The Effectiveness Of Implementing An E-Book: Antigen And Antibody Reaction For Diagnosis Of Diseases In Microbiology Learning

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ABSTRACT

Currently very few Thai Immunology e-Books are available online. The authors created an online e-Book titled, "Antigen and Antibody Reaction for Diagnosis of Diseases" and used a quasi experimental research design to assess the effectiveness of its implementation in terms of knowledge gained, written exam scores and student satisfaction. Both the experimental and control groups exhibited higher mean scores of between the post- and pretest at $p < 0.001$, as calculated by paired t-test. The two groups' Immunology mean scores were not significantly different. All participants passed the Immunology examination. It is hoped that further improvements to the e-Book and consistent Internet access will result in statistically significant differences for e-Book users in the future.

Keywords: Effectiveness; Implementation; Antigen-Antibody Reaction; Thai Immunology e-Book

INTRODUCTION

Immunology, a part of Microbiology, needs high understanding in learning both theory and laboratory. An e-Book, which is generally the digital media equivalent of a printed textbook read on personal computers, tablets, or smart phones, is expected to enhance Microbiology learning. Rickman, Holzen, Klute, and Tobin (2009) suggested that e-textbooks can be more powerful learning resources as well as having the potential to accelerate student learning. Hong-Fei (2007) wrote about reinforcing Microbiology teaching and helping students gain comprehensive knowledge in four areas including teaching, employing multimedia, optimizing contents of the textbook, and integrating theory and practice. In addition, Computer Assisted Learning (CAL) is an intervention that equal to or better than traditional teaching methods in terms of student satisfaction and knowledge gain (McNulty, Sonntag, & Sinacore, 2009). Therefore, the promises and challenges of learning objectives have been attracting the attention of international research and development in technology-enhanced learning (Krämer, 2010). A multitude of subjects, didactic knowledge and practical skills, which need to be integrated into a wholesome package for understanding (cognitive and procedural), should be analysed by learners who integrate and apply appropriately. Moreover, the instructors should broaden their mindsets, understand and evaluate these in order to adapt themselves with evidence-based practices, combining elements of clinical practice, teaching and research on a practical basis (Lateef, 2011). Qiang and Cai-hui (2007) proposed a new way of establishing an open-type networking laboratory management software so as to realize the effective management of the users (i.e., students), equipment, time, location, and laboratory tasks.

Khlaisang (2011) evaluated the student self-satisfaction data comprising 16 points divided into 3 principal items: (a) multimedia design, (b) content design, and (c) website interface design and found that self-satisfaction to website earned in teaching and learning was at a high level.

The objective of this work was to gauge the effectiveness of implementing a newly created e-Book, entitled *Antigen and Antibody Reaction for Diagnosis of Diseases*, focusing on knowledge gained, written exam scores, and student satisfaction. The authors designed this research to include four parts of efficiency studies: development, feasibility, implementation and evaluation (Craig et al., 2008; Ringsted, Hodges, & Scherpbier, 2011).

MATERIALS AND METHOD

Development of an e-Book

The e-Book entitled *Antigen and Antibody Reaction for Diagnosis of Diseases*, which we created and uploaded on the Internet, has been updated from the original one named *Antigen and Antibody Reaction* in 2006, 2008, and 2011 and saved in CD-ROM format. For the modified 2012 version we added more contents and photos. We launched this version with the 41 medical cadets and students of Phramongkutklao College of Medicine (PCM) in academic year 2012 (pilot group 1) reading in the Experimental zone of the Thai Cyber University (TCU) project website and asked students to complete the satisfaction form. Next, the first-year nursing students (n = 30) of the Royal Thai Army Nursing College, Thailand (pilot group 2) read the e-Book and completed both the pre-and posttests and satisfaction forms. We determined the validity and reliability of the pre- and posttest and the satisfaction forms from these two group trials before using them in this research. This e-Book version (see Figure 1) in this research was added with instructions in multimedia formats including a video titled, *The Immunological Diagnostic Test for HIV Infection*.

