

Peer-assisted versus expert-assisted learning in virtual chest x-ray interpretation

A randomized controlled trial

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ABSTRACT

الأهداف: مقارنة ما بين فعالية التعلم من الأقران والتعلم من الخبراء من ناحية اكتساب المعلومات في تحليل أشعة الصدر السينية عن بعد. كان الهدف الثانوي هو قياس مستويات رضى الطلبة بين المجموعتين.

المنهجية: في هذه الدراسة التجريبية المعشاة، تم تعيين طلاب الطب بالسنة الثانية الذين وافقوا شروط البحث عشوائياً لمجموعة التعلم عن طريق الأقران ومجموعة التعلم عن طريق الخبراء. أجريت الدراسة ما بين ديسمبر من العام 2020م وفبراير من العام 2021م في جامعة أم القرى، المملكة العربية السعودية. كان الهدف الأولي هو الفروق بين نتائج الطلاب والتي حددت عن طريق مراجع مستقل، كان الهدف الثانوي هو مستوى رضى الطلاب.

النتائج: مجموع المشاركين في الدراسة كان 166 طالباً. متوسط العمر والانحراف المعياري لمجموعة الدراسة كان 19.73 ± 0.66 (الذكور: 79 (47.6%); والإناث: 87 (52.4%). تم توزيعهم بشكل متساوي على مجموعتي الدراسة (83 طالب في كل مجموعة). النتائج أظهرت عدم وجود اختلافات بين نتائج الطلاب في المجموعتين ($p=0.507$). مستوى الرضى كان أعلى في مجموعة التعلم عن طريق الأقران فيما يتعلق بكون الحصة كانت على الوقت ($p=0.043$)، وأن المعلم سهل عملية تعلمهم ($p=0.01$)، وأن التعليم عن بعد يعادل التعليم وجهاً لوجه في الكفاءة ($p=0.03$)، وما إذا كانت الحصة مفيدة ($p=0.011$). لم يكن هنالك اختلاف بارز في مستويات الرضى في الجهات الأخرى من الاستبانة.

الخلاصة: التعلم عن طريق الأقران يمتلك فعالية مماثلة مقارنة بالتعلم عن طريق الخبراء عن بعد. الطلاب أظهروا مستويات رضى أعلى في مجموعة التعلم عن طريق الأقران.

Objectives: To compare the effectiveness of peer-assisted learning (PAL) and expert-assisted learning (EAL) in terms of knowledge gain in virtual chest x-ray (CXR) interpretations. The secondary objective was to assess students' satisfaction levels between both groups.

Methods: In this randomized controlled trial, second-year medical students who met the inclusion criteria were randomly assigned to the PAL and EAL groups. The study was carried out from December 2020 to February 2021 at Umm Al-Qura University, Makkah, Saudi Arabia. The primary endpoint was

the difference in the students' scores, which were determined by an independent reviewer. The secondary endpoint was students' satisfaction levels.

Results: A total of 166 second year medical students were included. The standard deviation and mean age of the population were 19.73 ± 0.66 (males: 79 [47.6%]; females: 87 [52.4%]). Participants were allocated equally into two groups (83 in each group). Student scores did not differ significantly between the two groups ($p=0.507$). Students in the PAL group thought the session was useful ($p=0.01$), kept on time ($p=0.043$), and the tutor facilitated their learning process ($p=0.011$). They also felt that online teaching was as effective as traditional teaching ($p=0.03$). There was no significant difference in satisfaction scores on the other aspects of the questionnaire.

Conclusion: Peer-assisted learning has equivalent efficacy compared to EAL in a virtual setting. The Students in the PAL group had higher level of satisfaction.

