016). Designing the interactive multimedia learning for elementary students grade 1 st -3 rd a case of plants (Natural Science Subject). Fourth International Conference on Information and Communication Technologies, 4(c), 1–5. https://doi.org/10.1109/icoict.2016.7571873

[2] Ramganesh, E. (2012). Effect of self-regulatory strategies with interactive multimedia on problem solving ability of higher secondary students in physics. Shodh Sanchayan, 3(2), 1–5.

[3] Leow, M. F., & Neo, M. (2014). Interactive multimedia learning: innovating classroom education in a Malaysian University, The Turkish Online Journal of Educational Technology, 13(2), 99–110.

[4] Li, Y. W. (2014). Transforming Conventional Teaching Classroom to Learner-Centred Teaching Classroom Using Multimedia-Mediated Learning Module. International Journal of Information and Education Technology, 6(2), 105–112. https://doi.org/10.7763/ijiet.2016.v6.667

[5] Chen, Z., Stelzer, T., & Gladding, G. (2010). Using multimedia modules to better prepare students for introductory physics lecture. Physical Review Special Topics - Physics Education Research, 6(1), 1–5. https://doi.org/10.1103/PhysRevSTPER.6.010108

[6] Hill, M., Sharma, M. D., & Johnston, H. (2015). How online learning modules can improve the representational fluency and conceptual understanding of university physics students. European Journal of Physics, 36(4), 45019. https://doi.org/10.1088/0143-0807/36/4/045019

[7] Sadaghiani, H. R. (2012). Controlled study on the effectiveness of multimedia learning modules for teaching mechanics. Physical Review Special Topics - Physics Education Research, 8(1), 1–7. https://doi.org/10.1103/PhysRevSTPER.8.010103

[8] Hazra, A. K., Patnaik, P., & Suar, D. (2013). Relation of modal preference with performance in adaptive hypermedia context: An exploration using visual, verbal and multimedia learning modules. Proceedings - 2013 IEEE 5th International Conference on Technology for Education, T4E 2013, 163–166. https://doi.org/10.1109/T4E.2013.47

[9] Sadaghiani, H. R. (2011). Using multimedia learning modules in a hybrid-online course in electricity and magnetism. Physical Review Special Topics - Physics Education Research, 7(1), 1–7. https://doi.org/10.1103/PhysRevSTPER.7.010102

[10] Lee, T. T., & Osman, K. (2012). Interactive multimedia module in the learning of electrochemistry: effects on students' understanding and motivation. Procedia - Social and Behavioral Sciences, 46, 1323–1327. https://doi.org/10.1016/j.sbspro.2012.05.295
[11] Li, Y. W., Mai, N., & Tse-Kian, N. (2014). Impact of learner-centred teaching environment with the use of multimedia-mediated learning modules in improving learning experience. Jurnal Teknologi (Sciences and Engineering), 68(2), 65–71. https://doi.org/10.11113/jt.v68.2911
[12] Mayer, E.R. (2016). Multimedia learning (2nd ed). New York: Cambridge University Press.
[13] Nursuhud, P. I., Oktavia, D. A., Kurniawan, M. A., & Wilujeng, I. (2019). Multimedia Learning Modules Development based on Android Assisted in Light Diffraction Concept. Journal of Physics: Conference Series. https://doi.org/10.1088/1742-6596/1233/1/012056
[14] Oktavia, D. A., Nursuhud, P. I., Kurniawan, M. A., Jumadi, Wilujeng, I., & Kuswanto, H. (2019). Application of Multimedia Learning Modules assisted by "Tracker" Virtual Laboratory to Train Verbal Representation of Class XI High School Students. Journal of Physics: Conference Series, 1233, 012055. https://doi.org/10.1088/1742-6596/1233/1/012055
[15] Stelzer, T., Gladding, G., Mestre, J., & Brookes, D. T. (2008). Comparing the efficacy of multimedia modules with traditional textbooks for learning introductory physics content. *American Journal of Physics*, 184(2009), 184-190. https://doi.org/10.1119/1.3028204
[16] Arief, M. K., Handayani, L., & Dwijananti, P. (2012). Identifikasi kesulitan belajar fisika pada siswa RSBI: studi kasus di RSMABI se kota Semarang. Unnes Physics Education Journal, 1(2), 5-10. Retrieved from http://journal.unnes.ac.id/sju/index.php/upej
[17] Checkley, D. (2010). High school students' perception of physics, (February). Tesis, tidak diterbitkan, University of Lethbridge, Alberta.
[18] Yoon, S. Y., Suh, J. K., & Park, S. (2014). Korean students perceptions of scientific practices and understanding of nature of science. International Journal of Science Education, 36(16), 2666-2693. https://doi.org/10.1080/09500693.2014.928834
[19] Prasetyo, Z. K. (2013). Pembelajaran sains berbasis kearifan lokal. Makalah disajikan dalam Seminar Nasional Fisika dan Pendidikan Fisika, di Universitas Sebelas Maret. https://doi.org/10.25273/jems.v2i1.172
[20] Dewi, I. N., Poedjiastoeti, S., Prahani, K., & Sri Poedjiastoeti. (2017). Elsii learning model based local wisdom to improve students' problem solving skills and scientific communication. International Journal of Education and Research, 5(1), 107–118. https://doi.org/10.1088/1742-6596/1157/2/022014
[21] Subali, B., Sopyan, A., & Ellianawati, E. (2015). Developing local wisdom based science learning design to establish positive character in elementary school. Jurnal Pendidikan Fisika Indonesia, 11(1), 1–7. https://doi.org/10.15294/jpfi.v11i1.3998
[22] Schoenfeld, A. H. (2013). Reflections on problem solving theory and practice reflections on problem solving theory and practice. The Mathematics Enthusiast, 10(1), 9-34.
[23] Docktor, J. L., & Mestre, J. P. (2014). Synthesis of discipline-based education research in physics. Physical Review Special Topics - Physics Education Research, 10(2), 1–58. https://doi.org/10.1103/PhysRevSTPER.10.020119
[24] De Cock, M. (2012). Representation use and strategy choice in physics problem solving. Physical Review Special Topics - Physics Education Research, 8(2), 1–15. https://doi.org/10.1103/PhysRevSTPER.8.020117
[25] Kurnaz, M. A., & Arslan, Ğ. L. A. M. (2014). Effectiveness of multiple representations for learning energy concepts : Case of Turkey, Procedia - Social and Behavioral Sciences, 116, 627–632. https://doi.org/10.1016/j.sbspro.2014.01.269

[26] Purchase, H. C. (2014). Journal of Visual Languages and Computing Twelve years of diagrams research. Journal of Visual Language and Computing, 25(2), 57–75. https://doi.org/10.1016/j.jvlc.2013.11.004
[27] Manalo, E., Uesaka, Y., Pérez-kriz, S., & Fukaya, T. (2013). Science and engineering students ' use of diagrams during note taking versus explanation, Educational Studies, 39(1), 37–41. https://doi.org/10.1080/03055698.2012.680577
[28] Nieminen, P., & Viiri, J. (2013). Does using a visual-representation tool foster students ' ability to identify forces and construct free-body diagrams, Physical Review Special Topics - Physics Education Research, 010104, 1–11. https://doi.org/10.1103/PhysRevSTPER.9.010104
[29] Ardi, F. L. (2017). Pengembangan perangkat pembelajaran fisika berbasis kearifan lokal (andong) berbantuan android untuk meningkatkan kemampuan representasi diagram dan representasi vektor. Tesis, tidak diterbitkan, Universitas Negeri Yogyakarta, Yogyakarta. https://doi.org/10.25157/.v1i2.545
[30] Chu, J., Rittle-Johnson, B., & Fyfe, E. R. (2017). Diagrams benefit symbolic problem-solving. British Journal of Educational Psychology, 87(2), 273–287. https://doi.org/10.1111/bjep.12149
[31] Docktor, J. L., Strand, N. E., Mestre, J. P., & Ross, B. H. (2015). Conceptual problem solving in high school physics. Physical Review Special Topics - Physics Education Research, 11(2), 1–13. https://doi.org/10.1103/PhysRevSTPER.11.020106
[32] Sheredos, B., Burnston, D., Abrahamsen, A., & Bechtel, W. (2014). Why do biologists use so many diagrams. Philosophy of Science, 80(5), 931–944. https://doi.org/10.1086/674047
[33] Savinainen, A., Mäkynen, A., Nieminen, P., & Viiri, J. (2013). Does using a visual-representation tool foster students' ability to identify forces and construct free-body diagrams. Physical Review Special Topics - Physics Education Research, 9(1), 1–11. https://doi.org/10.1103/PhysRevSTPER.9.010104
[34] Aiken, L. R. (1985). Three coeffiecient for analyzing the reliability and validity of ratings. Educational and Phychological Measurement, 45, 131–142. https://doi.org/10.1177/0013164485451012
[35] Samkoff, A., Lai, Y., & Weber, K. (2016). Research in Mathematics Education On the different ways that mathematicians use diagrams in proof construction. Research in Mathematics Education, 14(1), 49-67. https://doi.org/10.1080/14794802.2012.657438
[36] Savinainen, A., Mäkynen, A., Nieminen, P., & Viiri, J. (2017). The effect of using a visual representation tool in a teaching-learning sequence for teaching Newton's Third Law. Research in Science Education, 47(1), 119–135. https://doi.org/10.1007/s11165-015-9492-8
[37] Widhiarso, W. (2011). Aplikasi anava campuran untuk desain eksperimen pre-posttest design. Yogyakarta: Fakultas Psikologi UGM.
[38] Moore, J. C. (2014). Efficacy of multimedia learning modules as preparation for lecture-based tutorials in electromagnetism. Education Sciences, 8(23), 1-14. https://doi.org/10.3390/educsci8010023

7 Authors

Warsono is a lecturer in the postgraduate program in physics education at Yogyakarta State University. The undergraduate education program was completed at Yogyakarta State University. Masters and doctoral programs are completed at Gadjah

Mada University. Research carried out related to physics education, learning evaluation, mobile learning (Email: warsono@uny.ac.id).

Puji Iman Nursuhud is a graduate student in a physics education program at Yogyakarta State University. Undergraduate education was completed at Semarang State University. Research carried out related to physics education, learning evaluation, mobile learning (Email: nursuhudofficial@gmail.com).

Rio Sandhika Darma is a graduate student in physics education at Yogyakarta State University. The undergraduate education program was completed at Mulawarman University. Research conducted related to physics education, learning evaluation, mobile learning (Email: riodarma58.2017@student.uny.ac.id).

Supahar is a lecturer in the postgraduate program in physics education at Yogyakarta State University. The undergraduate education program was completed at Yogyakarta State University. The master's program is completed at the Bandung Institute of Technology and the doctoral program is completed at Yogyakarta State University. Research conducted related to physics education, evaluation and learning assessment, mobile learning (Email: supahar@uny.ac.id).

Danis Alif Oktavia is a graduate student in physics education at Yogyakarta State University. Undergraduate education was completed at Semarang State University. Research conducted related to physics education, evaluation of learning, mobile learning (Email: danisalifoktavia.2017@student.uny.ac.id).

Ahdika Setiyadi is a graduate student in the physics education program at Yogyakarta State University. The undergraduate education program was completed at Yogyakarta State University. Research conducted related to physics education, learning evaluation, mobile learning (Email: adika.setiyadi.2017@student.uny.ac.id).

Mas Aji Kurniawan is a graduate student in the physics education program at Yogyakarta State University. Undergraduate education was completed at Yogyakarta State University. Research conducted related to physics education, learning evaluation, mobile learning (Email: kurniawan.masaji.2017@student.uny.ac.id).

Article submitted 2019-09-08. Resubmitted 2019-12-23. Final acceptance 2019-12-23. Final version published as submitted by the authors.

Applying Concept Map to Game-Base Concept Assessment

https://doi.org/10.3991/ijim.v14i06.12057

Chien-Hung Lai (✉), Bin-Shyan Jong, Yen-Teh Hsia
Chung Yuan Christian University, Taoyuan, Taiwan
soulwind@cycu.org.tw

Tsong-Wuu Lin
Soochow University, Taipei, Taiwan

Abstract—There have been lots of studies using traditional concept assessment to measure student's learning achievement. This study adding game elements in concept assessment try to measure student's learning achievement, and compare this result with traditional concept assessment to see what's the difference between traditional concept assessment and adding game element in concept assessment. Traditional concept assessment using SPRT method in multiple-choice to measure student's concept mastery, our study using the same method and present this method in concept game so that student won't feel boring and tiring during this assessment. Our study observe each student's feedback and their concept mastery by using game element to display concept assessment, and analyze is using concept game assessment can shorten student's test time and improve student learning concept knowledge after assessment, the result shows that when student using concept game assessment they can know their concept mastery immediately by seeing process bar present as their life so the test time will be shorten, and student's concept knowledge was improved after concept game assessment. Student's feedback shows that they prefer concept game assessment because they can measure their concept mastery during the concept game assessment; this study shows that adding game element in concept assessment can improve student's concept mastery and shorten the test time student took.

Keywords—Concept assessment, concept game assessment, SPRT, concept mastery.

1. Introduction

Traditional teaching mainly uses tests to understand students' learning condition. Therefore, when there are too many test questions or too many tests, students will be fed up with tests and their learning motivation will decrease. If some interesting elements are added to tests, students' learning condition can be measured and they may become more interested in courses and more diligent in learning.

Many studies have verified that game-based learning can increase students' learning motivation [1] [2] [8]. The addition of game situations to teaching materials enables students to learn in fun ways and further increase their learning motivation. Moreover, test results can be used to understand the effectiveness of students' use of game-based learning. Compared with the teaching tests in traditional teaching where tests are used to test students' learning progress and students certainly will prepare for them in advance, game-based teaching uses the same approach to test students' learning progress. However, this study intends to investigate whether it is possible to test students in a more relaxed manner without informing them of tests in advance and whether students can reflect their learning effectiveness of the concepts of chapters during the tests.

Traditional tests still are required to be used to test learning effectiveness in some of the game-based learning. Therefore, this study proposed the test of game-based concept map to enable students to maintain their motivation to use the test during the test of course concept without experiencing learning fatigue due to high frequency of tests. This study designed a game-based concept map test system to enable students to reflect their learning in a game-based manner during the use of concept test, as well as to enable them to fully reflect their learning condition after operation. Moreover, this study also compared the game-based concept map test with general traditional concept map test.

2. Literature Review

2.1. Game-based learning

Due to the gradual development of computer games, it has become a trend to add teaching materials to computer games to enable students to further develop learning interest through their interest in games. Moreover, compared with general traditional learning, game-based learning can maintain students' learning motivation because it enables students to actively participate in game activities. Therefore, a well-designed game can assist students in learning.

According to relevant studies, the characteristics of game-based learning environment are as follows [6]:

- Integrating course content into games to enable students to understand the knowledge and content of courses through the games. Compared with the learning methods of traditional courses, it brings different experiences to learners.
- Learners can solve the difficult problems they encounter through the knowledge obtained from games, as well as verify whether they can understand or are familiar with the course content.
- The instant feedback provided by games enables learners to understand whether the knowledge they obtain is accurate according to the feedback, as well as constantly revise their answers through the feedback, to further complete their learning.

The provision of tests or levels of different difficulty levels enables students to perform the self-test, as well as to understand their level of understanding of course knowledge

2.2. Computer-based testing

Nowadays, with the rapid development of computer-based teaching, some scholars have investigated the effect of used of computer in teaching tests [10]. The use of computer in the tests of various fields has become the approach that many scholars intend to investigate because the use of computer in tests can rapidly obtain the information on user status.

Some scholars have also discovered that the use of computer not only reduces the time of tests, but also increases users' participation motivation [9]. To education and teaching courses, the use of computer in tests has become a catalyst catalyzing the transformation of learning types.

It is uncertain whether the effectiveness of the use of computer in tests is the same as that of the use of written tests. Some people question the effectiveness in certain courses, such as mathematics, science & technology, language. Some scholars used biology course to test whether the effectiveness of computer-based test is the same as that of written test. A study found that the effectiveness of computer-based test is the same as that of written test [10]. Therefore, the use of computer in tests has become a gradually practical approach.

2.3. Concept map test

In addition to the general written tests, other studies have proposed different measurement methods, such as oral report and specific project, as the tests for students' learning condition. Although oral reports and specific project enable students to develop their own knowledge framework without being restricted by regulations [5], the knowledge framework reflected by students according to the measurement results are completely different. Therefore, it is impossible to understand students' exact learning condition.

Concept map test has been verified as an effective tool which can assist students in expressing the knowledge they have learned [3][4]. The use of structural characteristics of concept map enables students to understand their own knowledge level, and enables teachers to implement remedial teaching according to students' familiarity of concept map. For example, concept map system can be used to assist students in English writing training [7], or the knowledge building methods of concept map can be used to help students improve their ability to tell a story or an event [7].

The concept map included two parts. Part 1 was concept mapping. This part was teachers' and experts' analysis on the concepts covered in courses and the connection among concepts, as well as the development of corresponding figure of course concepts. Part 2 was the concept map evaluation. This part was to have students take the tests of various concepts, and teachers could understand students' familiarity with

each concept based on their test results. Moreover, they could adjust the courses according to students' learning condition of course concepts [5].

3. Game-Base in Concept Assessment System Design

A scholar has used role-playing to enable students to integrate themselves to teaching game situations in the past study on game-based learning, in order to increase students' interest in concepts and learning motivation [1]. Therefore, based on the past study, this study added game elements to tests to analyze whether game-based concept map test can more effectively understand students' familiarity with concepts than traditional concept map system can, and investigated the influence of game-based concept map test and traditional concept map test on students, in order to find out the test method applicable to students.

Firstly, students would log in their accounts through a start page, and their registration information could be used for testing. The users would be introduced to the game page to take the concept test game if their accounts and passwords match. The users would be introduced to the results page when the game of concept of a stage is ended. The users could see whether they succeeded or failed in the learning of concept.

A. **Animation Display Area:** The display of ongoing games and animations. This study used the game of castle guardian. When students answered questions, the soldiers of the two parties would attack one another.
B. **Q&A Interactive Area:** When users clicked the attack button, questions would be generated for them to answer. In addition, animation would be displayed in the central display area to enable them to understand whether their answer was wrong or right.
C. **Concept Progress Bar:** The progress bar would be generated according to the values input in the SPRT formula when students' answers were right or wrong to enable them to understand their current progress (the red denotes the current progress. When the bar is fully in red, the students succeed in the learning of the concept. When the bar is not in red, the students fail in the concept).
D. **Text Message Area:** The name of the current concept is displayed here. When students answered the questions, the corresponding text messages would be displayed according to the students' answers.
E. **Game Message Area:** This area instructed students whether to attack or not. Moreover, the messages of success and failure would be displayed when students succeeded or failed in the learning of concept.

The results page was divided into three major blocks:

a. The success or failure of learning of each concept was displayed through text messages to enable users to understand whether they succeeded or failed in answering the question of concept.
b. Results block: the proportion of number of right and wrong answers of users was displayed. A bar chart was drawn according to the proportion.

c. Score block: the score of students was displayed. The score of students was calculated according to the number of right and wrong answers to the questions of concept. The students could refer to their total score of the learning of the current concept according to this score since the score was calculated using the proportion.

After entering the system, the students clicked "Attack." The animation of soldiers of the two parties attacking one another would be displayed on the screen. Once the soldiers attacked one another, the system would randomly select a question of a concept. The soldiers above the screen would keep attacking one another. After the users clicked "Submit," the display area would determine the soldiers of which party won according to the answer (right or wrong) and enable the winning soldiers to move towards the castle of the losing ones. When the value obtained from the SPRT formula reached specific proportion, the castle would be damaged to a different extent.

The success and failure in the learning of a concept was subject to the damage of the castle. Because the SPRT calculation cannot determine the result of the learning of concept under the situation of repeated right and wrong answers, the concept "partial familiarity" was added in the experiment.

