

# Fostering Teaching-Learning through Workplace Based Assessment in Postgraduate Chemical Pathology Residency Program Using Virtual Learning Environment

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## Research article

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# Abstract

## Background

The principle of workplace based assessment (WBA) is to assess trainees at work with feedback integrated into the program simultaneously. A student driven WBA model was introduced and perception evaluation of this teaching method was done subsequently by taking feedback from the faculty as well as the postgraduate trainees (PGs) of a residency program.

## Methods

Descriptive mixed method study was conducted. A WBA program was designed for PGs in Chemical Pathology on MOODLE and forms utilized were Case-based discussion (CBD), Direct Observation of Practical Skills (DOPS) and Evaluation of clinical events (ECE). Consented assessors and PGs were trained on WBA through a workshop. Pretest and post-test to assess PGs knowledge before and after WBA were conducted. Every time a WBA form was filled, perception of PGs and assessors towards WBA, time taken to conduct single WBA and feedback were recorded. Faculty and PGs qualitative feedback on perception of WBA was taken via interviews. WBA tools data and qualitative feedback were used to evaluate the acceptability and feasibility of the new tools.

## Results

Six eligible PGs and seventeen assessors participated in this study. A total of 79 CBDs (assessors n=7 and PGs n=6), 12 ECEs (assessors n=6 and PGs n=5), and 20 DOPS (assessors n=6 and PGs n=6) were documented. PGs average pretest score was 55.6%, which was improved to 96.4% in posttest. Overall mean time taken to evaluate PG's was  $12.6 \pm 9.9$  min and feedback time  $9.2 \pm 7.4$  min. Mean WBA process satisfaction of assessors and PGs on likert scale of 1 to 10 was  $8 \pm 1$  and  $8.3 \pm 0.8$  respectively.

## Conclusion

Both assessors and fellows were satisfied with introduction and implementation of WBA. It gave the fellows opportunity to interact with assessors more often and learn from their rich experience.

## Background:

Interpretation and reporting is an important aspect of post-graduate learning in Chemical Pathology (1–3). This is accomplished mainly by discussing cases and laboratory investigations with peers and clinicians, examining preanalytical, analytical and post analytical problems before validating any biochemical result, investigating for the effect of interferences on test results and conducting regular clinical audits for quality and process improvements (4, 5). Additionally postgraduate trainees of Chemical Pathology are closely involved with the consultants in performing procedures, provocative test and evaluating new tests for introduction in service (3). Their curriculum is further complemented by structured case discussions and journal clubs usually held once a week in various institutions. While these teaching sessions focus on rare or unusual cases from old or new collections and are more structured; the teaching during such didactic teaching sessions often do not fulfill the purpose of critical thinking and reasoning (6). A well facilitated journal club can become an important forum for teaching research methodology, clinical epidemiology and statistics, and seldom provides opportunities for training in clinical decision making and gaining critical appraisal skills (7–9). There has been a concern that postgraduate (PG) trainees in chemical pathology are seldom observed, assessed, and given feedback during their work, while feedback is an integral teaching and learning tool. This has led to an increasing interest in a variety of workplace based assessment (WBA) methods that require observation and offer the opportunity for feedback in the clinical workplace (9, 10). The principle of WBA is to assess trainees on work that they are actually doing and give feedback on their performance (10). Benjamin Bloom et. al successfully classified students'

thought process into six very dynamic levels that increase in complexity, from knowledge as the baseline level, through comprehension, application, analysis, synthesis, to evaluation as the highest level (11, 12). Frequent interactions of Chemical Pathology faculty with trainees working in high volume clinical laboratory can help identify students' understanding, critical thinking ability in formulating a diagnosis, competency of laboratory procedures along with communication skills, attitude and decision making (reflected higher in Bloom's taxonomy).

A Virtual Learning Environment (VLE) is a distance learning platform for synchronous or asynchronous teaching that integrates course materials, assignments, assessments, and other tools (13–15). For any healthcare institute a VLE can offer a place where students' performance can be encouraged, managed, recorded and monitored (16, 17). The goal of the current study was to introduce a student driven WBA model in postgraduate residency program of Chemical Pathology using VLE. We also wanted to gauge the feasibility and acceptability of WBA program and to determine the gain in knowledge via pre and posttest before and after the WBA implementation.

