Testing and Validating a Conceptual Framework for E-Collaboration in an Undergraduate Course

Alimatu-Saadia Yussiff[1], Wan Fatimah Wan Ahmad[1] and Emy Elyanee Mustapha[1]
Department of Computer and Information Sciences
Universiti Teknologi PETRONAS,
Tronoh, Malaysia
alimasaf@yahoo.co.uk, fatimhd@petronas.com.my, emy.elyanee@petronas.com.my

***Abstract*—Electronic collaboration can provide the environments for educators and learners to connect electronically via the Internet to study together, communicate discuss, and to exchange information and resources from anywhere, anytime and in any place. However, despite the progress registered in the use of e-collaboration system as educational tools through the incorporation of constructivism learning theories and its related didactics in higher educational institution, the approach has not yet been successfully transferred to the classroom. More importantly, there are still misconceptions among researchers regarding students achieving authentic learning from online interaction and collaboration. In an attempt to close this gap, a framework was developed to assist in the design, development and implementation of e-collaboration in a higher education institution. The framework addresses the development process of e-collaboration content, approaches for e-collaboration, pedagogical didactics, learning theories, and roles of users in e-collaboration. In an attempt to validate the framework, an e-collaboration system named 'Teach, Learn, and Research E-collaboration System' (TELERECS), was developed and experimentally implemented in a classroom context. An experimental research design based on control and experimental groups, pre/post-test and usability survey were used to validate the framework. The results revealed that there is significant difference between the post-test mean scores of the experimental and control groups. In addition, there is moderate, positive monotonic correlation between easy to use and post-test-scores; and between useful for team work and post-test-score for the experimental group. These imply that the framework offers a promising basis for meaningful learning. Future work includes a further exploration and validation of the framework and comparing results.**

Keywords- Evaluation; Validation; Conceptual Framework; E-collaboration; pretest; posttests; experimental design

I. INTRODUCTION

Electronic Collaboration (e-collaboration) implies working with others, usually in pairs or small groups on an intellectual, academic, or practical endeavor via electronic technologies to achieve common learning goals. It is defined by Chebil et. al and Kock et. al, as "collaboration among individuals engaged in a common task using electronic technologies" [1, 2]. According to Hassandoust and Kazerouni [3], electronic collaboration is the "purposeful use of networking and collaboration technologies to support teams in the creation of shared understanding toward joint effect" [3]. E-collaboration, therefore, connects educators and learners electronically via the Internet, laptops, personal computers, smart-phones, or personal digital assistances (PDA).

E-collaboration offers numerous advantages. In education, e-collaboration allows collaborators to study together, to communicate and discuss, or reflect on their own practices, exchange information, and share resources from anywhere, anytime and in any place. In addition, it can be used to facilitate knowledge construction and sharing of resources[3]. Similarly, e-collaboration is used to support co-laboring, co-creation, co-sharing and sees students as active partners in the community of learners, where meaningful learning can occur and where knowledge is produced socially by consensus [4, 5]. Hassandoust and Kazerouni [3] suggested the need to put more emphasis on e-collaboration rather than traditional collaboration method to achieve the maximum benefits of initiating and sharing knowledge and resources.

However, despite the progress registered in the use of e-collaboration system as educational tools through the incorporation of constructivism learning theories and its related didactics in higher educational institution, the approach has not yet been successfully transferred to the classroom. In addition, there are still misconceptions among researchers regarding the fact that students will achieve deep and meaningful learning from online interaction and collaboration among students, between students and instructors and between students and contents [6]. In an attempt to close these gaps, a framework was developed to assist in the design, development and implementation of e-collaboration in a higher education institution.

Our earlier studies have resulted in publishing a conceptual framework for effective e-collaboration and didactic enhancement [7]. The paper presented the elements and constituents of the framework. This was followed by the publications of two other papers: prototype design of an e-collaboration system and heuristic evaluation of the system to test the reliability of two test instruments entitled; usability and effectiveness questionnaires [8]. A pilot study on the evaluation of the usability and effectiveness of TELERECS e-collaboration system has also been published in [5].

978-1-4799-7896-0/15/$31.00 ©2015 IEEE

The purpose of the current study was to further validate the framework using usability and effectiveness questionnaires, pre-test and post-test. The following research questions guided this study: (a) Are there significant differences between the mean scores of students' pre-test and post-test scores? (b) To what extent does students' perceived usefulness and ease of use for collaboration relate to their grade-scores? (c) Does TELEREC E-Collaboration system increase students' grade-scores when used in introduction to business information course?

