



Impact of Feedback on the Performance of Undergraduate Medical Students in the Practical Classes- A Comparative Study

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Abstract

Medical teachers have serious concern about the decline in practice skills of undergraduate medical students. Feedback as a process improve students knowledge and skills toward Ziehl Neelsen (ZN) staining method. This study was performed to identify the areas of concern while performing ZN staining and to assess the effect of feedback on practical skills during microbiology postings. This interventional comparative study was conducted in the department of microbiology on 130 students. Their competency on ZN staining method was analysed through the questionnaires, observation and oral assessment in the first and second session. Effect of feedback was evaluated in the second session. The areas of knowledge gap assessed through oral assessment, observation and questionnaires was about "the unique acid fast nature of mycobacteria" (0.75 ± 0.41), and "grading of smear as per RNTCP" (3.32 ± 0.86) respectively. Formative assessment had a statistically significant difference between the test scores and performance of students ($p < 0.001$). The perception of students based on the questionnaire was statistically significant ($p < 0.001$). Formative evaluation helps identify the students strengths and weaknesses. Feedback provide learners with information on past performance and helps enhance their knowledge, attitude and practical skills. Interactive and timely feedback has a beneficial effect on students performance.

Keywords: Formative assessment, feedback, medical education, practical skills, staining.

Introduction

Learning, feedback and assessment are inextricably linked. Feedback is essential for the acquisition of knowledge, attitude and skills. In medical education feedback refers to information about the students' performance in a given domain aimed to guide their learning experience in future with the same or related activity. The feedback serves to improve the pattern of teaching and so it

plays a pivotal role in teaching as well as in learning^[1]

Formative assessment is defined as "the process used by teachers and students to recognize and respond to student learning in order to enhance that learning, during the learning"^[2]. The intent of formative type of evaluation is to encourage mastery of the content, hone skills, alter attitudes and encourage student growth. Formative

assessment enriches and enhances learning. It has been used to deliver feedback against end-of-course grades and prepare students for examinations

Feedback that is intended to provide specific enhancement on the performance of the learner has a good impact than vague feedbacks. It should aim to bridge the gap between the present understanding capacity of the student and the expected performance^[3]. Proper handling of the feedback between the students and teacher is very important as any damage would hinder future feedbacks and assessments. The medical education is a field with many new trends and innovations with regard to teaching as well as in the assessment of the gained knowledge among the students. The dedication and commitment of the teachers will help the students achieve their goals and learning capabilities. The end result will lead to improved success rate in performance of students^[4].

Assessment of medical students is an integral part of learning in medical education as assessment drives learning to improve performance of medical graduates in practice. The method and timing of assessment is a challenge for medical instructors^[5]. The role of assessment is not just mere assessment of the student based on a predetermined criteria but facilitate his or her learning through continuous feedback process. By giving an opportunity for the student to improve^[6]. This realisation has shifted the focus of assessment from end stage summative to formative assessments with periodic feedbacks.

Tuberculosis (TB) still remains a global health problem with its resurgence associated with the advent of the HIV/AIDS epidemic affecting world's population at the rate of one per second^[7]. The most effective and the reliable means to control the spread of TB disease is the early diagnosis and treatment of Pulmonary tuberculosis. The presence of acid fast bacilli in sputum smear examination and growth in culture

gives information regarding the diagnosis, initial assessment, drug sensitivity and treatment response^[8].

Staining techniques are used as a preliminary method to diagnose infections. The basic practical staining skills like Grams staining, ZN staining, etc are taught to the undergraduate students by the traditional "See one do one method" in the second year of medical curriculum. But yet they fail to perform the correct staining procedure and report the slide as these are considered as complex skills in undergraduate education^[9].

