



INTEGRATED LEARNING PROGRAMME IN TEACHING PHARMACOLOGY

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ABSTRACT **BACKGROUND:** An innovative method of teaching found to be a successful approach to promote learning among medical students is curriculum integration. However, the available data on integrated learning programmes in India is limited. **METHODS:** The Department of Pharmacology, Christian Medical College, Vellore, India, organised and implemented an integrated learning programme among second year medical students. The programme incorporated horizontal integration among the disciplines and vertical integration of basic and clinical sciences. A pre and post-test were conducted to evaluate the programme. Multiple formative assessments were conducted throughout the programme and one final summative assessment was conducted at the end of the programme. **RESULTS:** Overall students' performance had improved after the implementation of integrated learning programme, and this was evident in the formative assessment performed by faculty during the small group sessions. The mean difference in percentage between the post and pre test marks was found to be + 8.16 %. A paired students ttest was conducted to compare the pre and post test scores which showed the difference observed to be significant (p value <0.05). The maximum integration occurred between cardiology, cardiothoracic and Physiology and Pharmacology and this was identified using Network analysis by frequentist method. Majority of students performed better after problem based learning. Feedback from the students and faculty was to include this method of teaching for other topics of clinical relevance. **CONCLUSION:** We found the integrated learning Programmes to be an effective educational strategy for second year medical students. It enables students to apply the concepts learnt in basic science in their routine clinical practice. Our suggestion is to supplement integrated learning programmes into the conventional lecture based teaching.

KEYWORDS :

INTRODUCTION

Didactic subject wise lecturing is the method of teaching followed by many medical institutions(1). The majority of the reason being the vast curriculum that has to be completed within a given period of time. Moreover, lectures provide a basic framework for further learning and are found to be highly economical and time saving. Despite these advantages, this method of education fragments medical knowledge into segments and is ineffective while teaching complex and abstract medical problems. And more importantly, students fail to assimilate applied knowledge learnt over the four and half year course. In this situation, a better approach in teaching medical students would be to provide a holistic approach to medicine(2). Studies incorporating integrated learning programmes into medical curriculum have found this method of teaching to be highly effective—(36)

Application of previously learned basic science while treating patients is the goal of integrated learning programmes (2). The programme aims at improving clinical judgement by applying fundamental basic science knowledge to clinical care. Further, a clinician's role is application of clinical skills and rational decision making; a continuous and indispensable process of treating the ill. It is in this situation that interdisciplinary programmes are proven to be an effective teaching strategy.

With the tremendous increase in cardiovascular disease world over, we incorporated this module into our medical curriculum. We organised and implemented an integrated learning programme on the cardiovascular system. The interactive programme was complex, involving faculty from preclinical and clinical departments. For the first time this programme involved the contribution of Department of Allied health sciences. Facilitators guided students in obtaining medical history, examination of patient and application of basic science knowledge whilst ordering appropriate biochemical, microbiological, pathological investigations. This was followed by interpretation of laboratory results, diagnosis of condition and clinical management: pharmacological, medical and surgical (atleast 2 references for similar studies).

New methods: use of flip boards to teach students in small groups, role play in groups, quiz, match the following, crossword solving, hands on vein grafting using sheep aorta were introduced. These methods

ensured active participation by all group members.

We describe in detail the planning, methods and challenges faced while implementing this programme.

METHOD

An eleven day interdisciplinary programme was planned, organised and implemented by the Department of Pharmacology in the year 2017. Ninety-nine, second year undergraduate medical students participated in this programme.

The departments involved in the programme included

Preclinical departments -Anatomy, Physiology, and Biochemistry, Para clinical Departments-Pharmacology, Pathology, Microbiology and Forensic Medicine
Clinical Departments-Medicine, Electrophysiology, Cardiology, Cardiothoracic Surgery, Emergency Medicine, Radiology and Preventive and Social Medicine.
Allied Health Science including - Nursing, Physiotherapy and Dietary

The topics of clinical relevance included:

1. Congestive cardiac failure
2. Myocardial infarction
3. Rheumatic fever
4. Hypertension
5. Arrhythmia
6. Hypertension in Pregnancy

STEPS INVOLVED IN IMPLEMENTATION OF THE PROGRAMME-

Organisation-

The organiser, a pharmacologist and medical education specialist played a vital role in organising regular meeting within the faculty of departments who participated in the programme. A facilitator or representative was nominated from each department. The designated facilitators formed the integral core group and were instrumental in defining the specific learning objectives. The next step involved conducting multiple organisational meetings to design the course of the programme; with a key focus on interlinking medical subjects. During the planning and setting up the programme the organisers motivated teachers to help students to identify the connections and relevance between subjects.

