ORIGINAL ARTICLE

A Group-Randomized Study Comparing the Traditional Lecture and Informal Cooperative Learning For Undergraduate Radiology Training In A Malaysian University

Ibrahim MS[a], Mat Jusoh N[a]*, Amen Rebuan HM[a], Thwe Aung MM[a], Cheah WH[a], Esa AR[b]
[a]Faculty of Medicine, Universiti Sultan Zainal Abidin, Medical Campus, Kuala Terengganu, Malaysia.
[b]Formerly in UCSI University, Terengganu Campus, Terengganu, Malaysia.

ABSTRACT

INTRODUCTION: Radiology teaching via the traditional lecture (TL) is susceptible to a decline in focus and engagement, leading to compromised training and competency. In this study, we investigated the teaching of topics on radiology via informal cooperative learning (ICL). **MATERIALS AND METHODS**: We randomly delivered teaching via the TL or the ICL to four clinical groups of thirteen third-year undergraduate medical students. The study involved eleven radiology topics throughout one academic year. For each topic, two groups underwent the TL while the other two learned via the ICL. All students underwent a pre-test at the beginning of each class, consisting of One Best Answer (OBA) and Objectively Structured Clinical Examination (OSCE) to assess their knowledge and skills, respectively. They subsequently underwent post-tests with another OBA and OSCE assessments at the end of classes and six weeks later. **RESULTS:** Students who learned from the ICL classes scored significantly higher in the knowledge assessment immediately post-teaching, six weeks later, and the overall score regardless of time. Assessments of skills showed no statistically significant difference between the two teaching methods. However, for both the ICL and TL groups, post-teaching scores of knowledge and post-teaching scores of skills were significantly higher than the pre-test. **CONCLUSION**: Our study provides empirical evidence on the superior competency of undergraduate radiological skills through the ICL. The findings signify the need to engineer competent doctors via innovative clinical training. The novel experience from this study better-orientate radiology teaching and contribute to the broader field of medical education, clinical practice, and patient safety.

Keywords
cooperative learning, informal cooperative learning, traditional lecture, active learning, radiology teaching

Corresponding Author
Dr. Norhasiza Mat Jusoh
Radiology Unit,
Faculty of Medicine,
Universiti Sultan Zainal Abidin (UniSZA),
Medical Campus, Jalan Sultan Mahmud,
20400, Kuala Terengganu,
Terengganu, Malaysia
Email: hasizamj@unisza.edu.my

Received: 12th October 2021; Accepted: 13th April 2022

Doi: https://doi.org/10.31436/imjm.v21i3

INTRODUCTION

The traditional lecture (TL) is one of the commonest methods for medical training. TL refers to the conventional delivery of knowledge via talks and speeches on an open platform for the benefits of the viewing audiences. The TL differs from the contemporary approach to lecturing which employ various methods, techniques, and activities to encourage participation for active learning. TL is relatively easier to conduct and require little or no prior experience, resulting in widespread adoption for the undergraduate medical education.

However, medical training via the traditional lecture (TL) suffers from several crucial limitations. Learners have described the TL as passive learning, boring, uninteresting, and even useless.[1,2] Students have limited time and opportunity to investigate their comprehension or participate in a discussion to enjoy the benefits of understanding from other trainees. A landmark study of medical education by Stuart and Rutherford [3] analyzed 1353 questionnaires from 12 lectures demonstrated gaps of learning when learners' concentration peaked at around 10 to 15 minutes before steadily decreasing after that.

Informal cooperative learning (ICL) underlies the evidence-based practice to fill this gap.[4] ICL is a teaching of small-group approach where students are assigned various roles to be actively teaching their peers and also learning by interrogating own understanding based on targeted discussions. The informal notion refers to the groups structure which can be adapted to the resources, experience, and expertise of the teachers. Thus, being pivoted away from the rigid formality of structure confers flexibility of implementations so the focus of curriculum delivery is emphasized on learning rather than teaching.