## Materials And Methods

### Research setting

A descriptive mixed methods study was conducted in the section of Chemical Pathology, Department of Pathology and Laboratory Medicine, Aga Khan University and Hospital (AKUH), Karachi, Pakistan. The study was conducted from January to December 2019 and was introduced in the training process of Chemical Pathology residency program. The Chemical Pathology training program is a five year residency at Aga Khan University; accredited by College of Physicians and Surgeons of Pakistan (CPSP). The program is a self-directed adult learning, systemically organized in the form of week by week structured bench rotations for learning analytical skills and rotations for enhancing their clinical skills in practice of biochemical laboratory medicine to diagnose disease and to manage patients. A major part of fellows' time is spent in advising other clinicians about the appropriate tests for the investigation of a particular clinical problem, the interpretation of results and follow-up, performing procedures, provocative tests and evaluating new tests for introduction in service, assay optimization and validation and research.

### Eligibility Criteria and Ethical Considerations

Before initiating the study the university's ethical review committee's permission was sought. All PGs registered at CPSP, including fellows of Chemical Pathology training program at Aga Khan University and fellows rotating in Section of Chemical Pathology from other pathology specialties from January to December 2019 were eligible to participate in the study. Faculty, senior technologists and managers at the section of Chemical Pathology were taken as assessors. Seventeen assessors and six eligible PGs were contacted for written informed consent and all agreed.

### Data collection

To ensure that the outcomes achieved at the end of each phase meet their purpose, and that WBA program team members are properly prepared for the next phase we divided the WBA project into phases. To deliver the WBA program effectively the entire study process was divided into following seven phases

#### Phase 1-Development of assessment tools

The Chemical Pathology residency program has a different teaching learning and training environment which includes report interpretations and correlating with clinical data, clinical audits, clinical consultations, and laboratory procedures, provocative testing, quality assurance measures and complaint handling. Therefore it was essential to know that the selected WBAs tools were fit for purpose. Using Norcini AMEE guide, validated WBA tools were chosen and modified according to the needs of Chemical Pathology residency program by WBA project team (10). These tools included; direct observation of practical skills (DOPS), evaluation of clinical events (ECE) and case based discussion (CBD). Multiple validated tools (CBD, DOPS and ECE) were to be used by assessors to assess knowledge, skills, professionalism and critical thinking of PGs. Literature on medical education states that multiple assessing formats provide a sound basis for assessment (23–25). Reliability of these WBA tools depend on how they are being utilized and also requires assessors training for making the best use of these tools(10). Therefore all the tools were piloted (on two assessors and two PGs who

were not included in the study) and reviewed (by five assessors who were part of the study). The WBA tools included items like case identification, PGs and assessors identification, knowledge/ skills/ attitude assessed, strengths and weaknesses of the PG, whether patient centered care and infection control advice was given. There were 28 items to be filled for DOPs, 26 for ECE and 23 for CBD on VLE. The WBA tools were modified as per laboratory training requirements and items were made specific to the laboratory environment. Assessing components of every WBA tool were graded from 1–6 where 1–2 were marked 'below expectations', 3-'borderline', 4-'meets expectations' and 5–6 implied 'above expectations'.

Phase II: Outlining the WBA process: The process of WBA was clearly delineated with the goals of making it student driven and making it instrumental in the provision of feedback to PGs to navigate their learning towards desired outcomes. The PG was supposed to select a case (for CBD), any laboratory procedure (for DOPS) or complaint/ clinical audit (for ECE) which he/she has recently been involved with. The WBA process was to be initiated by PGs and they were supposed to select the assessor of their choice. For DOPS assessor was supposed to be present during the demonstration of the procedure by the PG. The discussion will start from and be centered on the PG's record in the notes or reports and is designed to assess clinical decision-making and the application or use of medical knowledge in the care of patients. The discussion of assessors and PG would be followed by immediate feedback on assessment form uploaded on Moodle in another 5–10 minutes in the presence of the PG trainee. The assessments were to be performed against the standard expected at the end of the PG's current stage of training. The primary goal of the assessment was to provide relevant comprehensive feedback to the PGs. Prior to submitting any of the three WBA tools PGs and assessors satisfaction level with the overall WBA process was recorded on VLE. Satisfaction level of both PGs and assessors was gauged separately on a likert scale of 1–10 every time a WBA tool was filled. To maximize the educational impact of WBA, assessors were invited to provide qualitative comments for PGs on their overall performance in CBD, DOPS or ECE.

Phase III: Utilizing innovative technology in WBA: For WBA program structure, activities, management and application MOODLE (free of charge resource) was selected as the VLE platform. With support from the department of I.T. Academic and Computing the WBA tools finalized in phase I of the study were developed on the VLE and all essential documents including WBA process were uploaded (Table 1). Description of all three WBA tools and guide to the whole process of conducting WBA was also provided on the VLE.

