

USING FLIPPED CLASSROOM FOR TEACHING PROCEDURAL SKILL IN RESIDENCY SPECIALLY DERMATOLOGY–A SYSTEMATIC REVIEW

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ABSTRACT

Objective: To review the available literature investigating effectiveness of flipped classroom (FC) in context to teaching of procedural skills in residency in various medical fields especially in dermatology.

Study Design: Systematic review.

Place and Duration of Study: Flipped classroom meeting out inclusion criteria published in 9 years from 2012 to 2020.

Methodology: Flipped classroom meeting out inclusion criteria published in 9 years from 2012 to 2020 were reviewed by the authors and co-authors as per their feasibility and discussion done by video conferencing by mobile software apps.

Results: To review of 25 full-text articles. Strategic organization of course material, wise choice of pre-class activities, usage of Virtual learning environment, class time utilization tailored to learners needs, adherence to timelines, proper training of staff and proper evaluation; are required for successful implementation of flipped classroom. Students had positive perceptions about this technique.

Conclusion: Flipped classroom is an effective teaching method for procedural skills training in post graduate medical training.

Keywords: Flipped classroom, Post graduate trainees, Procedural skills.

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INTRODUCTION

The post-graduate (PG) training including fellowship programs of our health professionals in different specialties serves as the back bone of our future quality health care system. Exposure to procedural skills in PG training is currently diffuse as it relies on availability of opportunities rather than following pre-designed structured objectives. A good clinical educational environment incorporates PG residents' active involvement, contribution; ensures that both the learning and teaching processes are related to the patients; activates deep learning, encouraging professional intelligence, skill and behavior¹. Work-life imbalance, peer pressure, burn-outs, career uncertainty, lack of family support, no rewards, sluggish career advancements and institutional policies are the factors negatively effecting the quality of residency training in our settings². Use of flipped classroom (FC) intervention in teaching of residents can help to remove the time and workload barriers in their training and hence improving their competencies and satisfaction with the learning opportunities.

FC intervention can enhance the flexibility of our curriculum especially in COVID-19 pandemic which

has overwhelmed our health care system, compromising bedside teaching of procedural and behavioral skills to our residents. Its designing principles include; provision of pre-class opportunities for knowledge acquisition to students, motivating students for in-class activity, planning assessment, provision of need based individual guidance by facilitator, adequate time given for assignments, timely feedback by facilitator and availability of accessible technologies for students³.

Cognitive load theory makes the theoretical framework for FC by helping students to make cognitive schemas and thus decreasing cognitive load than traditional face to face training methods⁴. And literature showed FC intervention as an effective method using pre-learning and individual learning pace to decrease the cognitive load⁵. FC for procedural skills has been used in specialties like emergency medicine, gynecology, dentistry, surgery, ophthalmology and dermatology⁶. But more work is required to implement this teaching strategy more feasibly and effectively in post graduate medical training.

METHODOLOGY

Systematic review of selected articles was done by 4 step process of identification, screening, establishing eligibility and final inclusion. Articles shortlisted as per inclusion criteria published from 2012-2020 (9 years) were analyzed in 4 months duration. To review the available literature documenting FC in teaching of

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procedural skills in post graduate medical students especially dermatology.

To find the different pre-class, in-class and assessment strategies for medical procedural skills FC. To find instruments used for recording students perceptions about FC.

Online electronic databases were searched for the purpose of this study i.e. Pub med, ERIC, Psych INFO. In addition, a hand search of the reference lists of identified articles was undertaken and Google Scholar was utilized to identify any other primary sources within After removal of duplicates and going through the abstracts, the non-relevant articles were eliminated based on the inclusion and exclusion criteria. Thirty two studies were finally identified as being relevant to the research topic. Full text versions of the articles were obtained, with each article being critically appraised after giving them numerical weightage on the basis of Qualsyst criteria⁷. Any additional relevant literature from a review of the reference lists of each article was scanned. Finally 25 articles were selected for critical appraisal based on good Qualsyst scores. The process of article selection followed the preferred reporting of items for systematic reviews and meta-analyses method. English articles published in peer-reviewed journals from 2012 to 2020 including Original articles and systematic reviews. Articles with literature focus on FC intervention and procedural skills teaching in residency programs. Articles not complying with the inclusion criteria were excluded. Conference papers, opinion papers, letters to editors or editorials or articles not primarily focused on FC or procedural skills but only mentioning it contextually were also excluded.

To avoid selection bias, 2 team members independently reviewed each relevant article, and then all reviewers collectively made the final selection. An iterative process was used to reach consensus. Content analysis of the articles in a step-by-step process was done. The team started with the formulation of the objectives of the study; and reviewing and analyzing the trends and contents of FC research leading to formulation of coding units. Then reviewing of the documents were done again based on application of the coding units. Data were obtained were manually, descriptively analyzed based on the research questions.

