

**A COMPARATIVE STUDY ON THE EFFECTIVENESS OF ADJUNCT
ONLINE LEARNING TOOL BETWEEN CONVENTIONAL AND GAMIFIED
E-LEARNING IN ENHANCING ELECTROCARDIOGRAM COMPETENCY
AMONG MEDICAL STUDENTS**

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THISIS SUBMITTED FOR FULFILLMENT OF DOCTOR OF PHILOSOPHY

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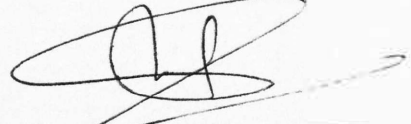
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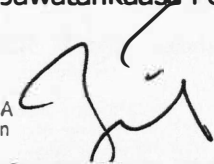
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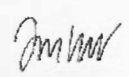
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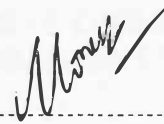
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ABSTRACT

The abstract knowledge of Electrocardiogram (ECG) is tough for medical students to comprehend and requires higher order cognitive skills such as application of knowledge into graphic analysis and evaluation in order to make a correct clinical diagnosis. Several studies have shown that the graduate medical students lack proficiency and confidence in ECG interpretation and in turn, they tend to be dissuaded to learn ECG more. Such negative affect state toward learning has a substantial impact on the learning process, academic performance and success in a particular subject, but has been received relatively little attention in the medical education research. If these affective state cannot be improved, medical students could not only fail to achieve the targeted learning outcome but also it could affect the diagnostic accuracy to correctly interpret ECGs by those graduated medical doctors in the real clinical world. The development of technology has ushered in the use of new teaching and learning strategy such as gamification to enhance learning in medical education. Preclinical and clinical medical training have evolved from the use of traditional approaches in order to infuse the new tools and media into the curriculum that is required to meet the needs of the internet generation. Thus, many medical schools have begun to incorporate technology-enhanced active learning and online blended learning in medical education. However, gamification in the medical field is still new. Therefore, more empirical research is needed to prove the effectiveness of gamified learning in medicine. Furthermore, little is known how game elements impact on motivation, engagement of students and their learning performance. In this study, a quasi-experimental action research was conducted among pre-clinical and clinical year medical students in the Faculty of Medicine and Health Sciences, University Malaysia Sabah between the academic year 2017 and 2018. The study's context was to improve ECG teaching and learning by introducing a new instructional method called online gamified learning. An online gamified learning platform called GaMED ECG[®]™ was developed by a working team composed of programmers, multimedia designers, guided by a gamification expert, and lead by the researcher as the ECG expert. It was developed using the instructional design ADDIE model. In order to analyze the achievement of the goal of the research, both

quantitative and qualitative research methods were adopted. Independent t-test and Whitney U-test were used to analyze the mean score differences between the two cohort groups among pre-clinical year and clinical year students. The findings suggest that gamified e-learning (GaMED ECG[®]) is as effective as conventional e-learning (Moodle a.k.a. SMART2UMS) to improve ECG knowledge, diagnostic accuracy and interpretation skills among undergraduate medical students. Surprisingly, gamified e-learning enhances the faster interpretation time compared with the conventional e-learning group in both clinical and pre-clinical year students. Interview findings reveal that gamified learning was mostly perceived as enjoyable and interesting learning platform. Structural equation modelling (SEM) was used to examine the causal relationships and test the hypotheses between the observed and latent variables in the proposed research model. In order to test the model of this research, SmartPLS 3.2.7 software was used for the partial least squares analysis of the proposed measurement model and structural model. Findings revealed that learning engagement had the strongest effect on learning achievement followed by learning satisfaction motivation. Therefore, gamified learning environment may be used as a tool to stimulate students' understanding of certain knowledge in ECG interpretation and largely medical education. Winning two Gold medal innovation awards, GaMED ECG[®] showed that it provides interactive self-paced activities structured as gamified e-lessons to enlighten the students with ECG knowledge and skill. Further modification of this gamified learning principle and strategy is recommended to upgrade the platform into a learning management system (LMS) by supporting multiple administrative accounts.