The entire programme was approved by the institution and approval from the Institutional Review Board was obtained.

Specific Learning Outcomes:

Anatomy- Elaborated the gross anatomy of the coronary circulation using plastinated specimens.

Biochemistry- Enumerated the biochemical basis of dyslipidaemia and its association with atherosclerosis and enlisted the biochemical markers used in diagnosis of congestive cardiac failure and myocardial infarction.

Physiology- Discussed the factors affecting blood pressure and regulation of blood pressure

Forensic Medicine- Elaborated 1. Consent 2. Medical negligence 3. Medical cause of death certification 4. Documentation and Communication of medical legal issues

Pharmacology- Paper cases were presented to the students. The rationale for use of Calcium Channel Blockers, alpha adrenergic blockers (Prazosin), Angiotensin converting enzyme inhibitors and blockers – Enalapril, Ramipril and Aliskiren, Thiazide and vasodilators – hydralazine in each case were discussed.

Pathology- Illustrated the sequential progression of acute coronary artery lesion and pathogenesis of Rheumatic heart disease. Assessment of the temporal evolution of the morphological (Gross and Microscopy) changes in Myocardial infarction.

Microbiology- Enlisted the manifestations and sequelae of Rheumatic fever, its morphology, antigenic structure and its cultural characters.

Cardiology- Discussed the pathogenesis behind the ECG changes during myocardial infarction and ECG findings involved in the territory or coronary artery affected. The role of treadmill test, echocardiography and coronary angioplasty were explained. Finally, students watched a live video coverage of coronary angioplasty.

Cardiothoracic surgery- Introduced surgical options in valvular heart disease and rheumatic heart disease. A video on live cardiovascular bypass graft was displayed.

Emergency Medicine- An overview of Cardiopulmonary resuscitation and ACLS (Advanced Cardiac Life Support) and BLS (Basic Life Support) was provided using mannequins.

Medicine- Clinical Case discussion at the bedside on the following cases 1. Young hypertensive 2. Myocardial Infarction 3. Congestive cardiac failure 4. Rheumatic fever

Radiology- Students were taught how to read a normal chest X-ray and identify both congenital and acquired cardiac conditions. Finally, an overview of use of CT and MRI in diagnosing common cardiac pathologies was explained.

Nursing- Students were described the care of various drains and wound care. Home care management was also elaborated on.

Dietary- The components of a Balanced diet and DASH diet were explained. Healthy Foods along with portion sizes were displayed to students in groups.

Physiotherapy- Stratifying persons with ischaemic heart disease into low, medium and high risk for exercise participation, physiotherapists demonstrated the various types of exercises advised to patients.

Preventive and Social Medicine: Primary prevention, secondary prevention and tertiary prevention of Cardio-vascular diseases were explained. Also emphasised on importance of primordial prevention.

After 5 months of careful planning and arranging the Integrated Learning Programme-Cardiovascular Module 2017 was implemented in the month of August 2017. Students attended an orientation programme on the first day; ninety- nine students were divided into six groups with 16-17 students in each group. Amongst these 16 members, four designated leaders were given the responsibility to receive assignments and coordinate activities. Students came forward with unique cardiovascular group names.

Components of Integrated Curriculum

Strategies for Teaching in an Integrated Programme The methods used were carefully planned during a series of meetings with the facilitators. Strategies implemented in the module included small group teaching, case-based learning with faculty guides, laboratory exercises, bed side clinics, role play, flip chart presentation and live video coverage. The technique of cardio pulmonary bypass, live valve surgery and coronary artery bypass grafting was broadcasted. Students had a hands-on experience on the technique of performing cardiopulmonary resuscitation using mannequins. The strategies employed are explained below:

I. Case Based Learning-

The department of Pharmacology, Forensic Medicine, Physiotherapy and Biochemistry Department prepared clinical scenarios that were electronically mailed to the group leader. On the day of the programme, students assembled in groups discussing with a trained facilitator the clinical condition and finally drawing a management plan.