Table 1

Material developed for WBA on Moodle for assessors and PGs to access and utilize

Type of content	Description
WBA Forms	- Case based discussion (CBD) - Evaluation of clinical events (ECE) - Direct observation of practical skills (DOPS)
Videos	- Introduction to WBA program in Chemical Pathology - Workshop videos including role plays of CBD, ECE and DOPS - Real time CBD discussion and feedback video
Documents	- Process of WBA - List of Assessors - Residency Manual - Course Curriculum - Year wise Learning Objectives - Year wise Entrustable Professional Attributes
Educational content	- Review articles - Presentations - Book chapters

Phase IV Introducing WBA Program to the Assessors

A half day hands-on WBA workshop to prepare the assessors to use the VLE for WBA was designed and executed face to face to fifteen participants. In-depth briefing regarding the entire process of WBA was given by the principal investigator

(PI) and CO-PIs through various activities to determine the strengths, weaknesses, opportunities and threats (SWOT) of introducing WBA, along with hands-on use of WBA tools (CBD, DOPS and ECE) by role play. The SWOT analysis on WBA project was done in flipchart activity format with assessors by dividing them into four groups. Preliminary results from SWOT analysis were then detailed and the session invited comments and feedback using post-it's to elaborate as described in Table 2. Positive attitude of assessors, documentation of informal teaching and awareness that this was the need of time were identified as major motivators. From the post workshop feedback the momentum, support and excitement of the workshop participants for the new process change could be appreciated.

Table 2  
Findings of SWOT analysis of WBA project

Internal	Strengths	<ul style="list-style-type: none"> <li>- WBA is conducive to the construction of a learning culture</li> <li>- Will identify PGs who need assistance</li> <li>- Will assist PGs in logbook entries</li> <li>- Documentation of faculty-PG interactions</li> </ul>
	Weaknesses	<ul style="list-style-type: none"> <li>- Faculty not comfortable with Moodle</li> <li>- Faulty time</li> <li>- WBA not integrated to current curriculum and assessment process</li> <li>- Student driven so student dependent</li> <li>- Low reliability</li> </ul>
External	Opportunities	<ul style="list-style-type: none"> <li>- Great demand for WBA</li> <li>- Great demand of using Moodle in the digital era</li> <li>- In line with institute's goals</li> <li>- Support available from Digital and Teaching and learning network of the institute</li> <li>- If it works can be presented as a model at national level</li> </ul>
	Threats	<ul style="list-style-type: none"> <li>- Other institutes in the country may start WBA before us</li> <li>- May not work because of national policies</li> </ul>
Abbreviations: SWOT: strengths, weaknesses, opportunities, and threats; PG: postgraduate; WBA: workplace based assessment		

#### Phase IV Using training of trainers (TOT) approach

A full hands-on workshop was conducted by experts from department of I.T. Academic and Computing to prepare the assessors to use the VLE for WBA seven master trainers. The workshop was a complete training session with hands on practice of using MOODLE on individual laptops. Following the TOT methodology the master trainers, given the title of 'Moodle Champs', then trained the rest of the assessors in the Section by small group discussions. They demonstrated how to use VLE for WBA in multiple small group discussions.

#### Phase V Training of the Fellows

PG trainees were introduced to WBA with a presentation and eight to ten small group discussions on WBA and the use of VLE for teaching and learning. The whole WBA theory was explained and they were demonstrated the overall process of WBA. It was explained that it was for their benefit and to provide regular timely feedback to them. It was reiterated that in order to close the gap between actual performance and desired performance they need to actively take action and improve. Blueprint of the course curriculum was made available on VLE for them with the desired outcomes.

#### Phase VI WBA Program Execution

Once WBA tools were developed, validated and tested on VLE, all assessors and PGs were trained and the process was clear to all participating the WBA process was implemented. Pretest of all PGs participating were conducted before WBA implementation and posttest was taken after three months of participating in WBA program. Being convenient, cost effective with the ability to cover broad content, multiple choice questions (MCQs) were chosen as the method of assessment for both pre and post tests. The MCQs based on CPSP Chemical Pathology Residency Program curriculum were developed by two content experts and uploaded on VLE. All twenty questions developed were scenario based and were structured for a higher cognition level of analyzing and interpretation. Data gathered during WBA execution were PGs performance through WBA tools, time spent in each WBA feedback and discussion and pretest and post test scores.

Results of annual assessment before (year 2018) and after implementation (year 2019) of WBA were also evaluated to see the effect of WBA in PGs knowledge.