The quality assessment tool employed was the QUALSYST⁷. The tool utilizes two scoring systems for quality assessment, for both quantitative and qualitative research. The score is calculated as sum of ratings

of applicable criteria divided by the maximum possible scores of applicable criteria. Based on the scores following articles were finalized for critical appraisal.

RESULTS

Out of the 26 full text articles reviewed, mostly were quantitative including Randomized control trials, retrospective studies, prospective cohort, case-control, cross-sectional validation studies as well as one meta-analysis. Only 2 studies had mixed-method design and

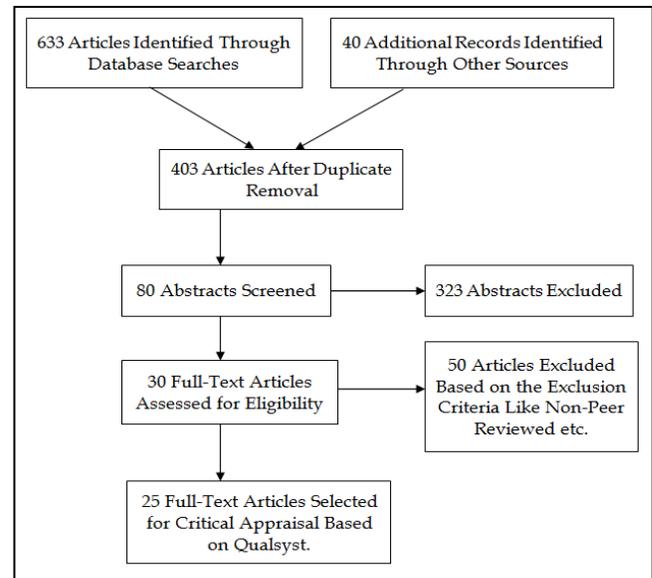


Figure: Flow diagram of the research process.

one was a systematic review¹⁹. Studies were carried out in different medical/dental/nursing colleges and universities of United States of America, 3 in China, 2

Table-I: Key terms used for literature search.

Keywords	Pub Med	ERIC	Psycinfo
Flipped Classroom	1194	842	13
Procedural Skills	15643	823	223
Postgraduate Trainees	5634	106	259
Boolean Operators			
Flipped classroom and Procedural skills	133	7	3
Flipped classroom and Procedural skills and Postgraduate trainees	23	0	1

in Canada, 1 each in Pakistan and India respectively. Different methods were utilized for pre-class activities including power point presentations, VLE, Simulation based or real time videos of procedures with accompanying reading material. The adobe connect learning systems was most commonly used for pre-class activities which encompasses all of the technology

necessary to realize FC project. It allows live streaming of lecturers with variety of windows including live video and the ability to see the instructors as they speak. They also can view the instructor's desktop or

Power Point presentation at the same time and interact utilizing combinations of a variety of pods, both the instructor and the learner could manipulate the learning environment to their best uses¹⁷.

Table-II: Critical appraisal of relevant studies.

Year/Journal/ Country/Title	Design & Objective	Sample	Data collection	Key findings
USA ⁸ J Grad Med Educ. 2019 Effects of a Flipped Classroom Curriculum on Inpatient Cardiology Resident Education	Quasi-experimental To prove that a FC of Medical Knowledge Self-Assessment Program could improve resident knowledge and preparedness in cardiology.	37 in each group	20MKSAP question scores and 5-point Likert scales for preparedness	Flipped classroom did not affect knowledge and preparedness when compared to usual teaching. Residents expressed high satisfaction.
USA ⁹ J Grad Med Educ. 2017 Results of a Flipped Classroom Teaching Approach in Anesthesiology Residents	Prospective, controlled, multicenter, educational research study To prove that a FC improves knowledge acquisition and retention for residents compared to traditional lecture	142 (n=83 flipped class; n = 59 lecture)	Primary outcome - knowledge acquisition and retention- scores in MCQs. Secondary outcome - resident attitudes surveys	Anesthesiology residents' preference for the flipped classroom and a beneficial effect of this teaching method on knowledge retention.
Canada ¹⁰ BMC Medical Education 2015 Flipping for success: evaluating the effectiveness of a novel teaching approach in a graduate level setting	Quantitative Survey To analyze FC affectivity with: 1) socio-demographics, 2) exam grades, 3) student satisfaction, 4) course effectiveness.	67 Masters-level graduate students	Likert scale Surveys, open ended questions, Peer evaluation report, quiz, SEEQ.	FC provided better opportunities for students to nurture critical thinking, independent learning, and peer learning.
USA ¹¹ Ochsner Journal 2016 Using the Flipped Classroom to Bridge the Gap to Generation Y	Quantitative-Interventional To find out if the FC model translate into better performance in examinations	70 students	Scores in MCQs and OSCE	A statistically significant increase in scores on the MCQs and OSCE was seen in students taught by FC.
USA ¹² The Clinical Teacher 2015 The flipped classroom for medical students	Mixed method To implement a FC curriculum for the obstetrics and gynae clerkship, and to find out student satisfaction with it.	89 students	Validated satisfaction survey, scores of pre and post-test	Student were very satisfied with both phases of curriculum. There was no significant difference in final student grades post intervention
India ¹³ Korean Journal of Medical Education 2016 Flipped clinical training: a structured training method for undergraduates in complete denture prosthesis	Analytical type of observational study To use FC training in removable complete denture treatment and find out itseffectiveness by comparing assessment results against those taught by traditional methods	181 students.	Checklist scores	The number of students demonstrating competency in complete denture treatment was more for FC.
USA ¹⁴ WestJEM 2014 The Flipped Classroom: A Modality for Mixed Asynchronous and Synchronous Learning in a Residency Program	Mixed method To learn about resident and faculty impressions of FC sessions.	35 residents	4 point Likert scale. Open-ended questions	Residents appreciated the flipped model. They preferred a small group size.