Keywords: gamification, gamified e-learning, Electrocardiogram competency, innovative learning, blended learning.

ABSTRAK

KAJIAN PERBANDINGAN ATAS KEBERKESANAN PEMBELAJARAN TALIAN SAMPINGAN DALAM ANTARA PEMBELAJARAN KONVENSIONAL DAN GAMIFIKASI DALAM MEMPERTINGKATAN KOMPETENSI ELEKTROKARDIOGRAM ANTARA PELAJAR PERUBATAN

Pengetahuan abstrak Electrokardiogram (EKG) adalah sukar bagi pelajar perubatan untuk memahami. Selain itu, ia memerlukan kemahiran kognitif yang lebih tinggi untuk menerapkan pemahaman yang dicapai dalam analisis grafik dan tafsiran supaya dapat membuat diagnosis klinikal yang betul. Beberapa kajian menunjukkan bahawa pelajar perubatan siswazah tidak mempunyai kecekapan dan keyakinan terhadap interpretasi EKG dan ini telah menyekat semangat untuk belajar pengetahuan EKG dengan selanjutnya. Kesan negatif seperti ini mempunyai kesan yang besar terhadap proses pembelajaran, prestasi akademik dan kejayaan dalam subjek tertentu, tetapi ia hanya mendapat sedikit perhatian dalam penyelidikan pendidikan perubatan. Sekiranya keadaan ini tidak dapat diubah, pelajar perubatan bukan sahaja gagal mencapai hasil pembelajaran yang disasarkan tetapi ia juga mengimplikasikan bahawa kelemahan pentafsiran EKG yang tepat oleh mereka yang berkelulusan doktor perubatan di dunia klinikal sebenar. Perkembangan teknologi telah membawa kepada penggunaan strategi pengajaran dan pembelajaran baru seperti gamification untuk meningkatkan pembelajaran dalam pendidikan perubatan. Demi memenuhi keperluan era generasi internet, penggunaan pendekatan alat dan media baru dengan pendekatan traditional dalam kurikulum latihan perubatan pra-klinikal dan klinikal telah berkembang. Oleh itu, banyak sekolah perubatan telah menggabungkan pembelajaran aktif berdasarkan teknologi dan pembelajaran penyelaras dengan talian campuran dalam pendidikan perubatan. Dalam bidang perubatan, gamifikasi masih baru. Oleh itu, lebih banyak kajian empirik diperlukan untuk membuktikan keberkesanan pembelajaran gamifikasi dalam bidang perubatan. Selain itu, pengetahuan bagaimana elemen permainan memberi kesan kepada motivasi, penglibatan pelajar dan prestasi pembelajaran mereka adalah kurang. Dalam kajian ini, penyelidikan berdasarkan kuasi-eksperimen dijalankan dalam kalangan pelajar perubatan pra-klinikal dan klinikal di Fakulti Perubatan dan Sains, Univeristi Malaysia Sabah dalam kalangan pelajar tahun akademik 2017 dan