4. Experimental Procedure

The research subjects were the students taking the course of operating system. A total of 139 subjects were selected, and they were divided into two classes, class A and class B. This experiment tested 5 concepts concerning the operating system, including brief introduction to operating system, computer system structure, operating system, processing elements and central processor scheduling. Class A was firstly tested using the traditional concept map test system, and then was tested using the game-based concept map test system. Class B was firstly tested using the game-based concept map test system, and then was tested using the traditional concept map test system. The experiment mainly investigated the effect of game-based concept test system on concept testing. The experiment compared the test results of the students using the two systems as the validity of the system concept test. According to the experiment results, 96 students completed the experiment, including 43 students in class A and 53 students in class B.

The experimental procedures were: students used two systems, respectively. Multiple choice questions were used in the system for testing. In the experiment, the same question back was used in the experiment for the concept test. During the test, the students used two systems one by one. Because students would engage in impression-based learning of concepts after using the systems, they would pass the test using learning memory if there were similar questions. Therefore, this study adjusted the experiment data according to the post-learning. TABLE I is the set-up of pre-and-post concept maps. If the previous concept test was a success (S) and the next one was a failure (F) or partial learning (P), the students' performance would be regarded as regress and two different values (2,0)(2,1) would be offered.

The reason why the result of former concept as partial learning (P) and the next one as a failure (F) was that, partial learning represented that students did not fully under-

stand the knowledge of the concept. In other words, the system was not sure whether the students understood the content of the concept. As a result, the value (P) offered to the students represented partial learning. Failure represented that students were not familiar with the content of the concept. Therefore, when the students' former concept was partial learning and the next one was a "failure," this study offered them the value (1,1) for comparison. If the pre-test of the concept was a failure (F) and the post-test of it was partial learning (P) and the students improved their test result of the concept from failure to partial learning due to the test learning, this study would also offer them the value (0,0) for comparison.

Table I. The consistency of the concept results set

First do concept	After do concept	Condition and encode
S	F	Regress (2, 0)
S	P	Regress (2, 1)
F	S	Progress (2, 2)
P	S	Progress (2, 2)
F	P	Fair (0, 0)
S	S	Fair (1, 1)
F	F	Fair (0, 0)
P	P	Fair (1, 1)
P	F	Fair (1, 1)

5. Result and Discussion

TABLE II to TABLE VII are the Pearson's test on concept 1~5 and the overall concept. The results showed that, there was a significant correlation between the two systems, suggesting that the two systems were correlated. Moreover, there was a high correlation between them, which further showed that the effectiveness of the two systems was the same.

Table 1. Concept 1 Pearson Correlation

Concept 1		First Game	First Concept
First Game	Pearson Correlation	1	.816**
	Sig. (two-tailed)		.000
	N	97	97
First Concept	Pearson Correlation	.816**	1
	Sig. (two-tailed)	.000	
	N	97	97

Table 2. Concept 2 Pearson Correlation

Concept 2		First Game	First Concept
First Game	Pearson Correlation	1	.812**
	Sig. (two-tailed)		.000
	N	97	97
First Concept	Pearson Correlation	.812**	1
	Sig. (two-tailed)	.000	
	N	97	97

Table 3. Concept 3 Pearson Correlation

Concept 3		First Game	First Concept
First Game	Pearson Correlation	1	.827**
	Sig. (two-tailed)		.000
	N	97	97
First Concept	Pearson Correlation	.827**	1
	Sig. (two-tailed)	.000	
	N	97	97

Table 4. Concept 4 Pearson Correlation

Concept 4		First Game	First Concept
First Game	Pearson Correlation	1	.903**
	Sig. (two-tailed)		.000
	N	97	97
First Concept	Pearson Correlation	.903**	1
	Sig. (two-tailed)	.000	
	N	97	97

Table 5. Concept 5 Pearson Correlation

Concept 5		First Game	First Concept
First Game	Pearson Correlation	1	.882**
	Sig. (two-tailed)		.000
	N	97	97
First Concept	Pearson Correlation	.882**	1
	Sig. (two-tailed)	.000	
	N	97	97

Table 6. Concept 1 to Concept 5 Pearson Correlation

Concept 1 to Concept 5		First Game	First Concept
First Game	Pearson Correlation	1	.856**
	Sig. (two-tailed)		.000
	N	485	485
First Concept	Pearson Correlation	.856**	1
	Sig. (two-tailed)	.000	
	N	485	485

The experiment found that, because the students used the traditional concept map test and game-based concept map test to take their tests of concepts, they might learned from the former test system, which led to the fact that the students could learn the concepts through system and complete the answers when the questions of concepts were displayed. Therefore, this study classified the data, and performed the analysis on the correlation among data. There was a high correlation among data, suggesting that the effectiveness of the two systems was the same.

There was a significant correlation between the two systems. This study added game elements to the tests of concepts. During the use of systems, students did not suggest that they were taking the tests of concepts. The students would learn concepts based on the questions of the tests when answering to the questions. Because this study enabled the students to use two systems one by one, the effectiveness of the test of concepts of students was better if they used game-based concept test first and then use traditional concept test.

TABLE VIII to TABLE IX are the ratios of progress and regress of class A and class B. Class A firstly used the traditional concept map to take the test, and then used game-based concept map to take the test. According to TABLE VIII, this study found that students' understanding of game-based concept map test was slightly improved after using the traditional concept map system. However, the progress was not significant. Therefore, the traditional concept map test system only had the effect of testing the learning effectiveness of concepts and could not improve students' familiarity with concepts.

On the contrary, class B used the game-based concept map test first, and then used the traditional concept map test. The results showed that, the learning of concepts was improved in the data of traditional concept map test after the students used the game-based concept map to take the test of their learning. Therefore, after using the game-based concept map test system, students learned the knowledge of concept through the game process and further improved their familiarity with concepts to "progress."

TABLE X is the ratios of progress and regress of students' overall concept. The progress ratio of the overall familiarity with concept 1 was 6.2%, while the regress ratio of learning was 6.1%. The reason why the progress ratio was slightly larger than the regress ratio was that students could learn concepts through game-based map test. The overall familiarity of concept 2 improved by 11.34%. This study found that after using the two systems to take tests, the students' score of the system used later (traditional concept map test) improved due to the learning of concepts. The overall progress ratio was 10.51%, and the regress ratio was 8.57%, suggesting that game-based

concept map test enabled students to better understand the learning of concepts. This study regarded progress as students' progress due to the learning of concept, and regarded regress as the situation caused by the students' condition or environmental factors. Therefore, the use of systems, first or later, would lead to students' learning of concept.

Table 7. A Progress and Regress

	Progress %	**Regress %**
Concept 1	0%	11.6%
Concept 2	4.6%	16.27%
Concept 3	16.27%	11.62%
Concept 4	2.3%	9.3%
Concept 5	7%	6.97%
Total	6%	11.16%

Table 8. Class B Progress and Regress

	Progress %	**Regress %**
Concept 1	11.32%	1.88%
Concept 2	15.09%	5.66%
Concept 3	11.32%	20.75%
Concept 4	15.09%	3.77%
Concept 5	13.20%	1.88%
Total	13.20%	6.79%

Table 9. Total Progress and Regress

	Progress %	**Regress %**
Concept 1	6.18%	6.12%
Concept 2	11.34%	10.2%
Concept 3	14.43%	16.33%
Concept 4	10.30%	6.12%
Concept 5	10.30%	4.08%
Total	10.51%	8.57%

Compared with the traditional concept map test, the game-based concept map test displayed the success or failure of learning of concepts and progress of learning in a graphical manner. Therefore, students could better understand the changes in values and whether they were going to learn the concepts. The tests of concepts could hence be speeded up. However, on the other hand, because SRPT formula calculates familiarity according to the number of right and wrong answers, the progress ratio of students would significantly decrease when they carelessly completed the wrong answers. The students were confused with this phenomenon. Because traditional concept map test displayed values and students were less sensitive to values than to images, students would experience emotional changes according to the increase or decrease in the progress bar, which further affected their speed of tests.

The results of the questionnaire showed that the mean of the two questionnaires was close and homogeneous (TABLE XI). However, there was no significant correlation between them. The students' motivation to use the two systems was the same.

Table II. the mean of the two questionnaires

No.	Subject	Traditional	Game
1	Using the traditional concept map test (game-based concept map test) let me know more about the course content.	4.81	4.86
2	After using the traditional concept map test (game-based concept map test), you will understand the concept content that you are not enough.	4.96	5.00
3	I feel very happy using the traditional concept map test (game-based concept map test).	4.43	4.47
4	The subject description is very complete in the traditional concept map test (game-based concept map test).	4.38	4.72
5	Through the traditional concept map test (game-based concept map test), I feel that the course will not be too boring.	4.58	4.76
6	I am satisfied with the graphical interface in the traditional concept map test (game-based concept map test).	4.4	4.35
7	I am satisfied with the interactive way of the traditional concept map test (game-based concept map test).	4.54	4.39
8	Traditional concept map test (game-based concept map test) makes me feel easy to use.	4.78	4.68
9	I will promote the traditional concept map test (game-based concept map test) to other students.	4.5	4.54
10	I like the traditional concept map test (game-based concept map test).	4.56	4.5
11	Using traditional concept map test (game-based concept map test) makes me curious about the course content.	4.45	4.66
12	Using traditional concept map test (game-based concept map test) I feel very helpful to me.	4.68	4.72
13	Compared to the general paper test, I prefer to use the traditional concept map test (game-based concept map test) to measure.	4.81	4.62
14	I won't be bored with traditional concept map test (game-based concept map test)	4.78	4.63
15	I will strengthen my study when I use the traditional concept map test (game-based concept map test) to learn the concept familiarity.	4.88	4.93
16	Using the traditional concept map test (game-based concept map test), I feel that my heart beats very quickly.	3.87	4.02
17	I am annoyed when using traditional concept map test (game-based concept map test).	4.13	4.13

During the interviews, some students mentioned that the speed of animation display would affect their motivation to use the system. For example, some students suggested that the animation display was too slow, and it took a lot of time to wait for soldiers to walk to the castle or attack one another in the middle. They could know the results of the traditional concept map test right after they completed the answers. However, some students suggested that the animation was interesting, and they liked this type of test methods. They could succeed in the learning of concepts by damaging the rival's castle. Compare with general traditional concept map test system, students preferred using game-based concept map test system. The feedback from the questionnaire showed that, more than half of the students liked game-based concept map

test, 1/3 of them suggested that the traditional concept test was better and other 17 students did not have any opinion. Moreover, some students mentioned that the images can be simplified. The system page with too many images made it hard to read the questions.

6. Conclusion

The main purposes of this study are to use game-based approach to test concepts, to investigate whether the addition of game elements to tests of concepts can speed up the effect of tests and to improve students' familiarity with concepts after the tests. According to the experiment results, after using game-based concept map test system, students' familiarity with concepts was improved. Moreover, the instant display of students' current progress of learning of concepts enabled them to understand their familiarity with concepts in a timely manner. Therefore, students would not lose patience or motivation due to excessive number of questions during the test or the excessively frequent tests. According to the research findings, after using game-based concept map test, students' familiarity with concepts was improved. Therefore, if uncertain factors are added to the system and images are updated, students' motivation to use the system may be better maintained and their familiarity with concepts may be improved. For example, if students can use different functions after giving a certain number of right answers, their interest in the system will be increased and they will be more absorbed in games. Eventually, students' learning motivation will be further increased according to the results of the game-based concept map test. Compared to the general traditional concept map test, students' learning enthusiasm will be higher.

Moreover, if the effectiveness of learning of concepts can be reflected in scores, students can also better grasp their own familiarity with concepts. The experiment found that students' response to scores was stronger. If such type of test can be used to enable students to understand their level of understanding according to the tests, there is no need to perform more tests on students' learning progress of courses. It is believed that education can have more diversified effects.

7. References

[1] Meluso A., Zheng M., Spires H.A., & Lester J. (2012). Enhancing 5th graders' science content knowledge and self-efficacy through game-based learning, Computers & Education, 59(2), 497–504. https://doi.org/10.1016/j.compedu.2011.12.019

[2] Shafie A., & Ahmad W. F. W. (2010). Design and Heuristic Evaluation of MathQuest: A Role-Playing Game for Numbers, Procedia Social and Behavioral Sciences, 8, 620–625. https://doi.org/10.1016/j.sbspro.2010.12.086

[3] Chiou C. C. (2008). The effect of concept mapping on students' learning achievements and interests, Innovations in Education and Teaching International, 45(4), 375-387. https://doi.org/10.1080/14703290802377240

[4] Hwang G. J., Shi Y. R., & Chu H.C. (2011). A concept map approach to developing collaborative Mindtools for context-aware ubiquitous learning, British Journal of Educational Technology, 42(5), 778-789. https://doi.org/10.1111/j.1467-8535.2010.01102.x
[5] McClure J. R., Sonak B., & Suen H. K. (1999). Concept Map Assessment of Classroom Learning : Reliability, Validity, and Logistical Practicality, Journal of Research in Science Teaching, 36(4), 475-492. https://doi.org/10.1002/(sici)1098-2736(199904)36:4<475::aid-tea5>3.0.co;2-o
[6] Papastergiou M. (2009). Digital Game-Based Learning in high school Computer Science education: Impact on educational effectiveness and student motivation, Computers & Education, 52(1), 1-12. https://doi.org/10.1016/j.compedu.2008.06.004
[7] Liu P. L. (2011). A study on the use of computerized concept mapping to assist ESL learners' writing, Computers & Education, 57(4), 2548–2558. https://doi.org/10.1016/j.compedu.2011.03.015
[8] Watson W. R., Mong C. J., & Harris C.A. (2011). A case study of the in-class use of a video game for teaching high school history, Computers & Education, 56(2), 466-474. https://doi.org/10.1016/j.compedu.2010.09.007
[9] Chua Y. P. (2012). Effects of computer-based testing on test performance and testing motivation, Computers in Human Behavior, 28(5), 1580–1586. https://doi.org/10.1016/j.chb.2012.03.020
[10] Chua Y. P., & Don Z. M. (2013). Effects of computer-based educational achievement test on test performance and test takers'motivation, Computers in Human Behavior, 29(5), 1889–1895. https://doi.org/10.1016/j.chb.2013.03.008

8. Authors

Chien-Hung Lai is an assistant professor in the Department of Electronic Engineering, Chung Yuan Christian University. His research interests include computer aided education.

Bin-Shyan Jong is a professor in the Department of Information and Computer Engineering, Chung Yuan Christian University. His research interests include computer graphics and computer aided education.

Yeh-Teh Hsia is now a professor in the Department of Information and Computer Engineering, Chung Yuan Christian University. His research interests include computer aided education and artificial intelligence.

Tsong-Wuu Lin is a professor in the Department of Computer Science and Information Management, Soochow University. His research interests include computer graphics and computer aided education.

Article submitted 2019-10-27. Resubmitted 2019-12-08. Final acceptance 2019-12-10. Final version published as submitted by the authors.

Design and Implementation of an E-learning Platform Using N-Tier Architecture

https://doi.org/10.3991/ijim.v14i06.14005

Nawar S. Alseelawi
Misan University, Amarah, Iraq

Enas K. Adnan
Middle Technical University, Baghdad, Iraq

Hussein T. Hazim
Misan University, Amarah, Iraq

Haider TH. Salim ALRikabi (✉)
Wasit University, Wasit, Iraq
hdhiyab@uowasit.edu.iq

Khalid Waleed Nasser
Misan University, Amarah, Iraq

Abstract—Any educational institution aimed at developing towards e-learning and creating a more interactive environment and use in all fields of governmental institutions. The Ministry of Higher Education and Scientific Research (MOHESR) of Iraq and some of the countries in the Middle East suffer from weak use of information technology in general and weak use of e-learning in particular. Therefore, Iraqi MOHESR is in dire need of an electronic educational system that solves most of the problems experienced by most educational institutions. In this paper, we will develop a strategic plan to build an e-learning platform that provides an interactive environment between teachers and students in Iraqi universities and offers many advantages to overcome some problems in the use of traditional old education. This work is related to the use of multi-layered architecture to build the e-learning platform (Standard design of e-learning platform for Iraqi MOHESR). The advantage of these layers is that each layer is created in the Asp.Net program using N-Tier architecture that has functions that are independent of the rest of the layers which are(user interface(UI), business Access Layer(BAL),Data Access Layer(DAL), Database(DB)). A particular object will not affect the rest of the layers or the performance of these layers.

Keywords—MOHESR, N-Tier, Ado. Net, UI, BLL, DAL, SP, ADDIE.

1 Introduction

The process can be considered as People–Process–Product continuum or P3 models shown in Figure 1. For example, people involved in the e-learning development process can be instructional designers, graphics designers, project managers, and quality assurance managers. The product can be a well-designed e-learning module and the process can be any criterion process like ADDIE [1-3]

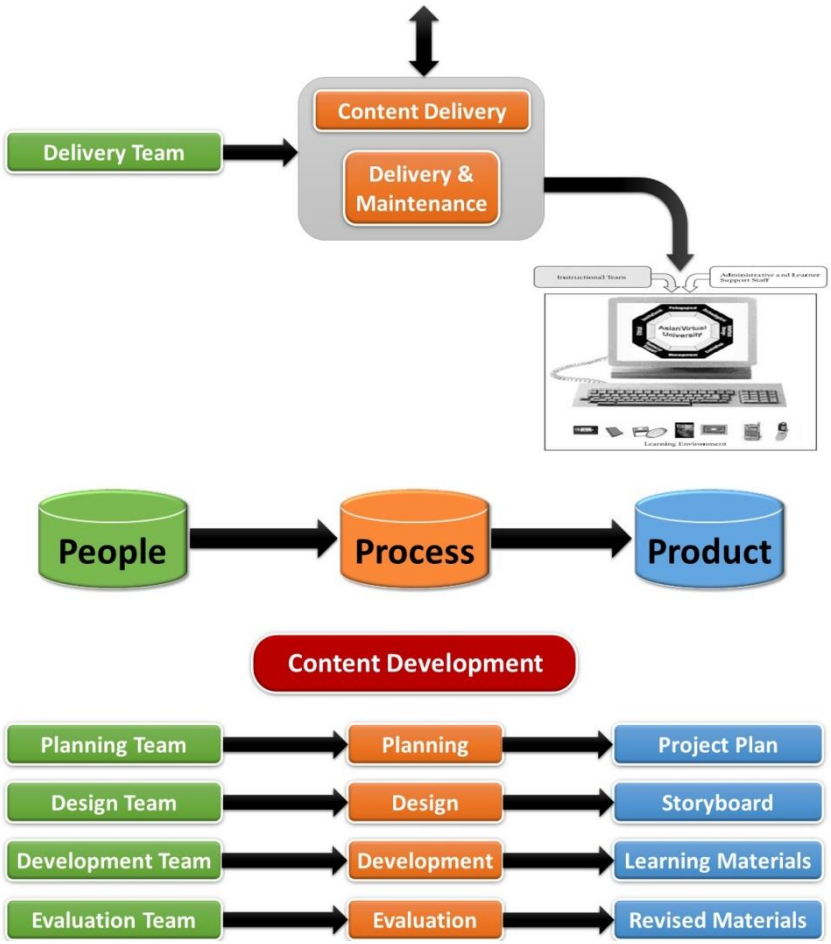


Fig. 1. E-Learning People-Process-Product Continuum (P3 model)

The P3 model is a holistic approach to course development and helps in not only creating very high-quality e-learning content but also in the submission and maintenance of the course. This work is an attempt to improve the entire educational platform development process in a modular approach. We have developed various

stages of the entire e-learning development process with regard to the people responsible for providing various e-learning and mixed education products.

Since this paper pertains to improving and developing electronic educational platforms affiliated to the Iraqi MOHESR, we conducted a comprehensive study and put the most important points of the improvement and development process, so the educational platform provides the environment to exchange information more easily and quickly using presentations for beginners (trainees).

The Iraqi MOHESR is always working to stimulate the development and creation of e-learning platforms for integration and use in Iraqi education systems, And move away from using the traditional education system which is no longer more appropriate in view of the current unique status of society gradually, and it wastes time, criticism and humanitarian endeavours. Current curricula used by schools in the exceptional opposite direction of how to learn and communicate outside of the classroom[4-6].