USA ¹⁵ J Am Acad Dermatol 2011 Procedural dermatology training during dermatology residency: A survey of third-year dermatology residents	Quantitative Survey To assess the third-year resident experience in procedural dermatology during residency training.	240 residents	Survey questionnaire	55% were very satisfied with their procedural training during residency.
USA ¹⁶ Advances in Medical Education and Practice 2017 Flipped classroom model for learning evidence-based medicine	Observational To present the flow of learning activities in flipped EBM classroom and highlight specific considerations for implementing a flipped classroom model.	14	Questions regarding validity and results of study	Implementing a FC model to teach EBM improves learning opportunities for students
United States ¹⁷ Frontiers in Neurology 2017 Randomized Control study of a remote flipped classroom of neuro-otology curriculum.	Randomized Control trial To test the hypothesis that learning in on-line class will produce similar outcomes to traditional classroom based on FC approach	274	Scores of pretest and posttest.	The use of FC demonstrated similar results to the traditional one.
United States ⁶ JAAD 2019 A video-based, flipped classroom, simulation curriculum for dermatologic surgery: A prospective, multi-institution study	Prospective multi institutional study To assess the impact of video education and surgical simulation on dermatology resident procedural skills.	31	OSATs scores Surveys	Video education and simulation are effective for improving dermatology residents' procedural skills.
USA ¹⁸ Education for health 2017 Teaching Procedural Skills to Medical Students: A Pilot Procedural Skills Lab	Cross-sectional Quantitative To check the effect of a multifaceted Procedural Skills Lab on the improvement in confidence of medical students performing the procedures.	106	Student's confidence level Likert scale	A strategically improvised Procedural skill increases students' confidence to perform procedural skills.
USA ¹⁹ JCEHP 2016 Flipping the Continuing Medical Education Classroom: Validating a Measure of Attendees' Perceptions.	Cross-sectional validation study. To develop and validate an instrument measuring flipped classroom perceptions of the students experiencing the intervention.	167	A flipped classroom perception instrument (FCPI) with Likert scale	The FCPI has good validity evidence.
USA ²⁰ J EducEval Health Prof 2016 Flipping the ACLS classroom with TBL: comparison of cognitive testing performance for medical students at the University of California,, United State	Quasi-experimental pre-posttest. To find if written test scores improved for ACLS taught in flipped classroom/team-based Learning (FC/TBL) vs. lecture-based (LB) traditional control.	354	MCQs, rhythm matching, fill-in clinical cases.	A FC/TBL format for ACLS marginally improved written test scores.

Short quiz submission after pre-class activity was a common method used by teachers to commit their students in the activity. Multiple choice questions, OSCEs, OSPEs, OSTEs, Peer evaluation reports and marks given for presentations were the instruments used for assessing students' performance of procedural skills after FC. As for learning strategies in the in-class stage, the most frequently adopted strategies were peer-peer or facilitator guided discussion, guided practicing of skills, and problem-based learning. Most stu-

dies mainly focused on imparting and assessing knowledge, skills and to a lesser extent attitude training, while focus on learners' higher order thinking skills was lacking. POGIL-Process oriented guided inquiry learning activity and SICKO online decision making games were novel in-class activities used in 2 studies ^{22,24}.

Application of FCs in medical education has grown rapidly over the past decade, with the number

growing dramatically from 7 papers in 2014, to 16 papers in 2015, and 22 papers in 2016³¹.

