The Impact of Peerwise Approach on the Academic Performance of Medical Students

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ABSTRACT

PeerWise is a novel, freely available, online pedagogical tool that allows students to create and deposit questions for peer evaluation. A participatory learning approach through this web-based system was used to motivate and promote a deep approach in learning nervous system by 124 second year MBBS students at Cyberjaya University College of Medical Sciences. PeerWise was introduced to the students as an optional component within the nervous system course syllabus. The students were asked to create at least two multiple-choice questions (MCQs) covering different aspects of the syllabus components and to evaluate four MCQs from other students throughout the 5-week duration from December 2013 to January 2014. It was mandatory that the students write, answer and explain their MCQs. It was also essential that they answer, rate and give constructive comments on the MCQs written by their peers. The study reveals that the students were active participants and created a large question bank based on the course syllabus with variable quality. Spearman correlation analysis was performed and shows correlation coefficient values falling in a range between .634 to .739 indicating moderately strong relationship of PeerWise activity with the mark scored in the course. This study reveals that PeerWise is a feasible and large-scale team-based learning tool as the students improve their learning through peer support, analytical and critical thinking as well as personal reflection.

Keywords: *PeerWise, multiple-choice questions, nervous system course, peer evaluation, deep approach to learning.*

INTRODUCTION

Numerous advantages, one of which is engaging students by providing varied opportunities, have been proven when educationists employ technology in the teaching-learning process (Shadaan & Eu, 2013). PeerWise combines technology and pedagogy which is of benefit to both the students and academics thus adding value to the teaching approachand learning strategies. Being available online, PeerWise attracts students as they are very familiar with the internet.

The nervous system module is often comprehended as difficult, especially when taken as a compulsory and major subject in the Bachelor of Medicine, Bachelor of Surgery degree (MBBS). This study will provide an insight into considering alternative teaching technologies in nervous system module with emphasis on the issues involved in implementing such technology.

Literature Review

Medical students when exposed to difficult topics that involve the full employment of their cognitive abilities, often resort to a superficial-learning approach. However, this superficial knowledge is volatile and

not fruitful. Bottomley and Denny (Bottomley & Denny, 2011) suggested that deep approach learning is possible only with the active involvement of students. As the positive outcome to the learning process is exam-based, academics should select suitable learning activities with co-existent assignments appraising the students' attainment of the learning outcomes (Ryan, 2013). The most challenging aspect of conducting written exams is the construction and validation of questions with appropriate scientific content, reliable marking schemes and fair allocation of time and clarity (Jobs et al., 2013). This scientific process can be used as a learning tool for students in the participatory learning approach method (PLAM)(Bieber, 2005). Authoring, solving, and evaluating a problem and its solutions enhance self-paced learning catalyzed by self-assessment as well as peer assessment (Ryan, 2013).

Previous studies show that peer assessment immensely helps students to develop their practical and cognitive skills, which eventually leads to improved learning outcomes (Ballantyne, 2002). PeerWise is a well-known freely available, easy to use a web-based system that allows students to research and write their own multiple-choice questions (MCQs) with peer support and personal reflection. PeerWise is available at http://peerwise.cs.auckland.ac.nz/ (Bottomley & Denny, 2011).

Statement of Problem

Teaching and learning of nervous system have been considered as an uphill task as it involves the understanding and memorizing intricate neuronal pathways. Hence, students tend to employ a superficial approach in learning rather than deep understanding of the subject. To overcome this, we implemented novel learning strategies that would help to motivate students and promote a "deep approach" to learning.

Objectives of the Study

The prime objective of this study conducted on year 2 MBBS students at Cyberjaya University College of Medical Sciences (CUCMS) is to evaluate the relationship between PeerWise usage together with the student activity and student academic performance. The secondary objective is to demonstrate the students' feedback concerning the usage of Peer Wise.

Research Questions

This study addresses the following research questions:

1. Does Peer Wise positively enhance the academic performance of Year 2 MBBS students at CUCMS?
2. What are the students' perceptions toward PeerWise?

This case study involves a cohort of 120 MBBS students in the second year of their five-year undergraduate degree studying a core nervous system subject at Cyberjaya University College of Medical Sciences (CUCMS). Their contributions to and feedback about the PeerWise system is elaborated. We also describe our methodologies with an extensive report on the relationship between student activity and academic performance. The potential issues in implementing PeerWise are also discussed.

METHODOLOGY

Study Design

This is a cross sectional survey done on students who registered for the nervous system course (MED 2044). This course is a compulsory in third semester, second-year for students taking degrees in MBBS, at CUCMS. The students were given marks if they participated in this study. In addition, all the students were also required to answer a pretested questionnaire asking about their perception on PeerWise following the course.