ICL promotes individual accountability and responsibility in an environment that permits mistakes.[5,6] From 1960 to 2006, a meta-analysis of 305 studies revealed that university students of various countries and institutions were significantly enjoying more and preferring team-based pedagogy than individualistic learning.[7] On the other hand, a 2005 cross-sectional study among 180 university students of economy classes in the United States of America investigated the relationship between cooperative learning and students' perception of learning quality.[8]

An overwhelming majority of the students (87.2%) reported that they had a better attitude towards the course due to the team-based activities.[8] Most of the students also perceived better understanding, wielded better problem-solving skills, and proficient in articulating complex concepts.[8] In Malaysia, a study at Universiti Teknologi Malaysia (UTM) in 2004 was surveying educational practices among fourteen lecturers from three distinct engineering faculties.[9] Ten of the lecturers who adopted ICL reported their students had improved attendance, were more participative during classes, and scored higher in examinations.[9]

Unfortunately, the evidence to support this pedagogy for radiology training is limited. Inadequate extramural research funding, a dearth of skilful and experienced medical education researchers, and a limited number of academic radiologists have been attributed to this gap.[10] To establish the evidence of all the relevant reports, Linaker[11] conducted searching and screening literature from 1990 through December 2012 to investigate how radiologists underwent training for teaching. The systematic mapping study concluded limited empirical evidence was available to support the effective teaching methods for radiology. Instead, most 51 reports identified in the study focused on activities explaining educational concepts to the radiologists.[11] Thus, there is little evidence to better-inform the training for radiology practice and patient safety.

Thus, this research investigates the effectiveness of the ICL among the third-year medical students in this institution compared to the TL for radiology classes. The subsequent sections of this article outline the conduct of the study and the outcomes to achieve this goal.

MATERIALS AND METHODS

Study Design and Sampling Method

This is a randomized control trial study. A total of 52 third-year medical students at Universiti Sultan Zainal Abidin, Kuala Terengganu, Malaysia were allocated to four groups of 13 each with similar and matching profile. The process of grouping was conducted by the faculty to ensure all groups contained a healthy mix of students with various background, performance based on academic ranking, and attributes of professionalism. It was a robust process carried out before the start of the academic calendar to ensure similar and matched profiles of students across all groups. Therefore, matching of profiles between all groups were assured at the institutional level and free from any research influence.

To further minimise systematic bias, we randomised the groups selected for each radiology topic, two groups will undergo learning via the TL and the others via the ICL. The TL group served as the control group representing the conventional practice of radiology teaching in our institution. The overall process is summarized in Chart 1.

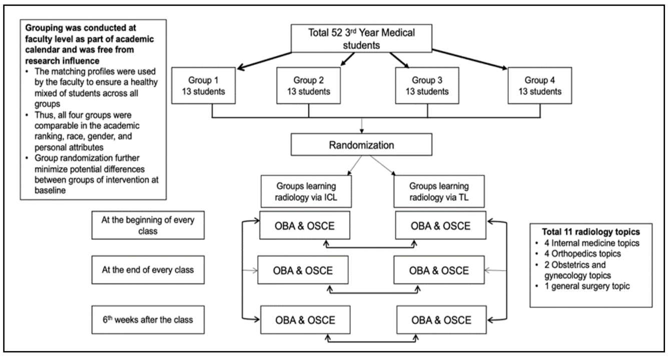

Chart 1 : Flowchart of the methodology employed in this study

Participants and Study Design

All groups underwent a total of 11 radiology topics throughout the academic year. The radiology topics were related to the internal medicine rotation (four topics), orthopaedics (four topics), obstetrics and gynaecology (two topics), and general surgery (one topic). The random selection of groups resulted in each group underwent five or six radiology topics either via the TL or the ICL with equal 13 contact hours.

Conduct of the Teaching

Students were permitted to ask questions and share their thoughts throughout the routine lecture. There was a dedicated question-and-answer session at the end of every TL session. However, the TL did not advocate student-based activities to invigorate further interactions.

Meanwhile, in the ICL classes, the session started with a short lecture to introduce the topic followed by series of small-group activities and presentations as outlined in previous study[6] and is described below.[12]

Note checking

Students were asked to write down the critical points from the short lecture. Then, students compared their notes with peers who sit beside them. In pairs, they share their discussion to clarify, identify, summarize, and prioritize the critical information from the short lecture.

Guided reciprocal peer questioning

Students discussed a set of generic structure of questions related to the radiology topics in a small group of three or four. These were;

How does... relate to what I've learned before?
What conclusion can I draw about ….?
What is the difference between …and….?
What is the main idea of ….?
Why is … important?