The use of diagnostic tests is a crucial aspect of clinical practice since they assist clinicians in establishing whether a patient has or does not have a particular condition. Expertise in the practical skills to arrive at a proper diagnosis is the intended goal for the students at the end of the curriculum. Imparting precise staining skills and periodic assessment is vital to improve the knowledge of students. In the present scenario where diagnosis and management is based more on laboratory reports, it is imperative that the skills of students to perform ZN staining is emphasized more in the practical classes.

To achieve competency in a particular subject formative assessments are the right method of assessment. Timely, relevant and supportive feedback provided during the course of learning process can help identify appropriate actions to improve learning and contribute to improved learning outcome^[10-14].

In the present scenario, medical education programs fails to provide adequate and timely feedback to students on their learning^[15]. Hence assessment of competence has shifted from summative assessment to formative learning events^[16-17]. On literature search there is paucity of data on Ziehl-Neelsen staining skills among undergraduate students. So this study was undertaken to identify the critical areas of concern while performing ZN staining and to assess the effect of feedback on the performance of students. The study aimed to assess the observing capacity, procedural skills and knowledge of undergraduate

medical students about Ziehl Neelsen staining technique and to assess the performance of the students following feedback.

Materials and Methods

Aims and Objectives

- 1) To identify the areas of concern while performing ZN staining
- 2) To assess the effect of practical skills among undergraduate medical students

Study Design

Interventional comparative study conducted in the Department of Microbiology, Karpagam Faculty of Medical sciences and Research, Coimbatore.

Sample Size

A total of 130 students who consented to take part were included in the study. The students were assured of their anonymity.

Methodology

Approval from the institutional ethics committee was obtained prior to the study. Informed consent was obtained from the students willing to participate in the study. The students were divided into 2 groups for the ease of conduction of the study. Both the groups were taken two classes in Acid fast staining (namely a demo class followed by a revision class two weeks later). In the demo class the students were first taught about the important aspects regarding the acid fast staining including the theory as well as the practical aspects, then they were divided into small groups each consisting of 10 students per demonstrator

and are given a chance to perform the procedure on their own. During this period the students are evaluated by the demonstrator for the practical skills through direct observation method, and also their ability to understand the concepts explained by the teacher through an oral assessment method. Finally the students gave a feedback in the form of a structured questionnaire based on their own perception and satisfaction regarding the teaching and assessment method. The collected feedback was reviewed and the corrections and improvements were addressed to the students prior to the revision class in a positive manner. The students were again asked to perform the procedure after the feedback and the same evaluation in the form of direct observation method, oral assessment and structured questionnaire was carried out. Finally the demonstrators who assessed the students were asked to provide a feedback regarding the nature of the study as well as the performance and attitude of the students.

The ability to understand the concept explained and the effect of feedback was analysed and the data interpreted using IBM SPSS 23.0 statistical analysis software.

The structured questionnaire

Please rate the following on a scale of 5 (strongly agree) to 1 (strongly disagree). The information will be used solely by your instructor to assess the students' satisfaction while the course is still underway.

Name:	Number				
Session: Pre feedback /post feedback					
Components	Strongly agree(5)	Agree(4)	Neutral(3)	Disagree(2)	Strongly disagree(1)
Able to understand the concepts explained					
Able to perform the staining without any help					
Able to focus the field under the microscope					
Able to obtain proper staining result as desired (blue back ground and pink bacilli)					
Able to identify the acid fast bacilli					
Able to perform grading of the smear using RNTCP grading					
Able to answer the questions put forth by the instructor.					

Complete the following:

The time given to perform the study was adequate – yes or no

I am satisfied with the quality of my staining technique – yes or no

Feedback during the course of study was useful for my learning – yes or no

The instructor communicated the aim and objective of the session clearly – yes or no

Additional comments for instructor:

Direct observation method: (to be observed and filled by the assessor/demonstrator during the process of staining)

1. Added the stains in the right order (primary followed by secondary stain): yes / no
2. Maintained the appropriate time needed for each steps: yes / no
3. Was the smear intact at the end of the staining: yes / no
4. Was a) properly stained b) under decolourised c) over decolourised

5. Was correct RNTCP grading given: yes / no

Oral assessment method: (to be assessed based on oral examination)

1. Why are Mycobacterium acid fast in nature?
2. What type of stain is acid fast stain?
3. Name some organism that are acid fast and alcohol fast
4. Mention the types of acid fast staining methods
5. What is the percentage of decolouriser used for Mycobacterium tuberculosis and Mycobacterium leprae?