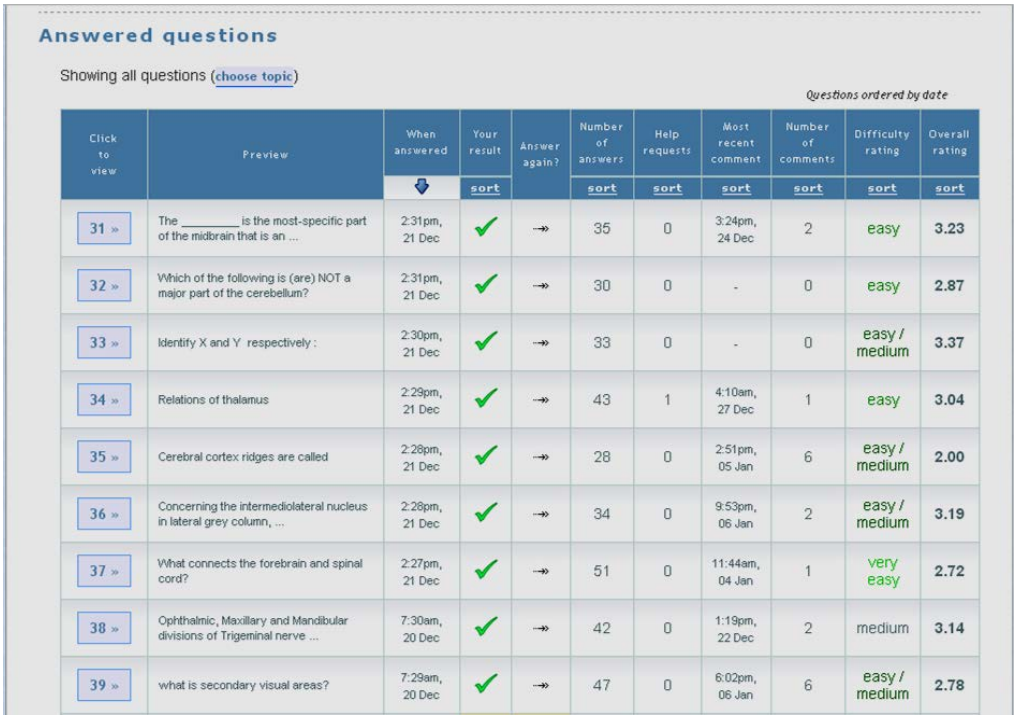
PeerWise was introduced to the students as an optional component within the nervous system course syllabus. The students were asked to create at least two MCQs covering different aspects of the interactive lecture (IL), student centered team-based-learning (SCTL), problem based learning (PBL) and clinical skill training (CST) components of the syllabus and evaluate four MCQs from other students throughout the 5-

week duration from December 2013 to January 2014. The students were provided with detailed instructions on how to use PeerWise. As an initiative, the administrators provided MCQs in the required format comprising of the question stem, five alternative answers (one correct and four incorrect answers), and an explanation for the correct option as shown in Table 1.

Table 1: An example of a question authored by a student.

Following a road traffic accident, a 23-year-old woman was brought unconscious to the emergency department with a large dough like swelling over the right temporal region. A lateral radiograph of the skull showed a fracture line running downward and forward across the anterior inferior angle of the right parietal bones. Her coma deepened, and she died 5 hours after the accident.
What is the most likely cause of the swelling over the right temporal region in this patient?
Superficial bruising of the skin
Haemorrhage from a blood vessel in the temporalis muscle
Rupture of the right middle meningeal vessels
Oedema of the skin
Haemorrhage from a blood vessel in the scalp
Explanation: The following explanation has been provided relating to this question: The swelling over the right temporal region and the radiologic finding of a linear fracture over the anterior inferior angle of the right parietal bone would strongly suggest that the **right middle meningeal artery** had been damaged and an epidural hemorrhage had occurred. Blood had spread through the fracture line into the overlying temporalis muscle and soft tissue.

Answering a question also required rating and providing a comment as feedback to the question author as shown in Figures 1 and 2.