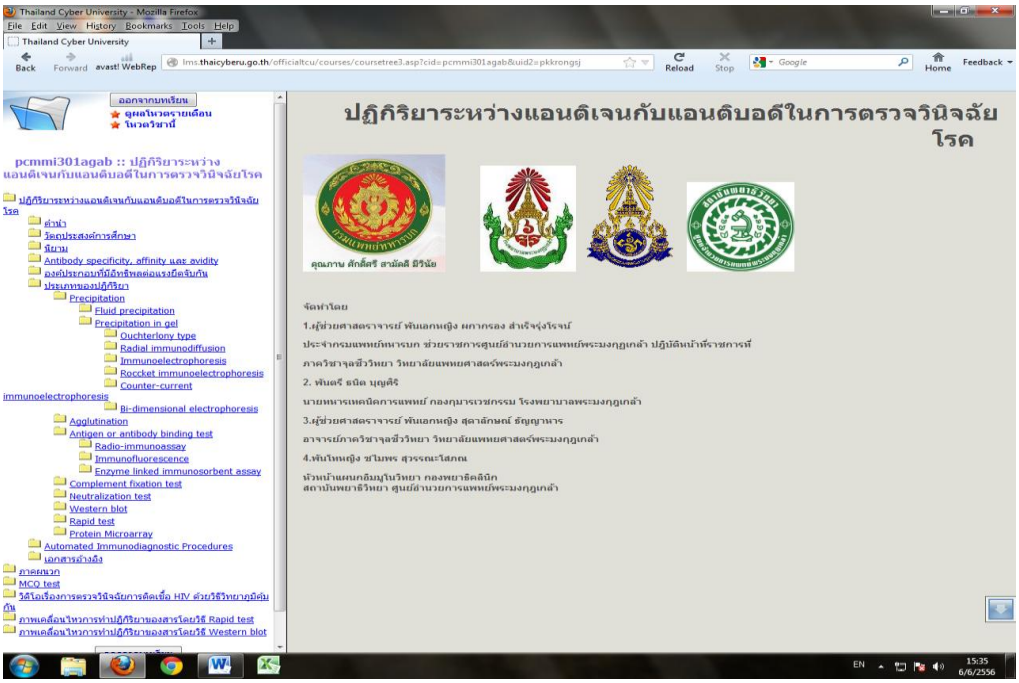


Figure 1: The Web Page of the e-Book titled *Antigen and Antibody Reaction for Diagnosis of Diseases*

Study Participant Background and Characteristics

The satisfaction form used in this research study included two parts: (a) student backgrounds, and (b) satisfaction for the e-Book reading group. This form was completed by both pilot groups to confirm the reliability values expressed as Cronbach's Alpha, which were 0.89 and 0.83. The content validity and the objectivity of the satisfaction form were viewed by one expert and it had been passed for Ethics and approved by the Institutional Review Board, Royal Thai Army Medical Department, Ministry of Defence, Bangkok, Thailand as well. The data completed by the third-year medical cadets and students of PCM in academic year 2013 in Part 1 and questions number 1 to 5 of Part 2 were collected to be analyzed for student backgrounds and characteristics. Questions 6 to 10 referred to students' satisfaction in reading the e-Book.

The e-Book Implementation

The third-year medical cadets and students of PCM, academic year 2013, who signed the consent forms were divided into two groups: (a) e-Book Reading group (R group), and (b) no e-Book group (U group). We used the technique of three-stage cluster sampling to group the participants. For Step 1, we sorted their grade-point averages (GPAs) in 2012 from maximum to minimum. Then in Step 2, the odd and even numbers were used to form two groups in which their average scores had no significant difference at $p < 0.05$. Finally, in Step 3, the members of group 1 and 2 were assigned the R or U group by sampling in accordance with their willingness (i.e., convenience sampling). The R group registered to access the e-Book via the website of TCU Project in Self-Directed Learning (SDL): *e-Learning for Antigen and Antibody Reaction*, included in the Microbiology course at PCM. The U group read other online reference resources (four websites suggested by the lecturer of the Immunological Reaction topic) within the SDL class at the same time, for 2 hours. The online pre- and posttests were intended to be completed in both groups, but some network connection problems occurred during the test, so paper tests were used. Some of the R group members had the opportunity to take the online test for the remaining time. Wang, Jiao, Young, Brooks, and Olsen (2008) noted that the computer-based testing and the traditional paper-and-pencil testing did not affect the differences in reading scores between test modes. The tests of our study were comprised of 10 multiple choice questions (MCQs) with five choices that had been already measured for reliability by paired t-test (i.e., the mean scores of the posttests were significantly higher than of the pretests at $p < 0.05$ and the paired difference was 2.90 ± 1.92). Validity and objectivity were evaluated by the comments of three experts as well as the calculation for Item Object Consequence Index (IOC), which was found to be 0.87. Other medical cadets and students who did not participate in this research (OP group) were allowed to read as the U group did in the SDL class but did not perform the pre- or posttests.