Keywords: peer-assisted learning, expert-assisted learning, student's satisfaction

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The first confirmed case of COVID-19 was reported in Saudi on the 2nd of March 2020.¹ Since then, the Saudi Arabia government has taken drastic changes to contain the outbreak, suspending all in-person teaching at universities across the country.² The Ministry of Education was able to provide online platforms for all university students within days to continue their education smoothly.³ This huge transition from conventional to virtual learning has also changed teaching methods in medical institutions.⁴ Pandemics provide the opportunity to examine available resources, identify weaknesses, and evaluate the technological advances in the field of digital learning.⁵ There are several advantages to online education, including access to materials and flexibility in study time and place.⁶ Online education also has its limitations, including poor internet connectivity, limited access to the internet, and the need for learners to improve their digital skills.⁶ Moreover, many countries have eliminated clinical clerkships from their medical curriculums. For medical students, online learning cannot substitute the experience of interacting with patients in a clinical setting.⁷

Peer-assisted learning (PAL) refers to a method of learning where non-professional teachers from similar social groupings help and educate each other.⁷ Peer-assisted learning has different categories depending on the number of peers and peers' teachers. Two or fewer students per-peer teacher refers to peer mentoring, while 3 to 10 students per-peer teacher refers to peer tutoring, and more than 10 students per-peer teacher refers to peer didactics.⁸ This study used a peer-to-peer didactic approach. Due to a lack of resources, PAL programs were created to serve a growing number of students and provide cost-effective teaching strategies. They offer the requisite competencies to several students with a finite number of faculty staff in a fixed academic calendar.⁹ Peer-assisted learning helps tutees develop organizational, interpersonal, and teaching skills.¹⁰ The aim of expert-assisted learning (EAL) is to impart knowledge and experience to less knowledgeable learners.¹¹ In a meta-analysis published in 2016, Rees et al¹² concluded that the difference in knowledge gain or skill development between the 2 teaching modalities was insignificant.

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Several articles in the literature discuss the utility of using PAL in teaching radiology. A 2017 review article on the use of PAL in teaching imaging interpretation skills concluded that there is insufficient evidence regarding the use of PAL in radiography.¹³ A 2019 study showed that PAL in radiology teaching gave learners self-confidence and effective group work and communication skills, enhancing their cognitive ability.¹⁴ The purpose of this study was to compare the effectiveness of PAL and EAL in terms of knowledge gain in virtual CXR interpretations. Moreover, the study compared student satisfaction levels in both teaching modalities.

Methods. This study used a randomized, open-label, parallel-group controlled trial (RCT) carried out at Umm Al-Qura University (UQU), Makkah, Saudi Arabia. The sample comprised of second-year medical students who met the inclusion criteria. An online invitation form was sent to all second-year medical students, which contain a brief description of the study, a copy of the consent form, and a demographic data form. The consent form contains a statement to assure the students that their data would be kept confidential and that their performance in the study would not affect their academic scores. Out of the 281 students who received the invitation form, a total of 194 responded. The number of students who met the inclusion criteria and consented was 166. Students who had no previous knowledge of CXR interpretations were included. Students who did not attend and those who failed to complete the post-lecture test were excluded. The enrolled students were allocated equally to both interventions, with an allocation ratio of 1:1 (Figure 1).

After delivering the online lectures, students were instructed to fill a second online form which contain The CXR interpretation test and the modified Mills et al¹⁵ survey. Both groups' test questions were standardized. The modified Mills et al¹⁵ survey was used to measure students' satisfaction with the teaching method they were allocated to.

The participants were randomly chosen from the student's list and was contacted through WhatsApp. After reassuring participants that their data would be kept confidential and that their performance in the study would not affect their academic scores, informed consent was obtained from all the students. Following this, all students who agreed to participate received instructions on the study process before the study began. A statistician conducted a stratified randomization method to allocate male and female students equally

