Factors Associated with Learning Outcomes in First Pre-clinical Year Medical Students at the Faculty of Medicine Siriraj Hospital, Mahidol University

Pongsakorn Buraphat, M.D.*, Mayuree Homsanit, M.D., MPH, Ph.D.**

*Department of Pharmacology, **Department of Preventive and Social Medicine, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok 10700, Thailand.

ABSTRACT

Objective: Electronic learning system (e-lecture) has been developed and used as a tool to assist students' learning. Usage of e-lecture and learning behaviors were evaluated for their associations with learning outcomes.

Methods: This questionnaire-based, cross-sectional study enrolled 107 first pre-clinical year medical students at the Faculty of Medicine Siriraj Hospital, Mahidol University, Thailand. Information on learning outcomes of biomedical subjects and learning behavior including e-lecture use, self-study time, skipping class and inattention were collected. Mann-Whitney U test and logistic regression were used for statistical analysis.

Results: Compared to students who earned average biomedical grades of >3.0, students who earned average grades ≤3.0 significantly used more e-lecture (median, IQR 63.81, 49.17-70.03 and 31.08, 11.29-51.49, respectively, p =0.001), had more inattention time during lectures (median, IQR, 22.13, 14.94-31.19, and 13.1, 8.05-20.30, respectively, p=0.008), and spent less time for self-study and review of lessons (median, IQR 102.00, 68.00-176.50, and 147.50, 106.25-246.00, respectively, p=0.04). For each one hour increase in e-lecture usage, the chance of earning an average biomedical grade of >3.0 was decreased by 4%. Positive correlations were found between e-lecture usage with skipping class and with inattention during lecture (coefficients = 0.31 and 0.37, with p=0.001 and p<0.001, respectively). Time spent for self-study and review of lessons negatively correlated with inattention during lectures (coefficient =-0.28, p=0.003).

Conclusion: E-lecture may be misused by students who have poor learning behaviors as a substitute for in-class lectures. Time voluntarily spent in e-lecture may be an indicator for students who need educational guidance and/or counseling.

Keywords: Learning outcomes; learning behavior; electronic-lecture system; e-lecture; medical education; medical student (Siriraj Med J 2018;70: 496-501)

INTRODUCTION

Identifying new methods for improving learning outcomes in undergraduate medical students is an important challenge. Electronic learning tools (e-learning) designed to support students have developed in popularity over the last decade.[1-3] Benefits of e-learning include convenient access and compatible with lifestyles.[4-11] However, the efficacy in imparting knowledge is still being debated.[12] One meta-analysis compared traditional and internet-based learning in health profession and found the two methods to be equal in learning outcomes.[13] Another study on learning outcomes in *Gross Anatomy* concluded that

students could decrease time and improve satisfaction using supplemental videos, despite a failure to improve final learning outcomes.[14]

The Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand ("the faculty") offers a six-year undergraduate medical degree program. Lectures for pre-clinical students were traditional one-way lectures. First pre-clinical year students are required to attend at least 80% of classes in order to be eligible for evaluations. The faculty supports and provides self-learning tools including libraries and e-learning systems with unlimited access. E-learning materials include videos of previous lectures, training materials, self-assessment tests, and others. For students in their first pre-clinical year, video recorded lectures (e-lecture) comprise the majority of e-learning resources.

In the real world, many learning behaviors besides electronic learning system usage also affect learning outcomes.[15-18] Absence from class was related to negative academic achievement and positive achievement was related to reading to a level of expectation.[19-20] While several studies have investigated the effect of learning behaviors on academic achievement, no studies have explored the association between learning outcomes and voluntary use of e-learning combined with individual learning behaviors in first pre-clinical year medical students. The objective of this study was to evaluate the association between learning behaviors and learning outcomes in the first pre-clinical year medical students.

METERIALS AND METHODS

This was a questionnaire-based cross-sectional study approved by Siriraj Institutional Review Board (Si 267/2013). Eligible students must have been enrolled in and passed all first pre-clinical year courses in the academic year 2012. Recruitment of participants was conducted in a lecture class. Students were informed and asked to join the study voluntarily. Those who completed and returned the questionnaire were considered to have provided informed consent.