Subsequently, each student spent about five minutes in private to add another two or three thought-provoking questions on the lecture's content. The small group then came together for peer questioning, where group members take turns answering additional student-initiated questions and shared each answers of others. Following the small group discussion, the whole class discussed questions that were particularly interesting or did not yield a satisfying answer in the small group discussion.

Think-pair-share

The teacher began by triggering individual thoughts by asking a question. Then, each student paired with another colleague who sat next to him/her to exchange ideas. Next, one student from each pair would share the answer of his/her pair. This technique empowered a safe learning environment because all students whose opinions were shared did not have to present publicly. In contrast, the students who gave their pairs' views publicly did not have to share their own thoughts.

Closure review pairs

At the end of the ICL session, each student worked with a new pair to list the major concepts being learned throughout the class. Each pair took one concept at a time and wrote down the best answer to the following question:

> What is the topic, and why is it important?
> What interests you most about the topic?

Lecturers took this opportunity to monitor and correct any misunderstanding by randomly asked a student to explain the topic.

Assessment

We employed vetted and faculty-endorsed 20 questions of one best answer (OBA) and three questions of the objective structured clinical examination (OSCE) to assess knowledge and skills, respectively. Students took the assessment just before the start of every class (pre-test) and repeat the same test at the end of the class (post-test), and six weeks later (long-term). Therefore, upon completing all 11 radiology topics, each student had been assessed with a total of 220 OBA and 33 OSCE questions.

Data Analysis and Statistical Application

All data were analyzed using Statistical Package for the Social Sciences (SPSS) version 22. Descriptive statistics were applied, such as frequency (%) for categorical data, while numerical data were statistically described through mean and standard deviation (SD). For each OBA and OSCE assessment, repeated measures Analysis of Variance (ANOVA) was applied. The repeated measures ANOVA assess mean differences within each group based on time, between groups regardless of time and between groups based on time.

Concerning intra-group difference, if multivariate tests were significant, pairwise comparison with confidence interval adjustment was performed. For the differences between each pair of comparisons, findings were presented as every group's mean with the 95% confidence interval (CI) and respective *p*-value.

Concerning the intervention effect (inter-group comparison based on TL vs. ICL) regardless of time, if the *p*-value of the test of inter-group effect was significant, the overall total mean value for each intervention group was calculated to compare these two intervention groups. The outcomes were presented as their mean difference with its 95 % CI, *F*-statistic and degree of freedom (df), and *p*-value.

For intra-inter group analyses, the results are interpreted by using estimated marginal means. The findings are presented as adjusted means with its 95% CI for each group in each measurement. The level of significance (α) was set as the *p*-value of < 0.05 for this study.

RESEARCH ETHICS

This study protocol was approved by Human Research Ethics N/1/TD2/628-1 Jld.2 (19).

RESULTS

There were 12 (23.1%) male and 40 (76.9%) female students who participated in the study. Based on time-effect analysis, there was significant difference of mean scores within each group based on time for OBA assessment (F=402.398, $p < 0.001$) (Table 1, Figure 1) and for OSCE assessment (F=627.894, $p<0.001$) (Table 2, Figure 2). Then, a pairwise comparison with confidence interval adjustment was performed. The results showed that there were significant differences in pre and post comparison in the ICL group ($p <0.001$) as well as in the TL group ($p <0.001$).

Table 1: Comparison of OBA Marks Within Each Group Based on Time (Time Effect)

Comparison	Informal cooperative learning		Traditional lecture	
	MD (95% CI)	*p*-value	MD (95% CI)	*p*-value
Pre-lecture and post-lecture assessment	-3.75 (-4.24, -3.25)	< 0.001	-3.69 (-4.14, -3.24)	< 0.001
Pre-lecture and long-term assessment	-0.62 (-1.07, -0.17)	0.003	-0.96 (-1.40, -0.53)	< 0.001
Post-lecture and long-term assessment	3.13 (2.63, 3.63)	< 0.001	2.73 (2.24, 3.21)	< 0.001

Repeated measures ANOVA within-group analysis was applied followed by pairwise comparison with 95% confidence interval adjusted by Bonferroni correction; MD= mean difference