In general, the e-learning development process can be divided into two major phases:

a) Development
b) Delivery and maintenance

where the appropriate content is developed in the first stage and delivered using a suitable medium in the second stage. Development is an antecedent activity, whereas maintenance is an ongoing activity. A typical e-learning process has planning, design, development, evaluation, delivery and maintenance stages. The e-learning development process is iterative in nature. The number of individuals involved in various stages of an e-learning project may differ, based on the size and scope of the project[7-10].

In this paper we will explain the details of using the class to create the structure of the education system that will contribute to the process of improving and developing educational platforms for the Iraqi MOHESR, where the project will be divided into three or more projects, each project is separate from the other and then we combine these projects to form one project that will be suitable for use with the client's server, especially on the Internet. The features in this technology allow more people to work on the same project. It also raises the level of validating the applications and data that are passed to the database, while defining the different roles and responsibilities involved in the process of developing e-learning.

2 Methodology

There are distinctive terms used to characterize instructive educational computer applications, for example, e-learning Systems, Learning Management Systems (LMS), Course Management System (CMS) or even Virtual Learning Environment (VLE).In these frameworks, students can get to courses' substance in various configurations (content, picture, sound), and additionally connect with educators as well as colleagues by means of message sheets, meetings, conversations, video-meetings or different sorts of specialized devices, These stages give an arrangement

of configurable highlights, keeping in mind the final goal is to permit the production of online courses, pages of subjects, work meetings and learning groups[11].

In this paper, we relied on ADDIE methodology in developing and improving e-learning platforms, which includes the following basic stages (Analysis, Design, Development, Implementation, and Evaluation). Where the design and distribution of a questionnaire among the various Iraqi universities, including the Iraqi University, Baghdad University, and the University of Technology to investigate the direction of e-learning with the most prominent basic problems proposed that may face the implementation of e-learning projects, and what the main benefits that we can get for the higher education sector.

Through analysis, the developer builds a complete visualization of the "gaps" between the results or activities required for the audience's learning tools and their current capabilities. The design phase documents specific learning destinations, assessment tools, activities and content as shown in Figure 2. Real learning materials are completed in the development phase. By implementation, these materials are either submitted or posted to the student group, the validity of the preparatory material is then evaluated [12-14].

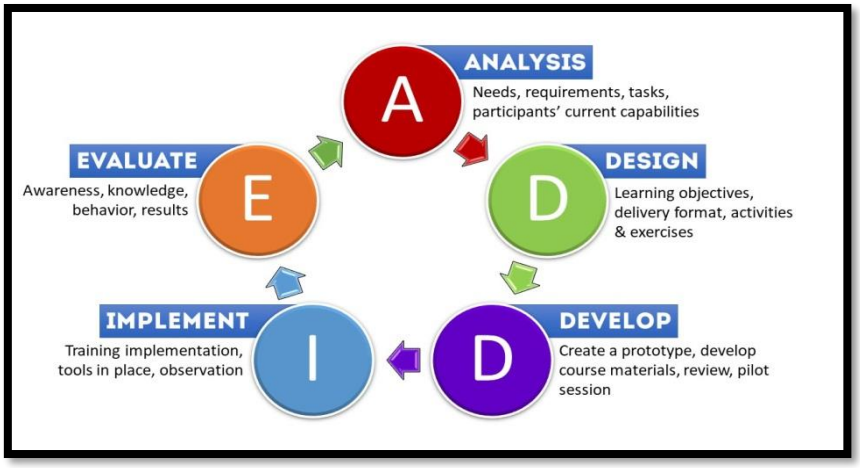


Fig. 2. ADDIE model

3 E-Learning Platform Model

This model is relied on layered technology to create and set up an e-learning platforming-Tier architecture is an industry-standard engineering model, suitable for assisting client/server applications at the project level by solving problems such as scalability, security, adaptive fault tolerance, etc. [15, 16].

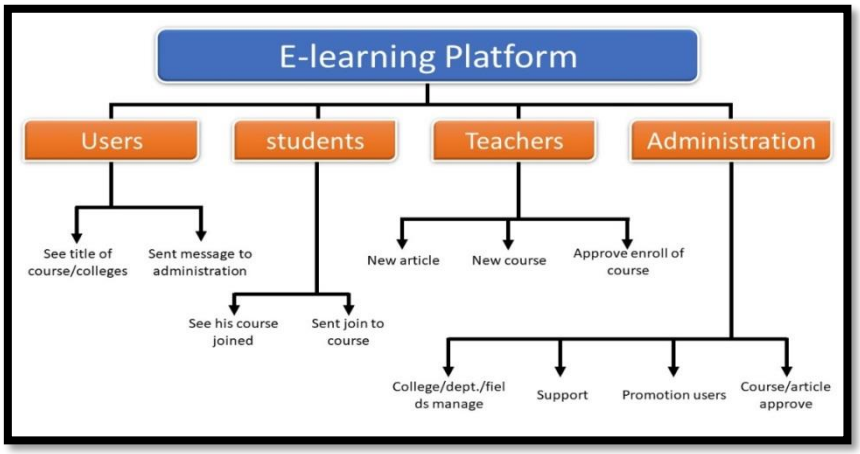


Fig. 3. Block diagram of e-learning platform

These layers are the User Interface Layer (UIL) or Selected Presentation Layer (PL), Business Access Layer (BAL), Data Access Layer (DAL). Figure 3 shows the N-Tire layer structure.

The display layer/user interface is the one that interacts with the user, receives the requests and shows the results. It consists of web pages, HTML, Ajax, etc. After receiving the data and verifying it, the data passed to the next layer. Whereas Business Access Layer (BAL) or Business Logic Layer (BLL)is an intermediate layer between the first and third layers, whose task is to receive data from the display layer and verify that data. If the verification is true, it will pass it to the third layer,most of this layer is (a namespace), that is, it contains only the classes we call within the method of some of the third layer.

Data Access Layer(DAL)is the brain of the project, where it is directly linked to the database, through which the queries are sent to the database coming from the working layer, and receive the results from the database, then pass it to the display layer.The 3-Tier system basically works as illustrated in Figure 4.

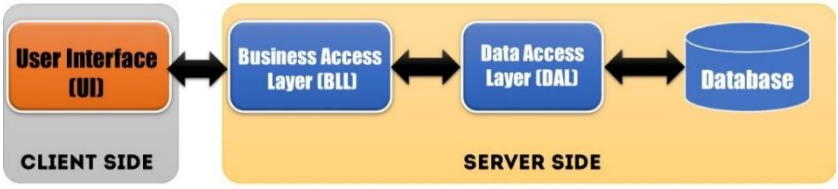


Fig. 4. The proposed scenario of the 3-Tier layer architectures

As shown, the most piece of contemporary e-learning stage can be seen as sorted out into three essential full-scale segments: Learning Management System (LMS),

Learning Content Management System (LCMS), and a Set of Tools for uploading lectures and educational materials and publishing various types of evaluations and establishing communication. The Content Management System is essentially intended to help education or scholarly courses[17, 18]. It enables the teacher to make a course platform, where documents can be transferred in common formats such as JPEG, doc, ppt, pdf, and so on, without converting them to a web format, for instance, HTML."A Content Management System is a combination of techniques used to depict forms in a domain that requires a joint effort between various performers" [19, 20].

These methods are intended to oversee:

1. Acquiring data based on client settings.
2. Collecting and sharing data.
3. Data Storing management.
4. Content excess check.
5. Reporting [5,6].

The second type of contemporary e-learning stage has been used to design the e-learning platform, which is Learning Management System (LMS), by utilizing LMS, an e-electronic course is conveyed through and happens inside an incorporated framework. Interestingly, engaging students with apparatuses that they can use for various purposes and independently supports self-administered and issue-based exercises.

Moreover, each student will have a similar lesson on the web. It means that the systems will always provide students with references within the educational platform as shown in Figure 5. This speaks to a variation option to discover resources by searching online or computerized libraries over the Internet. Everyone who uses a similar web index has similar login information to the materials[16].

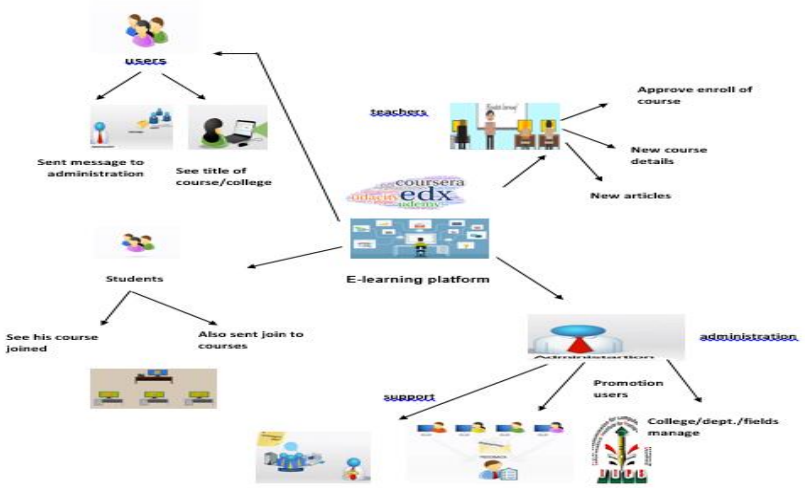


Fig. 5. Screenshot of E-learning framework

4 E-Learning Platform Database Objects

Learning objects are basically content units that are communicated by individuals through an online platform. We assume that, with regard to such a stage, students are the "customers" who consume the material, and that the authors are the individuals who provide educational things, in relation to the content, preparation, and learning of the offerings must come in reusable packages that can be independently created from a transport medium Gradually obtained [21, 22], as shown in Figure 6.

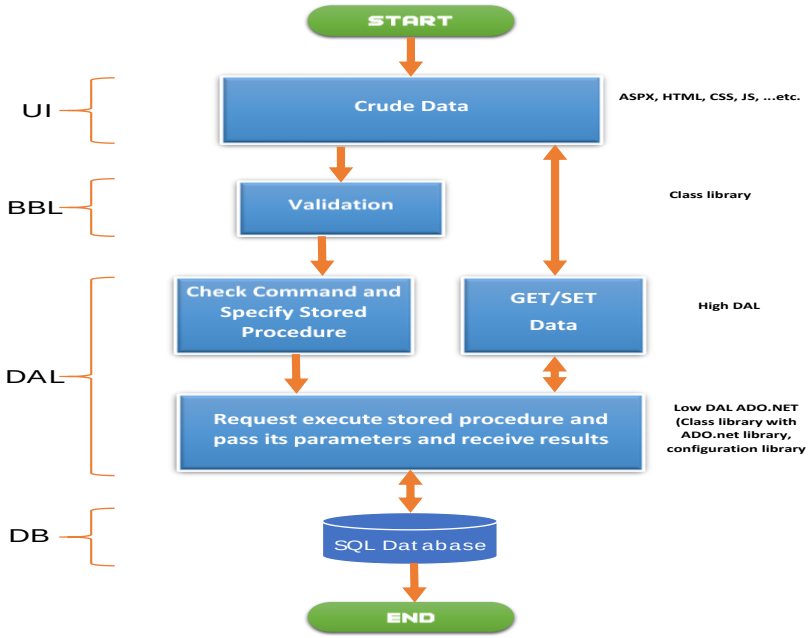


Fig. 6. E-learning platform development flowchart.

As noted, this diagram is different from the previous scheme in Figure 2, in this diagram a middle layer has been added between the user interface layer and data access layer. Also, the user interface layer consists of two parts, the data pane, and the command pane. When data, commands or both are sent to the data access layer, the request is passed to the business logic layer. This layer has been used or created to be intermediate between the two layers as well as validation of the commands passed to the data access layer, Data that is sent to the data access layer does not pass through the business logic layer.

In addition, the data access layer consists of two levels (Low DAL, High DAL), Low DAL communicates directly with the database, while High DAL communicates with Low DAL And then into the database. The purpose of the partitioning or working layer is to access the data level in this scheme because we used the ADO.net technique in order to deal with the database. ADO.net needs a class and a function separated from the rest of the classes and functions of the data access layer. High

DAL Consists of two blocks (Get/Set Data).Its function is to send and fetch data, Check Commands, and Specify Stored Procedure.

In order to build a database for the educational platform, the structure of this database must be well designed and contains many objects and need to make relationships between the tables and choosing the correct data type of the listed fields. Objects consist of two types of tables and stored procedures, each of these types will be used to build the database for the electronic learning platform. The educational platform is mainly focused on the courses. These courses contain videos and text files; therefore, we need to create a special table for text files and videos. This course may be presented on specific times or days, for example, every week or every month, hence, we need to design a special table for lectures and connect them with the course table using one to many relationships. As a security aspect of the educational platform, we organize users, so we need to create a table for the registrants to the platform, which is the user table. The users who register on the platform are classified into three categories (teachers, students, guests), and here we need to create a table of user permissions that will connect this table with the users' table using one to many relationships. Moreover, a table named (course join) has been created. In addition, a user profile is created by creating a table named (Profile) to identify each user in this platform.

As part of the utilization and organization of course registering process, and since this platform is affiliated to a university and this university contains multiple colleges ,a special table has been created for each college, also separate tables have been created for each department in each college. As this platform is educational, so there will be a lot of courses added to this platform. A special table has been created to search for a specific course in order to organize and arrange the educational platform. Also, secondary special-purpose tables have been created such as help tables, articles table, etc. The stored procedure is a function inside the SQL server. The advantages of using stored procedure are ease of maintenance, testing capability, and its speed are higher than normal command, and also provides high security to the database. The listing below specifics why stored procedures have obtained such a going strong following between application developers and even database administrators for that matter: Maintainability, Testing, isolation of business rules, speed/optimization, and Security[23, 24]. As illustrated in Figure 7.

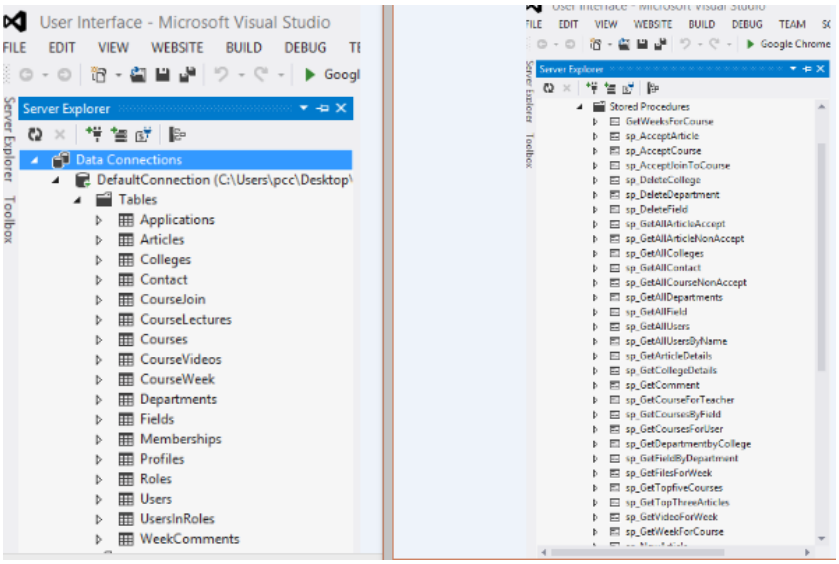


Fig. 7. Tables and stored procedure Used to create an electronic educational platform

5 Implementation E-learning Platform

To build an e-learning platform, we used a multi-layer architecture and built a planner and developed it to create a more flexible, user-friendly interactive platform. The basic function of using multiple N-Tier architectures is to design three projects in one integrated project. These three projects are isolated from each other. It is possible to use any programing language. These projects are (Presentation Layer, Business Logic Layer, Data Access Layer).

In the Presentation Layer or User Interface layer, the design of pages such as (ASP.net, java scripts, CSS, etc.) has been done. In Business Logic Layer we created the class library (DLL), so it is possible to create a web service inside this layer.

In Data Access Layer(DAL)we also created the class library (DLL).It is implemented as a separate class library project, where all the basic data source code is located, such as creating a database connection and issuing database commands such as (SELECT- INSERT- UPDATE- DELETE).

Figure 8 shows the mechanism of adding courses to the educational platform by clicking on the new course option and then showing a new window which consists of (select field) through which we choose the name of the field, while (course start) specifies the starting date of the course, (course finish) specifies the course ending date.

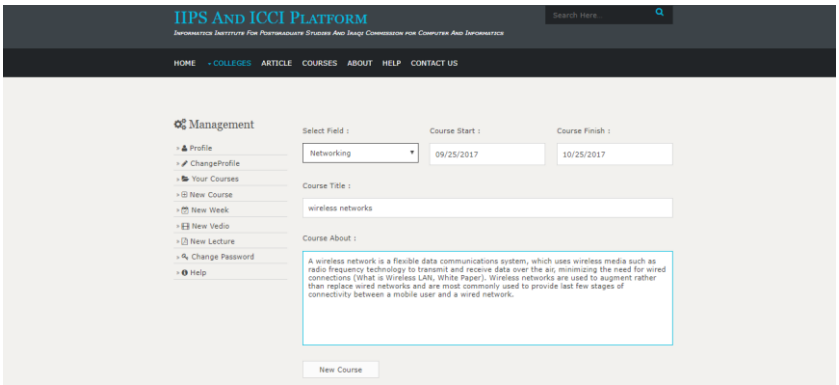


Fig. 8. Adding courses in the E-learning platform.

The next field is (course title) through which we can type the course title and a brief introduction to the course in the (about course) typing box. After completion, we click on the new course command.

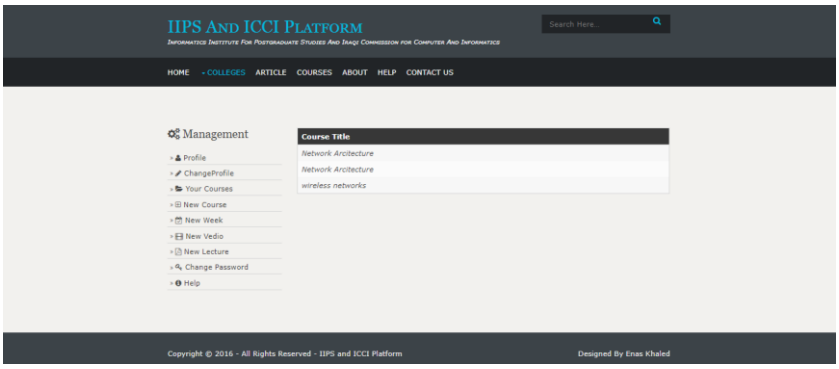


Fig. 9. Displaying courses in the E-learning platform.

After adding a new course, check the enrolments the course and show the courses by going to (your course) tab. This page shows all the courses provided by the teacher.

6 Results and Discussions

The results of the e-learning platform assessment questionnaire Informatics Institute for Postgraduate Studies (IIPS)and the Iraqi Commission for Computer and Informatics ICCI platform, has been implemented by teachers and students. The form of the e-learning platform assessment questionnaire IIPS and ICCI platform has been written as shown in Figure 10.

E-learning platform assessment questionnaire

IIPS And ICCI Platform

(Informatics Institute For Postgraduate Studies And Iraqi Commission for Computer And Informatics)

Name:..... Gender: male ☐ female ☐

Current career level:..... |Specialization:.....

The program is assessed on the basis of the following criterion 5 - Very OK 4 - OK 3 – don't know 2 - Not OK 1 - Never agree

NO	Content	evaluation				
	The program features in general	1	2	3	4	5
1	Includes accuracy of facts.					
2	Free from lingulstic and grammatical errors.					
3	Provides an interactive learning environment.					
4	Easy to use in general.					
5	Achieves what we aim at.					
	Method of education					
1	Use the language clearly.					
2	Presenting ideas and facts in an interesting sequence.					
3	Provide different levels of education.					
	Administration					
1	Record the results of the work.					
2	Results can not be reviewed only by authorized persons.					
	View content					
1	Easy to download sessions on your computer.					
2	Easy to download video sessions.					
3	The work lists are clear and organized.					
4	Ability to exit the program at any time with security out during a certain time if there is no interaction on the page by the user.					
5	Used without the need for assistance.					
6	Ease of moving from page to page.					
7	Courses and materials are offered within a specified period of time by setting a date for the start and end of the course					

Fig. 10. Illustrated E-learning platform assessment questionnaire IIPS And ICCI platform

The total number of teachers is 13 among Ph.D. and M.Sc. holders in various specializations, and the total number of students is 10 also in various specializations, as shown in Figure 11.