The Thai language self-reported questionnaire was designed to evaluate following parameters: 1) grade of each biomedical subject taken in the first pre-clinical year; 2) time voluntarily spent using e-lecture; 3) time spent for self-study and review of lessons in three-week period before examinations not including e-lecture; 4) time skipping lecture classes, defined as not being present for >50% of a scheduled class period; and, 5) inattention time in class (e.g., napping, daydreaming, using mobile electronic device, and/or engaging in other non-educational activities).

Each questionnaire item was reviewed and edited by five medical students who did not take part in conducting this study. Questionnaires were provided to all 324 first pre-clinical year medical students enrolled for the 2012 academic year.

The dependent variables were biomedical grades earned in the first pre-clinical year including *Gross Anatomy I and II, Histology, Neuroanatomy, Embryology, Physiology, Biochemistry, Preventive Medicine, Medical Education & Medical Profession, and Health Promotion and Humanistic Medicine*. The grades, A, B+, B, C+, C, D+, and D, were transformed to numerical data (4.0, 3.5, 3.0, 2.5, 2.0, 1.5, and 1.0, respectively) for analysis. Time voluntarily spent in behaviors of interest including skipping classes and inattention during lecture were estimated by using a percentage replied in the questionnaire for each subject multiplied by scheduled and additional lectures duration in the courses and reported in hours.

GRADE was defined as a credit-weighted average academic grade for all the previously described biomedical subjects. Others grades were excluded.

E-LECTURE was defined as a summation of time spent in e-lecture for every subject. STUDY was defined as a summation of time spent in self-study and review of lessons in three-week period before examinations. SKIP was defined as a summation of time skipping traditional lecture classes. INATTENTION was defined as a summation of inattention time in lecture.

Participants were separated into two groups according to GRADE, HIGH-GRADE for GRADE >3.00 and LOW-GRADE for GRADE ≤3.00. Kolmogorov-Smirnov test revealed a non-normal distribution of the data. The data were described as median (interquartile range) or proportion, as appropriate. Mann-Whitney U test was used to compare learning behaviors between the two study groups. Multiple logistic regression analysis was employed to adjust for confounding effects. Correlation coefficients were calculated to explore collinearity among the variables.

RESULTS

Eight responses were excluded due to missing data and 107 participants, 55.14% male and 44.86% female, were included. The response rate was 33.02%. Data were analyzed using STATA 13.0 (StataCorp, Texas, USA). There was no statistically significant difference in GRADE between male and female ($p = 0.81$). The median age (range) was 20 (19-22) years.

The subjects with the highest median percentage of time voluntarily spent in e-lecture were *Physiology* (60.00%), *Biochemistry* (50.00%), *Neuroanatomy* (30.00%),

and *Preventive Medicine* (30.00%). The subjects that had the highest median time spent in self-study were *Gross Anatomy II* (28.00 hours), *Gross Anatomy I* (24.00 hours), *Neuroanatomy* (20.00 hours), and *Physiology* (20.00 hours). The subject that had the highest median percentage of inattention time in lecture classes was *Health Promotion and Humanistic Medicine* (30.00%). The subjects with the highest proportion of students skipping class were *Health Promotion and Humanistic Medicine* (46.73%), *Preventive Medicine* (28.04%), and *Medical Education & Medical Profession* (26.17%). The median GRADE among participants was 3.58 (IQR = 0.63). Other descriptive results are shown in Table 1.

Table 2 demonstrated learning behaviors of HIGH-GRADE (n=92) and LOW-GRADE (n=15) students. Time spent in e-lecture in LOW-GRADE was significantly higher than in HIGH-GRADE (median 63.81, IQR 49.17-70.03 and median 31.08, IQR 11.29-51.49, respectively, *p* =0.001). Inattention in LOW-GRADE was significantly higher than in HIGH-GRADE (median 22.13, IQR 14.94-31.19, and median 13.1, IQR 8.05-20.30, respectively, *p*=0.008). In contrast, self-study in LOW-GRADE was significantly lower than in HIGH-GRADE (median 102.00, IQR 68.00-176.50, and median 147.50, IQR 106.25-246.00, respectively, *p*=0.04).