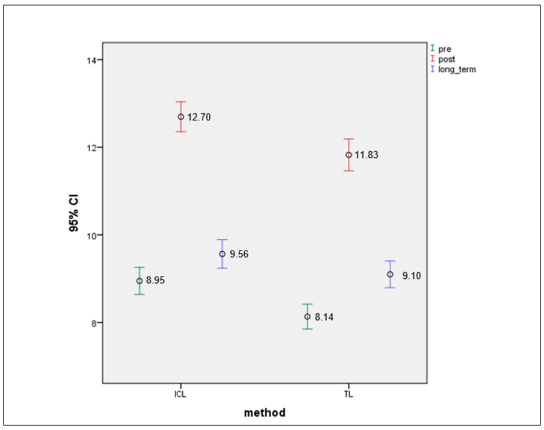

Figure 1: Error bar showing mean and 95% CI values of OBA marks for pre, immediate post, and six-week post-lecture assessment.

Table 2 Comparison of OSCE Marks within Groups Based on Time (Time Effect)

Comparison	Informal cooperative learning		Traditional lecture	
	MD (95% CI)	*p*-value	MD (95% CI)	*p*-value
Pre-lecture and Post-lecture assessmen	-3.66 (-4.04, -3.27)	< 0.001	-4.42 (-4.84, -4.00)	< 0.001
Pre-lecture and Long-term assessment	-0.74 (-1.14, -0.34)	< 0.001	-1.55 (-1.93, -1.18)	< 0.001
Post-lecture and Long-term assessment	2.92 (2.53, 3.30)	< 0.001	2.87 (2.45, 3.28)	< 0.001

Repeated measures ANOVA within-group analysis was applied followed by pairwise comparison with 95% confidence interval adjusted by Bonferroni correction. MD= mean difference

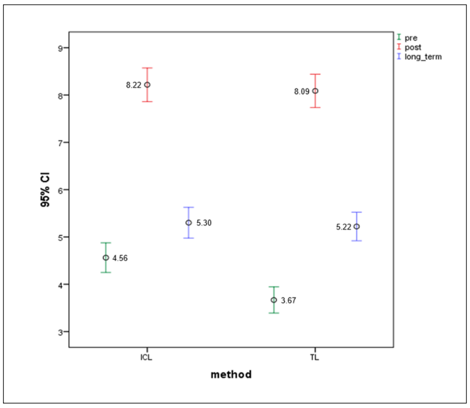

Figure 2: Error bar showing mean and 95% CI values of OSCE marks for pre, immediate post, and six-week post lecture assessment.

As for the intervention effect, in the OBA assessment, ICL gave statistically significant higher marks than the TL (p<0.001), whereas in OSCE assessment, there were no statistically significant different effects of these two methods (p=0.050) regardless of time. These results are shown in Table 3 below.

Table 3 The Overall Mean Difference of OBA and OSCE Marks between the ICL and TL groups (Intervention effect)

Comparison	Mean difference (95% CI)	*F* statistic (df)	*p*-value*
ICL (OBA)- TL (OBA)	0.72 (0.39, 1.05)	18.13 (1)	<0.001
ICL (OSCE)- TL (OSCE)	0.37 (0.00, 0.74)	1.965 (1)	0.050

*Repeated measures ANOVA between-group analysis was applied.

Regarding intra-inter group analysis, when the mean for one group does not overlap with another group's corresponding confidence interval, the mean value is significantly different between groups in that particular time of measurement. In the OBA assessment, there was a significant difference of marks between two different intervention groups based on time (Figure 3). Meanwhile, in the OSCE assessment, there was no significant difference of marks between two different intervention groups based on time (Figure 4).

Table 4 Comparison of OBA and OSCE Marks between Different Learning Methods based on Time (Time-treatment effect)

Time	Treatment group	Mean OBA marks	95% CI	Mean OSCE marks	95% CI
Pre-lecture assessment	ICL	8.95	8.65, 9.25	4.56	4.26, 4.86
	TL	8.14	7.85, 8.42	3.67	3.38, 3.96
Immediate Post-lecture assessment	ICL	12.70	12.33, 13.06	8.22	7.86, 8.58
	TL	11.83	11.48, 12.17	8.09	7.74, 8.43
Six weeks Post-lecture assessment	ICL	9.56	9.24, 9.89	5.30	4.98, 5.62
	TL	9.10	8.79, 9.41	5.22	4.91, 5.53

Repeated measures ANOVA between-group analysis with regards to time was applied.
Assumptions of normality, homogeneity of variance, and compound symmetry were checked and were fulfilled.