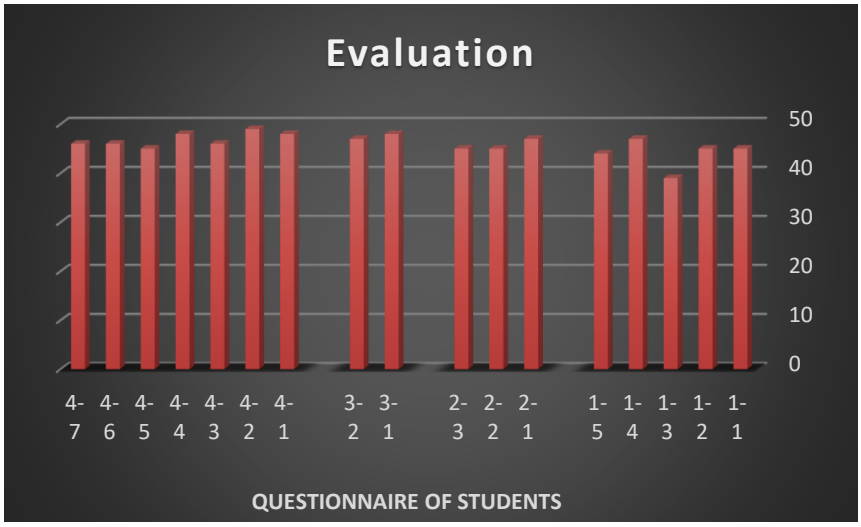


Fig. 11. The questionnaire of students.

As noted, the average of responses was as follows:

1. The program is easy to use in general.
2. Includes the accuracy of the contents and free from linguistic and grammatical errors.
3. Easy to upload and download materials through the platform.

For the statistical chart of the teachers, the answers were as follows:

4. This platform is free of grammatical and linguistic errors.
5. It provides an interactive environment between the trainer and the trainee.
6. It provides different levels of education.
7. Easy to upload and download materials without any help.
8. Ease to navigate through the pages.

For materials submitted through a specific time by allocating a period of time to start and end this course.as shown in Figure12.

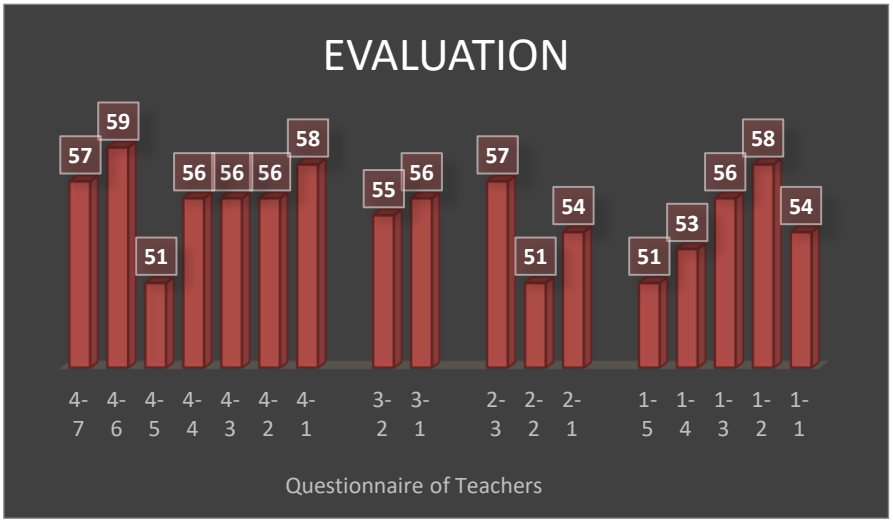


Fig. 12. The questionnaire of teachers.

7 Conclusion

This paper presents a comprehensive review of e-learning and the development of the electronic learning platform system using the three-layer architecture, the presentation layer, the business logic layer, and the data access layer. The theoretical parts of the courses are provided by a standard LMS, enabling:

1. Account management
2. Security protection

3. Collaborative learning
4. Student activity tracking
5. Feedback collection

Detailed approaches to this architecture are discussed and analyzed in detail. A more interactive and user-friendly learning platform has been developed to promote education and encourage its use in all educational institutions.

8 References

[1] F. Martin and A. K. Betrus, Digital Media for Learning: Theories, Processes, and Solutions. Springer Nature, 2019.
[2] B. H. Khan and V. J. J. o. C. C. Joshi, "E-Learning Who, What and How?," vol. 1, no. 1, pp. 61-74, 2006.
[3] H. T. Alrikabi, A. H. M. Alaidi, A. S. Abdalrada, and F. T. J. I. J. o. E. T. i. L. Abed, "Analysis the Efficient Energy Prediction for 5G Wireless Communication Technologies," vol. 14, no. 08, pp. 23-37, 2019. https://doi.org/10.3991/ijet.v14i08.10485
[4] R. Ajjawi and J. J. Q. R. Higgs, "Using Hermeneutic Phenomenology to Investigate How Experienced Practitioners Learn to Communicate Clinical Reasoning," vol. 12, no. 4, pp. 612-638, 2007.
[5] H. T. S. ALRikabi, A. H. M. Alaidi, and F. T. Abed, "Attendance System Design And Implementation Based On Radio Frequency Identification (RFID) And Arduino."
[6] L. S. Riza, T. Sawiji, N. Nurjanah, H. Haviluddin, E. Budiman, and A. J. I. J. o. E. T. i. L. Rosales-Pérez, "A Labyrinth Game for Blind Children Using Problem Solving Learning Model," vol. 15, no. 02, pp. 58-71, 2020. https://doi.org/10.3991/ijet.v15i02.11375
[7] A. Baby and A. J. C. i. H. B. Kannammal, "Network Path Analysis for developing an enhanced TAM model: a user-centric e-learning perspective," p. 106081, 2019. https://doi.org/10.1016/j.chb.2019.07.024
[8] H. Alrikabi, A. H. Alaidi, and K. J. I. J. o. I. M. T. Nasser, "The Application of Wireless Communication in IOT for Saving Electrical Energy," vol. 14, no. 01, pp. 152-160, 2020. https://doi.org/10.3991/ijim.v14i01.11538
[9] H. F. Khazaal, H. T. Salem, and A. A. T. J. U. o. T.-Q. J. f. E. S. Abbas, "Design and Implementation of Unmanned Autonomous Armed Cart Used for Military Purposes," vol. 9, no. 1, pp. 103-107, 2018. https://doi.org/10.31663/tqujes.9.1.295(2018)
[10] P. J. I. J. o. E. T. i. L. Jaiswal, "Integrating Educational Technologies to Augment Learners' Academic Achievements," vol. 15, no. 02, pp. 145-159, 2020. https://doi.org/10.3991/ijet.v15i02.11809
[11] G. H. Acsai, "Project management of virtual teams: A qualitative inquiry," 2016.
[12] T. Brush, J. J. E. t. r. Saye, and development, "Implementation and evaluation of a student-centered learning unit: A case study," vol. 48, no. 3, pp. 79-100, 2000. https://doi.org/10.1007/bf02319859
[13] G. R. Morrison, S. J. Ross, J. R. Morrison, and H. K. Kalman, Designing effective instruction. John Wiley & Sons, 2019.
[14] H. T. S. J. W. J. o. E. S. ALRikabi, "Study the Matching of the Level of Electromagnetic Radiation Emitted by Communication Towers in the Kut City with the International Health organization criterion," vol. 4, no. 1, pp. 101-111, 2016.
[15] A. Seth and K. Seth, Understanding Service-Oriented Architecture: Designing Adaptive Business Model for SMEs. BPB Publications, 2020.

[16] A. Gill, C. J. I. I. J. o. C. S. Singh, and I. Technologies, "Implementation of NTRU Algorithm for the Security of N-Tier Architecture," vol. 5, no. 6, pp. 7631-7636, 2014.
[17] P. G. Altbach, L. Reisberg, and L. E. Rumbley, Trends in global higher education: Tracking an academic revolution. Brill, 2019.
[18] Y. Yoshimura, B. Cai, Z. Wang, and C. Ratti, "Deep learning architect: classification for architectural design through the eye of artificial intelligence," in International Conference on Computers in Urban Planning and Urban Management, 2019, pp. 249-265: Springer. https://doi.org/10.1007/978-3-030-19424-6_14
[19] B. Galitsky, "A Content Management System for Chatbots," in Developing Enterprise Chatbots: Springer, 2019, pp. 253-326. https://doi.org/10.1007/978-3-030-04299-8_9
[20] Naseer Ali Hussien, Iman Kadhim Ajlan, Mohamed Fazil Mohamed Firdhous, Haider TH. Salim Alrikabi, "Smart Shopping System with RFID Technology Based on Internet of Things," International Journal of Interactive Mobile Technologies (iJIM), vol. 14, no. 4, pp. 17-29, 2020 . https://doi.org/10.3991/ijim.v14i04.13511
[21] D. Dagger, A. O'Connor, S. Lawless, E. Walsh, and V. P. J. I. i. c. Wade, "Service-oriented e-learning platforms: From monolithic systems to flexible services," vol. 11, no. 3, pp. 28-35, 2007. https://doi.org/10.1109/mic.2007.70
[22] A. Seridi, L. Dib, and R. J. J. o. E. S. Bourbia, "Modernization of e-learning platforms towards a service-oriented architecture," vol. 15, no. 1, 2019.
[23] P. LeBlanc, Microsoft SQL Server 2012 Step by Step: Micr SQL Serv 2012 Step _p1. Pearson Education, 2013.
[24] E.-E. A. Durham, A. Rosen, and R. W. Harrison, "Optimization of relational database usage involving Big Data a model architecture for Big Data applications," in 2014 IEEE Symposium on Computational Intelligence and Data Mining (CIDM), 2014, pp. 454-462: IEEE. https://doi.org/10.1109/cidm.2014.7008703

9 Authors

Nawar Saad Alseelawi:- He is faculty member college of engineering , electrical engineering department ,university of Misan in Misan city , Amarah ,Misan,Iraq .He received his master in electronics and telecommunication from university of Baghdad ,Iraq .The number of articles in national data base -1 The number of articles in international data base -1 Contact:-+9647705595539.

E-mail:nawar.alseelawi@uom.edu.iq

Enas Khalid Adnan: -Is working as lecturer at computer system technologies department, Middle Technical university, Iraq. the number of articles in national data base-1. The number of articles in national data base -1. E-mail enaskhalid69@yahoo.com

Mr.Hussein Tuama Hazim Al-kinani:- His Major is Master of electronic telecommunication engineering from University of Pune, India.works as lecturer at Department of electrical engineering in university of Misan in Amarah , Misan city Iraq where he thought several courses. His current research interest include wireless communication, artificial intelligent, deep learning, intelligent control systems and internet of things. The number of articles in international data base is 2. Contact: -+9647735717775. E-mail:-hussein.tuama@uomisan.edu.iq

Haider Th. Salim ALRikabi, He is presently one of the faculty college of engineering, electrical engineering department, Wasit University in Al Kut, Wasit, Iraq. He received his B.Sc. degree in Electrical Engineering in 2006 from the Al Mustansiriya University in Baghdad, Iraq. his M.Sc. degree in Electrical Engineering focusing on Communications Systems from California state university/Fullerton, USA in 2014 .His current research interests include Communications systems with mobile generation, Control systems, intelligent technologies, smart cities, and Internet of Things (IoT) .Al Kut city – Hay. ALRabee, Wasit, Iraq. Contact:- +9647732212637 E-mail:- dhiyab@uowasit.edu.iq. The number of articles in national databases – 10. The number of articles in international databases – 10

Khalid Waleed Nasser Master of Electrical Engineering from The Great Saint Petersburg polytechnic university/Russia. Lecturer at Department of Electrical Engineering, College of Engineering, University of Misan. Contact:- 9647702787670. E-mail:- khalid.waleed@uomisan.edu.iq. The number of articles in international databases – 2

Article submitted 2020-02-19. Resubmitted 2020-03-23. Final acceptance 2020-03-23. Final version published as submitted by the authors.

Development of Learning Management System-Based Blended Learning Model using Claroline in Higher Education

https://doi.org/10.3991/ijim.v14i06.13399

Munir Tubagus (✉), Suyitno Muslim, Suriani
Jakarta State University, Jakarta, Indonesia
munirtubagus_tp14s3@mahasiswa.unj.ac.id

Abstract—Learning Management System (LMS) is a learning process that utilizes computer information technology equipped with internet and multimedia telecommunications facilities (graphics, audio, video) in delivering material and interaction between instructors and learners. The purpose of this study is to develop blended learning Using Claroline as a learning tool that facilitates students in learning. To achieve the objective of the study the research uses a quantitative approach to collect data using pre and post tests and questionnaires. The sample in the study were students of economic Islamic consisting of two classes, with a total of 50 students enrolled in this study. The results show that the difference in the average pre-test and post-test score was -29.43720. While the t-test that tests Ho: μ pre-test = μ post-test gives a value of t = -37.43720 with a degree of freedom of 49. While the p-value for the two-sided test of 0,000 is smaller than α = 0.05. This data approves that the statistical hypothesis Ho: μ pre-test = μ post-test is rejected, meaning that the average pre-test and post-test scores are significantly different. The findings of this study can be used to recommend effective ways of learning and teaching using e-learning that can improve student learning outcomes in higher education. The implications of this research is to encourage teachers to use e-learning technology and facilitate students with the technology in improving academic learning outcomes.

Keywords—Learning Management System, Blended Learning, Claroline, Motivation

1 Introduction

The rapid development of information and communication technology (ICT) in the current era of globalization cannot avoid its influence on the world of Education. The demands of the global world urge the world of education to constantly adapt to technological developments, especially adaptation to the use of ICTs in the learning process. The progress of information technology has had a positive impact on the advancement of education today. Especially computer and internet technology, both in terms of hardware and software, provide many offers and choices for the world of

education to support the learning process. The advantages offered not only lie in the speed factor for getting information but also multimedia facilities that can make learning more interesting, visual and interactive. Changes in the education system are the demands of a nation to have quality human resources. In line with the development of Information and Communication Technology (ICT) as can be seen in the e-learning based learning environment, each individual student has the freedom to determine what he wants to learn, where and how the learning process is carried out. In a learner centered learning environment, various facilities are provided in such a way that each individual student can actively build his own knowledge structure based on his own initiatives and responsibilities.

Through a learning environment supported by Information and Communication Technology (ICT), students have enormous access to abundant learning resources, receive feedback, and continually refine their understanding through a process known as generative learning. Lecturers as facilitators or moderators of their duties help students to want to learn on their own, formulate their understanding, evaluate the suitability of students' ideas with the ideas of experts. While the task of students is to actively learn and digest the knowledge provided, students can express ideas, criticize the opinions of lecturers which are considered inappropriate. Learning outcomes are actual abilities that can be measured directly, where the learning outcomes will later be known to what extent the educational and teaching goals that have been achieved. The learning outcome assessment process can provide information to the lecturer about the progress of students in an effort to achieve their learning goals through learning activities, then from that information later the lecturer can arrange and plan the process of further learning as an effort to realize better learning goals. The study "Student Characteristics and Learning Outcomes in a Blended Learning Environment Intervention in Ugandan University" found that the effect of blended learning on learning outcomes showed significant results. This shows that blended learning improves student learning outcomes. [1]

Research on "Evaluation of Blended Learning Approaches in Computer Engineering Education" Integrates face-to-face online and traditional learning in Algorithms and Programming courses at the Computer Engineering Department at Suleyman Demirel University, taught with blended learning methods. Achievement of the Learning Management System (LMS) at the university by using distance education technology in the flash animation course, the evaluation carried out has met the specified standards. Then analyze and compare student performance both with online learning and traditional learning or face to face. Showing results that are more effective, student achievement is better than expected compared to traditional face-to-face learning. The ability to think of student algorithms is better [2]. Referring to the results of the existing research, the blended learning learning model that combines face-to-face learning, with online learning learning shows an increase in students' comprehension skills in mastering learning material so that it can improve student learning achievement. For this reason, it is necessary to conduct research that can develop strategies or learning models that are an alternative to achieving effective learning goals.

2 Literature Review

A literature review will be used to study different definitions of blended learning, the difference between a traditional, web facilitated, blended learning and online course; the implementation of a blended learning course in the process of learning English at National Research Tomsk Polytechnic University. Also the example of using the English course to teach engineering students will be provided. Allen and Seaman divide all courses into groups;

1. Traditional course which doesn't use online technologies. All the material is given orally or in pen
2. Web facilitated course user web-based technologies, For example, web pages are used to provide the syllabus and assignments (1-29 % of the material is given online)
3. Blended (hybrid) course combines online learning and face-to-face classes (30-79% is delivered online)
4. Online course implies that most of all the content (more than 80%) is delivered online [3].

The potential for implementing learning with the blended learning system is very possible to implement, along with the development of information and communication technology. Book of "Preparing for Blended e-Learning" The combination of conventional teaching approaches and e-learning elements within a single course or programme is commonly referred to as 'blended learning', but we can also think of it as blended e-learning, the blend refers to the proportion of e-learning content within the course [4]. Next the basic principle of blended learning is that face-to-face oral communication and online written communication are optimally integrated such that the strengths of each are blended into a unique learning experience congruent with the context and intended educational purpose. [5]. Research Student Characteristics and Learning Outcomes in a Blended Learning Environment Intervention in a Ugandan University menemukan bahwa pengaruh pembelajaran blended learning terhadap hasil belajar menunjukan hasil yang signifikan. Hal ini menunjukan pembelajaran bleneded learning peningkatan hasil belajar mahasiswa. [1]. Research Development of blended learning model with virtual science laboratory for secendary students. The aim of this development study is to develop a blended learning model that uses project-based learning through virtual science laboratories in science classes for high school students. This model can improve students' ability to understand lessons more easily, and make it possible to conduct experiments as high as encouraging students to carry out further experiments. [6].

Based on the assumptions above, blended learning based learning is the best choice to increase effectiveness, efficiency, and greater attractiveness in interacting between humans in diverse learning environments. Blended learning offers learning opportunities to be good together and separate, as well as at the same time or different. A learning communication can be done by students and instructors who can interact at any time and anywhere because they use the use of computer and other devices (iPhone)

as learning facilities. Based on the assumptions above, blended learning based learning is the best choice to increase effectiveness, efficiency, and greater attractiveness in interacting between humans in diverse learning environments. Blended learning offers learning opportunities to be good together and separate, as well as at the same time or different. A learning communication can be done by students and instructors who can interact at any time and anywhere because they use the use of computer and other devices (iPhone) as learning facilities. Blended learning has a number of advantages in comparison with traditional learning courses. One of the advantages of blended learning is that it is easily adaptable to learners' needs. The adaptability comes from different ways how online resources can be used. The most important component of blended learning is its flexible course. If the teacher notices any problems that the learners have while studying the course, he/she can immediately solve these problems by changing the material and learning activities. Learners' individual needs should be taken into consideration, otherwise even well-designed courses can fail. If the course is flexible it contributes to raising learners' motivation.

3 Research Methodology

The paper outlines the methodology for the Both qualitative and quantitative data were used together in this study, including pedagogical objectives, task design, selection of a blended course, as an educational tool and its implementation in the learning process. We use the following methods in our research: the analysis, the review of literature, observing our own professional experience with data analysis. The purpose of the study is to solve the problems that occur in learning by developing a blended based learning package in the management information system course, we've formulated the following pedagogical objectives:

1. Obtain an overview of the conceptual model of blended learning based on management information systems courses
2. Describe the procedural model of blended learning based management information systems courses
3. To evaluate the hypothesis that blended learning is an effective educational tool to learn and teach management information systems at the technical university

This research was conducted at the Manado State Islamic Institute (IAIN) in 2018. The first step in conducting a literature study included: summarizing, interpreting and evaluating the literature related to the subject of research in building a theoretical framework. The researcher modified the questionnaire before giving it to the respondent to answer, the number of respondents was 50 students consisting of 25 class A students and 25 class B students, which would be distributed to all respondents directly in their respective classes. Questionnaire data was collected within 2 weeks. After filling in the answers, all of them are collected for further data analysis by researchers to obtain results and findings from the development of blended learning models. All the data collected from the respondents were gathered together to be analyzed using Statistical Package for the Social Sciences (SPSS) version 21. The analysis includes

both descriptive and inferential analysis. The researchers used descriptive analysis to analyze the frequency and percentage of the overall population in the demographic background. Besides, it is also used to determine the mean, standard deviation, frequency and percentage to identify the effectiveness development of blended learning models.