TABLE 1. Learning outcome and learning behaviors of study participants (n=107)

Variables	Median	IQR[1]	Maximum	Minimum
GRADE[2]	3.58	3.23 – 3.87	4.00	2.00
E-LECTURE[3] (hour)	35.64	13.56 – 55.80	100.00	0.00
SELF-STUDY[4] (hour)	143.00	101.00 – 221.00	528.00	0.00
SKIP[5] (hour)	0.14	0.00 – 3.15	73.48	0.00
INATTENTION[6] (hour)	13.65	8.15 – 21.99	108.57	0.00

[1]Interquartile range
[2]Credit-weighted average grade
[3]Summation of time spent in the E-lecture system
[4]Summation of the time spent in self-study and review of lessons in the three weeks before examinations in each subject (not including time voluntarily spent in the E-lecture system)
[5]Summation of time skipping lecture classes
[6]Summation of inattention time in lecture classes.

TABLE 2. Difference in grade and learning behaviors between LOW-GRADE[1] (n=15) and HIGH-GRADE[2] (n=92) groups

Variables	LOW-GRADE[1] (median, IQR[3])		HIGH-GRADE[2] (median, IQR[3])		*P*-value
GRADE[4]	2.63	2.48 – 2.88	3.70	3.43 – 3.89	<0.000*
E-LECTURE[5]	63.81	49.17 – 70.03	31.08	11.29 – 51.49	0.001*
SELF-STUDY[6]	102.00	68.00 – 176.50	147.50	106.25 – 246.00	0.040*
SKIP[7]	2.04	0.03 – 5.93	0.06	0.00 – 2.38	0.055
INATTENTION[8]	22.13	14.94 – 31.19	13.11	8.05 – 20.30	0.008*

*p-value less than 0.05 indicates statistical significance
[1]Participants who earned a credit-weighted average grade equal to or below 3.00
[2]Participants who earned a credit-weighted average grade above 3.00
[3]Interquartile range
[4]Credit-weighted average grade
[5]Summation of time spent in the E-lecture system (hour)
[6]Summation of the time spent in self-study and review of lessons in the three weeks before examinations in each subject (not including time voluntarily spent in the E-lecture system (hour)
[7]Summation of time skipping lecture classes (hour)
[8]Summation of inattention time in lecture classes. (hour)

Relationships between GRADE and all independent variables were analyzed by logistic regression. Univariate analysis showed that E-LECTURE and INATTENTION significantly decreased the chance to be in HIGH-GRADE (ORs 0.95, 95%CI 0.93 to 0.98 and 0.95, 95%CI 0.91 to 0.99, respectively). Multiple logistic regression was performed. In model 1, all independent variables were included, but in model 2, only variables with significant associations ($p <0.05$) in univariate analysis, E-LECTURE and INATTENTION, were used. Only E-LECTURE remained significantly associated with decreasing the chance to be in HIGH-GRADE in both models (OR 0.96, 95%CI 0.93 to 0.99). The results of logistic regression analysis were as shown in Table 3.

Multicollinearity was evaluated by Spearman's correlation coefficients for all learning behaviors. Statistically significant positive correlations were identified between E-LECTURE with SKIP, and E-LECTURE with INATTENTION (coefficients = 0.31 and 0.37, with $p=0.001$ and $p<0.001$, respectively). Moreover, SELF-STUDY was found to have significant negative correlation with INATTENTION (correlation coefficient = -0.28 with $p=0.003$).

DISCUSSION

This study found that time voluntarily spent in the e-lecture system was significantly associated with poor learning outcomes. This finding was not consistent with those of prior studies.[4,5,14] The e-lecture system was established by the faculty to support students in self-directed learning. The intended use of the system was as supplemental support to enhance learning outcomes. Rather, this study found a voluntary use of e-lecture to be statistically significantly associated with skipping class and inattention in the classroom which imply that students who skipped classes more often and lacked in-class attention tended to use the e-lecture to compensate. This finding corresponds with a prior study found that students relying on video lecture records tended to get lower scores in *Histology* than who regularly attended class.[21]

In this study, learning outcomes was positively correlated with time spent in self-study and review of lessons before examinations, but was negatively correlated with duration of inattention in classes. An earlier study reported that percentage of reading to a level of expectation had a positive effect on learning outcomes in *Physiology, Anatomy*, and *Biochemistry*.[20] The cognitive load theory[22] stated that attention is essential for long-lasting knowledge to be created from incoming information also supports this finding.