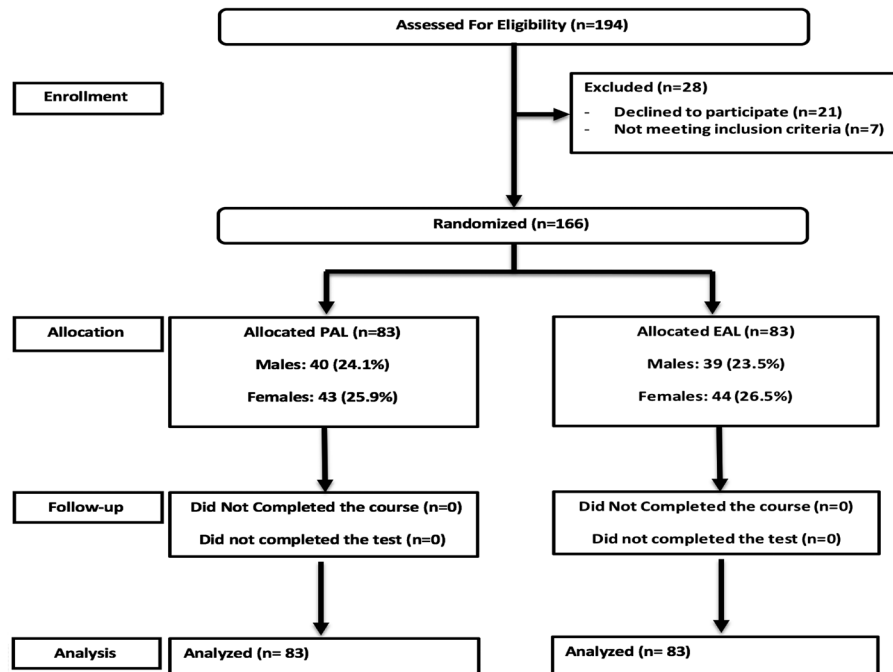


Figure 1 - Consort chart demonstrates sample size, enrolment, and the allocation of students. PAL: peer-assisted learning, EAL: expert-assisted leaning

into the 2 groups. Following this process, the information technology specialist assigned students to their respective virtual classes on a blackboard.

An experienced sixth-year medical student who has previously taught the same subject was recruited by the investigators to deliver the lecture to the PAL group. Additionally, the investigators assigned a radiology faculty member for the EAL. Both the faculty member and the medical students were provided with course content 2 weeks before the start of the trial. A consultant radiologist designed the teaching objectives, materials, and tests for this study.

The lecture objective included the general principles of radiography, as well as a review of thoracic anatomy, discussed during the first hour. The second hour included an overview of common CXR abnormalities. Several cases were discussed, including pneumonia, pneumothorax, cardiomegaly, pleural effusion, atelectasis, pulmonary edema, anterior mediastinal mass, and interstitial lung disease. Following a 15-minute break, students were instructed to complete the online forms.

The primary outcome was the differences in student scores via a multiple-choice quiz to assess knowledge gained in CXR interpretation skills. The secondary outcome was the difference in satisfaction levels between PAL and EAL groups.

Statistical analysis. The study data was verified prior to the analysis to be accurate and complete. The categorical variables were presented as frequencies or percentages, while the continuous variables were presented as means or standard deviations. There were 14 CXR interpretation multiple-choice questions in the test. The study participants' scores were calculated by adding the correct answers to these 14 MCQs. Therefore, the highest possible score was 14 and the lowest possible score could be 0 for any participant. Participants' scores were checked for normality using the Shapiro-Wilk test ($p < 0.001$) and the Kolmogorov-Smirnov test ($p = 0.010$). The reliability of the test was checked (Cronbach's $\alpha = 0.776$). An independent samples t-test was performed between PAL and EAL groups in terms of age and scores. To examine the relationship between satisfaction levels and participant groups (EAL and PAL) a Chi-square test was used. Statistical Package for Social Science, version 23.0; (IBM, Armonk, NY, USA) was used for the analysis, which was carried out within a 95% confidence interval.

This study was approved by the Medical Ethics Committee of UQU's College of Medicine and was carried out according to the principles of the Helsinki Declaration. A PubMed search was used to search for relevant articles. The keywords used were PAL, EAL, and virtual radiology.

Results. A total of 166 second-year medical students were randomly chosen and included in this study after confirming their eligibility. They were divided into 2 groups: 83 students were enrolled in the EAL group and 83 students in the PAL group. Randomization and trial took place in February 2021. All participants completed the trial without any dropouts. The mean age and standard deviation were 19.73±0.66 years (males: 79 [47.6%]; females: 87 [52.4%]).