3.1 Testing Requirements Analysis

Table 1. Testing the Normality of Initial Value Data (Pre-test)

Initial Value	Frekuensi	Fkomulatif	Z	F(Z)	S(Z)	L
29.97	1	1	-2.0823389	0.0186558	0.02	0.0013442
33.3	3	4	-1.7431958	0.0406497	0.08	0.0393503
36.63	2	6	-1.4040526	0.0801516	0.12	0.0398484
39.96	4	10	-1.0649095	0.1434584	0.2	0.0565416
43.29	5	15	-0.7257663	0.233991	0.3	0.066009
46.62	7	22	-0.3866232	0.3495176	0.44	0.0904824
49.95	6	28	-0.04748	0.4810653	0.56	0.0789347
53.28	4	32	0.2916631	0.6147279	0.64	0.0252721
56.61	5	37	0.6308063	0.7359164	0.74	0.0040836
59.94	3	40	0.9699494	0.8339641	0.8	0.0339641
63.27	5	45	1.3090925	0.9047485	0.9	0.0047485
66.6	4	49	1.6482357	0.9503478	0.98	0.0296522
69.93	1	50	1.9873788	0.9765598	1	0.0234402

Average	**50.4162**
Standard Deviation	9.81886
Alpha	0.05
L table	0.12530
L count	0.09048

Based on the above calculations obtained L count = 0.09048. At the real level (Alpha) = 0.05 n = 50, the price of L table = 0.12530. Because L count = 0.09048, the initial value data (Pre-test) is normally distributed.

4 Results and Findings

Normality testing is the calculation of statistical data to test data whether it is continuously distributed normally or not, so hypothesis testing can be carried out. The normality testing technique uses the Lilliefors Test, the calculation and testing process is shown in the appendix.

The statistical hypothesis underlying normality testing is:

Ho: data is normally distributed

H1: data is not normally distributed

Based on the hypothesis above, the criteria used are rejecting the null hypothesis, if the value of L count > L table at a significant rate $\alpha = 0.05$, which means the data is from a population that is not normally distributed. Instead accept the null hypothesis,

if the value of L count < L table at a significant level α = 0.05, which means the data is from a population that is normally distributed.

4.1 Normality of pre-test data

The initial value data (pre-test) is student value data before being taught using the blended learning. Based on the results of the Microsoft Excel application, it is known that the average pretest value is 50.41 and the standard deviation value (si) is 9.8188. Next is to determine the normal cumulative probability F (zi) and the cumulative probability of impulse S (zi), based on the results of the normal cumulative probability and the large probability is L count = 0.9048. Sample = 50 and significance level α = 0.05. L table = x = 0.12530 / (√50) = 0.12530. The calculation results show that at a significant level of 0.05 L count < L table (0.09048 <0.12530) which means accepting the null hypothesis. The conclusion of the pre-test data is that it comes from a population that is normally distributed

4.2 Normality of post-test data

The final value data (post-test) is student value data after being taught using the blended learning. Based on the results of the Microsoft Excel application count, it is known that the average value post-test is 79.99 and the standard deviation value (si) is 8.83574. Next, determine the normal cumulative probability F (zi) and the cumulative impulse probability S (zi), based on the results of the normal cumulative probability and the cumulative probability of the student's post-test results obtained the highest price is L count = 0.11675. Sample = 50 and significance level α = 0.05. L table = x = 0.886 / (√50) = 0.12530. The calculation results show that at a significant level of 0.05 L count < L table (0.11675 <0.12530) which means accepting the null hypothesis. The conclusion of the pre-test data is that it comes from a population that is normally.

4.3 Data homogeneity test

Testing the sample data that has been proven to be normally distributed, then further testing of the homogeneity of the variance of the two samples is carried out. Homogeneity testing techniques using the Barrett Test, the calculation process and testing are attached. The statistical hypothesis underlying homogeneity testing is:

Ho: homogeneous sample data

H1: sample data is not homogeneous

Based on the hypothesis above, the criteria used are rejecting the null hypothesis, if the value of x^2 count> x^2 table at a significant level α = 0.05, which means the sample data is not homogeneous. Instead accept the null hypothesis, if the value of x^2 count <x^2 table at a significant level α = 0.05, which means the sample data is homogeneous. Based on the results of the Microsoft Excel application count, the sample combined variance = 1.89762 and unit price B = 21.7000, and the value of x^2 count = -290,839, the value of x^2 table at a significant level α = 0.05 is 3.841. So x^2 count = -

290,839 <x^2 table = 3,841, so it can be concluded that Ho is accepted which means the sample data is homogeneous.

4.4 T test (paired t-test)

The implementation of the model is to see how the effectiveness of the blended learning the Management Information System course. he effectiveness of the product model developed is calculated through analysis using SPSS which produces the following information:

Table 2. Results of the SPSS Program Calculation Process.

Paired Samples Test									
		Paired Differences					***t***	***df***	***Sig. (2-tailed)***
		Mean	**Std. Deviation**	**Std. Error Mean**	**95% Confidence Interval of the Difference**				
					Lower	**Upper**			
Pair 1	Pre test - Post test	-29.43720	5.52157	.78087	-31.00641	-27.86799	-37.698	49	.000

Paired Samples Statistics					
		Mean	***N***	***Std. Deviation***	***Std. Error Mean***
Pair 1	Pre test	50.4162	50	9.81886	1.38860
	Post test	79.8534	50	8.81010	1.24594

Paired Samples Correlations				
		N	***Correlation***	***Sig.***
Pair 1	Pre test & Post test	50	.830	.000

The data above shows that the mean score of the pre-test and post-test score is -29.43720. While the t-test that tests Ho: μ pre-test = μ post-test gives a value of t = -37.43720 with 49 degrees of freedom. While the p-value for the two-tailed (2-tailed) test is 0.000 which is smaller than α = 0,05. This data proves that the statistical hypothesis Ho: μ pre-test = μ post-test is rejected. The conclusion that can be drawn is that the mean score of the pre-test and post-test are significantly different. The data above also shows the correlation of the two variables at r = 0.830 and hypothesis test data to determine the significance of the correlation p-value = 0.000. In this case, p-value = 0,000 is smaller than α = 0.05, so pearson correlation is significant.

Based on the above data analysis it can be concluded that the average score of the pre-test and post-test is different, and the difference is significant. This means that the product of the blended learning package in the Management Information System used by students is effective, because it produces meaningful learning outcomes for students. The findings of this study can be used to recommend effective ways of learning and teaching using e-learning so that it can improve student learning outcomes in higher education. The implications of this research recommendation are to encourage

them to use e-learning technology and facilitate students in improving academic learning outcomes.

5 Conclusion

The results of the research and data analysis obtained from the evaluation during the development process of blended learning products in the Management Information Systems course are

1. The process of research and development carried out has produced a product of the blended learning in the Management Information System course. This product consists of procedural models and physical models. The procedural model is the result of the construction of the theoretical study which is manifested in the form of images. The procedural model that was successfully developed consisted of the steps to develop a blended learning tool in the Management Information System course. Whereas physical products are manifested in the form of programs (systems) for blended learning based on learning management systems (LMS) which are equipped with learning tools such as syllabus, lesson plans, compilation of teaching materials, and evaluation systems.
2. Development of field testing to determine the effectiveness of the product of blended learning development in the Management Information Systems course. The effectiveness test is done by testing the normality of the initial test data (pre-test) with the results of calculations that show that at a significant level of 0.05 L count < L count < L table (0.96191 < 0.14010) which means accepting the null hypothesis. Conclusion of the pre-test data is derived from a population that is normally distributed. The final test data (post-test) with the calculation results shows that at a significant level of 0.05 L count < L table (0.107363 < 0.14019) which means accepting the null hypothesis. Conclusion of the pre-test data is derived from a population that is normally distributed.
3. Test homogeneity of data seen at the significance level of = 0.05 obtained x^2 table = 3,841, then x^2 count = -290,839 <x^2 table = 3,841, so it can be concluded that H_0 received means homogeneous data. And the effectiveness of the data test is done by analyzing the mean score of the results of the pre-test and post-test using the SPSS program. Based on the data about the opinions and ratings of students on the blended learning model they follow, it can be concluded that the mean score of the pre-test and post-test is not significantly different. This data shows the correlation of these two variables at r = 0.815 and hypothesis test data to determine the significance of the correlation p-value = 0.000. In this case, p-value = 0,000 is smaller than $\alpha = 0.05$, so person correlation is significant.
4. The right learning innovation will arouse the independence and confidence of students who have tried to find and explore learning resources not only from the teacher. It is this assumption that delivers blended learning to become an option when learning is not enough just face to face. Students get the opportunity to develop communication skills both in class and outside the classroom through online interaction with each other sambal discussing problems Together, for

teachers can optimize the learning model in improving student learning independence, especially management information systems.

6 References

[1] M. J. Kintu and C. Zhu, "Student Characteristics and Learning Outcomes in a Blended Learning Environment Intervention in a Ugandan University.," Electron. J. e-Learning, vol. 14, no. 3, pp. 181–195, 2016.
[2] T. Yigit, A. Koyun, A. S. Yuksel, and I. A. Cankaya, "Evaluation of blended learning approach in computer engineering education," Procedia-Social Behav. Sci., vol. 141, pp. 807–812, 2014. https://doi.org/10.1016/j.sbspro.2014.05.140
[3] I. E. Allen and J. Seaman, Changing course: Ten years of tracking online education in the United States. ERIC, 2013.
[4] A. Littlejohn and C. Pegler, Preparing for blended e-learning. Routledge, 2007.
[5] D. R. Garrison and N. D. Vaughan, Blended learning in higher education: Framework, principles, and guidelines. John Wiley & Sons, 2008.
[6] U. Klentien and W. Wannasawade, "Development of blended learning model with virtual science laboratory for secondary students," Procedia-Social Behav. Sci., vol. 217, pp. 706–711, 2016. https://doi.org/10.1016/j.sbspro.2016.02.126

7 Authors

Munir Tubagus is currently Student, Department of Education Technology, Jakarta State University, Jakarta, Indonesia. Author is working and interested in learning management system. For contact matrix.bagus@gmail.com

Suyitno Muslim is a Lecturer in, Department of Education Technology, Jakarta State University, Jakarta, Indonesia. Suyitno Muslim is working on learning management system and education technologies.

Suriani a Lecturer in Department of Education Technology, Jakarta State University, Jakarta, Indonesia. Author is working and interested in learning management system

Article submitted 2020-01-24. Resubmitted 2020-02-26. Final acceptance 2020-02-26. Final version published as submitted by the authors.

The Use of AR-Assisted Storybook to Reduce Mathematical Anxiety on Elementary School Students

https://doi.org/10.3991/ijim.v14i06.12285

Muhammad Nur Wangid (✉)
Postgraduate of Universitas Negeri Yogyakarta, Yogyakarta, Indonesia
m_nurwangid@uny.ac.id

Hendra Erik Rudyanto
Universitas PGRI Madiun, Jawa Timur, Indonesia

Gunartati
STKIP Catursakti, Yogyakarta, Indonesia

Abstract—Mathematics is essential to be mastered by students because it can help students to solve various problems in daily life. Students are anxious and afraid to take mathematics lessons. Augmented Reality (AR)-assisted storybook blends fantasy and reality and is developed to see the impact on students 'mathematics anxiety. This study aims to determine the effectiveness of AR-assisted storybooks on students' anxiety in mathematics learning. This study uses a quantitative approach with the type of research quasi-experiment and with the design of the pretest-posttest control group design. The study sample includes 348 fourth grade students in elementary school in Yogyakarta. The sampling technique used is the cluster random sampling technique. Independent t-test techniques analyzed data. The results showed that the sig value 2-tailed in the independent t-test was 0.00 (<0.05). Thus, it can be stated that AR-Assisted storybook has a positive and significant effect on students' mathematics learning anxiety.

Keywords—Anxiety, Augmented Reality, Elementary School, Mathematics Learning, Storybooks.

1 Introduction

Mathematics lesson often regards as a difficult subject for students to understand. The survey results revealed that many students at various levels experienced mathematical anxiety, ranging from early elementary school to college-level [1], [2]. Mathematical anxiety defines as feelings of tension that interfere with the ability to solve mathematical problems in everyday life and learning [3]. Mathematical anxiety divides into two parts. It was anxiety about learning [4] and the test [5].

Students with mathematical anxiety have disliked or worried, and this will affect their physiological conditions, such as changes in heart rate, nerve activation, and cortisol [6], [7]. Symptoms of students when asked to do math assignments show

nerve activation similar to that found when individuals experience physical pain [6]. Mathematical anxiety is even considered to be similar to a phobia [4]. When individuals see attention stimulation related to mathematics, their nerve responses will see it as something threatening to create individual behavior that is controlled by fear [8]. The conceptualization of anxiety focused on cognitive interference, such as incompetence, helplessness, and concerns of students who were anxious about the test [9]. Many of the irrelevant thoughts that describe to anxious students focus on the reasons for their performance (i.e., "I am not smart enough"). This anxiety can psychologically interfere with one's performance in learning [10]. Mathematical anxiety has been recognized as an important factor that influences mathematical learning, mathematical achievement, and basic numerical abilities in the classroom [11].

The emergence of mathematical anxiety is influenced by the students' negative experience with mathematics [1], [12]. Other causes are the teacher's teaching style in the class based on conventional methods, which is done with a focus on developing skills and understanding [13], [14]. Thus, the teacher needs to pay attention to providing positive experiences for students in learning. One way that teachers can try to overcome math anxiety is to use learning media that make students feel 'enjoy' when learning mathematics.

So far, no media has been focused on the examination of mathematical anxiety impact. The steps to reduce mathematics anxiety are still in the form of strategies for teaching so that students' math anxiety can be reduced [15], [16]. This study seeks to develop media that can attract students to learn mathematics. One medium that can attract and be close to students is a storybook with mathematical material contents. Storybooks have been developed by several researchers before proven to be able to attract students' attention, create an impact of pleasure and allow the subject matter to be included in it [17], [18].

The storybook is developed using the help of Augmented Reality, a technology that integrates the real world and virtual world interactively through a 3D visualization display [19], [20]. Augmented Reality has the advantage of attracting students' attention, create learning collaborative, and become independent. It is an ocular involvement that helps students cognitive processes [21], [22]. Also, visual assistance from AR can help students understanding mathematics materials being taught [23], [24].

Thus, it can be concluded that the study design study using learning-based Augmented reality led to an increase in the hypothesis of activity [25]. AR design principles, i.e., giving challenge, fantasy, and look at the invisible part for the user [26]. Through this media, students are invited to realize abstract images or objects to be semi-real. Augmented reality technology emerges to complete the storybook to make it more interactive. The advantages of storybooks that are equipped with AR are expected to reduce students' mathematical anxiety. The formulation of this study focuses on the effectiveness of storybooks to reduce anxiety in elementary school students.

2 Method

2.1 Participant and procedure

This research was conducted in the province of Yogyakarta with a population of all fourth-grade students in state-owned elementary schools in the Yogyakarta Special Region. The sample is determined using a cluster random sampling technique. As a result, 348 grade IV elementary school students were taken with consideration of essential school representation in 4 districts/cities in DI Yogyakarta, namely Yogyakarta city, Sleman district, Bantul district, and Kulonprogo district.

They were then divided into three groups, which were 2 experimental groups (group 1 consisted of 116 students and Group 2 consisted of 116 students) and the control group (1 class consisting of 116 students). Three groups were randomly selected, but they have the same characteristics (homogeneous). The two groups became the experimental group that would be treated by using AR-assisted Storybook on mathematics learning and one other group as the control group using conventional picture media in mathematics learning. The three groups were given a pretest by filling out the questionnaire at the beginning to determine students' anxiety in learning mathematics before being given special treatment. Then, in the end, after being given special treatment, students were given a posttest by filling out the questionnaire. Data obtained were then analyzed using a paired t-test and independent t-test. A paired t-test was conducted to prove whether there was a difference in anxiety between the students and the posttest. Next, an independent t-test was conducted to determine whether there were differences in anxiety among students who treated by using the AR-assisted Storybook with a group that did not use the AR-assisted Storybook in mathematics learning.

2.2 Measurement

The instrument in this research is Children's Anxiety in Math Scale (CAMS) questionnaire adapted from Jameson [27]. The number of questionnaire items consisted of 16 items on a scale taken in a range of 1-5. This tool has been tested through Exploratory Factor Analysis (EFA) with Parallel Analysis that produces three-factor solutions, which are general math anxiety (general math anxiety), mathematical performance anxiety (math performance anxiety), and math error anxiety.

2.3 Data analysis

This research uses descriptive statistical analysis techniques and inferential statistics. Descriptive analysis was carried out by categorizing the tendency of scores into five-level, which are very high, high, medium, low, and very low [28].

Inferential statistical analysis is done to test the predetermined hypothesis. Hypothesis testing uses paired t-test techniques and an independent t-test technique to find

out whether there are differences between groups treated with untreated groups. The testing of inferential statistics was carried out with the assistance of SPSS version 22.

3 Results and Discussion

3.1 Results of research

The result of descriptive statistic analysis data from pretest dan posttest applied on experiment and control class are as follows:

Table 1. Anxiety Score Tendency

Class	Criteria	Pre-test		Mean	Post-test		Mean
		F	%		F	%	
Experiment Group 1	Very high	13	11.21	55.91	0	0.00	34.78
	High	58	50.00		4	3.45	
	Medium	34	29.31		13	11.21	
	Low	11	9.48		72	62.07	
	Very low	0	0.00		27	23.28	
Experiment Group 2	Very high	17	14.66	58.00	0	0.00	34.26
	High	61	52.59		1	0.86	
	Medium	35	30.17		10	8.62	
	Low	3	2.59		84	72.41	
	Very low	0	0.00		21	18.10	
Control group	Very high	26	22.41	58.09	2	1.72	41.44
	High	45	38.79		12	10.34	
	medium	34	29.31		40	34.48	
	Low	11	9.48		52	44.83	
	Very low	0	0.00		10	8.62	

Based on the data in Table 1, the tendency of the pretest scores of the three classes shows that the highest frequency is in the high category compared to other categories. This means that students' anxiety towards mathematics learning is mostly in the high category. Experimental class 1 with 58 students (50.00%) were categorized as high, experimental class 2 with 61 students (52.59%) were categorized as high, and control class with 45 students (38.79%) were categorized as high with an overall average of 58.09 (high).

However, after treatment, the posttest results showed that there was a decrease in students' anxiety levels in mathematics learning. The tendency of the posttest scores of the three classes shows that the highest frequency is in a low category compared to other categories. This means that students' anxiety towards the majority of mathematics learning has begun to fall low category. Experimental class 1 with 72 students (62.07%) then entered a low category. Experimental class 2 with 84 students (72.41%) were in a low category, and the control class of 52 students (41.44%) down to low category with the overall average amounting to 41.44 (low category).

The decrease in students' anxiety levels in mathematics learning can be seen from the decrease in the average between before given treatment and after (pretest and posttest). In experimental class 1, the average pretest score was 55.91 which meant that it was still in the high category, but after being given treatment, the average posttest dropped to 34.78 in the low category, a decrease in the average score of 21.13 from the pretest. In experimental class 2, the average pretest score was 58.00 which means it was still in the high category. However, after being given treatment, the average posttest dropped to 34.26 in the low category, a decrease in the average score of 23.74 from the pretest. In the control class, the average pretest score is 58.09, which means it is still in the high category, but after being given treatment, the average posttest dropped to 34.26 in the low category, a decrease in the average score of 41.44 from the pretest.