II. Flip board presentation-

The Pharmacology Department distributed and instructed students the use of flip paper that was distributed on the day of orientation, allowing each student 7 days' time to prepare a flip board presentation. The mechanism of action and rationale behind the use of different pharmacological agents used in the management of each condition was elaborated in the form of creative drawings and flowcharts. The students were assessed formatively by 2 group facilitators. Students were graded on their knowledge of subject, ability to curate relevant study material and communication skills.

III. Small Group Teaching-

Anatomy- Using plastinated specimens, the coronary circulation was elaborated.

Physiology –The technique to measure blood pressure was demonstrated. Following which students were asked to demonstrate the method on their colleagues.

Cardiothoracic Surgery-The different types of valves used in cardiovascular surgery were displayed. Students had hands on experience with saphenous vein grafting.

Physiotherapists demonstrated the different types of exercises or workouts to be advised to patients with various cardiovascular diseases.

IV. Laboratory Exercises-

The *Department of Microbiology* demonstrated the method of performing a throat swab and inoculating blood culture bottles. Each group also had hands on experience with microscopy Gram stain, colony morphology of Strep pyogenes, ASO estimation by latex agglutination and anti- microbial susceptibility testing. *Pathology department* had laboratory exercises to identify microscopic and gross characteristics features seen in RHD. The fundamental basis of ordering laboratory investigations was explained, whilst promoting interactive group training.

V. Clinical Visits- Hospital visits, bedside discussion with a clinician on evaluating and managing patients with cardiovascular disease were assessed formatively.

VI. Role play- The six groups were given 7 minutes to enact the following topics of cardiovascular significance-

1. Prevention of Rheumatic Fever in a famous school in Vellore 2. Prevention of Hypertension in a factory in Ranipet (an industrial hub of Vellore city in the state of Tamil Nadu in southern India). 3. Myocardial Infarction on Gandhi Road (a busy street in front of Christian Medical College) 4. A Television Documentary on the awareness of Hypertension during pregnancy 5. Cookery shows enacting the diet advised to Prevent and reverse heart disease. 6. An Exhibition in CMC Hospital on Prevention of Heart disease.

Students were instructed to incorporate the pathophysiology, clinical significance and treatment of each condition in the play. The entire programme was judged by a reputed cardiologist, cardiothoracic surgeon, pharmacologist and emergency physician.

VII. Video-the technique of cardio pulmonary bypass, live valve surgery and coronary artery bypass grafting was broadcasted.

VIII. Mannequins for Cardiopulmonary Resuscitation training-The steps of cardiopulmonary resuscitation using mannequins was described by the emergency department faculty.

RESULTS

Overall students' performance had improved after the integrated learning programme, and this was evident in the formative assessment performed by faculty during the small group sessions. The mean difference in percentage between the pre and post test marks was found to be + 8.16%. A paired t test was conducted to compare the pre and post test scores which showed the difference observed to be significant (p value <0.05).

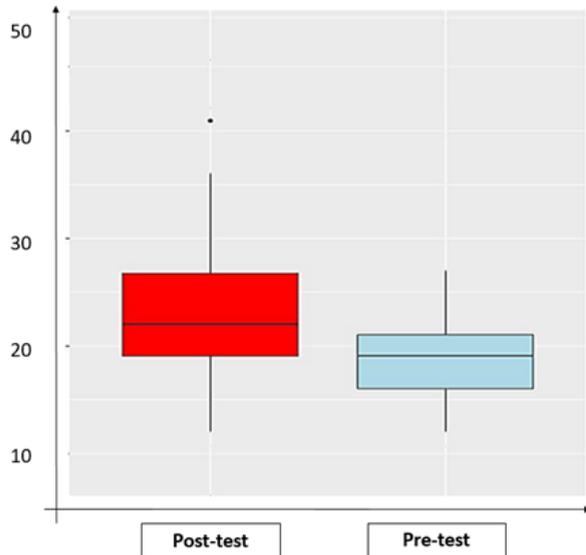


Fig 1, Box and Whiskers plot showing the distribution of Pre-test scores and Post-test scores following ILP as prime intervention. Though the difference between the mean score of Pre-test and Post-test was small but was found to be significant.