II. Literature Review

A. Validation, Verification and Evaluation

In an attempt to develop conceptual framework for expect system validation, Meseguer [9] defined validation as a global term encompassing both verification and evaluation. Verification is about completely examining the system against its specifications. Validation is concern with examining either a particular design meet its intended purpose and perform as expected. According to Marwedel, evaluation encompass the computation of quantitative information of some key characteristics of a certain design [10]. In this study, validation connotes the act of verifying and evaluating an artifact to meet a specific objective.

B. Social-Constructivism Learning Theory

One of the learning theories guiding e-collaboration is the social constructivism. According Lev Vygotsky, the founder of this theory, learning or cognitive development is an active mental process where students actively construct knowledge [11, 12] through the interplay of three elements: existing knowledge among learners or collaborators, the social context, and the problems to be solved.

Constructivism theory also emphasizes the creation of artifacts with real tasks to advance collective knowledge construction, the use of self-organization, monitoring, feedback and evaluation. The individual learning is seen as a by-product of the process. In addition, the theory placed emphasis on the importance of group collaborative tasks and knowledge sharing. Similarly, in order for learners to acquire knowledge based on previous experiences, they should be able to interact with meaningful activities [13].

The constructivism theory can be experienced in TELERECS e-collaboration environment. TELERECS provide the environment for team work, individual learning, group discussion, posting and providing feedback in support for knowledge construction and sharing. In addition, the environment supports editing, posting, evaluation and monitoring.

The constructivism theory also highlight the role of zone of proximal development (ZPD) in collaborative tasks whereby the adults (teachers and parents) and more experienced children collaboratively help other students to learn. [14].

According to [15], the following four principles can be applied in constructivism teaching.

i) The use of socio-collaborative activities in learning and development.

ii) Incorporating ZPD elements in curricular and lesson planning.

iii) School learning should be related to learning and knowledge that children develop in the real world.

iv) Child's school experiences should be related to out-of-school experiences.

These four principles are very important to this study. First the validation of the framework through TELERECS e-collaboration environment involved learners and instructor in social-collaborative activities that specified the didactics being employed to initiate the social interaction. Second, the act of posting, discussing, commenting, and providing feedback among students and between students and instructor ensure ZPD processes.

C. E-collaboration Projects

Different social media tools (SMTs) have been used in higher educational institutions in different ways; Lin and Tsai [16] reported on how students in introductory management information system course used and evaluated a 3D virtual environment set up in Second Life. The main purpose of the Second Life was to allow learners to be situated in an office and server-room in order to identify the security vulnerabilities found in the office. the findings from a survey conducted showed that the 3D virtual environments improved students learning outcomes, and was perceived by students to be interesting and rewarding.

In addition, Hadjerrouit [17] experimented and reported on the use of wiki by 16 students from a Web 2.0 technology course. The participants were divided into six groups consisting of 2-4 members. By collaborating with colleagues and instructor, the groups were to investigate a specific course topic and collaboratively create a wiki of their findings. They were also to make the wiki available to other groups and instructor for comments. The wikis were then empirically evaluated based on three criteria: history of students' actions, posted comments, and peers assessment using pre-established criteria. The findings shows some important contributions, but also revealed that the act of collaborative writing was lower than expected.

Furthermore, Su and Beaumont [18] developed and experimented with R&D wiki in a higher educational

institution. The purpose of the R&D wiki was to enable students to keep records or project logs of their final year projects. They were to write their articles online and to provide constructive feedback on their colleagues' works. The evaluation process involved the use of Salmon's five-stage e-learning framework, questionnaires and interview. Results demonstrate that even though the R&D wiki supported effective collaboration, effective feedback and the development of students' ability to perform critical evaluation; issues related to plagiarism, vandalism, and lack of personalization were also identified.

Even though none of the above e-collaboration projects focuses on traditional collaboration versus e-collaboration, they however offer some promising background and basis for this study.

III. METHODOLOGY

A. Participants

The study was carried out using experimental research design. Subjects were sixty-three (N=63) undergraduate students in introduction to business information system course at University Teknologi PETRONAS Malaysia. This was the second time the course was used for this study. The first study was a pilot study conducted during the January-April semester in 2014. This time around, the course was offered in between May-August semester 2014 in a blended mode consisting of three hours theory and two hours practical. This study was conducted during the practical section where the researcher participated fully for ten weeks.