DATA ANALYSIS

All data were statistically analyzed by using STATA/MP 12.0 Program. Descriptive statistics (i.e., percentage, means, and standard deviation [SD] were used for participant characteristics and satisfaction data. Chi-square, Fisher's exact test, unpaired t-tests, and paired t-tests were conducted to compare groups. A value of $p < 0.05$ was considered significant. To show the relationship between the posttest scores or prior GPA and the immunology exam scores of the participant groups, we used correlation coefficients.

RESULTS

The Backgrounds and Characteristics of the Participant Groups

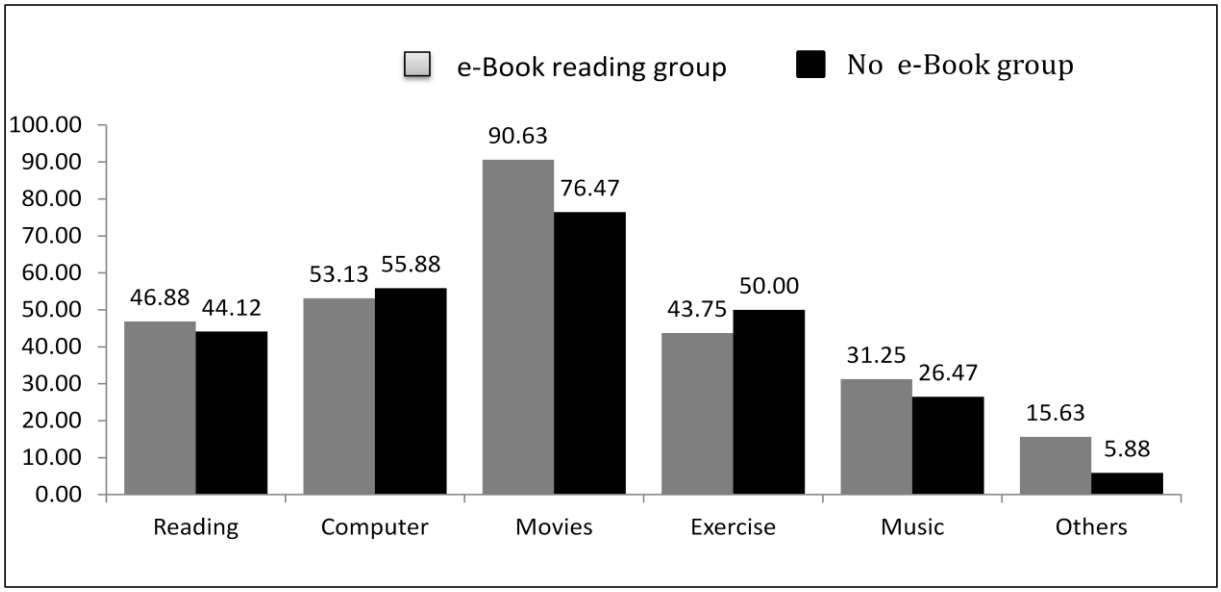
In all, 66 out of 109 or 60.55% of third year medical cadets and students at PCM consented to participate in this research project. The sampling results and completed data selected 32 medical cadets and students in the R group (29.36%) and 34 medical cadets and students in the U group (31.19%). Neither the characteristics nor hobbies of both groups were significantly different at $p > 0.05$ as measured by Mann-Whitney U test or Chi-Square or Fisher's Exact tests or Independent t-test (see Table 1 and Figure 2). Student hobbies are presented in Figure 2. In addition, their frequencies of studying the instructions for the examination were in the majority (53.13% in the R group, 43.33% in the U group) who could have one time for studying and were not significantly different at $p > 0.05$ compared by Fisher's Exact test (Table 2). The students' basic science preferences (in content, not in teaching) between the two groups were not significantly different at $p > 0.05$ by Chi-Square or Fisher's Exact test (see Figure 3). Ordering the preferences within each group, both showed the same results that microbiology and parasitology were the least favorite subjects while the most favorite was physiology.