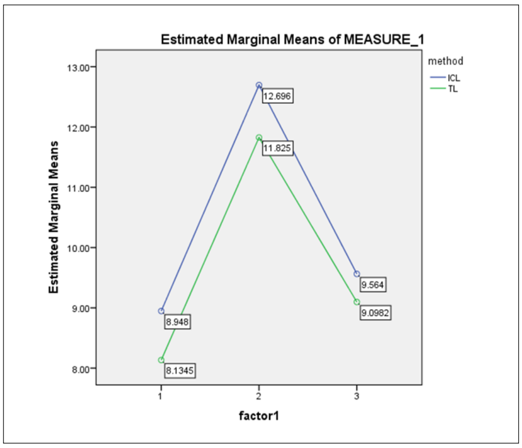

Figure 3*:* Profile Plot of OBA Marks Comparison Between Different Learning Methods Based On Time

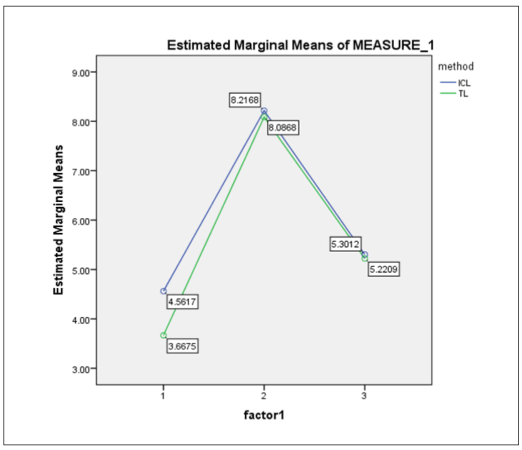

Figure 4: Profile Plot of OSCE Marks Comparison Between Different Learning Methods Based On Time

DISCUSSION

Relation with what is known

The time-effect analyses in this study demonstrates that students in both the TL and ICL teaching scored significantly higher in OBA and OSCE, immediately after teaching and six weeks later, compared to the pre-tests (Table 1). These results indicate that both the TL and the ICL group learned significantly and retain considerable radiology knowledge and skills after six weeks. These outcomes contradict certain perceptions that the traditional lecture is a waste of time. For example, an insightful study by Bati, Mandiracioglu [13] in Turkey researched 633 second-year medical, nursing, and dentistry students on why health professional students were missing classes. Besides being sick, not enough sleep, and overcrowded lecture hall, students reported feeling not getting valuable lessons as one of the main reasons for skipping classes.[13] Thus, our study vindicates existing practice in Malaysia medical schools to designate compulsory attendance among the undergraduates for all core medical classes including radiology.

Novel Contribution

Beyond mere attaining knowledge by attending classes, our study fundamentally establishes that future-doctors can attain better knowledge competency via the ICL. The intervention-effect analyses (Table 4 and figure 3) show students in the ICL group achieved significantly higher OBA scores than the TL group immediately post teaching and six weeks later. This evidence signifies that the peer-based learning in ICL did not just lead students to know more; they also understand and remember better than they otherwise from the routine TL.

This fresh evidence carries significant weight for the practice of medicine. The 220 OBA questions encapsulated all 11 radiology topics with complexity level one (remember) to level five (evaluate) in Bloom's cognitive taxonomy.[14] This volume of assessment represents the complex practice of medicine where radiological investigations facilitate diagnoses and treatments.[15] For example, in the orthopaedic case, the ability to recognize the image of an x-ray of the thigh bone with infection (osteomyelitis) dictates treatment with a high-dose antibiotic. Hence, in the clinic setting, especially in rural medical practices, recognizing critical radiological information does save lives.