B. Instruments

The main instruments used in this study were usability survey instrument and pretest/posttest questions. The usability instrument was adapted from [19-21] and consisted of 24 items categorized into six main elements: simple navigation, consistency, efficiency, attractiveness, visibility and controllability. The survey items in the usability instruments used a Likert scale with score ranging from 1 to 5, where 1=strongly-disagree, 2=disagree, 3=neutral, 4=agree, and 5=strongly-agree. It also consisted of open-ended questions for users to fully express their views.

A system named Teach, Learn and Research e-Collaboration System (TELERECS) was used as a medium for collaboration. The system support users' dialogue, content-creation, editing, deleting, sharing, linking, posting, markup language, threaded discussions, email notifications, and skype (call and IM). In addition, the system present learning objects to users through menus like resources, contact, lab-exercise, and syllabus pages.

C. Experimentation

The sample size of sixty-three (N=63) were from two different classrooms. The classroom was randomly selected to represent the control and experimental groups. The experimental group is the group using the TELERECS e-collaboration system and consisted of 30 participants. The control group is the group using the conventional methods of in-class collaboration and consisted of 33 participants. Each of the major groups was further divided into six sub-groups.

Regarding the blended nature of the experimentation, both groups were to attend three hours of lecture and two hours of practical every week. The theoretical part was to give student insight and introduction to course topics. The practical session was to apply theory gain in class in solving theoretical problems. Therefore, for the first three weeks of the semester participants attended classes to get acquainted with the course and the rest of the weeks involved groups collaboration to dialogue, discusses, solve problems and produce solutions to problems along with the theory session. TELERECS was configured to allow group members to post, read, edit, comment, share files, provide and receive feedback. Group solutions were presented using the section that supported threaded discussions to dialogue/discuss important issues related to the topic among group members only. Content posting and linking were carried out using the markup editor.

Apart from using TELERECS for collaborative tasks and collective knowledge construction, course materials in the form of syllabus, e-books, PowerPoint presentations, notes, important links to videos and quizzes were also located on TELERECS.

Regarding the method of in-class collaboration, the participants were divided into five sub groups consisting of five-to-six participants making a total of thirty-three (N=33). Participants were made to sit in groups in the class to collaboratively solve problem through discussion, dialoguing, cooperating, and coming to consensus about a particular task, problems and cases for one hour and then a representative from each group presented the outcome and solution to the whole class in another one hour. Contributions are made in the form of feedback and questions are then asked by member from other groups and instructors. Finally, together both instructor and students reached a consensus.

In addition, as both the control and experimental groups involve in collaboration activities, the evaluator/researcher observed, participate and provided feedbacks. Apart from real-life observation of participants, an online activity logs was monitored and captured for further analysis. Finally, data from all methods were analyzed.

D. Methods of analysis

Descriptive statistics were used to analyze the usability data and independent sample t-test was carried out on the pre-test and post-test data. Both quantitative and qualitative methods were used to extract important information from questionnaires. Five hypotheses were developed and tested on the pre-test and post-test data:

- Hypothesis (H1): There is no significant difference between pre-test mean scores of both the control and experimental groups.
- Hypothesis (H2): There is no significant difference between post-test mean scores of both the control and experimental groups.
- Hypothesis (H3): There is no significant difference between the mean of increment scores of the participants in the control and experimental groups.
- Hypothesis (H4): The ease of use for collaboration will have positive and significant effect on experimental group's post-test scores.
- Hypothesis (H5): The ease of use (F1) for collaboration will have positive and significant effect on experimental group's post-test scores.

If these hypotheses are supported, we argue that the validation of the conceptual framework has met its usefulness and effectiveness in contributing to meaningful learning.

IV. RESULTS

A. Descriptive statistics of the Participants

Overall, sixty-three (N=63) participants took part in the study. This was further divided into two major groups: experimental (n=30) and control (n=33).

B. Reliability analysis of the usability survey instruments

Reliability analysis was applied to examine the internal consistency of the usability scale. The result was interpreted using the scale from [22], which stated that the results are considered "Excellent" if the value of the Cronbach's Alpha > 0.9; "Good" if > 0.8; "Acceptable" if > 0.7; "Questionable" if > 0.6; "Poor" if > 0.5; and "Unacceptable" if < 0.5.