#### Phase VII Feedback and Evaluation

Semi-structured individual interviews were conducted with randomly selected five assessors and PG trainees to gauge their response about the advantages of WBA, challenges faced and how they can be resolved. A quiet and convenient venue was chosen for the interviews. The interviewer made written notes which were supplemented by extensions on those notes immediately following the end of the interview.

#### Statistical Analysis

All data from recorded WBA on VLE were extracted into Excel spreadsheets. Mean  $\pm$  SD were generated for quantitative data (pre and posttests scores) and for qualitative data frequencies were calculated. The feedback interviews were analyzed qualitatively by thematic analysis. The PI and research associate analyzed the feedback interviews to seek common concepts and opinions, grouping them into 'codes'. They met to debate their findings, confirming the codes and highlighting comments from the respondents that supported these. The individual codes were then sorted underneath 4 main themes from assessors' interview and 3 from fellows through an iterative process of discussion and reflection.

## Results

Six eligible PGs and seventeen assessors participated in this study. A total of 79 CBDs (assessors  $n = 7$  and PGs  $n = 6$ ), 12 ECEs (assessors  $n = 6$  and PGs  $n = 5$ ), and 20 DOPS (assessors  $n = 6$  and PGs  $n = 6$ ) were successfully recorded.

#### Case-based Discussions

The CBDs most frequently focused on clinical and laboratory data on an outpatient record (61/79, 77.2%) or inpatient record (18/79, 22.7%), and internal and external quality control summaries were also used. During the CBDs ( $n = 79$ ), 7 assessing components were marked 'borderline' while 2 components were found to be 'below expectations' at various events. PGs were at par in most of the discussions. Suggestions for development were provided in 67.2% ( $n = 39$ ) of CBDs. Most (98.3%) of the CBDs were on data interpretation, some (25.7%) on lab management and few (8.6%) on professionalism. Majority of CBD ( $n = 64$ , 81.01%) recorded dealt with laboratory data interpretation followed by analytical ( $n = 21$ , 26.5%) and preanalytical ( $n = 15$ , 18.9%) issues. From the total cases in CBDs, 22.4% ( $n = 13$ ) were of high complexity, 72.4% ( $n = 42$ ) moderate and 5.2% ( $n = 3$ ) of low complexity. Case mix included electrolyte imbalance, proteinuria, renal stones and renal failure, endocrinopathies (thyroid and parathyroid disorders, hyperprolactinemia, diabetes, growth disorders, insulinoma, hyperaldosteronism, Cushing Syndrome and Addison's disease), autoimmune disorders, hypervitaminosis D, dyslipidemia, liver and pancreatic insufficiency, sepsis, malignancies and rare diseases (acute intermittent porphyria, maple syrup urine disease, lysine protein intolerance, and methylmalonic acidurias).

#### Evaluation of Clinical Events

The ECEs were most frequently conducted patients with outpatient record ( $n = 12$ , 92.3%). Out of the total ECEs ( $n = 12$ ) conducted, 50% ( $n = 6$ ) were regarding consultation on laboratory data, 42% ( $n = 5$ ) on complaint handling while no clinical audits were documented. All complaints or consultations discussed in ECE were of moderate complexity ( $n = 9$ , 69.23%) to high complexity ( $n = 4$ , 30.7%). Seven components of ECEs were marked 'borderline' at several times. Topics discussed in ECE were autoimmune disorders, anemia, malignancy, endocrinopathies, quality control and proficiency testing survey data and prenatal screening panel.

#### Direct Observation of Procedural Skills

Out of the twenty recorded DOPS, 70% ( $n = 14$ ) were on biochemical analysis and instrument handling while 30% ( $n = 6$ ) were on procedural skills. Six components of DOPS were marked 'borderline' several times. None of these WBA demonstrated evidence of 'below expectation' by the assessors. Instruments on which DOPS was demonstrated were ion selective electrode analyzer, point of care testing, centrifuges, fourier transformed infrared spectroscopy and biochemical methods discussed were stone analysis, arterial blood gases analysis, protein electrophoresis. Additionally there were DOPS carried out on safety measures to be taken when there is a biological and chemical spill.

#### Gain in knowledge

The average pre and post-test scores were significantly different 55.6% and 96.4% respectively; p value 0.0038 (Fig. 1a). Results of annual assessment before (year 2018) and after implementation of WBA also showed significant difference, p value 0.039, shown in Fig. 1b.