The experiences in using computer technology of both groups were graphically compared, and no significant differences were found at $p > 0.05$ by Chi-Square or Fisher's Exact test (see Figure 4). Regarding their decisions in managing this e-Book, 40.63% of the R group liked to read in class while 24.14% of the U group did.

Table 1: Characteristics of the Participant Groups

Characteristics	R*	U**	*p*-value
1. Mean age, range	20.19(19-22)	20.29(19-22)	0.498‡
2. Sex, male: female	18:14	16:18	0.455
3. Exam score range: n (%)			
2010			0.102†
2.5-3.0	2(6.25)	-	
3.1-3.5	7(21.88)	14(41.18)	
3.6-4.0	23(71.88)	20(58.82)	
2011			0.539†
2.5-3.0	14(43.75)	18(52.94)	
3.1-3.5	15(46.88)	15(44.12)	
3.6-4.0	3(9.38)	1(2.94)	
2012	3.07(2.08-4)	3.04(2.06-3.86)	0.824

* = e-Book Reading Group. ** = no e-Book Group. Chi-Square test. † Fisher's exact test. Independent *t*-test. ‡ Mann-Whitney *U* test



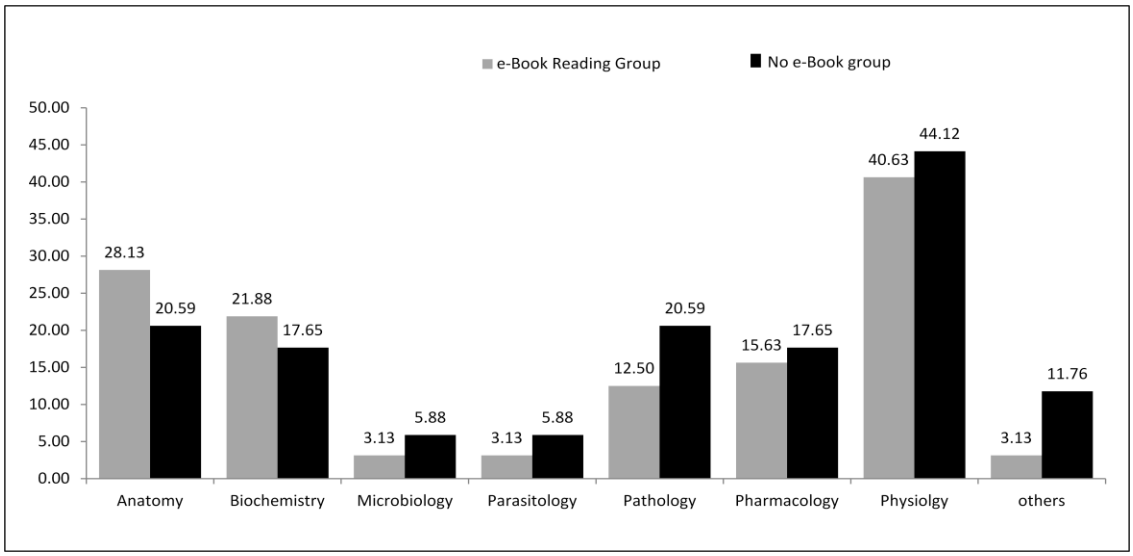
χ^2	0.051	0.051	2.378	0.259	0.184	1.650
p-value	0.822	0.822	0.123	0.611	0.668	0.251†

Figure 2: The Student Hobby Comparisons between the Participant Groups

Table 2: Habits in Studying Instructions of the Participant Groups and their Opinions for Immunology Teaching

Questions	R*	U**	χ^2	p-value
1. How many times did you have for studying the instructions for taking the examination? (%)			1.494	0.481†
- 1 time	17(53.13)	13(43.33)		
- 2 times	12(37.50)	11(36.67)		
- >2 times	3(9.38)	6(20.00)		
2. What is your level of satisfaction with the design of immunology teaching?			1.531	0.519†
- high	2(6.25)	2(6.67)		
- moderate	27(84.38)	22(73.33)		
-not satisfied	3(9.38)	6(20.00)		