The students were given marks for the above oral assessment as 1, 0.5 and 0 for the correct, partial and wrong response respectively.

Results

A total of 130 Undergraduate medical students were taken up for the study.

Table 1: Analysis of marks obtained by oral assessment

Questions	N	Mean marks		Standard deviation		P value
		Pre feedback	Post feedback	Pre feedback	Post feedback	
Why are Mycobacterium acid fast in nature?	130	0.75	0.87	0.418	0.298	0.005
What type of stain is acid fast stain?	130	0.80	0.93	0.395	0.254	0.001
Name some organism that are acid fast and alcohol fast	130	0.86	0.95	0.262	0.145	0.001
Mention the types of acid fast staining methods	130	0.93	0.98	0.241	0.097	0.032
What is the percentage of decolouriser used for Mycobacterium tuberculosis and Mycobacterium leprae?	130	0.87	0.95	0.317	0.187	0.014

* P<0.001 is statistically significant

In the pre feedback session the areas with competency gap about their knowledge based on the viva voice (oral assessment) was regarding the “unique nature of of acid fast nature of mycobacterium”(0.75 ± 0.41) followed by “the characterization of acid fast stains” (0.80 ± 0.39) and “the organisms that are acid fast and alcohol fast” (0.86 ± 0.26). The proficiency regarding “the acid fast staining methods” (0.93 ± 0.24) and “the percentage & decolouriser used for

Mycobacterium tuberculosis and leprae”. (0.87 ± 0.31) was understood better in the first session.

In the post feedback session knowledge about “the unique acid fast nature of mycobacterium (0.87 ± 0.29) and “the characterization of acid fast stains”(0.93 ± 0.25) was answered with difficulty followed by the knowledge about the “the organism that are acid fast and alcohol fast”(0.95 ± 0.14). The proficiency regarding “the types of acid fast staining methods” (0.98±0.977) and

“percentage of decolouriser used (0.95 ± 0.18) was demonstrated better. There was statistical

difference between the scores in the first and second session $p (<0.001)$.

Table 2 : Analysis of the feedback from the student questionnaire

Questions	N	Mean marks		Standard deviation		P value
		Pre feedback	Post feedback	Pre feedback	Post feedback	
Able to understand the concepts explained	130	4.34	4.66	0.784	0.578	0.00
Able to perform the staining without any help	130	4.00	4.51	0.731	0.560	0.00
Able to focus the field under the microscope	130	3.60	4.16	0.858	0.656	0.00
Able to obtain proper staining result as desired (blue back ground and pink bacilli)	130	3.40	4.03	0.701	0.692	0.00
Able to identify the acid fast bacilli	130	3.40	4.16	0.859	0.716	0.00
Able to perform grading of the smear using RNTCP grading	130	3.32	3.93	0.864	0.684	0.00
Able to answer the questions put forth by the instructor.	130	3.77	4.45	0.696	0.572	0.00

* $P<0.001$ is statistically significant

Based on the perception of the students in the pre feedback session, we noted that most students found it difficult to obtain proper staining result (3.40 ± 0.701), ability to identify AFB (3.40 ± 4.16) and to perform RNTCP grading (3.32 ± 3.93). We also observed that there was difficulty in focusing the field under the microscope (3.60

± 0.85). Such technical skills were properly addressed and was improved in the post feedback session (4.16 ± 0.65).