The results of an independent samples t-test were used to determine if there was an association between the 2 groups' ages and their test scores. **Table 1** shows

no statistically significant differences between student scores as the *p*-value of 0.507, greater than the chosen significance level $\alpha=0.05$. Therefore, we rejected the null hypothesis. Again, the age difference between the EAL and PAL groups was not statistically significant ($p=0.193$) (**Table 1**).

A Chi-square test was carried out to assess the significance between the 2 groups based on students' satisfaction levels. The PAL group showed a significantly higher satisfaction level in some aspects of the survey. Students in the PAL group thought the session was useful ($p=0.01$), kept on time ($p=0.043$), and the tutor

Table 1 - Comparison between EAL and PAL groups in terms of age and scores of the CXR interpretation test (N=166).

Variables	PAL group (n=83)	EAL group (n=83)	t-value	95% CI	P-value
Age (mean ± SD)	19.80 ± 0.66	19.66 ± 0.65	1.306	-0.7-0.33	0.193
Score (Mean ± SD)	6.76 ± 2.593	6.49 ± 2.544	0.665	-0.52-1.05	0.507

Independent samples t-test was carried out to compare between EAL and PAL groups. CXR: chest x-ray, PAL: peer-assisted learning, EAL: expert assisted learning, CI: confidence interval

Table 2 - Comparison between EAL and PAL groups in terms of satisfaction.

Statements	Answers	PAL	EAL	P-value
The session kept to time	Yes	80 (96.4)	73 (88.0)	0.043
	No	3 (3.6)	10 (12.0)	
I had the opportunity to actively participate in the lecture	Strongly agree	28 (33.7)	21 (25.3)	0.277
	Agree	32 (38.6)	29 (34.9)	
	Neutral	18 (21.7)	29 (34.9)	
	Disagree	NIL	NIL	
The tutor facilitated my learning process	Strongly disagree	5 (6.0)	4 (4.8)	0.001
	Strongly agree	32 (38.6)	26 (31.3)	
	Agree	38 (45.8)	25 (30.1)	
	Neutral	8 (9.6)	26 (31.3)	
I found the session useful	disagree	NIL	3 (3.6)	0.011
	Strongly disagree	5 (6.0)	3 (3.6)	
	Strongly agree	36 (43.4)	24 (28.9)	
	Agree	35 (42.2)	36 (43.4)	
I feel online teaching is as effective as face-to-face teaching	Neutral	7 (8.4)	21 (25.3)	0.003
	Disagree	NIL	NIL	
	Strongly disagree	5 (6.0)	2 (2.4)	
	Strongly agree	4 (4.8)	9 (10.8)	
After completing the sessions, I feel confident to interpret chest x-rays by myself	Agree	17 (20.5)	4 (4.8)	0.989
	Neutral	19 (22.9)	18 (21.7)	
	Disagree	26 (31.3)	20 (24.1)	
	Strongly disagree	17 (20.5)	32 (38.6)	
	Strongly agree	5 (6.0)	4 (4.8)	0.989
	Agree	25 (30.1)	23 (27.7)	
	Neutral	39 (47.0)	42 (50.6)	
	Disagree	12 (14.5)	12 (14.5)	
	Strongly disagree	2 (2.4)	2 (2.4)	

Values are presented as number and percentage (%). A Chi-square test was carried out for this comparison. NIL: nothing in line, PAL: peer-assisted learning, EAL: expert assisted learning

facilitated their learning process ($p=0.011$). Moreover, they felt that online teaching was as effective as traditional teaching ($p=0.03$)

However, 2 aspects of the survey had no significant difference between the 2 groups. Students in both groups reported a similar level of satisfaction regarding their chance to actively participate in the session ($p=0.277$), and their confidence in interpreting CXR ($p=0.989$)

Discussion. Our study showed no significant differences between the PAL and EAL groups. However, the PAL group showed a higher satisfaction level than the EAL group. The findings of our study are similar to a crossover randomized controlled trial carried out on fourth-year dentistry students in Pakistan.¹⁶ The participants were randomized into 2 groups: PAL and EAL. After completing the lectures, participants in both arms took an MCQ test to evaluate their knowledge of the topic. The study concluded that both teaching modalities had similar effectiveness in terms of knowledge gain ($p=0.97$). The teaching material in the study was regarding the “prevention of medical diseases” and was taught in class, contrary to our study, which was taught virtually. Moreover, our study had a larger sample size (166) than the 70 students. In addition, the study had a disproportionate ratio of male to female participants (34.3% males and 65.7% women). In contrast, our study had a close male to female distribution (47.6% males and 52.4% females).¹⁶