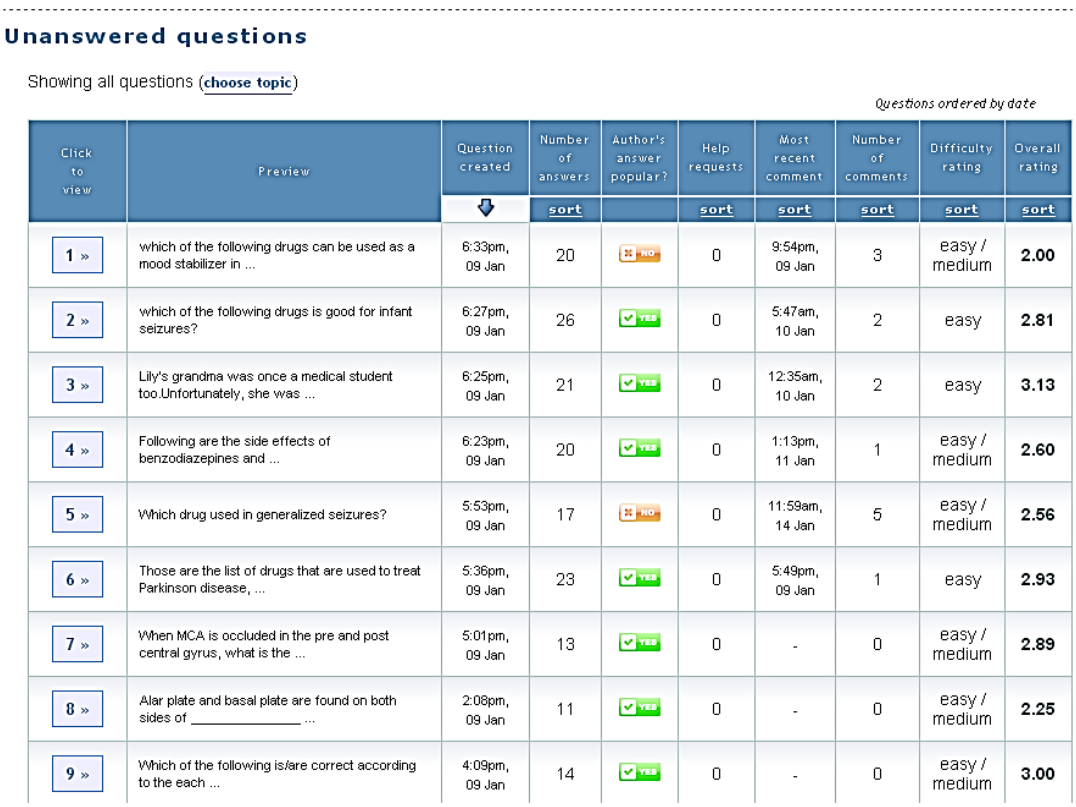
Answered questions

Showing all questions (choose topic)

Questions ordered by date

Click to view	Preview	When answered	Your result	Answer again?	Number of answers	Help requests	Most recent comment	Number of comments	Difficulty rating	Overall rating
		sort	sort		sort	sort	sort	sort	sort	sort
31 »	The _____ is the most-specific part of the midbrain that is an ...	2:31pm, 21 Dec	✓	→	35	0	3:24pm, 24 Dec	2	easy	3.23
32 »	Which of the following is (are) NOT a major part of the cerebellum?	2:31pm, 21 Dec	✓	→	30	0	-	0	easy	2.87
33 »	Identify X and Y respectively :	2:30pm, 21 Dec	✓	→	33	0	-	0	easy / medium	3.37
34 »	Relations of thalamus	2:29pm, 21 Dec	✓	→	43	1	4:10am, 27 Dec	1	easy	3.04
35 »	Cerebral cortex ridges are called	2:28pm, 21 Dec	✓	→	28	0	2:51pm, 05 Jan	6	easy / medium	2.00
36 »	Concerning the intermediolateral nucleus in lateral grey column, ...	2:28pm, 21 Dec	✓	→	34	0	9:53pm, 06 Jan	2	easy / medium	3.19
37 »	What connects the forebrain and spinal cord?	2:27pm, 21 Dec	✓	→	51	0	11:44am, 04 Jan	1	very easy	2.72
38 »	Ophthalmic, Maxillary and Mandibular divisions of Trigeminal nerve ...	7:30am, 20 Dec	✓	→	42	0	1:19pm, 22 Dec	2	medium	3.14
39 »	what is secondary visual areas?	7:29am, 20 Dec	✓	→	47	0	6:02pm, 06 Jan	6	easy / medium	2.78

Figure 1: Screen image of part of the web page in PeerWise for answered questions.



Unanswered questions

Showing all questions (choose topic)

Questions ordered by date

Click to view	Preview	Question created	Number of answers	Author's answer popular?	Help requests	Most recent comment	Number of comments	Difficulty rating	Overall rating
		sort	sort		sort	sort	sort	sort	sort
1 »	which of the following drugs can be used as a mood stabilizer in ...	6:33pm, 09 Jan	20	NO	0	9:54pm, 09 Jan	3	easy / medium	**2.00**
2 »	which of the following drugs is good for infant seizures?	6:27pm, 09 Jan	26	YES	0	5:47am, 10 Jan	2	easy	**2.81**
3 »	Lily's grandma was once a medical student too.Unfortunately, she was ...	6:25pm, 09 Jan	21	YES	0	12:35am, 10 Jan	2	easy	**3.13**
4 »	Following are the side effects of benzodiazepines and ...	6:23pm, 09 Jan	20	YES	0	1:13pm, 11 Jan	1	easy / medium	**2.60**
5 »	Which drug used in generalized seizures?	5:53pm, 09 Jan	17	NO	0	11:59am, 14 Jan	5	easy / medium	**2.56**
6 »	Those are the list of drugs that are used to treat Parkinson disease, ...	5:36pm, 09 Jan	23	YES	0	5:49pm, 09 Jan	1	easy	**2.93**
7 »	When MCA is occluded in the pre and post central gyrus, what is the ...	5:01pm, 09 Jan	13	YES	0	-	0	easy / medium	**2.89**
8 »	Alar plate and basal plate are found on both sides of _____ ...	2:08pm, 09 Jan	11	YES	0	-	0	easy / medium	**2.25**
9 »	Which of the following is/are correct according to the each ...	4:09pm, 09 Jan	14	YES	0	-	0	easy / medium	**3.00**

Figure 2: Screen image of part of the web page in PeerWise for unanswered questions.