Faculty feedback

To assess the quality of the programme a 10 item anonymous online questionnaire with a comment box was prepared. Faculty used a 7 point Likert scale to grade the programme. A score of 7- Strongly Agree 5-6- Agree 3-4- Undecided 2-4- Disagree 1-Strongly Disagree. The questionnaire was designed to assess the faculty views, opinions and difficulties faced in the programme. Forty nine facilitators participated in this programme.

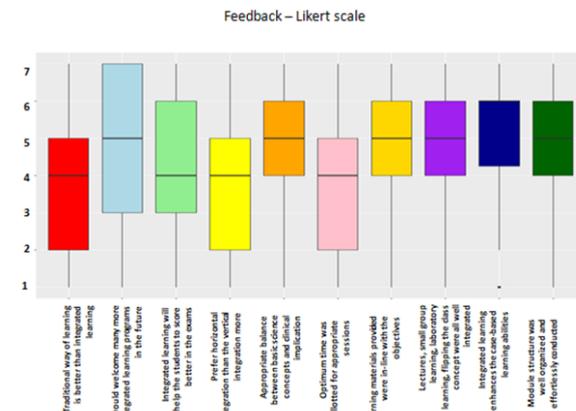


Fig 2: Responses of Faculty (n = 49) involved in facilitation of ILP. Out of 10 questions, responses to 6 questions had a median score of 5 and responses to 4 questions had a median score of 4 out of 7 on the Likert scale.

Weighted network:

1 Anatomy	5 Community Medicine	9 General Medicine	13 Pharmacology
2 Biochemistry	6 Dietary Services	10 Microbiology	14 Physiology
3 Cardiology	7 Emergency Medicine	11 Nursing Services	15 Physiotherapy
4 Cardiothoracic surgery	8 Forensic Medicine	12 Pathology	16 Radiology

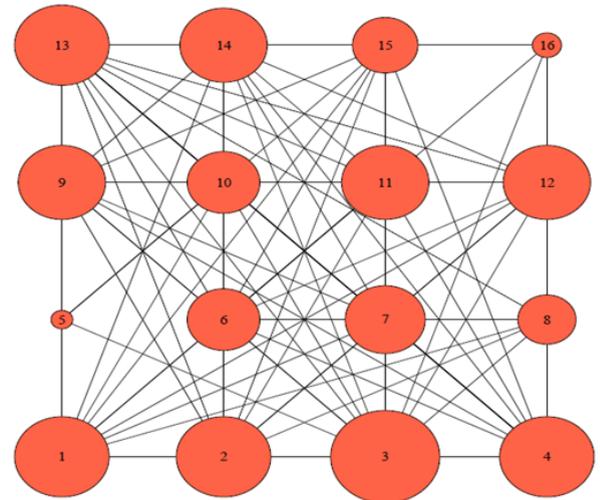


Fig 3: Shows the feedback response of students on integration of various subjects throughout this new learning programme. It is done using a method known as Weighted Network Analysis (Frequentist Method) on R / R studio. The data is captured from a feedback form provided to each student (n=99) as a wheel with 16 subjects. They were asked to link the subjects which according to them was well integrated. The above network shows how well each individual subject is linked to the rest 15 subjects. Each sphere depicts individual subject, size of the sphere indicates how frequent the subject was linked with others by the students. Cardiology followed by Pharmacology was frequently linked with other subjects. Students found Community Medicine and Radiology lectures difficult to integrate with other subjects.

Heat Map

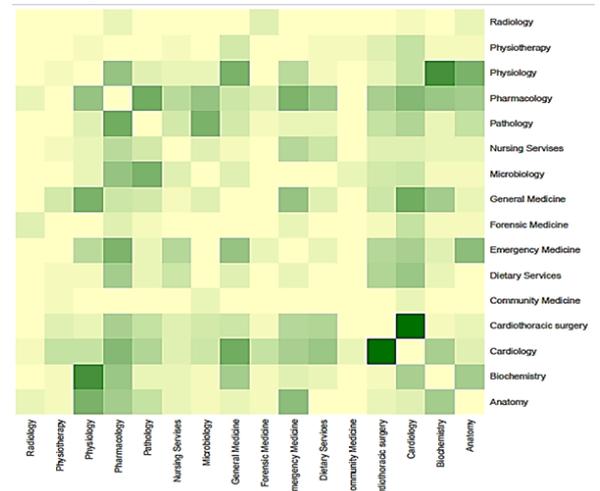


Fig 4: Heat map showing how strong the integrations are, between the subjects. The density of integration is proportional with intensity of the colour: green. Maximum integration was found between Cardiology and Cardio-thoracic surgery lectures. Students found that Pharmacology lectures followed by Cardiology and General Medicine were very well integrated with most of the other subjects. Students found it difficult to integrate the lectures of community medicine, forensic medicine, radiology and physiotherapy lectures with rest of the subjects.