#### Acceptability and feasibility

Overall mean time taken to evaluate PGs was  $12.5 \pm 8.9$  minutes and feedback time  $8.9 \pm 6.6$  minutes. Mean WBA process satisfaction of assessors and PGs on likert scale was  $8 \pm 1$  and  $8.3 \pm 0.8$  respectively. A total of five assessors were interviewed independently after informed consent. Four themes were derived from interviews after analysis by research associate and PI (Table 3). Challenges that the assessors faced, outlined in Table 3, were mainly due to their first exposure to VLE as a teacher. One of the assessors mentioned that it was a two-way learning process. They always learned something new from the fellows while assessing them as they came well prepared. One of the assessor responded, "The process of WBA has polished my assessment skills. Fellows are more up to date with recent developments which led to increase in my knowledge on various aspects as well". All of the assessors interviewed agreed that as per the format of WBA, the fellows were being assessed and provided feedback on regular basis and developed a feeling of accountability among fellows. An assessor stated "I had been reading about WBA for a while but got a chance to implement it now, all senior technologists and lab manager were involved in assessment on daily basis which helped monitoring and keeping a close eye on the fellows daily activities". A senior assessor suggested "Pilot should be presented at departmental level after successful completion and further taken to Postgraduate Medical Education for consideration to be incorporated into the system".

Table 3

Assessors' and Postgraduate trainees' feedback on introduction and execution of the WBA process in Postgraduate Chemical Pathology Residency Program

Themes Identified	Theme 1: Challenges that the Faculty faced	Theme 2: How can WBA process be improved?	Advantages of WBA	
			Theme 3: To the Assessors	Theme 4: To PGs
Assessors' Responses	Lack of interest on residents part and their laid back attitude	Residents need to show some rigor as its for their own development	Changed the format of informal teaching to formal	Assessed on daily basis making them accountable, focused & dedicated.
	A few Moodle related issue	Process should be made centrally operated through the department.	Two-way learning process. Always learned something new from the residents	Increased interaction with the faculty & opportunity to learn from their experience
	Forms can be further modified with emphasis on lab medicine	Give some weightage to the process and add in residents PGME evaluation	Polished assessment skills	Will come in handy to ace the exit exam
	Some difficulty in uploading teaching material on Moodle initially	Align WBA with Entrustable Professional Attributes	Efforts being documented	Whatever data is entered through WBA process can be used for logbooks entries
Themes Identified	Theme 1: Challenges that the PGs faced	Theme 2: How can the WBA process be improved?	Theme 3: Advantages of WBA to PGs	
Residents' Responses	The targeted number of CBDs that were needed was biggest challenge.	The number needs to reduce as its practically impossible to fulfill the required number	Opportunity to interact with the faculty more often than before and learn from them.	
	Faculty were a little strict with evaluation which led to unsuccessful attempts.	Our WBA process should align with ones happening in international institutes.	Increased exposure to bench work and instrument handling.	
	Should be given more access on Moodle to work on weaknesses highlighted by faculty.	WBA evaluation should be given some weightage and incorporated in PGME's half-yearly/yearly's assessment.	Identification of weak analytical skills.	
	Should be given enough access on Moodle to keep track of performance.	Moodle to be made more user friendly and encourage group discussions among residents when approaching a senior faculty for WBA.	Knowledge of lab safety enhanced.	

Table 4

Description of case complexity, time spent in WBA and satisfaction level of assessors and trainees.

Assessment Tools	Frequency n (%)	Complexity of cases n (%)			Time spent (in minutes)			Mean Satisfaction level on a scale of 1–10	
		Low	Medium	High	Overall	In discussion	In feedback	Assessors Response (n = 17)	Residents Response (n = 6)
Overall	113	Low	Medium	High	Overall	In discussion	In feedback	Assessors Response (n = 17)	Residents Response (n = 6)
CBD	79	3 (3.8)	62 (78.5)	14 (17.7)	10.2	11.2	9.2	8.23	8.42
ECE	12	-	9 (69.2)	3 (30.7)	8.2	8.7	7.7	8.15	8.38
DOPS	20	4 (19)	15 (76.2)	1 (4.7)	12.4	17.5	7.3	7.77	8.08

Five PGs were interviewed independently after informed consent. Three themes were derived from interviews after analysis by research associate and principal investigator (Table 3). All the PGs mentioned that it led to their development as they had the opportunity to interact with the assessors more often than before and learn from them. Besides, they had increased exposure to bench work and instrument handling and thorough study of topics they presented before the assessors. One of the fellows said “I got to improve my bench skills, report interpretation, knowledge of lab safety, and identification of weak analytical skills”. They all agreed that WBA was a great tool for learning, assessment and feedback. However, the number of target cases or bench mark should be realistic and suitable to PGs’ daily work load.