2018. Matlamat kajian ini adalah untuk meningkatkan kecekapan process pengajaran dan pembelajaran EKG dengan memperkenalkan kaedah pengajaran baru yang dinamakan pembelajaran gamifikasi dalam talian. Platform pembelajaran dalam talian yang dipanggil GaMED ECG @ TM telah dibangunkan oleh pasukan kerja yang terdiri daripada pengaturcara, pereka multimedia, dipandu oleh pakar gamifikasi, dan diketuai oleh penyelidik sebagai pakar ECG. Ia telah dibangunkan dengan menggunakan model ADDIE. Demi menganalisis hasil kajian matlamat penyelidikan, kedua-dua kaedah penyelidikan kuantitatif dan kualitatif telah digunakan. Ujian t bebas dan Whitney U-test digunakan untuk menganalisis perbezaan skor min sebelum dan selepas ujian untuk kedua-dua kumpulan kohort pelajar pra-klinikal dan klinikal. Hasil kajian menunjukkan bahawa gamifikasi e-pembelajaran (GaMED ECGTM) adalah berkesan seperti konvensional e-pembelajaran (Moodle a.k.a. SMART2UMS) untuk mempertingkatkan pengetahuan ECG, ketepatan diagnostic dan kemahiran pentaksiran dalam kalangan pelajar perubatan siswazah. Tambahan lagi, gamifikasi e-pembelajaran membantu pelajar pra-klinikal dan klinikal mempercepatkan masa pentaksiran berbanding dengan keadah e-pembelajaran secara konvensional. Hasil kajian menunjukkan GaMED ECGTM menyeronokkan dan menarik. Pemodelan Persamaan Struktur (SEM) telah digunakan untuk mengkaji hubungan kausal dan menguji hipotesis antara pembolehubah diamati dan laten dalam model penyelidikan yang dicadangkan. Untuk menguji model kajian ini, SmartPLS3.7 telah digunakan untuk analisis kudrat paling kurang separa bagi model pengukuran yang dicadangkan dan model struktur. Kajian ini mendapati bahawa penglibatan pembelajaran merupakan kesan terkuat pada pencapaian pembelajaran diikuti dengan motivasi kepuasan belajar

Oleh itu, persekitaran pembelajaran gamifikasi boleh digunakan sebagai alat untuk merangsang pemahaman pelajar tentang pengetahuan tertentu dalam pentafsiran EKG dan terutamanya pendidikan perubatan. Dengan pencapaian memenangi dua anugerah pingat emas inovasi, GaMED ECGTM dibuktikan merupakan alat pembelajaran interaktif berdasarkan individual pelajar sendiri untuk memberi pencerahan dalam pengetahuan dan kemahiran EKG. Pengubahsuaian lanjut mengenai prinsip dan strategi pembelajaran berdasarkan game adalah disyorkan untuk meningkatkan platform ke dalam sistem pengurusan pembelajaran (learning mangament system) dengan menyokong beberapa akaun pentadbiran.

Kata kunci: gamifikasi, gamifikasi e-pembelajaran, kecekapan Electrocardiogram (EKG), pembelajaran inovatif, pembelajaran peyelaras



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TABLE OF CONTENTS

PAGES

TITLE	i
DECLARATION	ii
CERTIFICATION	iii
ACKNOWLEDGEMENT	iv
ABSTRACT	v
<i>ABSTRAK</i>	vii
TABLE OF CONTENTS	x
LIST OF TABLES	xvii
LIST OF FIGURES	xx
LIST OF PHOTOS	xxii
LIST OF ABBREVIATION	xxiii
LIST OF APPENDICIES	Error! Bookmark not defined.
CHAPTER 1: INTRODUCTION	1
1.1 Chapter Introduction	1
1.2 Background of the Study	1
1.2.1 Electrocardiogram	1
1.2.2 Technology-Enhanced Blended Learning in Medical Education	4
1.2.3 Gamifications in Education	6
1.3 Research Gap	8

1.4	Significance of the Study	9
1.5	Theoretical Framework	10
1.5.1	Humanist learning theory	10
1.5.2	Behaviorist learning theory	11
1.5.3	Constructivist learning theory	11
1.5.4	Connectivist learning theory	11
1.5.5	Gamified online active learning theory	12
1.6	Conceptual Framework	17
1.6.1	Input	18
1.6.2	Process	19
1.6.3	Outcome	19
1.7	Statement of Problem	20
1.8	How the Problem Should Be Tackled?	20
1.9	Study Objectives	21
1.10	Research Questions	22
1.11	Statement of the Hypotheses	23
1.12	Motivation of the Research	26
1.13	Flow of the thesis presentation	28
1.14	Publications	29
CHAPTER 2: LITERATURE REVIEW		31
2.1	Review of Literature I	31