The overall reliability result for usability scale was 0.94, which means that the internal consistency of the usability scale was excellent.

C. Hypothesis Testing

Below are the results and interpretations of the hypotheses H1-H5.

Hypothesis (H1): There is no significant difference between pre-test mean scores of both the control and experimental groups.

Table 1 presents the independent sample t-test for both the pre-test and post-test data. The value in the Sig.(2-tailed) row for the pre-test-group is 0.71 which is greater than 0.05. We can therefore conclude that there is no statistically significant difference in the pre-test scores for the experimental group and control group. Also, t (61) =0.38, p = 0.71. This result support Hypothesis H1, which implies that before the use of TELERECS for collaboration the mean scores of both groups were about the same in the pre-test.

Table 1: Independent Samples Test on Pre and Post-Test

	Pre-Test Result	Post-Test Result
t-test for Equality of Means	**Equal variances assumed**	**Equal variances assumed**
t	.379	2.292
df	61	61
Sig. (2-tailed)	.706	.025

Hypothesis (H2): There is no significant difference between post-test mean scores of both the control and experimental groups.

Contrary to the pre-test values in table 1, the value in the Sig.(2-tailed) row for the post-test-group column is 0.03 which is less than 0.05. This therefore implies that there is a statistically significant difference in the post-test mean scores for the experimental and control groups. The value of t (61) =2.29, p = 0.03. Hypothesis H2 is therefore rejected and concludes that there is difference between the mean scores of the experimental and control groups.

Hypothesis (H3): There is no significant difference between the mean of increment scores of the participants in the control and experimental groups.

In other to test hypothesis (H3), Paired-t-test was carried out to compare the mean increment scores of the pre-test and post-test scores on the same sample sized for both the experimental and control groups. The question is, is there a difference in the increment of mean scores following the use of TELERECS for e-collaboration.

Looking at paired-sample statistics in table 2, the **sig.(2-tailed)** value is 0.00 which is less than 0.05. This means that there is a statistically significant difference between the mean increment scores of the experimental and control groups of participants. Therefore, there is a strong evidence that the use of TELERECS for e-collaboration by the experimental group improves their performance as t=12.98, p=0.0. Therefore, hypothesis (H3) is rejected.

Table 2: Paired Samples Test

	Pair 1
	PostTestGroup - PreTestGroup
t	12.979
df	62
Sig. (2-tailed)	.000

To further support the results in table 2, the increments scores between the two groups are graphically presented using box plots in figures 2 and 3. The box plot in figure 1 for the pre-test scores shows that the pre-test scores for both the experimental and control groups are similar. On the other hand, the result of the post-test scores in figure 2 shows that the experimental group scored higher than the control group.