The course assessment of this module comprised of 40% continuous assessment and 60% end of course assessment. The 10% of continuous assessment mark for the students was allocated for PeerWise participation. The progress was graded by the administrator where 0.5% was awarded for each question authored (2 required) and for each question evaluated (4 required) by a student. This was the basic component and it was expected to be fulfilled by every student of the course. For the higher contributors, the remaining 7% marks were awarded depending on their PeerWise score. The PeerWise score is awarded for all contributions such as authoring, answering and rating questions. This score was calculated and updated automatically and could be easily accessed by the administrators as illustrated in Figure 3.

The student's score increased whenever a peer rated his or her questions, there was a consensus among his or her peers on previous rating and whenever other students correctly answered questions that he or she has previously answered correctly.

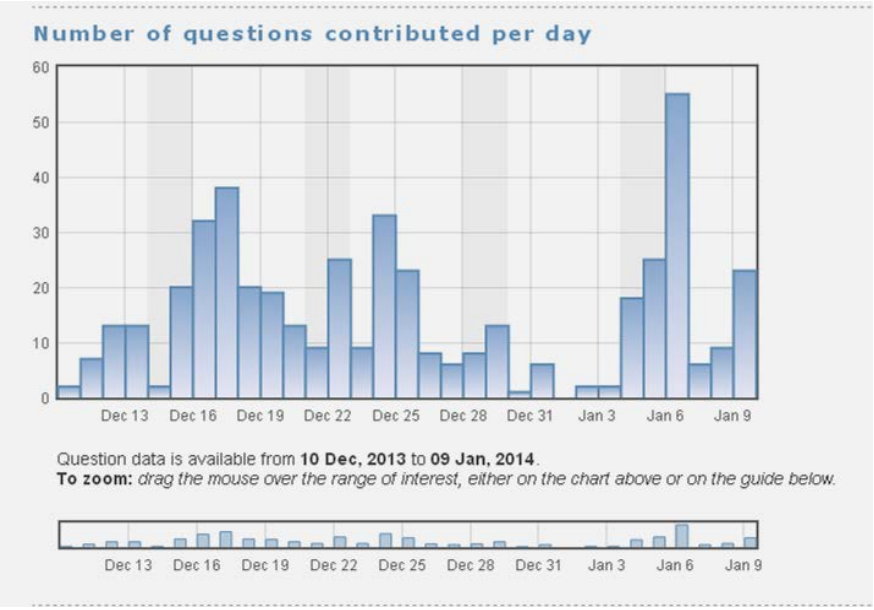


Figure 3: Screen image of part of the web page in PeerWise showing a bar-graph of individual contribution of authoring questions.

Following the course the instructors conducted a survey comprising of a close-ended questionnaire to gauge the students' perceptions regarding the use and outcome of PeerWise. One hundred and thirteen out of 124 students (91% participation rate) voluntarily contributed to the survey. The questionnaire consisted of 16 questions: 10 questions were ranked on a 5-point Likert scale, 2 questions were for facts (Gender and pre-university qualification) and 4 questions were ranked based on reference index (Paterson, 2011). The 5-point Likert scale was based on a student's agreement or disagreement with the question and was coded as: 1 = strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree, and 5 = strongly agree. The scores for both the "agree" and "'strongly agree" categories were combined to give a percentage agreement (% Agreement) of all 113 students who contributed to the survey. To investigate the relationship between activity PeerWise and the overall performance for the course, the students were ranked in order of their final mark of the course. That is, the student with the highest mark (86%) was ranked 1, and the student with the lowest mark (42.5 %) was ranked 120.

A passing mark of 50% corresponded to rank 111. The student rank was then plotted against each of five indicators of a student's activity or contribution to PeerWise. The five indicators of activity were the number of questions written (this includes deleted and edited versions of questions), questions answered, comments written, ratings submitted and the total reputational score.

PeerWise contribution and Academic Performance

Correlations between PeerWise activity and the end of course mark were analyzed to investigate the relationship between PeerWise activity and academic performance.

Data Analysis

Spearman correlation coefficient was calculated using the Statistical Package for the Social Sciences (SPSS) software version 21 (Wessa, 2014). The data from the survey questionnaire were analyzed by descriptive statistics.

RESULTS

A total number of 120 out of 124 (96.7% participation rate) students participated in this survey. They comprised about 77% of female students with an average age of 20 years. The students contributed a total number of 460 MCQs using PeerWise during the five week course. Since students edited their questions along the course, the older version was archived and unavailable for the peers to answer. Similarly, the deleted

questions were also noted and permanently removed from PeerWise. The final data showed 26 archived and 11 deleted questions. Hence, in total, this study analyzed 423 ''active'' student-contributed questions as the archived versions and deleted questions were no longer "active" for other students to answer.