2.1.1	ECG Competency	31
2.1.2	ECG Competency among Health Care Professionals	32
2.1.3	ECG Competency among Undergraduate and Postgraduate Medical Students	33
2.1.4	ECG Teaching Methods in Medicine	34
2.1.5	Technology-Enhanced Blended Learning	36
2.1.6	Psychometric Properties and Learning (Effectiveness of Teaching and Learning)	38
2.2	Review of Literature II	39
2.2.1	Gamification	39
2.2.2	Defining Gamification	40
2.2.3	Gamification in Education	41
2.2.4	Gamification in Online Education	46
2.2.5	E-Gamification and Related Concepts	47
2.2.6	Gamification and Games	48
2.2.7	Game-Based Learning (GBL)	49
2.2.8	Educational Games (in Education)	50
2.2.9	Games Beyond Education	51
2.2.10	Digital Games Based Learning (DGBL)	52
2.2.11	Serious Games	53
2.2.12	Game Design Elements	54
2.2.13	Gamification, Engagement and Motivation	57



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CHAPTER 3: METHODOLOGY	61
3.1 Chapter Introduction	61
3.2 Research Design	61
3.3 Research Methods	64
3.4 Setting of the Study	66
3.5 UMS Medical Curriculum	67
3.6 Clinical Curriculum	68
3.7 Objectives of the Clinical Curriculum	68
3.8 Subject of the Study	69
3.9 ECG Teaching Method and teaching materials	70
3.10 Sampling techniques and Participants	72
3.11 Sample Size calculation	73
3.12 Data Collection method	75
3.13 Instrumentation	77
3.14 Achievement test	79
3.15 Questionnaires	81
3.16 Questionnaire development	82
3.17 Validity and Reliability of the Instrument	84
3.17.1 Validity	84
3.17.2 Pilot test	87
3.17.3 Reliability	91

3.18	Threats to the research	92
3.19	Trustworthiness	94
3.20	Research Procedure	95
3.20.1	Action Case Research Cycle 1 (Using tradition face-to-face ECG teaching)	96
3.20.2	Action Case Research Cycle 2 (Game development and evaluation)	96
3.20.3	Action Case Research Cycle 3- (E-learning)	109
3.21	Statistical Analysis	110
3.22	Study outcome	114
3.23	Ethical Considerations	115
3.24	Flow Chart of Research	117
3.25	Conclusion	118

CHAPTER 4: FINDINGS 119

4.1	Chapter Introduction	119
4.2	Descriptive Statistical Report	120
4.3	Action Research Cycle 1	123
4.3.1	To explore the UMS medical students' negative attitude towards ECG learning.	123
4.3.2	Students' preferences to ECG teaching and learning materials and methods	130
4.3.3	To evaluate the level of students' ECG competency among medical students (RO 2)	132
4.4	Rhythm strip and 12-lead ECG diagnostic accuracy	143

4.5	Action Research Cycle 2	147
4.5.1	Introduction about GaMED ECG [®] ™ Platform	148
4.5.2	Instructional Design Model (ADDIE model)	148
4.5.3	Analysis Phase	149
4.5.4	Design Phase	152
4.5.5	Development Phase	159
4.5.6	Implementation Phase	160
4.5.7	Evaluation Phase	161
4.6	Qualitative Results	162
4.7	Challenges Encountered during GaMED ECG [®] ™ Platform Development and Implementation	167
4.8	Action Research Cycle 3	169
4.9	Descriptive results of pre-clinical year students	170
4.10	Descriptive Statistics of Clinical Year Students	177
4.11	Effect Size	182
4.12	Impact of gamified e-learning on learning achievement	184
4.12.1	Structural Equation Modeling (SEM) data analysis	184
4.12.2	Measurement Model	184
4.12.3	Model testing criteria	188
4.12.4	Evaluation of Structural Model	189
4.13	Hypotheses testing and path analysis	190