Recommendations

Students appreciated the initiative taken by the Department of

Pharmacology. When asked about the programme, the responses were “It makes medicine more interesting and I finally understood the how and why a diagnosis is made and the rationale behind an intervention. Most importantly, I learnt the importance of applying basic science knowledge in the routine clinical practise.”

After the programme the facilitators felt the need to incorporate integrated teaching to other topics of clinical relevance as well. When asked about the programme their responses we received which included: “The programme served as a great platform for better understanding of various aspects of medicine. It would be better if all the major systems are covered in ILP”, it was a comprehensive program which was designed and implemented well.”
 “ILP is excellent in motivating and encouraging students”
 “Students in small groups were able to clear their doubts better and more individual attention could be given by us”

Challenges

Small discussions had to be abruptly stopped due to time constraint. Despite informing the students the assignments and projects in advance, few of the students had not prepared. This resulted in mixed participation and contribution in small group discussions. Requirement of immense preparation and time consumption were 2 major issues faced by the organising team in implementing this method of teaching.

DISCUSSION-

The results of this study elaborate the numerous beneficial effects of the integrated approach to learning medicine. Currently, in India, medical students undergo two years of intense preclinical education followed by two and half years of clinical training. First, this results in medical students moving from one department to another acquiring subject wise knowledge that is poorly retained over the years. Second, until now, the focus of the medical curriculum was to establish knowledge on treating a human condition. This conventional approach of teaching medicine is found to be of poor benefit, especially, while managing complex heart conditions which are on the rise due to an increasing geriatric population, novel diagnostic and imaging techniques.

A few more literature review to correlate this study with likely or similar studies which links all aspects of a disease to give an integrated view for the students about a particular disease.

In this situation numerous studies have shown the important role and benefits of integrated learning programmes (4,5,6). Moreover, reviewing principles of medicine and purposeful exposure to clinical methods improved long term memory.

Over the years, we had frequently found students not involving or interested in lectures. However, in this programme; incorporation of case discussions, flip board presentation and clinical skill demonstration promoted active participation by each student and self directed. Despite all our efforts, we did find few students who failed to complete assignments. We plan to identify such students and introduce novel strategies that will enable all students to participate.

Among 16 subjects, students found integration between lectures of Cardiology, Cardiothoracic surgery, pharmacology, general medicine, physiology, biochemistry were established, whereas Community medicine, forensic medicine and physiotherapy lectures were difficult for the students to integrate with other subjects and needs more tailoring to have a better impact in learning Cardio-vascular system. We also felt that choosing the subjects to integrate and teach a particular system/topic needs more attention as certain lectures like Community medicine which failed to integrate with others in cardiovascular system can be very useful in learning Communicable diseases like Tuberculosis. We also feel that the chosen departments should come under single roof to pen down the areas that will be covered by them to avoid any repetitions or discrepancies.

CONCLUSION-

Integrated or interdisciplinary learning dissolves the boundaries among departments providing a new environment to learn. We feel that this form of curriculum integration provides a strong comprehensive approach to the management of the sick patient. We strongly recommend the incorporation of integrated learning programmes in the medical curriculum.

LIMITATIONS:

A prospective assessment of students after the four and half year course is planned and is to be implemented.

Disclosure of Potential Conflicts of Interest: No potential conflicts of interest were disclosed. Testing question papers were prepared by the faculty of respective departments who were not involved in conducting the teaching programme.