Similarly, chest x-ray is an everyday investigation in hospitals. Upon graduating as doctors, trainees need to identify subtle yet important radiological findings. These include time-critical radiological features of pneumothorax, bowel perforation, difficulty of breathing due to heart failure, and advanced tuberculosis. At the minimum competency, adequate radiology knowledge enables junior doctors to recognize when to call for help from the more experienced doctors. Thus, the teaching strategy that can better-equip students to harvest information and deduce the critical understanding from the radiological investigation is favourable and professionally warranted.[16]

New Direction for the Undergraduate Radiology Training

Thus, findings from this study helps to pivot to the new direction of training. Traditionally, doctors teach their juniors how they were trained.[17] The legacy mantra of seeing one, doing one, and teaching one is a classic concept where doctors undergo training by receiving a lesson from senior doctors until they can perform independently.[18] Then, the doctors-in-training repeat the cycle by teaching other doctors to mark the completion of their learning. In comparison, ICL champions learning via peers-based design where teachers merely act as facilitators to ensure attainment of the intended learning. This learning style is a significant departure from the conventional medical training. Thus, empirical evidence that showed better knowledge acquisition and retention through this innovative approach is paramount to shake the inertia of educational change and get stronger buy-ins among clinicians, medical experts, and policymakers.

Not only in radiology knowledge, but students also learn radiological skills significantly via the ICL compared with the pre-test (Table 1). However, at the *p*-value of 0.050, there is no significant difference between the ICL and TL for the overall skills (Table 4). The assessment of skills immediately post teaching and at six weeks later showed no significant difference in OSCE score between the ICL and TL (Table 2 and Figure 4). Hence, the radiology skills assessment does not shadow the significant outcomes of the radiology knowledge.

These findings were unexpected but not surprising. Radiology skills is a distinct learning domain of psychomotor skills. These include specific competencies such as describing radiological findings and explaining radiological diagnosis. Under the updated Malaysia Qualification Framework (MQF) 2.0 for higher educations, these radiology skills belonged to the learning cluster *C3A*, the practical skills related to the functional work skills.[14] Furthermore, unlike the radiology knowledge that belongs to the cognitive domain, the psychomotor domain are best learned from the simulation -based setting and the real workplace-based practice.[19] Hence, it is not surprising that the common classroom-based environment results in comparable gain of radiological skills between the ICL and TL.

Consequently, this study importantly demonstrates that despite delivering superior learning of knowledge, the ICL is not a substitute for hospital-based training. Valuable clinical skills from genuine interactions with the real patients, medical professionals and other health professional colleagues are irreplaceable. Moreover, in the context of the five-year undergraduate medical program in Malaysia, the gravity of workplace-based learning is emphasized later in the course, especially during the final year. Thus, a similar outcome of learning radiology skills with the TL does not degrade the fundamental gain of adopting the ICL for superior clinical knowledge.

Limitations

We were ethically bound to inform students about the conduct of this study, including the tests for the OBA and OSCE. Since assessments are among the most potent drive for learning[20], it is possible that despite being non-credit-bearing, the assessment would motivate students to invest more focus and engagement during the TL sessions. Therefore, it is likely that teaching via the ICL will yield even greater gains compared to the TL in real practice. Commonly, to eliminate systematic bias, a true experimental research design would adopt a double-blinded randomized control study. However, it is impossible to blind students and lecturers from the teaching styles employed for each radiology topic.

Additionally, this study was conducted within the structure of curriculum delivery which limited our option individual randomization rather than group randomization for a comprehensive randomized control study. Nonetheless, we believe robust matching profile for grouping conducted at the faculty level in addition to the randomization at the group provided strong justification that there was minimum systematic bias to support differences in performance found in this study were attributable to the teaching intervention.

CONCLUSION AND RECOMMENDATIONS

In summary, this study establishes new evidence to support the ICL as a superior teaching method compared to the TL for radiology knowledge. This outcome fundamentally connects the contemporary practice of higher education to radiology teaching for a safe practice of medicine in general. We have also demonstrated how the innovative ICL can be delivered in the context of a Malaysian medical school. This experience will likely be valuable in radiology, the more expansive medical fields, and for higher education in general. Future research may employ comprehensive assessments to investigate the effect of learning via the ICL on affective attributes to further consolidate the evidence.

ACKNOWLEDGEMENT

This work was supported by the University Internal Research Grant (13/GU 022). Authors are grateful for all participating medical students.

REFERENCES

1. Brown G and Manogue M. AMEE medical education guide no. 22: Refreshing lecturing: A guide for

lecturers. *Medical Teacher* 2001; 23: 231-244. DOI: 10.1080/01421590120043000.