CHAPTER 5: DISCUSSION	192
5.1 Introduction	192
5.2 Perceived difficulties in ECG learning	194
5.3 ECG diagnostic accuracy and interpretation proficiency from traditional classroom teaching	196
5.4 Rhythm strip and 12-lead ECG diagnostic accuracy	197
5.5 Gamified e-learning platform development	199
5.6 Reaction and perception toward gamified e-learning	200
5.7 Comparison of effectiveness between conventional versus gamified e-learning	201
5.8 Impact of online gamified learning on students' outcome	203
5.9 Future Work	203
6.0 Limitation of the Study	204
6.1 Recommendations	205
CHAPTER 6: CONCLUSION	206
REFERENCES	Error! Bookmark not defined.
APPENDICES	249

LIST OF TABLES	PAGES
Table 1.1 : Research objective, research question, research methodology and hypotheses mapping.	26
Table 3.1 : Pre-clinical year ECG Learning objectives taken from the UMS Undergraduate curriculum	71
Table 3.2 : Clinical year ECG Learning objectives taken from the UMS Undergraduate curriculum	72
Table 3.3 : Survey Constructs, Definitions, sources and References	82
Table 3.4 : Content validity scale	85
Table 3.5 : Interpretation of index values according to Ebel and Frisbe (1972)	87
Table 3.6 : Mean difficulty and discrimination index of pilot test results (clinical items)	89
Table 3.7 : Mean difficulty and discrimination index of pilot test results (pre-clinical items)	90
Table 3.8 : Conclusion of the validity and reliability of quantitative instruments	93
Table 4.1 : Characteristics of Students (N=284).	121
Table 4.2 : Characteristics of Students According to Pre-clinical and Clinical Year (N=284).	122
Table 4.3 : Overall Analysis of Perceived Learning Difficulties in ECG study (N=200).	123
Table 4.4 : Frequency of correct identification of abnormal ECGs among different clinical year students (N=220).	133
Table 4.5 : Mean of total ECG scores in each clinical year of the study (N=220).	134
Table 4.6 : Test of Homogeneity of Variances	136

Table 4.7 : ANOVA test	137
Table 4.8 : Bonferroni test	137
Table 4.9 : Mean Pre-test ECG scores of pre-clinical year students (N=64)	140
Table 4.10: Independent Samples Test to compare mean ECG scores between year 1 & 2 students (N=64)	141
Table 4.11: Pearson's correlation test for clinical year students (N=220)	141
Table 4.12: Pearson's correlation test for pre-clinical year students (N=64)	139
Table 4.13: Pearson's correlation test for clinical year students (N=220)	142
Table 4.14: Pearson's correlation test for pre-clinical year students (N=64)	140
Table 4.15: Comparison of 12-lead and rhythm strip ECGs test score on each variable. (N=220).	144
Table 4.16: Diagnostic accuracy of AV heart block and tachyarrhythmia on single rhythm strip and 12-lead ECGs (N= 220).	145
Table 4.17: ADDIE Steps Comparison Table with GAdECG@TM Action Case Research	149
Table 4.18: Preliminary themes and sub-themes derived from thematic analysis of game experience evaluation by interview.	163
Table 4.19: Numbers of valid samples of post-test ECG in the experimental and control groups (N=217)	170
Table 4.20: Distribution of pre-clinical year students by age, gender, ethnic, cGPA, prior gamified learning experience, and history of ECG course (N=64).	171
Table 4.21: Normality test and mean scores of MCQ test, OSCE and interpretation speed obtained by pre-clinical year students (N=64).	172
Table 4.22: Homogeneity of equality of variances for pre-and post-test MCQ, OSCE scores and duration between gamified learning	