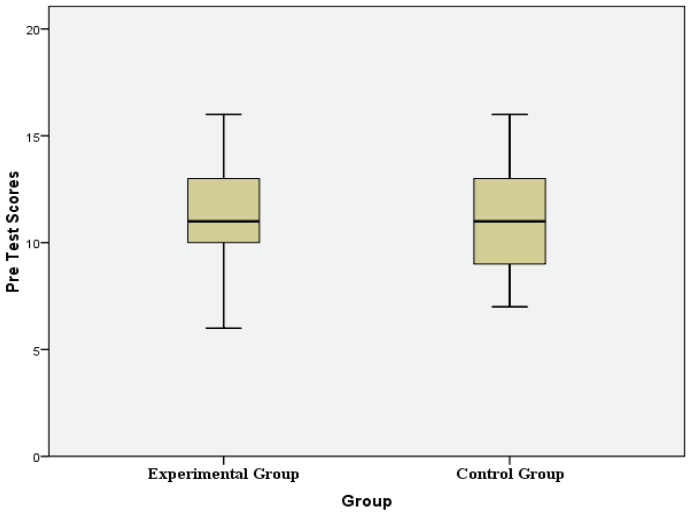

Figure 1: Box Plot for Pre-Test Scores

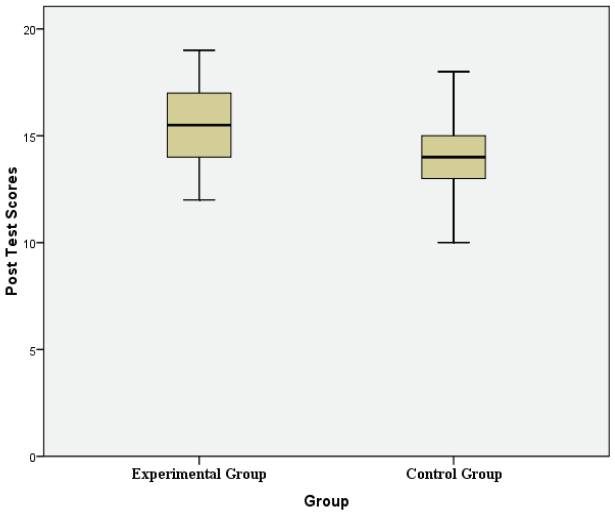

Figure 2: Box Plot for Post-Test Scores

Hypothesis (H4): Usefulness for team work will have a positive and significant effect on experimental group's post-test scores.
Hypothesis (H5): The ease of use for collaboration will have positive and significant effect on experimental group's post-test scores.

Hypotheses (4) and (5) were tested using Spearman's analysis in SPSS. Three variables correlated are: easy to use, useful for team work and Post-test-score for the experimental group. Spearman's correlation coefficient interpretation denotes that the values of r_s should be between +1 and -1 ($-1 \leq r_s \leq 1$). The r_s values between 0.00-0.19 is considered "very weak", between 0 .20-0.39 is considered "weak" , between 0.40-0.59 is considered "moderate", between 0 .60-0.79 is considered "strong", and between 0.80-1.0 is considered "very strong" [23, 24].

As shown in table 3, there is moderate, positive monotonic correlation between easy to use and post-test-score-experimental since $r_s = 0.19$. In addition, table 3 also shows that there is moderate, positive monotonic correlation between useful for team work and post-test-score-experimental since $r_s = 0.27$.

Table 3: Correlations between Easy to use, Usefulness for Team Work and PostTestScoreExperimental

			Easy to Use	Useful for Team Work	PostTestScore Experimental
Spearman's rho	**Easy to Use**	Correlation Coefficient	1.000	.273*	.186
		Sig. (2-tailed)	.	.034	.326
		N	60	60	30
	Useful for Team Work	Correlation Coefficient	.273*	1.000	.376*
		Sig. (2-tailed)	.034	.	.041
		N	60	60	30
	PostTestScoreExperimental	Correlation Coefficient	.186	.376*	1.000
		Sig. (2-tailed)	.326	.041	.
		N	30	30	30
*. Correlation is significant at the 0.05 level (2-tailed).					

V. CONCLUSIONS AND FUTURE WORK

This study has used experimental research approach to validate conceptual framework through the use of pre-test, post-test and usability questionnaire. Results show that Hypothesis (H1) is accepted since there is no significant difference between the pre-test mean scores of the experimental and control groups.

On the contrary, Hypothesis (H2) and Hypothesis (H3) are rejected since the results indicated that there are statistically significant differences between the post-test mean increment scores of the experimental and control groups of participants. This implies that while the experimental group showed a very significant improvement, the control group showed a marginal improvement

Finally, table 3, also indicated that there is moderate, positive monotonic correlation between easy to use and post-test-score for the experimental group since the value of $r_s = 0.19$. In addition, table 3 also shows that there is moderate, positive monotonic correlation between useful for team work and post-test-score for the experimental group since the value of $r_s = 0.27$.

The current results therefore indicated that the framework offers a promising basis for meaningful learning to occur. In order to strengthen the validity of this result, future work would be to further explore and validate the framework and compare results with the current study.

ACKNOWLEDGMENT

The authors gratefully acknowledge the assistance of the Center for Graduate Studies (CGS), UTP, for their support in paying for the conference. Secondly, our appreciation goes to the iSMSC reviewers and associate editors for their relevant and useful comments.

REFERENCES

[1] R. Chebil, W. Lejouad-Chaari, and S. A. Cerri, "An E-Collaboration New Vision and Its Effects on Performance Evaluation," *International Journal of Computer Information Systems and Industrial Management Applications,* vol. 3, pp. 560-567, 2011.

[2] N. Kock and J. Nosek, "Expanding the boundaries of e-collaboration," *Professional Communication, IEEE Transactions on,* vol. 48, pp. 1-9, 2005.