## Discussion

The fundamental rationale of this project was the provision of formative assessment and timely feedback to the trainees working in a busy high volume chemical pathology residency program. Formative assessment was introduced in the form of WBA in into the work environment of chemical pathology residency program. As with all methods of formative assessment, WBA methodology works best when they are embedded into the work environment, provide specific feedback, and are timely (18–21). Current study has shown positive educational impact and good opportunities for feedback to PGs for all of the three formative WBAs investigated, judging by the feedback from both PGs and assessors. A most important response in current study from PGs and assessors was that WBA conducted on real patients/ cases, in a clinical laboratory workplace by practicing pathologists, had true validity. All assessors felt that the PGs interaction with them had improved ever since the process was in place and stimulated a learning environment in the workplace. Whereas the PG trainees strongly felt that the feedback helped them ameliorate their performance, critical thinking and diagnostic ability. All the PGs in their interview mentioned that this act of formative assessment and feedback led to their development in terms of exposure to bench work and instrument handling via DOPS and thorough in depth learning of topics presented during the CBDs. This substantiates the satisfaction of the process which gauged as  $8 \pm 1$  and  $8.3 \pm 0.8$  for the assessors and PGs respectively.

The advent of VLE and supporting software systems has made it possible to capture data for educational assessments in real time. We introduced VLE for execution of WBA program in phases. Conducting SWOT analysis in faculty development workshop helped in identifying lack of experience on VLE as the biggest weakness of the assessors. Faculty or assessors who have been brought up in a world with little or no technology can find it hard to use technology to enhance and support learning. One thing which is essential for sustaining this program on VLE is continuous administrative support, for facilitating and guiding faculty and trainees where needed. The assessors were motivated to learn and recognized that VLE platform would be a potential route by which to document PGs feedback and formative assessment and overcome the

challenge of lack of faculty time. From the perceived positive educational impact in assessors' interviews provides evidence of the practicability, acceptability and of this VLE-based formative assessment system.

The WBA program being implemented for the first time turned out to be a game changer in Chemical Pathology residency program at our institute. Successful implementation of WBA program was possible by engaging the team from the very beginning, making appropriate choices of WBA tools, advance planning, building of mutual trust, and training of assessors which also helped reduce rater bias and staying connected with PGs throughout the execution phase (22). From our experience, we feel that continuous faculty development and administrative support are important factors that may influence the sustainability of any WBA program.

## Conclusion And Recommendation

WBA has benefits for both assessors and fellows, therefore it is highly advocated for inclusion in assessment program for any competency based PG training. The high level of satisfaction from our respondents (assessors and PGs) indicates that WBA can be successfully integrated in a Chemical Pathology postgraduate training program. Further steps are to be taken to align it with the curriculum, EPAs and make the process acceptable at a national level.

## Abbreviations

Workplace based assessment: WBA; postgraduates: PGs; Case-based discussion: CBD; Direct Observation of Practical Skills: DOPS; Evaluation of clinical events: ECE; Virtual Learning Environment: VLE; Aga Khan University and Hospital: AKUH; College of Physicians and Surgeons of Pakistan: CPSP; training of trainers: TOT; multiple choice questions: MCQs;

## Declarations

**Declaration of interest:** We have no conflict of interest and nothing to declare.

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## Author's contributions

LJ conceived the idea, taking guidance from FAIMER got the grant from SOTL-AKU, designed and conducted the study, trained faculty, collected and analyzed the data and wrote the manuscript. IS and AHK both contributed to writing the grant and article. MT assisted in faculty training, was co-PI of grant and review of manuscript. MUN managed VLE, conducted interviews, collected and analyzed data and contributed in manuscript writing. AN was involved in study planning and revising the article. Dr SA conducted the literature search and collected data for the study. FG assisted in data collection and manuscript review. SA managed PGs data on VLE and oversaw the study. NS managed VLE and assisted in course design and statistical data. HM conducted the literature search for the background of the study, analyzed and interpreted statistical data, and contributed in article writing and tables and figures. All authors read and approved the final manuscript.

## Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request

### **Ethics approval and consent to participate**

Written ethical approval was taken from the AKU's ethics committee (approval number 2018-0645-828) and written informed consent obtained from all the participants.

### **Consent for publication**

Not applicable

### **Competing interests**

The authors declare that they have no competing interests.