Though these questions had spelling and grammatical errors, overall the questions were generally rated highly by students. However, as far as the rating was concerned, the instructor rated more questions in the "fair" and "good" category owing to the difference in experience and knowledge between the students and instructors. As we analyzed the quality of the student- authored questions, we found out that the students targeted lower levels of Bloom's Taxonomy such as remembering, understanding and applying (Forehand, 2010; Krathwohl, 2002).

The majority of questions covered the course syllabus which was delivered as IL and SCTL. As a class, the students contributed an average of 84 questions per week throughout the course. About 27% of the total student-contributed questions were written during the second week of the course and out of the remaining 73% of questions, approximately 18% were written in the weeks 1, 3, 4 and 5. However, a total of 36% of answers were given 3 days preceding the mid-course assessment (MCA-14%) and 3 days preceding the end-of-course assessment (EOC- 22%).

1. Correlation Between PeerWise Contributions and Academic Performance

PeerWise contribution was awarded 10% in the continuous assessment for each student. This comprised of 3% and 7% marks given for participation and the overall PeerWise score respectively.

Spearman correlation analysis was performed as the data were not normally distributed. Figures 4a-4d and Figure 5 show the relationship between all the components of PeerWise activity and the end of course mark scored. Correlation coefficient values fall in a range between .634 to .739 indicating that the relationship of PeerWise activity is moderately strong with the mark scored in the course.

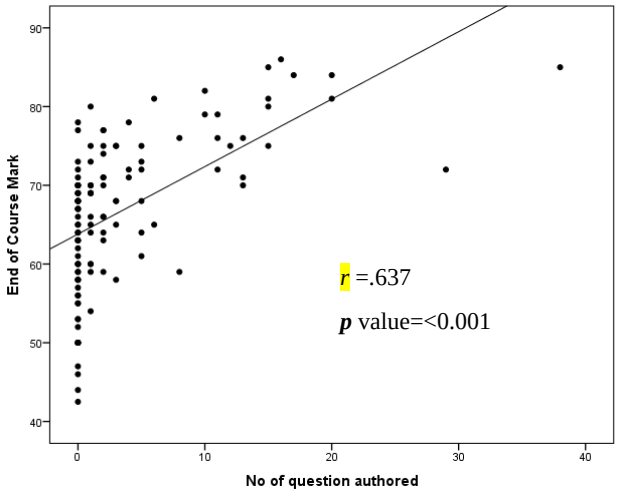


Figure 4a: Correlation between the end of course mark and the No. of question authored. The *r* value is Spearman's correlation coefficient and is significant at the .01 level.

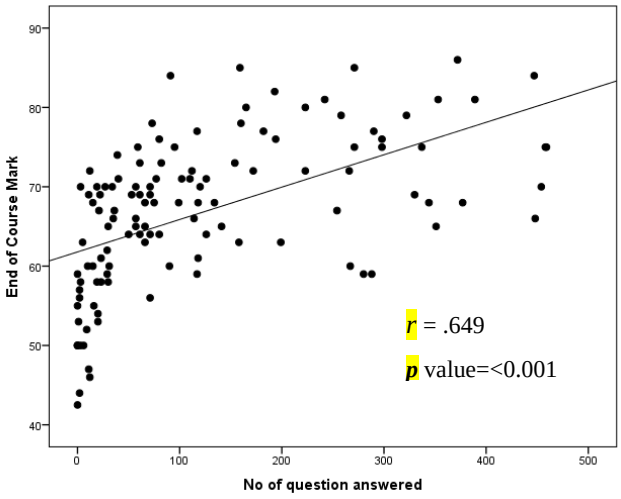


Figure 4b: Correlation between the end of course mark and the No. of question answered. The *r* value is Spearman's correlation coefficient and is significant at the .01 level.

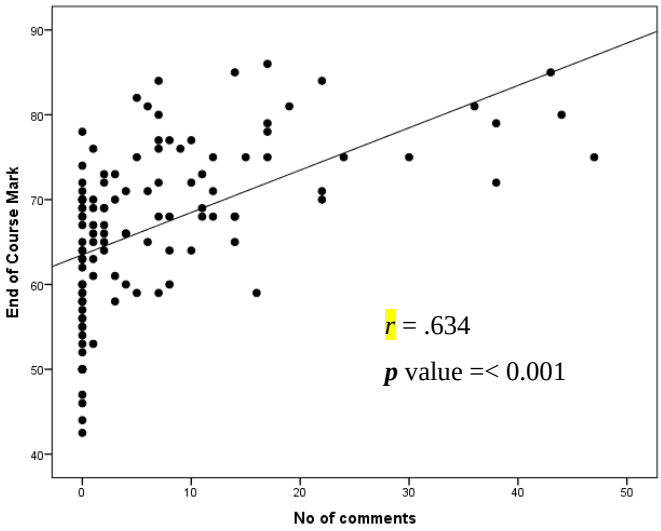


Figure 4c: Correlation between the end of course mark and the No. of comments. The *r* value is Spearman's correlation coefficient and is significant at the .01 level.