[3] F. Hassandoust and M. F. Kazerouni, "Implications knowledge sharing through E-Collaboration and Communication Tools," *Journal of Knowledge Management, Economics and Information Technology,* vol. 1, 2011.

[4] E. Barkley, C. Patricia, and H. M. Claire, *Collaborative Learning Techniques: A Handbook for College Faculty*: San Francisco: CA: Jossey-Bass, 2005.

[5] W. F. W. Ahmad, A.-S. Yussiff, and E. E. Mustapha, "The evaluation of the usability and effectiveness of TELERECS e-collaboration system," in *Proceedings of the International HCI and UX Conference in Indonesia*, 2015, pp. 18-25.

[6] J. A. Maddrell, G. R. Morrison, and G. S. Watson, "Community of inquiry framework and learner achievement," in *annual meeting of the Associaiton of Educational Communicaitons & Technology, Jacksonville, FL Retrieved from http://www. jennifermaddrell. com/papers*, 2011.

[7] A.-S. Yussiff, W. F. W. Ahmad, and A. Oxley, "Conceptual framework for effective E-collaboration and didactic enhancement," in *Computer and Information Sciences (ICCOINS), 2014 International Conference on*, 2014, pp. 1-6.

[8] A.-S. Yussiff, W. Ahmad, W. Fatimah, and E. E. Mustapha, "Prototype design and heuristic evaluation of e-collaboration environment," in *User Science and Engineering (i-USEr), 2014 3rd International Conference on*, 2014, pp. 143-148.

[9] P. Meseguer, "Towards a conceptual framework for expert system validation," *AI Communications,* vol. 5, pp. 119-135, 1992.

[10] P. Marwedel, "Evaluation and Validation," in *Embedded System Design*, ed: Springer, 2011, pp. 203-234.

[11] M. Tam, "Constructivism, instructional design, and technology: Implications for transforming distance learning," *Educational Technology & Society,* vol. 3, pp. 50-60, 2000.

[12] J. Willis, *Constructivist instructional design (C-ID): Foundations, models, and examples*: IAP, 2009.

[13] M. Chau, A. Wong, M. Wang, S. Lai, K. W. Chan, T. M. Li*, et al.*, "Using 3D virtual environments to facilitate students in constructivist learning," *Decision Support Systems,* vol. 56, pp. 115-121, 2013.

[14] C. D. Maddux and J. W. Willis, "Integrated learning systems and their alternatives: Problems and cautions," *Educational Technology,* vol. 32, pp. 51-57, 1992.

[15] C. D. Maddux, D. L. Johnson, and C. Willis, "Educational computing: Learning with tomorrow\'s technologies," 2001.

[16] C.-C. Lin and C.-C. Tsai, "Applying social bookmarking to collective information searching (CIS): An analysis of behavioral pattern and peer interaction for co-exploring quality online resources," *Computers in Human Behavior,* vol. 27, pp. 1249-1257, 2011.

[17] S. Hadjerrouit, "Wiki as a collaborative writing tool in teacher education: Evaluation and suggestions for effective use," *Computers in Human Behavior,* vol. 32, pp. 301-312, 2014.

[18] F. Su and C. Beaumont, "Evaluating the use of a wiki for collaborative learning," *Innovations in Education and Teaching International,* vol. 47, pp. 417-431, 2010.

[19] B. Fetaji, M. Ebibi, and M. Fetaji, "Assessing Effectiveness in Mobile Learning by Devising MLUAT (Mobile Learning Usability Attribute Testing) Methodology," *International Journal of Computers and Communications,* vol. 5, pp. 178-187, 2011.

[20] J. R. Lewis and J. Sauro, "The factor structure of the system usability scale," in *Human Centered Design*, ed: Springer, 2009, pp. 94-103.

[21] J. Nielson. (2012, 29/01/2015). *Usability 101: Introduction to Usability*. Available: http://www.nngroup.com/articles/usability-101-introduction-to-usability/

[22] D. George and P. Mallery, *SPSS for Windows Step by Step: A Simple Guide and Reference, 13.0 Update* Pearson A and B, 2006.

[23] M. Mukaka, "A guide to appropriate use of Correlation coefficient in medical research," *Malawi Medical Journal,* vol. 24, pp. 69-71, 2012.

[24] M. J. Campbell and T. D. V. Swinscow, *Statistics at square one*: John Wiley & Sons, 2011.