### **Availability of data and materials**

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

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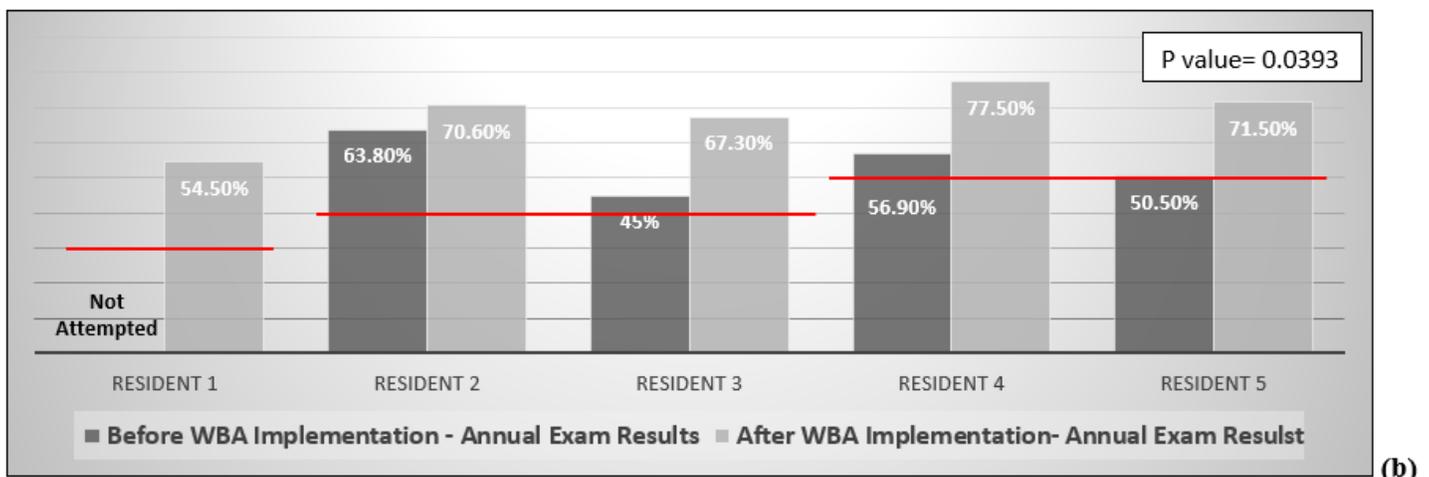
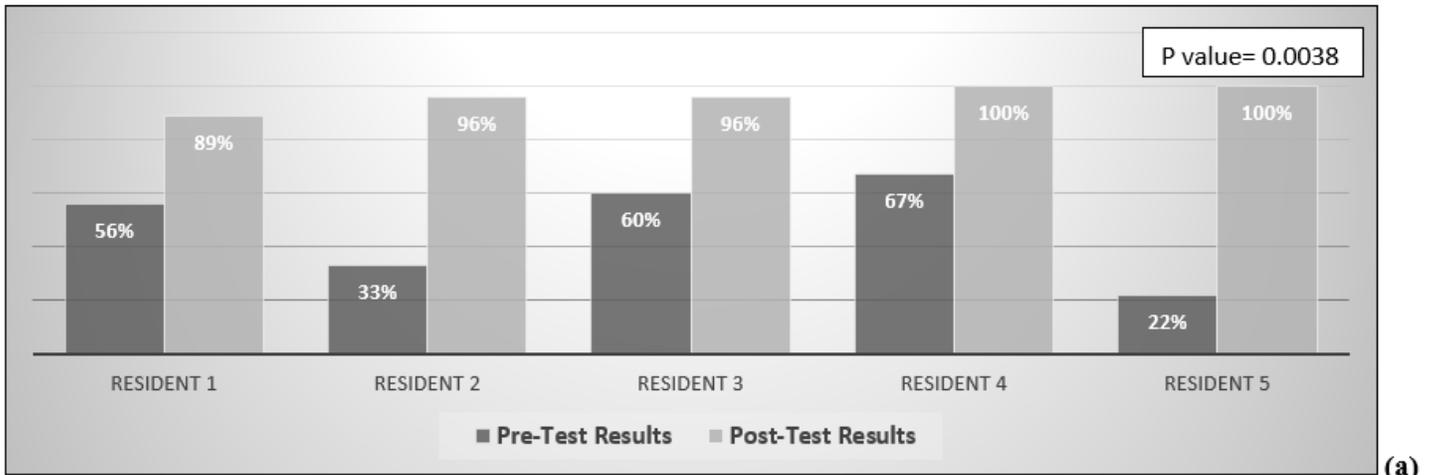
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## **References**