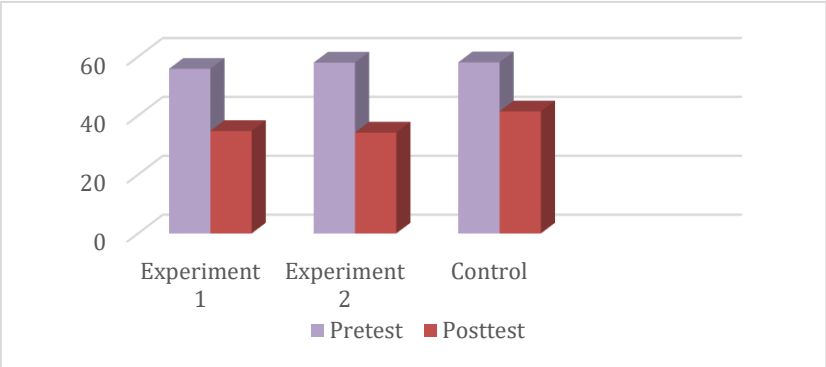


Fig. 1. *Pretest Posttest* Score Math Anxiety Decrease Diagram

The results of hypothesis testing with inferential statistics using the t-test paired t-test and independent t-test are as follows. The results of the paired t-test show that the value of sig. <0.05, which means that the accepted hypothesis is that there are differences in students' anxiety on mathematics learning between before being treated and after. The results of paired t-test calculations can be seen in the following table.

Table 2. Paired t-test Result

Paired Samples Test			
Pretest – Posttest	***Sig.(2-Tailed)***	***Alpha value***	***Desc.***
	0.00	0,05	Difference appeared

The results of hypothesis testing using the independent t-test technique indicate that the value of sig. <0.05, which means the accepted hypothesis is that there is a difference between the treated group (experimental group) using the AR-assisted storybook and the untreated group (the control group) using the AR-assisted storybook. The results of independent t-test calculations can be seen in the following table.

Table 3. Independent t-test Result

Independent Samples Test			
Equal variances assumed	Sig.(2-Tailed)	Alpha value	Desc.
	0.00	0,05	Difference appeared

3.2 Discussion

Mathematical anxiety involves various fields of science such as psychology, education, and neuroscience [29]. This can be a barrier for students in gaining achievements in learning mathematics. There are two opinions about the obstruction of learning achievement, first, the disruption accounts due to disruption of work memory performance (WM) and the second, due to reduced mathematical abilities (reduced competency accounts) which result in anxiety [2]. Students who experience anxiety will feel an increase in heart rate [16] and other researchers liken this to a feeling of phobia [4], [8].

Mathematical anxiety can be reduced if there is a comfortable mathematics learning, The teacher becomes an important factor in creating comfort in learning [30]. The Teacher’s error in conveying mathematics learning can make appearing of students' math anxiety increase. Therefore, the teacher needs to use media that makes students happy and comfortable, one of them through the AR-assisted storybook.

Storybooks are developed with the aspects of content and appearance. Content aspects include story elements such as themes, setting, characterization, plot, point of view, language style, and mandate [31]. Display aspects include color, text, and position of images, pages, and sizes. Color must consider the theme of the story because it will affect the atmosphere of the reader [32]. Primary school students like striking colors [33]. The position of the text and images must match and may not overlap. The number of pages that corresponds to elementary students is between 32-64 with a maximum book size of 11 inches [32].

Exercises or mathematical problem tasks are presented as a complement to storybooks. These exercises are used to increase students' self-efficacy and self-esteem. Both of these aspects are related to students' beliefs in their abilities and respect for themselves. Self-efficacy and self-esteem negatively correlated with math anxiety [34]. Thus through lots of fun exercises through storybooks, self-efficacy and self-esteem towards mathematics will increase, and students' math anxiety can decrease.

Storybooks are equipped with augmented reality assistance. As stated by previous researchers, AR is able to attract the attention and involvement of students through the 3D visualization displayed [21]. Learning with augmented reality offers flexible learning facilitation [35] and the creation of authentic learning [36]. Books that are augmented reality feature will be more dynamic and interactive [37].

The advantage of the augmented reality feature is its ability to help students understand mathematical concepts through form manipulation, understanding (from abstract to concrete) and providing contextual learning [23]. Augmented reality also helps students' spatial abilities [24], [38] which can ultimately reduce student anxiety [39].

4 Conclusion

Based on the results of the research and discussion presented, it can be concluded that the use of media in the form of storybooks assisted by augmented reality can have a positive and significant influence on the anxiety of fourth-grade students in mathematics learning. This is indicated by the results of hypothesis testing with paired t-test and t-test techniques. The results of the paired t-test show that the value of sig. <0.05, which means that the accepted hypothesis is that there are differences in students' anxiety on mathematics learning between before being given treatment and after. The results of the independent t-test indicate that the value of sig. <0.05, which means that the accepted hypothesis is that there is a difference between the treated group (experimental group) using the AR-assisted Storybook and the untreated group (control group) using the AR-Assisted storybook.

5 Acknowledgement

Thank you to the ministry of technology research and higher education who have provided financial assistance to carry out this research.

6 References

[1] M. Bekdemir, "The pre-service teachers' mathematics anxiety related to depth of negative experiences in mathematics classroom while they were students," Educ. Stud. Math., vol. 75, no. 3, pp. 311–328, 2010. https://doi.org/10.1007/s10649-010-9260-7

[2] G. Ramirez, H. Chang, E. A. Maloney, S. C. Levine, and S. L. Beilock, "The relationship between math anxiety and math achievement in early elementary school : The role of problem solving strategies," J. Exp. Child Psychol., vol. 141, pp. 83–100, 2016. https://doi.org/10.1016/j.jecp.2015.07.014

[3] F. C. Richardson and R. M. Suinn, "The Mathematics Anxiety Rating Scale: Psychometric data," J. Couns. Psychol., vol. 19, no. 6, pp. 551–554, 1972. https://doi.org/10.1037/h0033456

[4] R. Hembree, "The Nature, Effects, and Relief of Mathematics Anxiety," J. Res. Math. Educ., vol. 21, no. 1, p. 33, 1990.

[5] R. Kazelskis, C. Reeves, M. E. Kersh, and D. C. Holliday, "Mathematics anxiety and test anxiety: Separate Constructs?," J. Exp. Educ., vol. 68, no. 2, pp. 137–146, 2001. https://doi.org/10.1080/00220970009598499

[6] I. M. Lyons and S. L. Beilock, "When Math Hurts: Math Anxiety Predicts Pain Network Activation in Anticipation of Doing Math," PLoS One, vol. 7, no. 10, 2012. https://doi.org/10.1371/journal.pone.0048076

[7] B. Pletzer, M. Kronbichler, H. C. Nuerk, and H. H. Kerschbaum, "Mathematics anxiety reduces default mode network deactivation in response to numerical tasks," Front. Hum. Neurosci., vol. 9, no. April, pp. 1–12, 2015. https://doi.org/10.3389/fnhum.2015.00202

[8] R. G. Pizzie and D. J. M. Kraemer, "Avoiding math on a rapid timescale: Emotional responsivity and anxious attention in math anxiety," Brain Cogn., vol. 118, no. August, pp. 100–107, 2017. https://doi.org/10.1016/j.bandc.2017.08.004

[9] R. M. Arkin, T. A. Kolditz, and K. K. Kolditz, "Attributions of the test-anxious student: Self-assessments in the classroom," Personal. Soc. Psychol. Bull., vol. 9, pp. 271–280, 1983. https://doi.org/10.1177/0146167283092012
[10] G. Ramirez, S. T. Shaw, E. A. Maloney, G. Ramirez, S. T. Shaw, and E. A. Maloney, "Math Anxiety : Past Research , Promising Interventions , and a New Interpretation Framework," vol. 15, no. 20, 2018. https://doi.org/10.1080/00461520.2018.1447384
[11] E. A. Maloney and S. L. Beilock, "Math anxiety: who has it , why it develops , and how to guard against it," Trends Cogn. Sci., vol. 16, no. 8, pp. 404–406. https://doi.org/10.1016/j.tics.2012.06.008
[12] M. H. Ashcraft and A. M. Moore, "Mathematics anxiety and the affective drop in performance," J. Psychoeduc. Assess., vol. 27, no. 3, pp. 197–205, 2009.
[13] M. Finlayson and M. Finlayson, "Improving Schools Addressing math anxiety in the classroom in the classroom," 2014.
[14] Skemp, The Psychology of Learning Mathematics. England: Penguin Books, 1971.
[15] C. Blazer, "Strategies for reducing math anxiety," Inf. Capsul., vol. 1102, no. September, pp. 1–8, 2011.
[16] J. M. Furner and B. T. Berman, "Review of Research: Math Anxiety: Overcoming a Major Obstacle to the Improvement of Student Math Performance," Child. Educ., vol. 79, no. 3, pp. 170–174, 2003. https://doi.org/10.1080/00094056.2003.10522220
[17] N. Emmons, K. Lees, and D. Kelemen, "Young children's near and far transfer of the basic theory of natural selection: An analogical storybook intervention," J. Res. Sci. Teach., vol. 55, no. 3, pp. 321–347, 2018. https://doi.org/10.1002/tea.21421
[18] D. Kelemen, N. A. Emmons, R. Seston Schillaci, and P. A. Ganea, "Young Children Can Be Taught Basic Natural Selection Using a Picture-Storybook Intervention," Psychol. Sci., vol. 25, no. 4, pp. 893–902, 2014. https://doi.org/10.1177/0956797613516009
[19] R. T. Azuma, "A Survey of Augmented Reality," Presence Teleoperators Virtual Environ., vol. 6, no. 4, pp. 355–385, 1997. https://doi.org/10.1162/pres.1997.6.4.355
[20] M. Billinghurst, A. Clark, and G. Lee, "A Survey of Augmented Reality," Found. Trends® Human–Computer Interact., vol. 8, no. 2–3, pp. 73–272, 2015.
[21] J. Y. Chao and C. H. Liu, "A case study on the spatial conceptualization abilities for sixth grade elementary students from urban, suburban and remote schools," Eurasia J. Math. Sci. Technol. Educ., vol. 13, no. 6, pp. 1675–1686, 2017. https://doi.org/10.12973/eurasia.2017.00691a
[22] J. Martín-Gutiérrez, P. Fabiani, W. Benesova, M. D. Meneses, and C. E. Mora, "Augmented reality to promote collaborative and autonomous learning in higher education," Comput. Human Behav., vol. 51, pp. 752–761, 2015. https://doi.org/10.1016/j.chb.2014.11.093
[23] K. R. Bujak, I. Radu, R. Catrambone, B. Macintyre, R. Zheng, and G. Golubski, "Computers & Education A psychological perspective on augmented reality in the mathematics classroom," Comput. Educ., vol. 68, pp. 536–544, 2013. https://doi.org/10.1016/j.compedu.2013.02.017
[24] H. Kaufmann and D. Schmalstieg, "Mathematics and geometry education with collaborative augmented reality," Comput. Graph., vol. 27, no. 3, pp. 339–345, 2003. https://doi.org/10.1016/s0097-8493(03)00028-1
[25] M. F. Amir, C. Chotimah, R. Afandi, H. E. Rudyanto, and I. Anshori, "Design Research Study : Investigation of Increasing Elementary Student ' s Spatial Ability Using 3Dmetric," J. Adv. Res. Dyn. Control Syst., vol. 10, no. 6, pp. 1707–1713, 2018. https://doi.org/10.31227/osf.io/6fbzj

[26] M. F. Amir, N. Fediyanto, C. Chotimah, and H. E. Rudiyanto, "Developing 3Dmetric Media Prototype through a Hypothetical Learning Trajector to Train Students Spatial Skill," J. Adv. Res. Dyn. Control Syst., vol. 10, no. 02–Special Issue, pp. 1537–1542, 2018. https://doi.org/10.31227/osf.io/vmk45
[27] M. M. Jameson, "The Development and Validation of the Children's Anxiety in Math Scale," J. Psychoeduc. Assess., vol. 31, no. 4, pp. 391–395, 2013.
[28] Wagiran, Implementasi kurikulum 2013. Tulungagung: CV. Bahtera Wijaya Perkasa, 2014.
[29] A. Sarkar, A. Dowker, and R. Cohen Kadosh, "Cognitive Enhancement or Cognitive Cost: Trait-Specific Outcomes of Brain Stimulation in the Case of Mathematics Anxiety," J. Neurosci., vol. 34, no. 50, pp. 16605–16610, 2014. https://doi.org/10.1523/jneurosci.3129-14.2014
[30] E. Freedman, "Ten Ways to Reduce math Anxiety," Math Power, 2012. .
[31] R. J. Lukens, A critical handbook of children's literature. New York: Longman Publisher, 1999.
[32] C. S. Huck, S. Hepler, and J. Hickman, Children's Literature in The Elementary School. New York: Holt, Rinehart and Winston, 1987.
[33] D. M. Barone, Children's Literature in the Classroom: Engaging Lifelong Readers. New York: The Guilford Press, 2011.
[34] M. H. Ashcraft and K. S. Ridley, "Math anxiety and its cognitive consequences: A tutorial review," in Handbook of mathematical cognition, J. I. D. Campbell, Ed. New York: Psychology Press, 2005, pp. 315–326.
[35] C. Jara, P. Candelas, M. Fernández, and F. Torres, "An augmented reality interface for training robotics through the web," Communication, 2009. .
[36] S. Cai, "Case Studies of Augmented Reality Applications for Authentic Learning," no. 19, 2018.
[37] C. Diaz, M. Hincapié, and G. Moreno, "How the Type of Content in Educative Augmented Reality Application Affects the Learning Experience," Procedia Comput. Sci., vol. 75, no. Vare, pp. 205–212, 2015. https://doi.org/10.1016/j.procs.2015.12.239
[38] K. Lee, "Augmented Reality in Education and Training," Link. Res. Pract. to Improv. Learn., vol. 56, no. 2, pp. 13–21, 2012.
[39] A. M. Ferguson, E. A. Maloney, J. Fugelsang, and E. F. Risko, "On the relation between math and spatial ability : The case of math anxiety," Learn. Individ. Differ., vol. 39, pp. 1–12, 2015. https://doi.org/10.1016/j.lindif.2015.02.007

7 Authors

Muhammad Nur Wangid is a lecturer with 26 years of experience, associate professor in the field of educational psychology. Areas of research interest and publications are related to educational psychology, especially self-regulated learning, academic anxiety, school burnout. Recently his research interests have been linked to developments in information technology, such as augmented reality, blended learning, mobile learning, and so on. He has more than 12 years of experience as academics in postgraduate and successfully supervised five Ph.D. students. He presently supervises 15 Master & Ph.D. students and has examined Master & Ph.D. Theses. He has been the head of the Postgraduate Primary Education Study Program at Yogyakarta State University Indonesia since 2013. He is the head of the board of directors of the Indo-

nesian Primary Education Lecturer Association. He is also the editor in chief of the Prima Edukasia Journal.

Hendra Erik Rudyanto is a lecturer in the education department of elementary school teachers at Universitas PGRI Madiun from 2012 until now. He is now pursuing a doctoral degree in primary education at Yogyakarta State University, Indonesia. Research topics are often used are mathematics education especially in elementary school, such as elementary student's creative thinking ability, ethnomathematics learning in elementary school, etc

Gunartati is a lecturer, with 26 years of work experience. She is a doctor in educational sciences. Areas of research interest and publications are related to the development of learning models, aspirations of achievement of child laborers of primary education, students' discipline, character education. Currently, she is Assistant Chair I (Academic Field) and is active in the Annisa Bhakti Foundation which is engaged in education. On several occasions, she was also asked as a speaker at a joint meeting of women's organizations, teacher and employee coaching forums and at parenting events at school.

Article submitted 2019-11-10. Resubmitted 2019-12-07. Final acceptance 2019-12-10. Final version published as submitted by the authors.

Development of Learning Media Based on Android Games for Children with Attention Deficit Hyperactivity Disorder

https://doi.org/10.3991/ijim.v14i06.13401

Maria Agustini (✉), Yufiarti, Wuryani
Universitas Negri Jakarta East Jakarta, Indonesia
mariaagustini_paud16s3@mahasiswa.unj.ac.id

Abstract—This is a learning media with the scope of ADHD (Attention Deficit Hyperactivity Disorder) for children of age 7 – 8 years. The study aims is to education learning media for children with ADHD with existing games. The Dick and Carey instructional model that has been used is a model of development engaging steps of procedural approaches. The achieved results are going to be used to design a teaching and learning media through the Bible Warrior Adventure Games. This research brings out teaching material products that can be accessed by Android application. By using this learning media, the Sunday School Children with ADHD will be able to learn Christian education easily through Android. The results of the field trial found the fact that after testing the use of instructional media was able to facilitate and increase the knowledge and competence of children with special needs ADHD and can create effective learning, and motivate students in learning.

Keywords—Learning media, ADHD, Christian Education

1 Introduction

Children who are categorized as special needs include various kinds of children who experience physical disorders. One of them is Attention Deficit Hyperactivity Disorder (ADHD) [1][2][3]. Then, children with this category experience attention disorders in such a way that they cannot function with concentration in learning. ADHD is a medical condition that includes brain dysfunction, where individuals have difficulty controlling impulses, inhibiting behavior, and not supporting their attention. If this happens to a child, the child experiences various learning difficulties, behaviors and difficulties related to social relations. There are approximately 3-5% of school-aged children suffering from ADHD. Estimates of worldwide prevalence are 5% and 7.2% [4] . ADHD is increasingly known as a long-term disorder in many countries [5], although far fewer studies have focused on adult ADHD. Data shows that global consumption of the most prescribed psychostimulant medications for ADHD is also developing [6].

ADHD is one of the most common psychiatric disorders, which affects around 8% or 9% of schools. Children and 4.4-5.2% of adults in the US.2-5 Worldwide prevalence of ADHD has been reported to be 5.3% .6 The impact of ADHD on the health care system and community is also surprising, costing tens of billions of dollars each year other than personal and family expenses [7].

The growth of early childhood education (PAUD) in Indonesia is quite encouraging. Based on data from the Sapulidi Research Center (SRC) as of January 2016 the number of PAUD institutions throughout Indonesia reached 190,238 institutions. Consisting of: Kindergarten (TK) 80,140 institutions, Play Group (KB) 78,056 institutions, Child Care Center (TPA) 3,473 institutions, and the PAUD Similar Unit (SPS) 28,569 institutions, including Sunday Schools. The number of Sunday schools for the Indonesian Christian Church in West Java is 29,347 children (West Java Regional Synod: 21781 Central Java Regional Synod: 7566 children). There are approximately 0.2% of children aged 6-8 years who suffer from moderate ADHD, 0.4% of children aged 6-8 years who are likely to suffer from ADHD (Initial study results: at 204 people, with informed consent: 75 people, Possible ADHD: 31 children, ADHD Moderate 17 children). Based on the results of preliminary research through surveys, observations, and interviews at Sunday school for the Indonesian Christian Church in Jakarta, it is found that the learning process for children with special needs is still traditional or conventional in nature, learning that has not been supported by learning media and learning resources, only relies on the teacher as a source of learning. Learning activities should be able to optimize all potential students to improve the expected cognitive abilities.