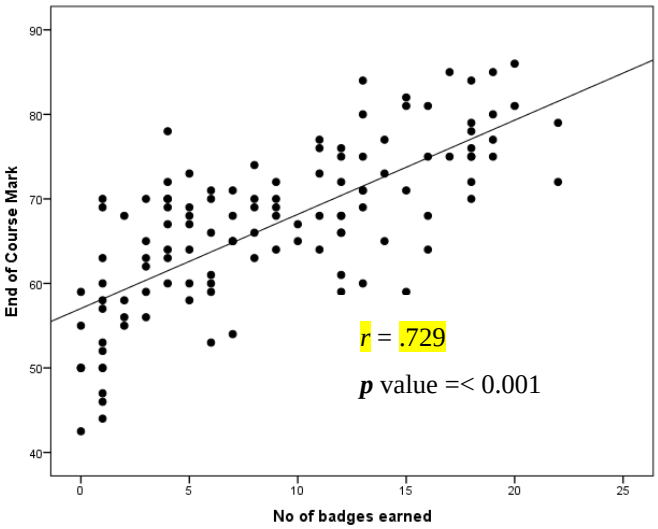


Figure 4d: Correlation of the end of course mark and No. of badges earned. The *r* value is Spearman's correlation coefficient and is significant at the .01 level.

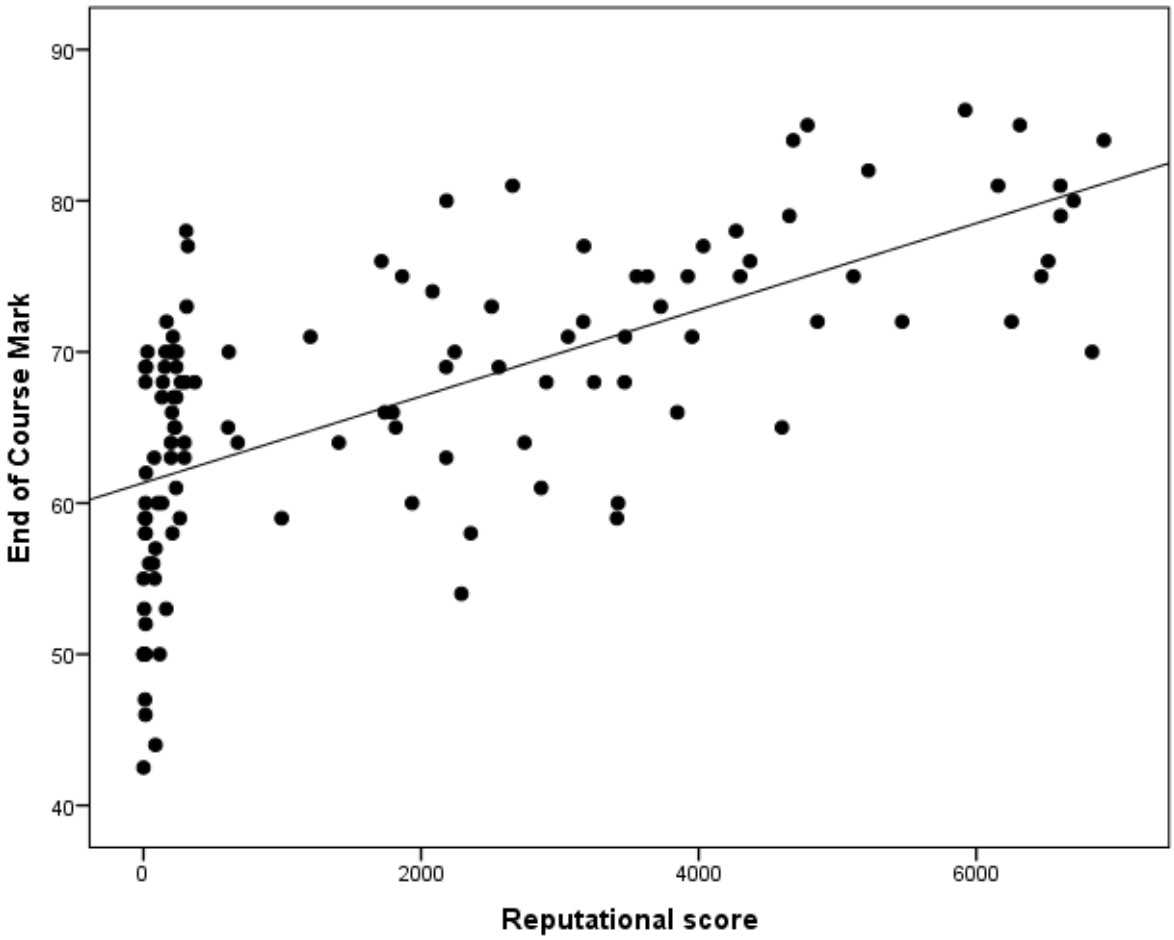


Figure 5: Correlation of the mark of the course with reputational score. The *r* value is Spearman's correlation coefficient and is significant at the .01 level.