The perceptions of students regarding their competency level in performing a Ziehl Neelsen stain is significant higher in the second session ($p<0.001$) (table 2)

Table 3: Analysis of data obtained by direct observation method

Question	Prefeedback		Post feedback	
	Yes	No	yes	no
Added the stains in the right order (primary followed by secondary stain)	125 (96%)	5 (4%)	130 (100%)	0
Maintained the appropriate time needed for each steps	116 (81.3%)	14 (10.7%)	123 (95%)	7 (5%)
Was the smear intact at the end of the staining	117 (90%)	13 (10%)	126 (97%)	4 (3%)
Was the smear a) properly stained (p) b) under decolourised (u) c) over decolourised (o)	P=81 (63%) U=36(27%) O=13(10%)		P=110 (84.6%) U=18(13.9%) O=2(1.5%)	
Was correct RNTCP grading given	94 (72%)	36(28%)	110 (84.6%)	20 (15.4%)

Discussion

This research shows that the process of feedback improved the practical skills of undergraduate medical students by providing an avenue to identify their areas of weakness, receive inputs and enhance their performance. This improved performance was based on a short feedback session suggesting that effective feedback have a demonstrable effect within a short time. The combination of training, practice and effective feedback improves students' practical skills with a positive perception about teaching and learning. Microbiology as a branch of medicine has been impacting directly on health, economy,

environment and still paves the way for many breakthroughs ^[18]. The basis of microbiology is essential in other fields such as immunology, genetics, and medicine. The newer methods to detect the Tb bacilli like the automated systems and polymerase chain reaction (PCR) are costly. The sputum smears examination, is a relatively cheap method though it carries the risk of low sensitivity ^[19]. First year undergraduate students are taught about the basics of staining during their training and still they don't exhibit adequate skills in their second year. They are expected to perform a Ziehl Neelsen staining along with correct interpretation exhibiting adequate knowledge

during their microbiology posting as per the curriculum.

In our study direct observation forms the basis for the feedback session. Feedback was delivered using the “feedback sandwich” in which positive comments were given followed by the areas in which the learner needs to improve. This was finally followed by another positive comment to end with an upbeat note^[20].

As the students progressed from a beginner to competent practitioner, the facilitator observed the performance and helped improve their skills by giving relevant feedback on the core areas of concern and success. The information collected during the process was significant and useful to the educator to make necessary adjustments to the teaching process. Feedback on the practical skills based on direct observation was learner friendly and instructive than feedback based on second-hand reporting^[21]. Ultimately students themselves were encouraged to gather feedback either by asking for feedback verbally or by questionnaire^[22].

The results of the questionnaires, observation, scores, self-assessment and peer assessment in this study show that feedback improves student's capability to understand concepts and improve upon them to develop their knowledge, attitude and skills. Formative assessment provides immediate feedback and enriches learning experience to identify medical students are strengths and weaknesses^[23]. Further it provides them an opportunity to identify their concern areas, receive appropriate feedback from the facilitator and enhance their level of performance. The complete repertoire of Ziehl Neelsen staining skills and knowledge was assessed which is not compromised by case specificity. This study served the dual purpose of assessing the hand, assess the effect of feedback on practical skills.

It has been shown that students lack the confidence and skills to actually perform correct staining in the bedside laboratory during their clinical postings or in medical practice. Appropriate, real time feedback improved their

knowledge and motivated them to enrich their proficiency and skills^[24]. The lacunae noted in the pre feedback session are inherently present at the beginning of the present posting. The knowledge, practical skills acquired during the previous year along with the capacity to recollect information, integration and application during this session were assessed with the first session marks^[25]. Hectic class schedule, busy workloads, absence of feedback provide limited opportunity for the students to improve their skills^[26].

Developing science based knowledge habits and encouraging self-learning abilities may inspire students to value science during their education and practice^[27]. The difficulty in answering the basics regarding ZN staining could be due to the exquisite interest shown by students in understanding the procedure and skills than in imbibing the theoretical aspect behind the same. This would also explain the good procedural skills shown by students during the assessment by observational method noticed during observation by the facilitators.