* = e-Book Reading Group. ** = no e-Book Group. Chi-Square test. † Fisher's exact test. Independent t-test



χ^2	0.510	0.186	0.289	0.289	0.776	0.049	0.082	1.757
p-value	0.475	0.666	1.000†	1.000†	0.378	0.826	0.774	0.357†

Figure 3: Basic Science Preferences of the Participant Groups

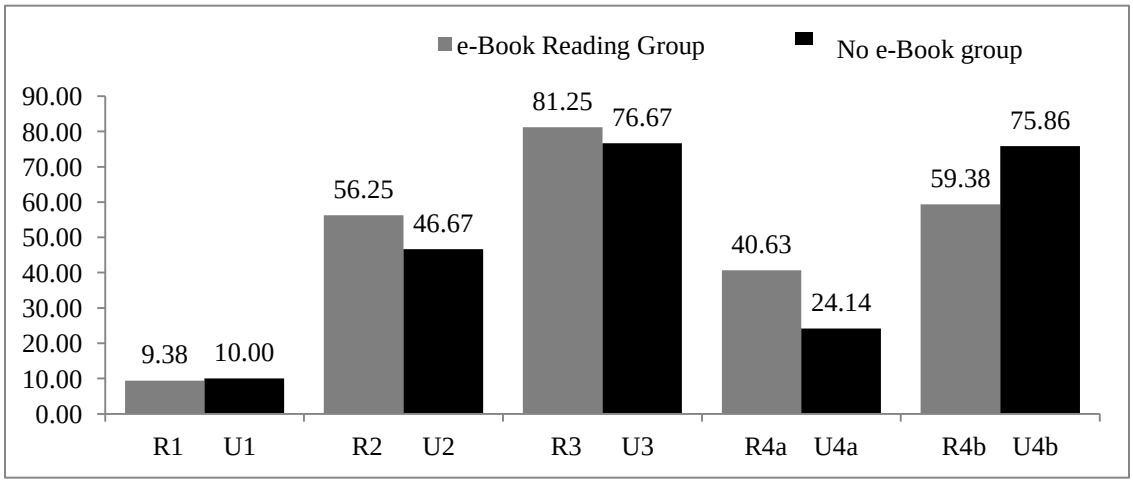


Figure 4: Experiences in using Computer Technology of the Participant Groups and their e-Book Management Opinions

Vertical axis represents percentages.

Horizontal axis represents R and U groups' responses to the following items:

1. Previous reading of an e-Book with the same topic of this e-Book
2. Previous reading of other e-Books or other CAI
3. Previous experience searching for data on a computer
4. This e-Book should be managed as
   a. extrateaching in class
   b. extra teaching outside class

Opinions in Immunology Teaching and e-Book Satisfaction

At the beginning of the immunology course in the SDL class (taken before the Immunological Reaction class), the majority of students in the R (84.38%) and U (73.33%) groups responded that they were moderately

satisfied with the design of immunology teaching methods (see Table 2) and their opinions in three levels were not significantly different at $p > 0.05$ by Fisher's Exact test.

At the end of the immunology class, the evaluation results by all students in class regarding the topic, Immunological Reaction, revealed that all items were mostly rated at a good level (mean ± SD range = 4.22 ± 0.75 - 4.59 ± 0.62) and the overall mean for teaching was 4.39 ± 0.68. (data analyzed by Evaluation and Registration Section, PCM).

The e-Book satisfaction results (see Table 3) of the R group revealed the items including content, language and e-Book assisting Immunology instruction were highly rated at a good level. Among these five items, they were mostly satisfied with the contents of the e-Book (3.72 ± 0.58) and least satisfied with the program used (3.28 ± 0.73). Their arithmetic sum was found to be 3.53 ± 0.19.

Some members of the R group commented about eye fatigue in reading e-resources, ineffective environment for e-Learning and a few expected to have a more attractive design of the e-Book, briefer contents, more pictures, better Internet connection and easier access. Some of the U group members complained that the Internet connection should be improved.