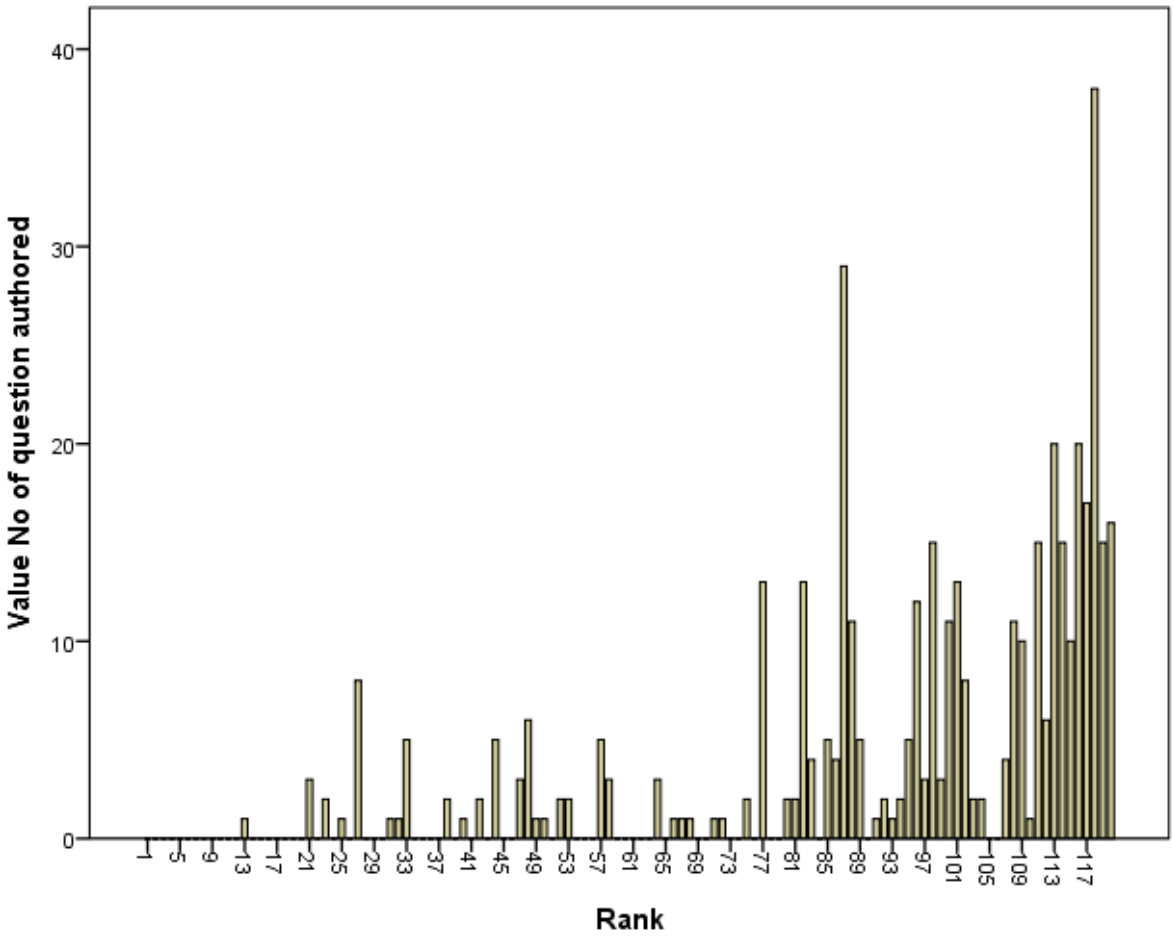


Figure 6: Correlation of the rank of the students and the number of questions authored.

2. Student Perceptions About PeerWise

The students' perceptions of the usage of PeerWise are summarized in Table 2 with the perceptions evaluated for male and female participants separately. The analysis shows that the majority of the students agreed that authoring and answering questions in PeerWise helped them understand and learn the topics in nervous system. However, the students showed least interest in finding out their peers' comments and ratings on their questions. Though PeerWise was introduced to engage the students in active learning process during the course and the students used it as a tool for recall (as evidenced by the surge in the number of answers preceding MCA and EOC), the students were skeptical in their perceptions as they felt that PeerWise did not really help to reduce their pre-exam stress and boost up their confidence prior to examinations. Overall, the students overwhelmingly agreed that PeerWise was innovative and would like to continue using PeerWise in another course even though bonus marks are not assured.

Table 2: Student perceptions of PeerWise determined by Likert-scaled questions

Question	Agreement % (agree and strongly agree)	
	Male (No=25)	Female (No=88)
Developing new questions using *PeerWise* helped me understand the topics.	77%	88%
Developing new questions using *PeerWise* helped me learn the topics better	88%	88%
Answering other students' questions helped me learn better	73%	95%
Reading other students' comments about my questions improved my existing knowledge about the topics.	54%	65%
I am interested to see how other students rated my questions	50%	69%
I thought that *PeerWise* is something new and different.	85%	93%
Authoring and answering questions in *PeerWise* reduced my pre-exam stress.	31%	26%
Authoring and answering questions in *PeerWise* made me more confident during my examination.	50%	55%
I would like to use *PeerWise* again in a future course	96%	88%
I would use *PeerWise* even if NO bonus marks are given	46%	64%

DISCUSSION

Exploring a range of nontraditional, alternative, teaching and assessment pedagogies are highly encouraged in the modern medical sciences education (SCTL, PBL, team-based learning, TBL)(Anderson, 2007; Wood, 2009).