DISCUSSION

Study results revealed 10 best practices for its use in skill training i.e. dedicated educational time, standardized general format, topic-based clinical modules, multiple instructional methods, good-quality video pre-class material, accountability in preparation of pre-class material, use of practice questions, case-based learning, simulation-based skills training and dedicated staff and faculty leader²². Going through pre-class material helps in priming with background knowledge for carrying out the in-class task³². FC for complete denture prosthesis was used as a structured training method for undergraduates¹³. It's role in the changing landscape of anesthesia training was researched³³. In gynaecobstetrics clerkship FC was used successfully in gynae oncology module and was also assessed in another study by OSCE showing better results than control group^{11,12}. It's role in ophthalmology clerkship, emergency medicine clerk-ship, evidence based medicine in residency, renal pharmacology module, foundation of anatomy module and procedural skill lab in undergraduate students has revealed promising result^{16,21,24,23,18,34}. It has been used successfully in procedural skill cadaveric laboratory for sonography scan, echocardiogram, lumbar puncture, arthrocentesis, and insertion of intraosseous and intravenous catheters³⁵. Flipped structured training program for complete dental prosthesis shifted learning from clinics to learning centers (phase 1) and preserved practice in clinics (phase 2) in Sri-Rama Chandra University¹³. Flipping the ACLS classroom with team-based learning also showed encouraging results in University of California, USA²⁰. Reviews of surgical students from Stanford University were overwhelmingly positive when simulation-based FC for surgical clerk-ship was introduced²². There are many procedural skills involved in dermatology residency and flipped learning has recently being introduced for improving the efficiency of training¹⁵. Introduction of a flipped dermatology module in an undergraduate setting gained positive reviews from students²⁷. Similarly, Duke University Medical Center Flipped curriculum was introduced and received positively by dermatology residents²⁸. Even in Pakistan it has been used for dermatology residents and assessed by OSCE and MCQs. Student perception were recorded by FCPI³⁰.

Perceptions about FC intervention were recorded using different survey questionnaires with Likert sca-

les, open-ended questions in these studies. However the only validated instrument and hence the best was FC perception instrument (FCPI) which was developed and validated by Dr. Christopher R. Stephenson and his team. Four major topics addressed were pre-class activity, in-class learning, active learning techniques and collaborative learning. After repetitive revisiting and subsequent improvements, finally eight items were selected with responses on five point Likert scale. Factor analysis was carried out for individual items for establishing internal structure validity. Internal consistency reliability values for items comprising each factor and overall were calculated with the Cronbach α ($\alpha > 0.7$ was considered acceptable)¹⁹. This instrument was successfully utilized in Mayo clinic Quality improvement curriculum in 2015²⁵. In a study carried out in dermatology residents in Pakistan it was again successfully used after 2 FCs for dermatology procedures with few open-ended questions, after permission from the original author and establishing reliability³⁰.

The format of the FC provide opportunities for students promoting critical thinking, student-centered learning, and promoting academically beneficial peer interactive learning. Facilitators also enjoy flexibility in chunking of study material, provision of in-class problem-solving activities and offering timely constructive feedback to students¹⁰. Pre-class study material appeared to be viewed easily by most students in a multitude of environments³⁶. It allows to put more responsibility of learning on students who then strive to work towards mastery of subject and improving their skills as per 21st century health care needs. Cost-effectiveness of courses and meeting the demands of ever increasing number of students in institutes with economic restraints is also an added benefit. Going through the pre-class material decreases the students anxiety and makes them more confident in class, Re-enforcement and better retention of important points along with preference for small group discussions in in-class sessions were results of another study based on the usage of this modality combining synchronous and asynchronous learning¹⁴. Hence if planning and responsibility for this pedagogical approach is done successfully, it improves students participation, satisfaction and performance at all levels³⁷. Flipped learning model requires effective faculty development programs before implementation³³. Many students in different studies have given negative reviews about the workload of the delivered pre-class content and the number of assignments. Flexibility in content acquisition has also been considered as a double edged sword by being fruitful

for students with good self-regulatory skills and promoting procrastination in poor time managers³⁸. Also the quality of discussion during interactive sessions is dependent on student's preparation¹⁴. Limitation of technology can also negatively impact the students experiences with flipped learning like many of them report poor audiovisual quality, long duration and inability to give feedback about the quality of videos in different studies¹⁰. Studies have also shown that FC can only be effectively used when content material is concrete and not abstract²¹. A study carried out in our settings on dermatology residents revealed FC as resource intensive, time demanding and useless for unmotivated students. Students recommended improving videos, making them short and concise and giving more time to students for pre-class activity³⁰.

CONCLUSION

Flipped learning can bring dramatic improvement if strategically applied based on structured training program having defined objectives. It can be adopted as an effective teaching strategy of procedural skills to residents in all fields including dermatology. It can increase the flexibility of curriculum to curtail the demands in face of COVID-19 pandemic.

CONFLICT OF INTEREST

This study has no conflict of interest to be declared by any author.

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