Table 3: Satisfaction Results of the e-Book Reading Group

Items	Mean ± *SD*
Design of e-Book	3.38 ± 0.75
Content	3.72 ± 0.58
Program	3.28 ± 0.73
Language	3.63 ± 0.55
Helpful in understanding Immunology instructions	3.63 ± 0.66

1 = Bad, 2 = Edit, 3 = Fair, 4 = Good, 5 = Very good

Pre-Test and Post-Test Scores of the Participant Groups

The posttest scores of both the R and U groups were significantly higher than the pretest scores at $p < 0.001$ (see Figure 5) by paired t-test. The improvement rates of the R and U groups were statistically significant as 3.03 ± 2.49 and 3.85 ± 2.97, respectively and they were not significantly different at $p > 0.05$ by independent t-test. Neither the pretest nor posttest mean scores compared between groups were significantly different at $p > 0.05$ (see Figure 5).

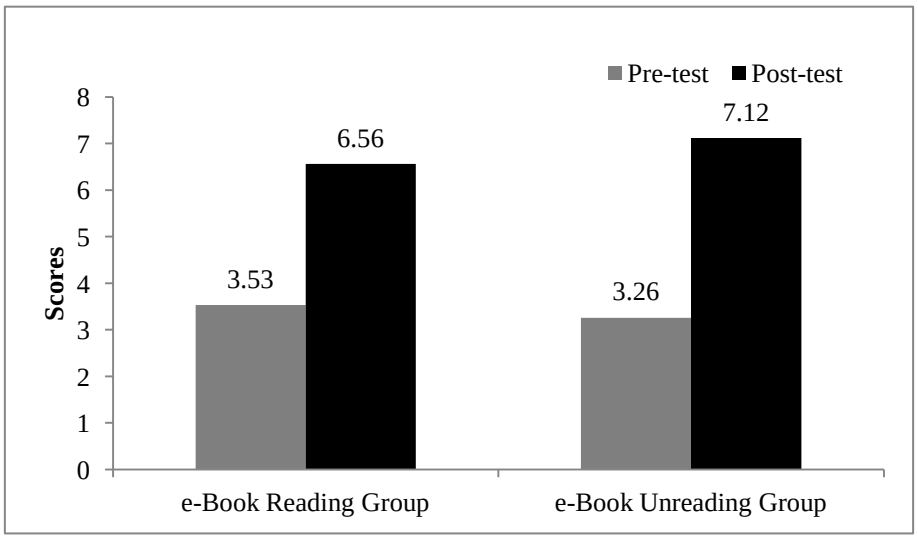


Figure 5: Pretest and Posttest Mean Scores in Comparison Graph between the e-Book Reading Group and the No e-Book Group

Immunology Examination of Both Groups

The immunology reaction part (22.22%), the other immunology part (77.88%) and the total immunology examination scores of both groups are shown as mean scores with SD in Table 4. No significant differences were found between the two groups' scores at $p > 0.05$ by Independent t-test. The reliability of this immunology examination was 0.56, the level of difficulty was (p) = 0.83 and the power of discrimination was (r) = 0.11. All students of both participant groups passed the immunology examination (passing level at 60%), while three of the nonparticipant group failed. When classifying the immunology examination scores into three levels (high, medium and weak score range), the R group possessed the highest percentage number of students in the high score range but this percentage number of students was not significantly different from the U group at $p > 0.05$ by Chi-square test.

Table 4: Percentage Mean Scores in Immunology Examination were Compared between both Participant Groups

	e-Book Reading Group n = 32	No e-Book Group n = 34	*df*	Mean Difference	*p*-value
Immunological Rx examination scores	75.94 ± 18.64	75.59 ± 13.75	64	0.349	0.931
Immunology examination scores (other part)	65.02 ± 5.17	67.00 ± 7.70	64	-1.986	0.226
Immunology examination scores (total)	67.16 ± 6.22	68.63 ± 5.69	64	-1.471	0.320

Independent *t*-test

Correlation between the Posttest Scores and the Immunology Examination Scores of the Participant Groups

The correlation coefficient (r) between the posttest and Immunological Reaction examination scores of the R and U groups was-0.018 (i.e., a weak negative correlation at $p = 0.923$) and 0.036 (no correlation at $p = 0.839$), respectively. In addition, the r values between the posttest and the total Immunology examination scores of both groups were 0.106 (weak positive correlation at $p = 0.562$) and 0.036 (no correlation at $p = 0.841$) respectively. When we compared the Immunology scores with previous GPAs of the members of the R and U groups, the correlation coefficients were as 0.371 and 0.369, respectively. Then positive medium correlations were discovered between the Immunology examination scores and previous GPA of both groups as shown in the scatter plot (see Figures 6 and 7) at $p < 0.05$.