This study found that many learning behaviors,

TABLE 3. Associations of learning behaviors with GRADE[#]

Learning Behaviors	ORs ± Std.Error	95% CI	*P*-value
Univariate Logistic Regression			
E-LECTURE[1]	0.95 ± 0.01	0.93 to 0.98	0.001*
SELF-STUDY[2]	1.01 ± 0.00	1.00 to 1.01	0.067
SKIP[3]	0.96 ± 0.02	0.94 to 1.01	0.530
INATTENTION[4]	0.95 ± 0.02	0.91 to 0.99	0.017*
Multivariate Logistic Regression			
Model 1: E-LECTURE[1*]	0.96 ± 0.02	0.93 to 0.99	0.008*
Model 2: E-LECTURE[1**]	0.96 ± 0.01	0.93 to 0.99	0.005*

*p-value less than 0.05 indicates statistical significance
[#]Credit-weighted average grade of all subjects
[1]Summation of time spent in the E-lecture system
[2]Summation of the time spent in self-study and review of lessons in the three weeks before examinations in each subject (not including time voluntarily spent in the E-lecture system)
[3]Summation of time skipping lecture classes
[4]Summation of inattention time in lecture classes.
*All independent variables included in multivariate model (1, 2, 3, and 4)
**Independent variables with statistical significance at P <0.05 in univariate analysis included in multivariate model (1 and 4)

but not all, affect learning outcomes. As such, students may improve their learning outcomes by developing personal strategies and teachers may be able to use these behaviors as indicators for early detection of learning problems.

The electronic learning system is an essential and effective educational tool. Students prefer it because of advantages that a traditional lecture cannot provide, such as flexibility and an improved ability to accommodate individual learning styles.[23-25] However, there are some disadvantages.[4,24,25] Traditional lectures allow students to directly interact with the instructor.[10] The e-lecture is similar to the traditional lecture system in that it is communication which may be not a perfect tool for replacing in-class lectures. Time voluntarily spent in the e-lecture could potentially be a red flag for identifying students who need educational guidance. Administrators and/or lecturers may consider monitoring amount of time each student spends in e-lecture and evaluate if a student is exhibiting signs of possibly needing help.

We also found that *Health Promotion and Humanistic Medicine, Preventive Medicine, Medical Education & Medical Profession* had the highest proportion of students skipping class. Possible causes may be explained by students' perceptions and nature of these subjects. Medical students give priority to the subjects related to pure biomedical science, since they think that only knowledge in this area is enough for being doctors. These subjects involved the knowledge in the field of public health, social sciences, and other "soft skills" which students are not familiar with and do not appreciate the importance of these as a part of being good doctors. From our experience, some students have no motivation, or cannot relate these subjects with patient care or medical practice at all. Promoting self-motivation or delivering knowledge using student-centered approach may be solutions to these problems.

This study had some limitations. A cross-sectional design does not allow demonstration of temporal relationships. Responder and recall biases may have occurred. Other limitations include the response rate which was only 33.02%., the size of the LOW-GRADE group (n=15) was much smaller than the size of the HIGH-GRADE group (n=92). Lastly, the average biomedical GPA who agreed to participate was 3.6, it is likely that selection bias may have occurred. Students with low GPAs may have demurred and decided against participating in this study. A future study to confirm this finding should be performed.

Multicollinearity was found among the following learning behavior variables: skipping class, inattention

in class, and e-lecture usage. The root causes of these behaviors should be explored. Achievement motivation may be the cause of some behaviors. One study reported that achievement motivation could predict academic achievement in health sciences students.[26] Future studies should be undertaken to explore associations between other factors and learning outcomes and endeavor to identify associations among that broadened list of learning behaviors.

An increase in usage of the e-lecture system was significantly associated with the likelihood of having low learning outcomes. In addition, more e-lecture usage was associated with higher rates of skipping class and inattention in class. The e-lecture system, like in-class lectures, delivers one-way information and should not be used as an alternative to in-class lectures. Learning outcomes were positively associated with time spent in self-study and review of lessons. Based on these findings, lecturers and/or administrators should consider monitoring student use of the electronic learning system to observe for behaviors that may suggest learning-related problems and/or to identify students who may require support. These findings may also benefit students by helping them to identify potential misdirection and motivate them to apply learning strategies improving learning achievement.

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