group and e-learning group among pre-clinical year students (N=64)	171
Table 4.23: Comparison of the pre-test ECG scores and duration between gamified learning group and e-learning group among pre-clinical year students (N=64)	175
Table 4.24: Comparison of the post-test ECG scores and duration between gamified learning group and e-learning group among pre-clinical year students (N=64)	176
Table 4.25: Changes in pre-clinical year students' ECG scores and interpretation time after blended learning in each cohort group (N=64).	177
Table 4.26: Distribution of clinical year students by age, gender, ethnic, cGPA, prior gamified learning experience, and history of ECG course among clinical year students (N=218).	178
Table 4.27: Normality test and Mean of ECG Post-test scores for MCQ exam, OSCE and interpretation speed obtained by clinical year students (N=218).	180
Table 4.28: Comparison of the ECG scores and duration between gamified learning group and conventional e-learning group among clinical year (N=218)	182
Table 4.29: The effect size based on means	183
Table 4.30: Reliability and convergent validity of the reflective items in the measurement model	Error! Bookmark not defined.
Table 4.31: Discriminant validity (HTMT results)	187
Table 4.32: F & L. The diagonal row numbers are square roots of average variance extracted.	187
Table 4.33: Goodness-of-fit Indices for the sample (N=100).	188
Table 4.34: Testing the hypothesis.	191

LIST OF FIGURES		PAGE
Figure 1.1	: Theoretical framework of online gamified learning.	17
Figure 1.2	: Conceptual Framework of Gamified Online Active Learning	18
Figure 1.3	: Hypothetical Model	25
Figure 3.1	: Iteration process in Action Research Cycles	95
Figure 3.2	: Data Analysis of the Study	113
Figure 3.3	: Flow Chart of Present Research	117
Figure 4.1	: Word Cloud depicts the students' perceived difficulties in ECG learning (N=200).	125
Figure 4.2	: Bar chart with error bar shows an extent to which Year 2-5 students expressed their difficulties in ECG learning (N=200).	129
Figure 4.3	: Bar chart with error bar shows an extent to which students with high and low cGPA expressed their difficulties in ECG learning (N=200). Error bars: 95% CI	130
Figure 4.4	: Preferences of ECG teaching and learning method by the participants (N=284)	131
Figure 4.5	: Preferences of ECG learning materials by the participants (N=284)	131
Figure 4.6	: shows the competency in interpreting common ECG emergencies by clinical year students of the study (N=220).	134
Figure 4.7	: shows the competency in interpreting non-life threatening common ECG abnormalities by clinical year students of the study (N=220).	134
Figure 4.8	: Comparison of total ECG competency among clinical-year students (year 3-5) (N=220)	138

Figure 4.9	: Boxplot of mean factual ECG knowledge comparing between academic year 1&2 (N=64).	139
Figure 4.10	: Boxplot of mean scores of normal ECG interpretation competency comparing between academic year 1&2 (N=64).	140
Figure 4.11	: Average time taken to interpret single lead and 12-lead ECG.	147
Figure 4.12	: Design flowchart of GaMED ECG [®] ™ Teacher side	154
Figure 4.13	: Design flowchart of GaMED ECG [®] ™ Student side	154
Figure 4.14	: Proposed relationship between game elements and learning outcome	157
Figure 4.15	: The Structural model	189



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LIST OF PHOTOS		PAGE
Photo 3.1	: Basic login page	97
Photo 3.2	: Login Profile	98
Photo 3.3	: Basic Features of GaMED ECG [®] ™ first prototype	98
Photo 3.4	: Feature of adding new quiz	99
Photo 3.5	: Discussion forum	99
Photo 3.6	: Case discussion forum	100
Photo 3.7	: Second prototype	101
Photo 3.8	: Badge System	102
Photo 3.9	: Quiz levels	102
Photo 3.10	: Quiz page	103
Photo 3.11	: Score Profile	103
Photo 3.12	: Discussion Listing	104
Photo 3.13	: Badge table	104
Photo 3.14	: Third Prototype	106
Photo 3.15	: Student's profile	106
Photo 3.16	: Advance quiz level	107
Photo 3.17	: ECG quiz	107
Photo 3.18	: Discussion Listing (improvised)	108
Photo 3.19	: Leaderboard page (improvised)	108