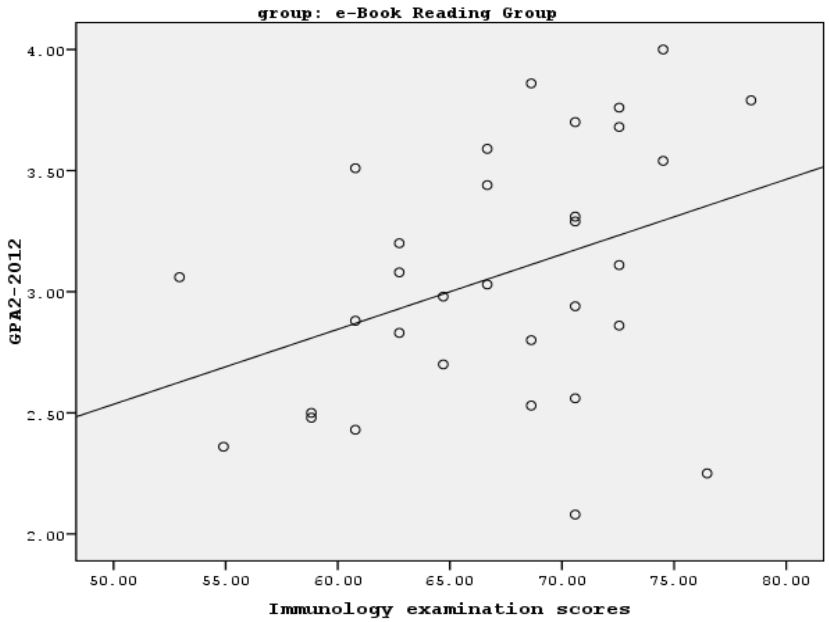


Figure 6: Correlation Coefficient between the GPA2-2012 and the Immunology Examination Scores of e-Book Reading Group

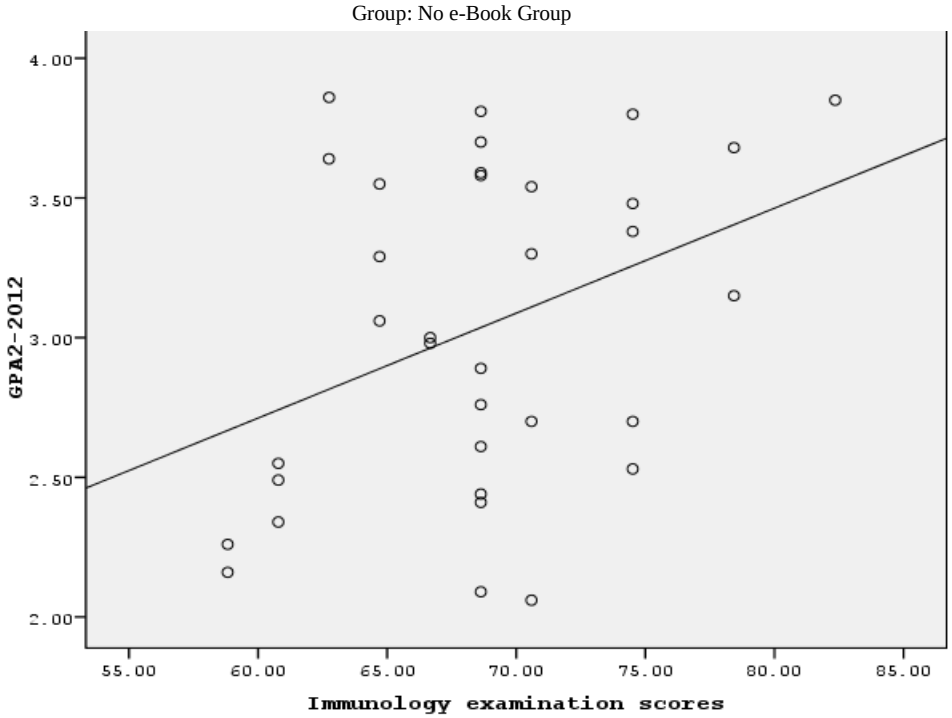


Figure 7: Correlation Coefficient between the GPA2-2012 and the Immunology Examination Scores of No e-Book Group