2. Abuid B. A student participation assessment scheme for effective teaching and learning. *Learning and Teaching in Higher Education: Gulf Perspectives* 2014; Vol 11.
3. Stuart J and Rutherford RJD. Medical student concentration during lectures. *The Lancet* 1978; 312: 514-516. DOI: 10.1016/S0140-6736(78)92233-X.
4. Johnson DW and Johnson RT. Cooperation and Competition. Elsevier Inc., 2015, pp.856-861.
5. Davidson N, Major CH and Michaelsen LK. Small-Group Learning in Higher Education — Cooperative , Collaborative , Problem-Based , and Team-Based Learning : An Introduction by the Guest Editors. 2014; 25: 1-6.
6. Mat Jusoh N, Mohd Amen Rebuan H, Thwe Aung MM, et al. Undergraduate Medical Students' Attitude And Preferences Toward Traditional Lecture Versus Informal Cooperative Learning. *Malaysian Journal of Public Health Medicine* 2016; 16: 55-63.
7. Johnson D and Johnson R. Cooperative Learning: Improving university instruction by basing practice on validated theory. *Journal on Excellence in College Teaching* 2015; 25: 85-118.
8. Rassuli A and Manzer JP. "Teach Us to Learn": Multivariate Analysis of Perception of Success in Team Learning. *Journal of Education for Business* 2005; 81: 21-27. DOI: 10.3200/JOEB.81.1.21-28.
9. Hassim MH, Hamid M, Hassan MA, et al. Enhancing learning through cooperative learning: UTM experience. In: 2004.
10. Collins J. Medical education research: challenges and opportunities. *Radiology* 2006; 240: 639-647. 2006/08/24. DOI: 10.1148/radiol.2403050542.
11. Linaker KL. Radiologists as Educators: A Narrative Review of the Literature. *J Chiropr Humanit* 2015; 22: 22-26. DOI: 10.1016/j.echu.2015.09.003.
12. Yusof KM. Active Learning Workshop. Kuala Terengganu, Terengganu: Universiti Sultan Zainal Abidin (UniSZA) & Centre of Engineering Education, Universiti Teknologi Malaysia, 2013.
13. Bati AH, Mandiracioglu A, Orgun F, et al. Why do students miss lectures? A study of lecture attendance amongst students of health science. *Nurse education today* 2013; 33: 596-601. 2012/08/07. DOI: 10.1016/j.nedt.2012.07.010.
14. MQA. Table 4 COPPA 2.0, https://www.mqa.gov.my/pv4/document/coppa/2019/September/230919/Table4.xlsm (2019, accessed Jan 7th 2020).
15. Ibrahim MS, Mohamed Yusoff H, Abu Bakar YI, et al. Digital health for quality healthcare: A systematic mapping of review studies. *DIGITAL HEALTH* 2022; 8: 20552076221085810. DOI: 10.1177/20552076221085810.
16. Ibrahim M, Yusof M and Rahim AA. Why Assessment Which Carries No grades and Marks is the Key for the Future of Education? *Education in Medicine Journal* 2021; 13. DOI: 10.21315/eimj2021.13.2.8.
17. Hassan S, Ibrahim M and Hassan N. The Structural Framework, Implementation Strategies and Students' Perception of Team- Based Learning in Undergraduate Medical Education of a Medical School in Malaysia. *Education in Medicine Journal* 2018; 10: 53-66. DOI: 10.21315/eimj2018.10.1.7.
18. Rodriguez-Paz JM, Kennedy M, Salas E, et al. Beyond "see one, do one, teach one": toward a different training paradigm. 2009; 18: 63-68. DOI: 10.1136/qshc.2007.023903 %J Quality and Safety in Health Care.
19. Miller GE. The assessment of clinical skills/competence/performance. *Academic medicine : journal of the Association of American Medical Colleges* 1990; 65: S63-67. 1990/09/01. DOI: 10.1097/00001888-199009000-00045.
20. Norcini J, Anderson B, Bollela V, et al. Criteria for good assessment: consensus statement and recommendations from the Ottawa 2010 Conference. *Medical teacher* 2011; 33: 206. DOI: 10.3109/0142159X.2011.551559.