2 Literature Review

Attention deficit / hyperactivity disorder (ADHD) is a common neuro developmental condition marked by developmentally inappropriate levels of attention, and / or impulsivity and hyperactivity that is significantly impaired functioning across multiple domains and places of risk for a variety of adverse outcomes [8] . ADHD, the acronym for attention deficit hyperactivity disorder, is a neuro developmental problem that can result in discrimination, forgetfulness, impulsivity, and in some cases excessive, restless physical movement, from fidgeting to pacing [9] . The diagnosis of ADHD arises from diagnostic categories related to "hyperactivity" and "minimal brain dysfunction." The most recent of ADHD is the diagnostic category of "attention deficit disorder (ADD: with or without hyperactivity)" from American Psychiatric 1980 Asosia [7] (APA) Diagnostic and Statistical Disorders Manual (DSM-III) [10], which describes the disorder characterized by hyperactivity, impulsivity, and lack of attention (see chapter 2 for details.) The 1987 revision of this manual (DSM-III-R) have changed the name of the condition of "Attention Deficit / Hyperactivity Disorder" or "ADHD". This term has been used in subsequent revisions and has become a popular designation. Attention deficit / hyperactivity disorder (ADHD) is a frequent occurrence, brain-based, neuro developmental disorder with substantial negative consequences for individual and public health. Once viewed as childhood condition, it is

now recognized that a majority of cases persist throughout adolescence and adulthood. This means that Attention Deficit / Hyperactivity Disorder (ADHD) are a common, brain-based neurodevelopment disorder with large negative consequences for individual and public health [11]. After being seen as a childhood condition, it is now recognized that the majority of cases persist throughout adolescence and adults. Web-based learning media provides learning materials for students to learn independently. The use of learning media can guide participants in independent. Game-based learning media is designed to enjoy learning [12] along with intervening content into games, and allowing students to play to gain knowledge through playing games, can help them create knowledge at the level of retention and understanding, and help motivate students to learn, and interact in the learning process, until they can learn on their own. Digital game-based learning media can increase learning interest and produce cognitive effects to help students learn. Game-based learning improves the learning process and its performance [13]. New media technology introduces changes in new learning methods and becomes the basis for designing a quality education process. The use of media allows interaction without constraints of space and time. Interaction offers learning that is not limited to classrooms. That learning through new media offers many things, efficiency, cost effectiveness, practicality, standardization, and different learning performance. An important aspect of learning through new media is the development of individuality in learning [14] [15]. Character education for early childhood in Korea is designed to compensate for the excessive focus on the academic field. There are six values developed, namely caring, respect, cooperation, willingness to share, orderly and devoted. These values are educated through reading, discussion, role playing, cooking demonstration, collaborative play, activity experiences, writing poems and inviting community leaders to give advice.

3 Methodology / Materials

This study uses a mix method with research and development methods (Research and Development). The products developed in this study were bible learning media through the Android War Warriors Adventures media game. As explained above, this study uses mix methods approach with three main methods, namely descriptive, development and experimental methods. Descriptive method is used to collect the initial data in the analysis of objective needs and conditions, namely to collect data about the condition of the products that have been compared for products to be developed, the condition of the users, students, teachers and schools, as well as inhibiting factors and supporting product development. Development methods are used in conducting expert experts in the development of a product. Before the product is used, the learning media design will be validated by experts to obtain a design that is truly valid and reliable. Meanwhile, in this study the experiment was used to determine the effectiveness of small-scale tests to ensure the functioning of instructional media developed.

4 Results and Findings

Based on the problems found at the needs analysis stage, to overcome this problem, design and development of instructional media is needed in order to improve the quality of achieving the objectives to be achieved, both process objectives and objectives.

Field trials were conducted with 19 Sunday class students in West Java representing the actual target population. The purpose of this evaluation is not just to get information from respondents about the assessment or responses about the quality and shortcomings of learning products developed, but also to find out the effectiveness of the product when used in conditions similar to actual field conditions. The product results from this revision are called final products.

The field trial is to carry out tests to see the results of the learning process by conducting initial tests and final tests. Likewise, the response of students are learn to use learning media to follow developing learning according to the learning media that has been done starting from the initial step.

The comparison of the results of the pretest and post test results of this field trial can be seen in table 1

Table 1. Pre Test Results and Post Test of Field Trials

No.	Respondent	Pretest score	Letter	Posttest score	Letter
1	Respondent 01	80,12	A	91,30	A
2	Respondent 02	74,20	B	82,30	A
3	Respondent 04	60,45	C	78,20	B
4	Respondent 04	59,46	D	71,12	B
5	Respondent 05	66,73	C	79,20	B
6	Respondent 06	63,65	C	76,68	B
7	Respondent 07	72,78	B	80,15	A
8	Respondent 08	78,30	B	85,67	A
9	Respondent 09	68,40	C	77,35	B
10	Respondent 10	67,40	C	77,50	B
11	Respondent 11	69,23	C	79,99	B
12	Respondent 12	78,54	B	81,25	A
13	Respondent 13	77,67	B	80,97	A
14	Respondent 14	70.35	B	79,99	B
15	Respondent 15	73,78	B	81,13	A
16	Respondent 16	67,50	C	78,99	A
17	Respondent 17	68,78	C	79,80	B
18	*Respondent 18*	78,50	B	81,22	A
19	*Respondent 19*	75,89	B	80,10	A
	Average Score	67,01	B	80,04	A

Based on table 1, the presentation of the results of the field trial pre-test can be seen in Figure 1 below.

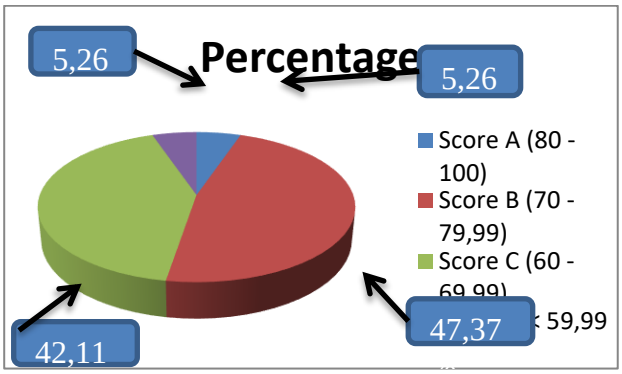


Fig. 1. Pre Test Results Field Test

Based on figure 1 above, the results of field trials on 19 students showed that students who scored 80-100 (A) as much as 5.26%, students who scored 70 -79.99 (B) were 47.37%, students who gained 60-69.99 (C) were 42.11% while those of 50-59.99 (D) were 5.26%. It can be concluded that almost 50% of students get a C value, this indicates an incomplete understanding of the material.

Based on table 1 above, the presentation of the results of the post-test field trials can be seen in Figure 2 below.

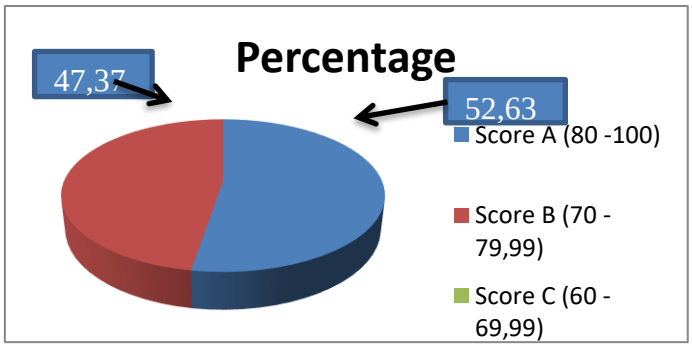


Fig. 2. Post Test Results of Field Test

Based on table 1 above, the results of the field trial test on 19 students showed that students who scored 80-100 (A) were 52.63%, students who obtained 70 - 79.99 (B) were 47.37% , students who get 60-69.99 (C) as much as 0%, and students who get <59.99 (D) as much as 0%, it can be concluded that all 100% students get the values A and B show the completeness understanding of material.

Based on the results of the pre-test and post-test in the field trials showed an increase in post test results, so it can be concluded that learning with learning media can improve students' knowledge and skills and the feasibility of learning media to be used in children with special needs in West Java. Research supported by researchers Sousa and Rocha [16] Digital learning can be a driver for skills development [16].

Also supported by researchers Hawlitschek and Joeckel [17] Digital media can motivate students to improve skills [17], and Participants improve their performance and satisfaction with performance in digital media [18]. Students increasingly need to study content and perspectives that are not given as part of the curriculum, students need to build additional forms of support for learning with digital media [19]. Digital media learners who manage to deal with disruptions in the form of social-cognitive conflict resolution and productive friction are needed for learning and knowledge construction [20].

Media increases efficiency in the use of study time, especially short breaks during workdays, new strategies for reading subject matter and costs [21]. The learning experiences of the previous participants and how they play a role in their responses to the e-learning experience [22]. Objects using text, images, audio, and video elements make stories more interesting [23], and effective learning, can improve students' interest, achievement, and confidence in learning [24] Hypermedia to find the content set that is most suitable for each student profile and we prove its effectiveness in some real cases [25].

5 Conclusion

Based on the results of the research and discussion on the development of game-based learning media for children with special needs ADHD, the following conclusions can be drawn:

a. Conceptually the development of game-based learning media has been carried out through needs analysis that takes into account methodological aspects in its development. Next is the design by developing learning materials in the design. Then, the results of the prototypes were validated by material experts, learning design experts, and learning media experts. Next, it is tested with prospective users through field testing so that the final product was produced from the development of game-based learning media.
b. Procedure in developing learning media based on this game uses Hannafin and Peck's learning development model, while conducting research using modified Borg and Gall procedures and evaluating procedural Dick and Carey.
c. The product results from this development are game-based learning media for children with special needs ADHD.
d. The results of the validation carried out by the expert team concluded that the product development had been carried out correctly following the methods, procedures, principles, and developments that were guided, starting from needs analysis, planning, design, evaluation, and testing. The expert team recommends that the learning media developed is very feasible to use.
e. The results of the field trial found the fact that after testing the use of instructional media was able to facilitate and increase the knowledge and competence of children with special needs ADHD and can create effective learning, and motivate students in learning.

6 Acknowledgements

I would like to say a big thank you to the research team, mentors, and friends and also to my beloved husband and children for the completion of this research. For your great support and motivation, I say many thanks.

7 References

[1] B. D. Fontana, F. Franscescon, D. B. Rosemberg, W. H. J. Norton, A. V Kalueff, and M. O. Parker, "Zebrafish models for attention deficit hyperactivity disorder (ADHD)," Neurosci. Biobehav. Rev., 2019. https://doi.org/10.1016/j.neubiorev.2019.02.009

[2] P. R. Killeen, "Models of attention-deficit hyperactivity disorder," Behav. Processes, 2019.

[3] M. Effatpanah et al., "Magnesium status and attention deficit hyperactivity disorder (ADHD): A meta-analysis," Psychiatry Res., 2019.

[4] G. V Polanczyk, E. G. Willcutt, G. A. Salum, C. Kieling, and L. A. Rohde, "ADHD prevalence estimates across three decades: an updated systematic review and meta-regression analysis," Int. J. Epidemiol., vol. 43, no. 2, pp. 434–442, 2014. https://doi.org/10.1093/ije/dyt261

[5] Z. Chang, L. Ghirardi, P. D. Quinn, P. Asherson, B. M. D'Onofrio, and H. Larsson, "Risks and benefits of ADHD medication on behavioral and neuropsychiatric outcomes: a qualitative review of pharmacoepidemiology studies using linked prescription databases," Biol. Psychiatry, 2019. https://doi.org/10.1016/j.biopsych.2019.04.009

[6] N. Tarrant, M. Roy, S. Deb, S. Odedra, A. Retzer, and A. Roy, "The effectiveness of methylphenidate in the management of Attention Deficit Hyperactivity Disorder (ADHD) in people with intellectual disabilities: A systematic review," Res. Dev. Disabil., vol. 83, pp. 217–232, 2018. https://doi.org/10.1016/j.ridd.2018.08.017

[7] M. R. Bergey, A. M. F., P. Conrad, and I. Singh., "Global Perpective On ADHD.," 2018.

[8] R. Vermeiren, "Psychopathology and delinquency in adolescents: a descriptive and developmental perspective," Clin. Psychol. Rev., vol. 23, no. 2, pp. 277–318, 2003. https://doi.org/10.1016/s0272-7358(02)00227-1

[9] J. Aloi et al., "Adolescents show differential dysfunctions related to Alcohol and Cannabis Use Disorder severity in emotion and executive attention neuro-circuitries," NeuroImage Clin., vol. 19, pp. 782–792, 2018. https://doi.org/10.1016/j.nicl.2018.06.005

[10] T. M. Liew, L. Feng, Q. Gao, T. P. Ng, and P. Yap, "Diagnostic utility of montreal cognitive assessment in the fifth edition of diagnostic and statistical manual of mental disorders: major and mild neurocognitive disorders," J. Am. Med. Dir. Assoc., vol. 16, no. 2, pp. 144–148, 2015. https://doi.org/10.1016/j.jamda.2014.07.021

[11] X. Yan, X. Zhao, J. Li, L. He, and M. Xu, "Effects of early-life malnutrition on neurodevelopment and neuropsychiatric disorders and the potential mechanisms," Prog. Neuro-Psychopharmacology Biol. Psychiatry, vol. 83, pp. 64–75, 2018. https://doi.org/10.1016/j.pnpbp.2017.12.016

[12] C.-C. Chang, C. Liang, P.-N. Chou, and G.-Y. Lin, "Is game-based learning better in flow experience and various types of cognitive load than non-game-based learning? Perspective from multimedia and media richness," Comput. Human Behav., vol. 71, pp. 218–227, 2017. https://doi.org/10.1016/j.chb.2017.01.031

[13] J. Huizenga, W. Admiraal, G. ten Dam, and J. Voogt, "Mobile game-based learning in secondary education: Students' immersion, game activities, team performance and learning

outcomes," Comput. Human Behav., vol. 99, pp. 137–143, 2019. https://doi.org/10.1016/j.chb.2019.05.020
[14] A. T. O. F. T. W. O. MINDS, "Proceedings from the 22nd Congress of the World Association for Sexual Health, Singapore, July 25–28, 2015," J Sex Med, vol. 12, no. 5, pp. 294–381, 2015. https://doi.org/10.1111/jsm.12956
[15] Physiotherapy, "World Physical Therapy 2007 - Abstracts. Physiotherapy," vol. 93, 2007.
[16] M. J. Sousa and Á. Rocha, "Digital learning: Developing skills for digital transformation of organizations," Futur. Gener. Comput. Syst., vol. 91, pp. 327–334, 2019. https://doi.org/10.1016/j.future.2018.08.048
[17] A. Hawlitschek and S. Joeckel, "Increasing the effectiveness of digital educational games: The effects of a learning instruction on students' learning, motivation and cognitive load," Comput. Human Behav., vol. 72, pp. 79–86, 2017. https://doi.org/10.1016/j.chb.2017.01.040
[18] P. Raghavendra, C. Hutchinson, E. Grace, D. Wood, and L. Newman, "'I like talking to people on the computer': Outcomes of a home-based intervention to develop social media skills in youth with disabilities living in rural communities," Res. Dev. Disabil., vol. 76, pp. 110–123, 2018. https://doi.org/10.1016/j.ridd.2018.02.012
[19] S. Ludvigsen, U. Cress, C. P. Rosé, N. Law, and G. Stahl, "Developing understanding beyond the given knowledge and new methodologies for analyses in CSCL," Int. J. Comput. Collab. Learn., vol. 13, no. 4, pp. 359–364, 2018. https://doi.org/10.1007/s11412-018-9291-0
[20] P. Holtz, J. Kimmerle, and U. Cress, "Using big data techniques for measuring productive friction in mass collaboration online environments," Int. J. Comput. Collab. Learn., vol. 13, no. 4, pp. 439–456, 2018. https://doi.org/10.1007/s11412-018-9285-y
[21] H. Nie, "Research on Visual Communication Design under the Influence of Digital Media," 2017.
[22] S.-C. S. Li, "Television media old and new: A niche analysis of OTT, IPTV, and digital cable in Taiwan," Telemat. Informatics, vol. 34, no. 7, pp. 1024–1037, 2017. https://doi.org/10.1016/j.tele.2017.04.012
[23] S. Prasetya, "The effect of textbooks on learning outcome viewed from different learning motivation," in 1st International Conference on Education Innovation (ICEI 2017), 2018. https://doi.org/10.2991/icei-17.2018.83
[24] Y. Liu, S. Zhong, and S. Wu, "Deep residual learning for image steganalysis," Multimed. Tools Appl., vol. 77, no. 9, pp. 10437–10453, 2018. https://doi.org/10.1007/s11042-017-4440-4
[25] F. Colace, M. De Santo, and L. Greco, "E-Learning and Personalized Learning Path: A Proposal Based on the Adaptive Educational Hypermedia System.," Int. J. Emerg. Technol. Learn., vol. 9, no. 2, 2014. https://doi.org/10.3991/ijet.v9i2.3211

8 Authors

Maria Agustini is currently affiliated with the PAUD, Universitas Negri Jakarta, Jl. Rawamangun Muka East Jakarta Indonesia. Author area of interest is eLearning medias and development. For contact email mariaagustini_paud16s3@mahasiswa.unj.ac.id

Yufiarti is withPAUD, Universitas Negri Jakarta, Jl. Rawamangun Muka East Jakarta Indonesia. Yufiarti area of interest is Android Games for Children. For contact email yufiarti@unj.ac.id

Wuryani works in Pendidikan Khusus, Universitas Negri Jakarta, Jl. Rawamangun Muka East Jakarta Indonesia. Author area of interest is eLearning medias and development. For contact wuryani@unj.ac.id

Article submitted 2020-01-24. Resubmitted 2020-03-13. Final acceptance 2020-03-14. Final version published as submitted by the authors.

Evaluating the Readiness of Malaysian Academic University Libraries Towards Library 4.0

https://doi.org/10.3991/ijim.v14i06.13477

Sabri Mohamad Sharif (✉)
Universiti Teknikal Malaysia Melaka (UTeM), Melaka, Malaysia
sabri@utem.edu.my

Ahmad Zam Hariro Samsudin, Anum Shafeera Amdan
Universiti Teknologi MARA (UiTM), Selangor, Malaysia

Abstract—This paper evaluates the readiness of Malaysian academic university libraries towards Library 4.0. The rise of this new intervention of Web 4.0 and Library 4.0 are being deliberated among librarians for future services. Information technology facilities have been identified and analysed which may comprehend the use of libraries for the next generation. This will also help to move the library forward and improve the overall performance of university libraries respectively. The methodology used for this study is qualitative. This qualitative study was piloted among librarians working in the selected academic university libraries. This study gives an outline of the readiness among the selected academic university libraries towards Library 4.0

Keywords—Library 4.0 Academic Libraries

1 Introduction

Over the past ten years, Library and Information Science (LIS) has been discussed on Library 3.0. Due to the advancement of the new technology all around the world, librarians and researchers are among those who have been impacted generally. The changes that take effect are in a large amount while the time for any implementation to take place is very short. Thus, they must think of the resolution in developing the libraries according to the new requirement needed. Libraries are the same as those living creatures. They change is based on the development of the technological environment and depends on the use of web services specifically. Since the pressure from the outside sources is perennial, libraries will have to evolve as well. Rohrbeck et al. [1] stated that human being and technology will unite and at the same time, it passed by very quickly.

In Web 1.0, television is an example of passive entertainment. Blogs and podcast are other examples of Web 2.0 which signify the content stage [2]. As for Web 3.0, people are most likely to go into the virtual medium like social media. Web 4.0, where the future will be is when users are connected via online using the technological devices [3]. According to Kirschner and Muller [2], especially the young people;

they are already connected to one another as in talking to their close ones. There is not much of a difference as compared to previous generation.

Callari [4] mentioned that in Web 3.0, Artificial Intelligence screens the data received and then analyses it. Meanwhile, for Web 4.0, people and the new technology will merge. The three conditions set by Godin [5] in Web 4.0 are ubiquity, identity and the connection. For Web 4.0, ubiquity can be defined as the line either in offline or in an online based anywhere and anytime possible. For identity, the set protocols will know the users, what they do and things they require at that time. Lastly, the connection is network of users. Again, assumed by Godin [5] when Web 4.0 takes in place, all that irrelevant information will be removed unlike the past where users received a lot of information when they do the searching of information on their own. For instance, any customers that passed by a store, will be recognized and later an ad will be sent personally to them. The existence of those web will influence the changing of Library 4.0 in this context and display new criteria which carry the uniqueness of the libraries. Library 3.0 has interrelated concepts of social semantic library, linked library and mobile library [6]. Thus, it is recommended for us to start discussing on criteria for Library 4.0 for the implementation in the libraries. The discussion has slowly been introduced and recognized by the librarians to embrace the new concept so that they remain relevant in the field. As a matter of fact, libraries should start to predict the future direction by now so that librarians can demonstrate their role in leading towards Library 4.0. Even though the discussion for Web 4.0 has been made, it is hard to allocate study that determines the actual criteria of Web 4.0. The researchers are progressively introducing the elements needed for the transformation towards Library 4.0. It is very important to kick off as well as to focus on the right way and its approaches.