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REFERENCES:

1. Arja SB, Arja SB, M Venkata R, Nayakanti A, Kottathveetil P, Acharya Y. Integrated curriculum and the change process in undergraduate medical education. *Med Teach.* 2018 Mar 13;1-6.
2. Ambwani S, Vegada B, Sidhu R, Charan J. Impact of Integrated Teaching Sessions for Comprehensive Learning and Rational Pharmacotherapeutics for Medical Undergraduates. *Int J Appl Basic Med Res.* 2017 Dec;7(Suppl 1):S57-61.
3. Rochmawati Erna, Wiechula Rick. Education strategies to foster health professional students' clinical reasoning skills. *Nurs Health Sci.* 2010 Feb 2;12(2):244-50.
4. Pipas CF, Peltier DA, Fall LH, Olson AL, Mahoney JF, Skochelak SE, et al. Collaborating to integrate curriculum in primary care medical education: successes and challenges from three US medical schools. *Fam Med.* 2004 Jan;36 Suppl:S126-132.
5. Roh YS, Kim SS, Kim SH. Effects of an integrated problem-based learning and simulation course for nursing students. *Nurs Health Sci.* 2014 Mar;16(1):91-6.
6. Yuab NN, Eldeek BS, Alshawa LA, ALSaba AF. Interdisciplinary Integration of the CVS Module and Its Effect on Faculty and Student Satisfaction as Well as Student Performance. *BMC Med Educ.* 2012 Jul 2;12:50.
7. Yusuf Salim, Reddy Srinath, Öunpuu Stephanie, Anand Sonia. Global Burden of Cardiovascular Diseases. *Circulation.* 2001 Nov 27;104(22):2746-53.
8. Rezaee R, Mosalanejad L. The Effects of Case-Based Team Learning on Students' Learning, Self Regulation and Self Direction. *Glob J Health Sci.* 2015 Jul;7(4):295-306.
9. Hortsch Michael, Mangrulkar Rajesh S. When students struggle with gross anatomy and histology: A strategy for monitoring, reviewing, and promoting student academic success in an integrated preclinical medical curriculum. *Anat Sci Educ.* 2015 Jan 16;8(5):478-83.
10. Brauer DG, Ferguson KJ. The integrated curriculum in medical education: AMEE Guide No. 96. *Med Teach.* 2015 Apr;37(4):312-22.
11. Bandiera G, Boucher A, Neville A, Kuper A, Hodges B. Integration and timing of basic and clinical sciences education. *Med Teach.* 2013 May;35(5):381-7.
12. Murad Mohammad H, Coto Yglesias Fernando, Varkey Prathibha, Prokop Larry J, Murad Angela L. The effectiveness of self-directed learning in health professions education: a systematic review. *Med Educ.* 2010 Oct 15;44(11):1057-68.
13. Ginzburg SB, Brenner J, Cassara M, Kwiatkowski T, Willey JM. Contextualizing the relevance of basic sciences: small-group simulation with debrief for first- and second-year medical students in an integrated curriculum. *Adv Med Educ Pract.* 2017;8:79-84.
14. Ghosh S, Pandya HV. Implementation of Integrated Learning Program in neurosciences during first year of traditional medical course: perception of students and faculty. *BMC Med Educ.* 2008 Sep 24;8:44.
15. Derstine PL. Implementing goals for non-cognitive outcomes within a basic science course. *Acad Med J Assoc Am Med Coll.* 2002 Sep;77(9):931-2.
16. Schmidt HG, Rotgans JJ, Yew EHI. The process of problem-based learning: what works and why. *Med Educ.* 2011 Aug;45(8):792-806.
17. Ozkan H, Degirmenci B, Musal B, İtil O, Akalin E, Kilinc O, et al. Task-based learning programme for clinical years of medical education. *Educ Health Abingdon Engl.* 2006 Mar;19(1):32-42.
18. Parmelee DX, DeStephen D, Borges NJ. Medical Students' Attitudes about Team-Based Learning in a Pre-Clinical Curriculum. *Med Educ Online [Internet].* 2009 Jan 7 [cited 2018 Apr 4];14. Available from: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2779620/>
19. Ghorbani N, Karbalay-Doust S, Noorafshan A. Is a Team-based Learning Approach to Anatomy Teaching Superior to Didactic Lecturing? *Sultan Qaboos Univ Med J.* 2014 Feb;14(1):e120-5.
20. Graffam B. Active learning in medical education: Strategies for beginning implementation. *Med Teach.* 2007 Jan 1;29(1):38-42.
21. Onishi H. Role of case presentation for teaching and learning activities. *Kaohsiung J Med Sci.* 2008 Jul;24(7):356-60.
22. Si J. An analysis of medical students' reflective essays in problem-based learning. *Korean J Med Educ.* 2018 Mar;30(1):57-64.