Additionally, another randomized controlled trial conducted on medical students in France¹⁶ proved that PAL was as effective as EAL ($p=0.430$). The study subjects were clinically trained for peripheral venous catheter insertion and comprised 86 students from multiple academic years. This study also concluded that the peer-led group had more confidence in their skills than the expert-led group ($p=0.026$). The evaluation in this study was carried out using a standardized grid scoring method with a maximum of 20 points. In our study, the evaluation was carried out shortly after the learning sessions, contrary to the mentioned study where the evaluation took place one week after the training. There was no pre-test to establish baseline performance in both of the studies, and only post-test evaluations were used.¹⁷

The outcome of our study is also supported by a crossover randomized controlled trial conducted in Australia¹⁸ on a sample of 24 physiotherapy students. The students were randomly assigned into 2 groups (peer-assisted and traditional groups) and the trial took 5 weeks. The study did not show a difference in physiotherapy practice scores between the 2 groups. A

Blinded assessor ($p=0.43$), clinical educator ($p=0.94$), and students who self-assessed ($p=0.99$) participated in the assessment process.¹⁸

We believe that the virtual model in our study helped recruit a large sample size and ensured better compliance than other studies. The contents were delivered in a duration of 2 hours followed by post-test MCQs. Both students and tutors were not blinded, as omitting tutor information from the participants were difficult on the blackboard website. A significant point of “no dropout” was observed.

The secondary outcome was to assess student satisfaction with their tutor’s performance. The results showed higher levels of satisfaction in the PAL group. A high percentage of PAL students (96.4%) believed the sessions were kept on time, while 84.4% felt their tutors helped them to better understand their lessons ($p=0.043$ and $p=0.01$). The session was viewed as useful by 71% of the PAL group ($p=0.01$).

Student satisfaction was previously assessed in a crossover randomized controlled trial carried out on fourth-year dentistry students in Pakistan. Most students were not satisfied with the content covered by their peers. However, half felt it was a safer environment and became more comfortable when their peers taught.¹⁵ Furthermore, another randomized controlled trial published in 2010 assessed the satisfaction level of peer-led teaching in comparison to staff-led ultrasound image interpretation. The PAL group showed greater satisfaction; they found the teaching more enjoyable and wanted to become peer teachers themselves. The staff-led group had more confidence in the knowledge they acquired compared to the PAL group.¹⁹

Conversely, one study compared physiotherapy students’ satisfaction with both teaching modalities in a clinical setting over 5 weeks. They showed that most students (81%) were more satisfied with the traditional method. Students noted that observing peer tutors working with a patient was more useful than teaching. The majority of students reported a higher level of stress with PAL. These results might be explained by the different nature of teaching in a hospital setting.¹⁸ The difference between the results of this study and ours is reasonable, as both studies had different teaching settings, durations, and contents.

Study strengths and limitations. Our study used an adequate sample size and addressed virtual learning, a critical topic in the COVID-19 era where a shift to a virtual learning environment has become commonplace. Additionally, a limited number of RCTs have been conducted on this topic.

Some participants reported poor network connectivity, which might have affected their learning experience. Students' attention and concentration, which play a key role in knowledge acquisition, were not assessed due to the nature of virtual learning. This study was open-labeled, and all participants were aware of which group they were enrolled in. The student assessment included only a post-test. However, it was reasonable to assume no differences between students' knowledge before taking the lectures as they are in the same academic year, and none of the students reported any prior knowledge of the topic in the survey.

Emphasis on PAL might provide more learning opportunities for students, which could help overcome universities' limited expert staff and resources. Future studies can compare the 2 teaching modalities in a virtual setting using different group sizes.

In conclusion, PAL has equivalent efficacy compared to EAL in a virtual setting. Students showed higher satisfaction levels when they were taught by their peers.

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