CONCLUSION

The characteristics of both participant groups were similar in age, sex, previous exam scores, basic science preference, hobbies, computer technology experiences and number of reading times to study instructions for the examination. According to their hobbies cocerning movies, computer and reading, the e-Book may possibly occupy in their hobby time. Microbiology, their least preference basic sciences required effective media to maintain their interest of learning. The majority members of both studied groups were moderately satisfied with the design of immunology teaching methods at the beginning of the course. All medical cadets in class evaluated the Immunology Reaction teaching method at a good level after implementing the online resources in the SDL class. The e-Book readers were mainly satisfied with the content, assistance in understanding immunology instruction and language. They gained immunology knowledge after reading this e-Book. All students who took the pre- and posttest passed the Immunology examination and the two groups' mean scores were not significantly different. Positive medium relationships were found between the previous GPA and immunology scores of both groups.

DISCUSSION

The characteristics of the e-Book and other resource reading groups in this study were quite similar which reflected that they were good samples for online resource reading comparison. Previously, Warren, Kerse, and Goodyear-Smith (2008), evaluating three e-textbooks (DynaMed, MD consult, and Up to Date) reported that their study was unable to show a clear preference or superior use among these e-textbooks designed for use in clinical practice. Ringsted et al. (2011) stated that one way to distribute knowledge about best evidence in medical education is by running courses, workshops and seminars. The outcome data of our e-Book implementation met some success. The improvement rate from the pre- to posttest results supported the validity of and knowledge gained from reading this e-Book. However, there was not a significant difference in mean examination scores between the two groups. Sitticharoon, Kanavitton, Summachiwakij, Anukulkitch, and Srisuma (2011) had already reported that positive correlations were found between the premedical year GPA and gross anatomy, physiology, and biochemistry scores, which also positively correlated with each other. They additionally concluded that the satisfaction with gross anatomy and biochemistry influenced their examination scores but not their physiology scores.

Extrareading in the e-Book outside the classroom was not appropriate for the medical cadets and students because of their limited free time, eye fatigue and incomplete facilities. To display an e-Book topic such as SDL via e-Learning seemed to be effective. The free download program used in this e-Book creation and the daily official facilities for Internet access indicated cost effectiveness. Importantly, the contents of the immunological assays in this e-Book could be applied in many subjects of basic sciences other than Microbiology, such as Parasitology, Pathology, and so on. In addition, the medical students could modify the knowledge gained for clinical practice and their work as a future physician. Although Brown (2012), mentioned several studies concerning students and their acceptance of e-Books as replacements for paper textbooks with mixed results in his work with only a quarter of faculty using e-textbooks, the attempt to overcome their rejection might be possible. Rickman et al. (2009) found that 56.25% of his students responded that the e-textbook was more convenient, but 60% thought they read more when using a physical textbook than they did using an e-textbook. The further expectation for our e-Book is to be developed as an effective resource for medical students and hospital laboratory staffs or else a substitute for a wet laboratory in an Immunology course as Kroncke (2010) studied in a biochemistry laboratory. Another interesting viewpoint is the preparation and management system of the Microbiology experiment, which integrated functions of student preparation for laboratory versions and teacher management (Hong et al., 2008). Therefore, the next steps of our work are: improving this e-Book according to this research results to approach the standard one and offering it to all medical students as an online resource in or outside class and to others who request it, while ensuring that there is adequate Internet access to support its use.

ACKNOWLEDGEMENT

This research had received financial support from Phramongkutklao College of Medicine, Thailand and was completed with the cooperation of the third-year medical cadets and students, academic year 2012 and 2013, PCM and first-year nursing students of the Royal Thai Army Nursing College. Thanks are due to Major General Preeyapan Sangarun, Director of Education, PCM for her advice and to the staffs of Microbiology, Phramongkutklao Information Center, Medical Education Section, Evaluation and Registration Section, PCM for their contribution with assistance in performing this work successfully. Thanks are also extended to the Institutional Review Board, Royal Thai Army Medical Department, Thailand for their services to approve Ethics of this work.

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