The demonstrators opined that the staff student ratio was healthy for interaction and they could clearly address the doubts/clarifications that the students wanted. They felt that time given for performing the staining method was adequate. On their personal analysis, they opined that the technical issues were more regarding the heating step involved in the staining process and in the amount and time of decolouriser used. Many students failed to allow adequate time for decolourisation, thereby leading to many under and over decolourised smears. They also informed that the students participated eagerly and performed with ease which further explains that students are interested in small group teaching & feedback.

The students opined positively about the structured framework of the study methodology and assessment including feedback. According to the students their knowledge was assessed equally both theoretically and practically and more continuous assessments like the same would help

them learn improve their practical skills. The students felt that the exam was less stressful and were comfortable with being assessed by the demonstrator. They also felt that more assessment like this would help them perform better in their final examinations.

The most difficult area while performing the staining procedure was in giving correct RNTCP grading for the smear. Slide interpretation is an analytical thinking based on the cognition and knowledge of a student^[28]. Based on the observation made by the observer/demonstrator the students were found to be confident with regard to the steps in performing the procedure, and in maintaining sufficient timing for the test. The difficulty was much with maintaining the time for the decolouriser as a result of which 63% were under decolourised 27% were over colourised and 10% were properly decolourised. This would also explain the inability to provide correct RNTCP grading for the smears.

The frequency and type of assessment is a challenge to medical instructors to produce an Ideal Indian medical graduate (IMG). Each assessment method has its own advantages and disadvantages. No individual assessment method results in a perfect assessment. In the post feedback session learners achieved the objectives through feedback so that they possess the necessary skill and knowledge. Formative assessment provides a process to integrate information, help identify weaknesses and empower them to rectify their deficiencies^[29].

Structured teaching methods improves the performance of procedure skill but not problem solving or interpretational abilities of a student. Regarding the observational assessment, students felt it is a fair tool of evaluation in practical exercises and that it was better structured^[30]. Majority of the students' scored more marks in the second session in all the domains underscoring the fact that relevant feedback had a significant positive effect on their performance. Formative evaluation allows programs to identify learners who are underachievers before the end of course

schedule. There was a statistically significant difference between the test scores in the first and second session ($P < 0.001$). Formative evaluation may aid medical teaching and strengthen primary training as per the intended goals of medical curriculum. The programs of assessment for learning individualize the student learning experience.

Limitations

Though the study had the strength of assessing the competency of the students in terms of practical skills as well as in assessing the conceptual understanding of the subject, it has a few limitations. The main limitations were busy schedule, heavy workload and the availability of faculty members. Assessment was not done to find out the basic knowledge of the students on Zeihl Neelsen staining before the beginning of the study knowing which would have proved the effectiveness of feedback and teaching in a more precise manner. This study is a single centric one with limited number of students. More studies may be performed with different batches of students involving various experiments and results analysed.

Conclusion

The study shows that feedback as an integral part of teaching and learning does have an important influence on students' performance. They have a positive attitude towards the value of feedback. Interactive feedback brings about academic improvement and professional development. It provides learners an opportunity to identify their problems and rectify them. Appropriative feedback during the practical classes provides a beneficial effect on the students' knowledge, attitude, proficiency and practical skills. This research recommends the use of feedback as an educational tool to enhance the performance of students in performing Ziehl Neelsen staining and interpretational skills.

Contribution of authors

The topic selection, core methodology and contact classes was done by the first author. Evaluation of questionnaire and marks, feedback sessions, manuscript preparation was done by the first and second authors. Designing of questionnaire, preparation of checklist, data analysis and interpretation was done by the all the authors. The final manuscript was read and approved by all the authors.

Acknowledgements

The authors extend their gratitude to the Management, Dean and Medical Education unit – KFMSR for their support. The authors thank the faculty and students involved in the study for their commitment and cooperation.

Funding: Nil

Conflict of interest: None

Permission from IRB: Yes

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