1. Bonham JR. The organisation of training for laboratory scientists in inherited metabolic disease, newborn screening and paediatric clinical chemistry. *Clin Biochem.* 2014;47(9):763-4.
2. Siddiqui I, Ali N. Induction process of trainees in pathology residency. *Adv Med Educ Pract.* 2016;7:321-3.
3. Siddiqui I. Changing prospects of chemical pathologist in Pakistan. *J Pak Med Assoc.* 2002;52(1):1-2.
4. Schmidt RL, Garcia CA, Panlener J, Ashwood ER, Jackson BR, Hussong JW. An analysis of clinical consultation activities in clinical chemistry: implications for transformation and resident training in chemical pathology. *Arch Pathol Lab Med.* 2014;138(5):671-7.
5. Do MC, Ben-Ezra J, McPherson RA. Call subject patterns among on-call clinical pathology residents in an academic institution: how can tracking changes in patterns over time benefit resident education? *Arch Pathol Lab Med.* 2008;132(8):1317-20.
6. Hryciw N, Knox A, Arneja JS. How Well Are We Doing at Teaching Critical Appraisal Skills to Our Residents? A Needs Assessment of Plastic Surgery Journal Club. *Plast Surg (Oakv).* 2017;25(4):261-7.
7. Mullen SJ, Sabri K. Role of journal club in Canadian ophthalmology residency training: a national survey of program directors. *Can J Ophthalmol.* 2016;51(3):226-31.
8. McDonough V. Improving journal club: increasing student discussion and understanding of primary literature in molecular biology through the use of dialectical notes. *Biochem Mol Biol Educ.* 2012;40(5):330-2.
9. McGlacken-Byrne SM, O'Rahelly M, Cantillon P, Allen NM. Journal club: old tricks and fresh approaches. *Arch Dis Child Educ Pract Ed.* 2019.
10. Norcini J, Burch V. Workplace-based assessment as an educational tool: AMEE Guide No. 31. *Med Teach.* 2007;29(9):855-71.

11. Dudley HA. Taxonomy of clinical educational objectives. *Br J Med Educ*. 1970;4(1):13-8.
12. Adams NE. Bloom's taxonomy of cognitive learning objectives. *J Med Libr Assoc*. 2015;103(3):152-3.
13. Janes G. Addressing the learning needs of multidisciplinary students at a distance using a virtual learning environment (VLE): A novice teacher reflects. *Nurse Educ Pract*. 2006;6(2):87-97.
14. Popovic N, Popovic T, Rovcanin Dragovic I, Cmiljanic O. A Moodle-based blended learning solution for physiology education in Montenegro: a case study. *Adv Physiol Educ*. 2018;42(1):111-7.
15. Wessa P, De Rycker A, Holliday IE. Content-based VLE designs improve learning efficiency in constructivist statistics education. *PLoS One*. 2011;6(10):e25363.
16. Memon AR, Rathore FA. Moodle and Online Learning in Pakistani Medical Universities: An opportunity worth exploring in higher education and research. *J Pak Med Assoc*. 2018;68(7):1076-8.
17. Reis LO, Ikari O, Taha-Neto KA, Gugliotta A, Denardi F. Delivery of a urology online course using Moodle versus didactic lectures methods. *Int J Med Inform*. 2015;84(2):149-54.
18. Wilkinson JR, Crossley JG, Wragg A, Mills P, Cowan G, Wade W. Implementing workplace-based assessment across the medical specialties in the United Kingdom. *Med Educ*. 2008;42(4):364-73.
19. Norcini J. Understanding learning in the workplace for those who practise: we can't wait another 50 years. *Med Educ*. 2016;50(1):18-20.
20. Duijn CCMA, van Dijk EJ, Mandoki M, Bok HGJ, ten Cate OTJ. Assessment Tools for Feedback and Entrustment Decisions in the Clinical Workplace: A Systematic Review. *J Vet Med Educ*. 2019;46(3):340-52.
21. Wagner N, Acai A, McQueen SA, McCarthy C, McGuire A, Petrisor B, et al. Enhancing Formative Feedback in Orthopaedic Training: Development and Implementation of a Competency-Based Assessment Framework. *J Surg Educ*. 2019;76(5):1376-401.
22. Kogan JR, Conforti LN, Yamazaki K, Iobst W, Holmboe ES. Commitment to Change and Challenges to Implementing Changes After Workplace-Based Assessment Rater Training. *Acad Med*. 2017;92(3):394-402.

## Figures



*The red lines represent the minimum required scores for the respective year of residency.*

**Figure 1**

Residents' (a) Pre and Post-Test Results and (b) Annual exam Results before and after implementation of the Workplace based Assessment.