Along with the achievement, the librarians will help to expand concepts for Web 4.0. Today, most of us can easily connect to any devices in order to get the access. Unlike many years ago where not many people can get the same benefit for whatever they have right now. Technology keeps changing and the new trends continues coming in drastically. It is growing fast and keeps changing how we live, work and communicate to one and another. It is important for librarians to stay abreast in the current market due to these fast-moving trends. Digital and Smart Library are part of the global changes for Library 4.0. The technology itself is using a remote control to take care of the library. With all the services and facilities equipped, the opening hours of the library can be extended, and more users can come and use the library at their convenient time. This paper describes the criteria of Library 4.0 and evaluates the readiness among selected university libraries. The respondents were the librarians while data were collected using the qualitative method. The technology drives peoples to access the gadget almost in every facet. Due to the changing demand, the library is progressively actively. As such, this study tends to propose a framework model of criteria for Library 4.0 by evaluating the readiness in university libraries. The framework model is developed to fit every university library in Malaysia.

2 Literature Review

The thought of having a direction for future libraries through the new development has already been discussed. With the rapid changes due to the advancement of the technology on new concepts and how huge the influences into human being, the researcher began to think on the duration the libraries will stay and how it will be created at that time. This paper evaluates the readiness of Malaysia selected academic universities libraries towards Library 4.0. Since the available resources on Library 4.0 are few, the focus is made to follow the criteria of Web 4.0 and next to apply for current libraries. The previous studies mentioned on identifying and analyzing the criteria of digital libraries starting from the first generation towards present libraries. The suggestion is for future generation to use the services in the libraries. Greenstein and Thorin [7] shared their experiences from the research libraries in USA and also the risk in developing the future libraries considering its cultural, legal and monetary support which will take effect on the history process and the direction to move forward in the long run.

On the other hand, Mukaiyama [8] argued that in the 21st century and with the influences from the technology, digital libraries will be developed for the next generation. According to Mukaiyama [8], there are three technologies applied in libraries such as architecture system, individual and integration. The criteria of current digital libraries as described by Kroski [9] are the mobile libraries, social and open. In general, all technologies listed match the direction for Web 4.0 elements. In contrast, Breeding [10] claimed the plan is indispensable for creating the future libraries so as to make use of the technologies soonest possible and to evade from being superseded. Until now, he added that the differences are the format for the libraries. Even though the present RFID system operates automatically, simple for the physical material can reduce its worth. Nevertheless, he cannot decide which technology is significant for the future libraries. Piper [11] mentioned a model that gives the guidelines in creating a massive library will be created within 15 years from now. It involves to include searching online, books to be written in all languages and scope and lastly, to assist user in searching the books using user-based system. The history on previous support between organization till now is impossible to be realized. McGettigan [12] established some initiatives, such as information services, virtual reference services, media and one whole service hour. Ideas generated are based on services rendered to community like free network and free technology resources with local people.

As stated by Sackey et al., [13] and Sharif et al., [14], this support facilitating the library system with its key role in helping to develop the creative content, collaborate resources, communicate machine to machine and machine to men. Globally, there are huge opportunities for the libraries to step forward based on the current demand from the users. It is an important role towards the technologies that are involved in their development and implementation [13]. Technology advancements will bring reduction in time, cost optimization, machine visualization and operations, design of experiments, layout markings and value addition in supply chain logistics, ergonomic analysis and man-machine interactions, and in robotics systems optimization [15] [26], [27], [36]–[45], [28], [46]–[48], [29]–[35]. Library 4.0 should work and recognize

those potentials in transforming the libraries with the latest knowledge and insights for becoming part of the transformation. The stress is on the future technology, such as in information, communication and automation, robotics and artificial intelligence (AI), is crucial so as to meet user expectations, before becoming obsolete.

2.1 Cloud Computing

Cloud computing is the use of internet for computing needs. It is freely accessible. It is used to establish and circulate the information to users [16].

2.2 Geotagging

Geotagging provides the location, coordinate and distance of library materials to users. It offers the users to locate the information that they require.

2.3 Artificial Intelligence (AI)

It is creating machine that can engage on human behaviours that human considers intelligent. AI involves expert system, fuzzy logic, artificial neural network, evolutionary algorithms, case base reasoning, image processing, natural language processing, speech recognition and robotic.

Chauhan [17] claimed that one day library will become intelligent library. It can analyse the information on its own and decide the solutions with the users around.

2.4 Big Data

Big data store and analyse large or compound information [18]. The future libraries carry massive data and services.

Big data is a large data set which is impossible to collect, store, manage, or even analysed by ordinary database due to its limitation [19].

Good thing about big data is that it saves the cost while improving the decision making [20].

2.5 Augmented Reality (AR)

Augmented Reality is installed in mobile which users can practise into the actual world [21]. Dunston [22] expressed new technology can be in 3D where unlimited data share, use anytime they want. This new technology is categorized for the purpose of finding a location. Users will be looking at the directions created by others using image recognition [23]. The system should be able to trace the information and the location of the books using the catalogue and guidance from the technology proposed. It is more convenient and needful to users in finding the right materials they want.

2.6 Cutting-Edge Displays

These are successful implementations of technological advancements and their use in library environments particularly those that libraries develop themselves. Library displays a wonderful collection of art.

2.7 Infinite Creative Spaces

The collaboration between infinite creative spaces and library services is a revolution that will attract users to come. It allows the users to view the libraries in a different perspective and create the chance to venture and think of a way to move ahead. The idea is to build a space using the technology. Creative people with creative space can leads to creative innovation and solutions. The intention is to get the users together to create something with the technology provided in the libraries. As expressed by Camoprodon et al.[24], important things to consider for infinite creative spaces are coworking, makerspaces and community. Similarly, Noh [25] added 12 concepts for the infinite creative space. It will be used by many users for any programs and activities.

2.8 Open Source

The term "open source" refers to something people can modify and share because its design is publicly accessible. A software development is to designate a specific approach to creating computer programs. Open source systems for libraries have improved significantly to gain the confidence of librarians

3 Research Methodology

Methodology is one of the rationale methods used and not from philosophical assumptions in a research. The method used in this study is qualitative. This is due to qualitative methodology helps to collect in-depth data from the respondents through face-to-face interviews questions and open-ended questionnaires. Purposive sampling was used in selecting five academic university libraries

4 Findings

4.1 Library 4.0 compliance

Table 1 shows the results regarding the compliance of the five selected academic university libraries towards Library 4.0 elements.

Table 1. Compliance of the five selected academic university libraries towards Library 4.0

No.	Library 4.0 elements	Academic Library 1	Academic Library 2	Academic Library 3	Academic Library 4	Academic Library 5
1	Cloud Computing	√	√	√	√	√
2	Geotagging					
3	Artificial Intelligence					
4	Big Data	√	√	√	√	√
5	Augmented Reality (AR)					
6	Cutting-Edge Displays	√	√	√	√	√
7	Infinite Creative Spaces	√	√	√	√	√
8	Open Source	√	√	√	√	√

5 Discussion and Conclusion

The findings of this study show the five selected academic universities libraries are in the midst of fulfilling the criteria for Library 4.0. Among the practices are Cloud computing, Big Data, Cutting-Edge Displays, Infinite Creative Spaces and Open Source. This study can be useful to motivate other academic university libraries towards Library 4.0 practices. It is clear from this study that the initiatives must be clearly communicated in the organization so that all librarians are aware on its importance and usefulness. It is hoped that this paper gives an understanding about the issue which can help to bridge the gap.

6 Acknowledgement

The authors would like to express gratitude to Universiti Teknologi MARA (UiTM) for supporting this research.

7 References

[1] R. Rohrbeck, C. Battistella, and E. Huizingh, “The road ahead for research on Corporate foresight.,” Rep. Corp. foresight track ISPIM Annu. Conf., 2012.
[2] R. K. Kirschner and H. R. Muller, “U.S. Patent no. 4,467,967.,” Washington, DC U.S. Pat. Trademark Off., 1987.
[3] D. Farber, “‘From semantic Web (3.0) to the WebOS (4.0)’.,” Int. J. Web Semant. Technol., vol. 3, no. 1, 2007.
[4] R. Callari, “‘Web 4.0, Trip Down the Rabbit Hole Brave New World?,’” 2009.
[5] S. Godin, “‘Web4,’” 2007.
[6] Y. Noh, “A study on Library 3.0 concept and its service model.,” J. Korean Soc. Inf. Manag., vol. 27, no. 4, pp. 283–307, 2010.
[7] S. E. Greenstein, D., & Thorin, “The Digital Library: A biography.,” Digit. Libr. Fed. Counc. Libr. Inf. Resour., pp. 1–70, 2002.
[8] H. Mukaiyama, “Technical aspect of next generation digital library project. ISRDP in digital libraries.,” 1997.
[9] E. Kroski, “On the move with mobile web: Libraries and mobile technologies.,” 2009.

[10] M. Breeding, "The system librarian. Preparing for the long-term digital future of libraries.," Comput. Libr., vol. 31, no. 1, pp. 24–26, 2011.
[11] P. S. Piper, "HathiTrust and Digital Public Library of America as the future.," Online Search., pp. 22–26, 2013.
[12] L. McGettigan, "Unafraid of the future-Edinburgh's next generation library and information services.," IFLA., 2013.
[13] S. M. Sackey, A. Bester, and D. Adams, "Industry 4.0 learning factory didactic design parameters for industrial engineering education in South Africa.," South African J. Ind. Eng., vol. 28, no. 1, 2017. https://doi.org/10.7166/28-1-1584
[14] S. M. Sharif, N. Z. Nizam, N. A. Rashid, N. R. Masrom, and M. H. Bakri., "Role of values and competencies in university intellectual property commercialization: A critical review.," Turkish Online J. Des. Art Commun. – TOJDAC, pp. 887–904, 2018. https://doi.org/10.7456/1080sse/125
[15] D. Plinta, "New information technologies in production enterprises, Advanced–industrial engineering, Industry 4.0.," Bielsko-Biała, pp. 7–20, 2016.
[16] J. Cho, "A study on the cloud collection.," J. Korean Libr. Inf. Sci. Soc., vol. 43, no. 1, pp. 201–219, 2012.
[17] S. K. Chauhan, "Library4.0.," 2009.
[18] D. Burrus, "Bigthink: FromWeb 3.0 to Web 4.0," 2013.
[19] J. Manyika et al., "Big Data: The Next Frontier for Innovation, Competition, and Productivity.," Mckinsey Glob. Institute., 2011.
[20] D. Lehong, H., & Laney, "Toolkit: Board-ready slides on big data trends and opportunities.," Stamford, CT Gartner., 2013.
[21] R. Azuma, Y. Baillot, R. Behringer, S. Feiner, and B. Julier, S., & MacIntyre, "Recent advances in augmented reality.," Comput. Graph. Appl., vol. 21, no. 6, pp. 34–47, 2001. https://doi.org/10.1109/38.963459
[22] P. S. Dunston, "Identification of application areas for augmented reality in Industrial construction based on technology suitability.," Autom. Constr., vol. 17, no. 7, pp. 882–894, 2008. https://doi.org/10.1016/j.autcon.2008.02.012
[23] S. Hah and J. Kim, D., & Kim, "Mobile augmented reality interface (AR) design for user experience of library.," Korean Soc. Des. Sci., 2011.
[24] G. Camoprodon, S. Bigazzi, P. Pineda, and S. Tham, C., & Mattia, "Samples of ongoing experiences in Europe.," Barcelona Coworking Eur. Conf., 2013.
[25] Y. Noh, "A study on creating and managing 'makerspaces' in libraries.," J. Korean Soc. Inf. Manag., vol. 31, no. 1, pp. 53–76, 2014.
[26] M. I. Qureshi et al., "Measuring the ecological footprint of inbound and outbound tourists: evidence from a panel of 35 countries," Clean Technol. Environ. Policy, 2019. https://doi.org/10.1007/s10098-019-01720-1
[27] M. I. Qureshi et al., "Modeling Work Practices under Socio-Technical Systems for Sustainable Manufacturing Performance," Sustainability, vol. 11, no. 16, p. 4294, Aug. 2019. https://doi.org/10.3390/su11164294
[28] M. I. Qureshi, R. M. Yusoff, S. S. Hishan, A. F. Alam, K. Zaman, and A. M. Rasli, "Natural disasters and Malaysian economic growth: policy reforms for disasters management," Environ. Sci. Pollut. Res., vol. 26, no. 15, pp. 15496–15509, May 2019. https://doi.org/10.1007/s11356-019-04866-z
[29] M. I. Qureshi, S. Qayyum, A. A. Nassani, A. M. Aldakhil, M. M. Q. Abro, and K. Zaman, "Management of various socio-economic factors under the United Nations sustainable development agenda," Resour. Policy, vol. 64, p. 101515, 2019. https://doi.org/10.1016/j.resourpol.2019.101515

[30] Q. M. I. & R. A. Harasis A. A., "Development of research continuous usage intention of e-commerce. A systematic review of literature from 2009 to 2015.," Int. J. Eng. Technol., vol. 7, no. 2.29 (2018), pp. 73–78, 2018. https://doi.org/10.14419/ijet.v7i2.29.13133

[31] M. Shahverdi, K. Ismail, and M. I. Qureshi, "The effect of perceived barriers on social entrepreneurship intention in Malaysian universities: The moderating role of education," Manag. Sci. Lett., vol. 8, no. 5, pp. 341–352, 2018. https://doi.org/10.5267/j.msl.2018.4.014

[32] M. I. Qureshi, R. M. Yusoff, A. R. Ahmed, K. Isa, and A. Imran, "Linking quality of work life with sustainable manufacturing performance," Adv. Sci. Lett., vol. 23, no. 9, pp. 8232–8235, 2017. https://doi.org/10.1166/asl.2017.9867

[33] M. I. Qureshi, M. A. Hassan, S. S. Hishan, A. M. Rasli, and K. Zaman, "Dynamic linkages between sustainable tourism, energy, health and wealth: Evidence from top 80 international tourist destination cities in 37 countries," J. Clean. Prod., vol. 158, pp. 143–155, 2017. https://doi.org/10.1016/j.jclepro.2017.05.001

[34] M. I. Qureshi, U. Awan, Z. Arshad, A. M. Rasli, K. Zaman, and F. Khan, "Dynamic linkages among energy consumption, air pollution, greenhouse gas emissions and agricultural production in Pakistan: sustainable agriculture key to policy success," Nat. Hazards, vol. 84, no. 1, pp. 367–381, 2016. https://doi.org/10.1007/s11069-016-2423-9

[35] M. I. Qureshi, A. M. Rasli, and K. Zaman, "Energy crisis, greenhouse gas emissions and sectoral growth reforms: Repairing the fabricated mosaic," J. Clean. Prod., vol. 112, pp. 3657–3666, 2016. https://doi.org/10.1016/j.jclepro.2015.08.017

[36] M. I. Qureshi et al., "Environment and air pollution: health services bequeath to grotesque menace," Environ. Sci. Pollut. Res., vol. 22, no. 5, pp. 3467–3476, 2015. https://doi.org/10.1007/s11356-014-3584-2

[37] M. I. Qureshi, N. U. Khan, A. M. Rasli, and K. Zaman, "The battle of health with environmental evils of Asian countries: promises to keep," Environ. Sci. Pollut. Res., vol. 22, no. 15, pp. 11708–11715, 2015. https://doi.org/10.1007/s11356-015-4440-8

[38] M. I. Qureshi, A. Md. Rasli, A. Jusoh, and T. O. Kowang, "Sustainability: A new manufacturing paradigm," J. Teknol., vol. 77, no. 22, pp. 47–53, 2015. https://doi.org/10.11113/jt.v77.6661

[39] M. I. Qureshi, M. Iftikhar, S. Y. Janjua, K. Zaman, U. M. Raja, and Y. Javed, "Empirical investigation of mobbing, stress and employees' behavior at work place: quantitatively refining a qualitative model," Qual. Quant., vol. 49, no. 1, pp. 93–113, 2015. https://doi.org/10.1007/s11135-013-9976-4

[40] M. I. Qureshi, A. M. Rasli, and K. Zaman, "A New Trilogy to Understand the Relationship among Organizational Climate, Workplace Bullying and Employee Health," Arab Econ. Bus. J., vol. 9, no. 2, pp. 133–146, 2014. https://doi.org/10.1016/j.aebj.2014.05.009

[41] M. I. Qureshi, A. Khan, K. Zaman, and N. Khaqan, "Structural investigation of service quality in conventional and islamic banking in pakistan," Int. J. Manag. Innov., vol. 6, no. 1, p. 84, 2014.

[42] M. I. Qureshi, M. N. Bhatti, A. M. Rasli, M. Yasir, and K. Zaman, "The Delphi method for internationalization of higher education in Pakistan: Integrating theory of constraints and quality function deployment," Mediterr. J. Soc. Sci., vol. 5, no. 20, pp. 2702–2710, 2014. https://doi.org/10.5901/mjss.2014.v5n20p2702

[43] M. I. Qureshi, S. Y. Janjua, K. Zaman, M. S. Lodhi, and Y. Bin Tariq, "Internationalization of higher education institutions: Implementation of DMAIC cycle," Scientometrics, vol. 98, no. 3, pp. 2295–2310, 2014. https://doi.org/10.1007/s11192-013-1163-9

[44] I. Q. Muhammad, B. Mansoor, K. Aamir, and Z. Khalid, "Measuring queuing system and time standards: A case study of student affairs in universities," African J. Bus. Manag., vol. 8, no. 2, pp. 80–88, 2014. https://doi.org/10.5897/ajbm2013.7247x

[45] A. M. Rasli, N. Norhalim, T. O. Kowang, and M. I. Qureshi, "Applying managerial competencies to overcome business constraints and create values evidence from small technology-based firms in Malaysia," J. Manag. Info, vol. 3, no. 1, pp. 99–121, 2014. https://doi.org/10.31580/jmi.v3i1.15

[46] M. Iftikhar and M. I. Qureshi, "Modeling the Workplace Bullying the Mediator of 'Workplace Climate-Employee Health' Relationship," Journal Of Management Info, vol. 4, no. 1. pp. 96–124, 2014. https://doi.org/10.31580/jmi.v4i1.27

[47] R. B. M. Yusoff, A. Imran, M. I. Qureshi, and A. G. Kazi, "Investigating the relationship of employee empowerment and sustainable manufacturing performance," Int. Rev. Manag. Mark., vol. 6, no. 4, pp. 284–290, 2016.

[48] M. Iftikhar, M. U. Shahid, M. H. Shahab, M. Mobeen, and M. I. Qureshi, "Exploring the relationship among organizational citizenship behavior, psychological empowerment and turnover intensions with the mediating role of affective commitment," Int. Rev. Manag. Mark., vol. 6, no. 4, pp. 296–304, 2016.

8 Authors

Sabri Mohamad Sharif is affiliated with the Universiti Teknikal Malaysia Melaka (UTeM). Author is interested in the field of technology and innovation.For contact email at, Email: sabri@utem.edu.my

Ahmad Zam Hariro Samsudin works for Universiti Teknologi MARA (UiTM), Malaysia. Ahmad Zam is interested in the field of technology development in IR 4.0. For contact, Email: ahmadzam@gmail.com

Anum Shafeera Amdan works Universiti Teknologi MARA (UiTM), Malaysia. Author is interested in the field of technology and innovation. For contact email at Email: afisha86@yahoo.com

Article submitted 2020-01-30. Resubmitted 2020-03-19. Final acceptance 2020-03-23. Final version published as submitted by the authors.

Imprint

iJIM – International Journal of Interactive Mobile Technologies
http://www.i-jim.org

Indexing
International Journal of Interactive Mobile Technologies is indexed in
Elsevier Scopus, INSPEC, Ulrich, DOAJ, EBSCO, Google Scholar, and DBLP.

Publication Frequency
Bimonthly

Publisher
International Association of Online Engineering (IAOE)
Kirchengasse 10/200
A-1070 WIEN
Austria