A preferable educational outcome is considered achieved when students are motivated enough that they apply their acquired knowledge to accomplish higher levels of revised Bloom's taxonomy (Krathwohl, 2002). This in turn can be accomplished by promoting the students to acquire a deep knowledge and understanding of the core topics rather than the superficial knowledge of the conceptual aspects of the subjects (Biggs, 1985, 1993).

Writing questions addresses higher levels of Bloom's Taxonomy as it is challenging, encourages a more intense approach to learning and the writer has to appraise the question critically. Moreover, this exercise also targets lower levels of Bloom's Taxonomy as the students use it as a tool for better understanding and recall of the topics. This is evidenced from our results which show that students answered more questions preceding MCA and EOC. Additionally, the students' questionnaire also stands as testimony (Jobs et al., 2013). PeerWise which is solely student driven, motivates learners to contribute questions which in turn enhances written communication skills, promotes deeper understanding, and improves problem solving skills (Fu Yun Yua, Yu Hsin Liub, & Chanc, 2005; Denny & Hamer, 2008; Yu, 2011; Yu & Liu, 2009) and the web-based peer review system (Liu, Chiu & Yuan, 2001; Miri Barak, 2004) allows them to become aware and take control of their learning (Jackson 2004).

In terms of effective feedback for the lecturers, PeerWise gives a concise overview of the students' deficits and information about grey zones which the students feel difficult to comprehend (Jobs et al., 2013). In addition, it gives an opportunity to the lecturers to know if their learning objectives have been met. This in turn helps them to update and modify the course outline accordingly.

The use of PeerWise as an effective learning tool is obviously supported by the significant correlation between a student's PeerWise mark and his or her end of course mark (Figure 5 and 6). This is further evidenced in Figures 4a-4d, which show that the students who scored high marks were the greater contributors to PeerWise.

A detailed investigation into the participation summary by the instructors showed that the academically average-scorers actively participated in PeerWise which has definitely improved their scores in the assessments. Hence, Peerwise has beneficial influence on the learning habits of average and low level performers though it had not caused a significant ripple among the already existing high achievers.

We further motivated the students to participate by awarding them bonus marks which were incorporated into their continuous assessment as we thought that this would influence their learning skills (McCoubrie, 2004). This positively influenced the students to contribute overwhelmingly (96.7% participation rate) and our goal was achieved. However, the students agreed for the future use of PeerWise in courses even when bonus marks will not be assured (male 46%, female 64% agreement) and this shows that the students are enthusiastic about the usage of PeerWise.

Limitations of the Study

As a limitation of our study, the students were not briefed about the levels of revised Bloom's taxonomy as it was laborious and the aim of promoting the active participation of the students in contributing questions would be hindered. As a result, we found that the majority of the students' questions targeted the first two orders of the revised Bloom's hierarchy and this was mainly attributed to inexperience. This could be overcome with the persistent use of PeerWise in other courses.

Another potential issue which added to the limitations is the inability of students to construct questions depicting clinical scenarios. Furthermore, poor language skills (Fellenz, 2004) exhibited by some students made it difficult for their peers to understand the imparted knowledge of their questions and eventually ended in the peers rating these questions poorly. However, we strongly believe that feedback regarding the poor language would allow the students to develop their language skills in future.

Additionally, our students have voiced out that PeerWise neither did significantly reduce the pre-exam stress nor potentially increased their confidence in facing examinations (Table 2). This is probably due to lack of experience in using PeerWise as an effective learning tool. Since assessment results are considered as a reliable measure of learning, reassurance by good grades in the examination following PeerWise usage would convince the students to logically accept the fact that PeerWise is a stress reliever.

CONCLUSIONS

A novel method involving second year MBBS students in the nervous system course to author and peer assess MCQs was implemented successfully at CUCMS. Based on our results, we conclude that there is a positive correlation between the improved academic performance and PeerWise contribution. The data from our questionnaires reveal that the interest shown by the students in posting and answering was lacking in rating and comments on peer questions. However, we ultimately believe that education through PeerWise is a feasible and large scale team-based learning tool as the students improve their lifelong learning tactics through peer support, analytical and critical thinking as well as personal reflection.

Based on the findings of the current study, academicians are encouraged to use PeerWise as a teaching-learning method. Further research is highly recommended to authoritatively determine the effects of PeerWise as an effective learning method in a broader horizon involving a myriad of subjects and on different levels of students. This is the first report on Peer Wise experience for medical students in CUCMS.

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Conflict of interest

The authors declare that they have no conflict of interest.

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