Learning Microbiology from Laboratory Bench to Bedside –A Project Based Learning

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ABSTRACT: The present study entitled, "Learning Microbiology from laboratory bench to bedside –a Project based learning" was carried out on 140 participants of second MBBS fourth semester students of Jawaharlal Nehru Medical College, Sawangi (Meghe), Wardha. The students were divided in two groups, group A was intervention group while group B was control group. Each group consisted of 70 participants. Pre test was taken in all 140 students before the start of the study. Intervention group was taken to hospital for project based learning on two modules whereas control group was taken for laboratory teaching on the same modules. The students from group A were given demonstration and performance of the task of both the modules. The post test was taken at the end of the activity in both the groups. Feedback of the students on the project based learning was taken from intervention group. The post test scores of group A and group B were compared (87.75% versus 69.25%). There was a significant improvement in post test in group A as compared to group B. (p<0.0001). The aLG, RLG and class average normalized gain was significantly higher in the intervention group as compared to control. The feedback was taken on both the modules. It was assessed on five point likert scale. The difference in the mean rating average in the control group and intervention group was statistically significant. The qualitative evaluation of the project based learning was done by open ended question. The students opined that the hospital oriented project based learning is more useful than the laboratory teaching. It gives better learning gain.
It is concluded that the hospital oriented project based learning in Microbiology has definitely better impact on the learning compared to the laboratory based learning..
KEY WORDS: Project based learning, absolute learning gain, Relative learning gain, Class Average Normalized gain, Rating Average

INTRODUCTION

Medical courses are traditionally taught deductively. The instructor first teaches students relevant theory and then moves on to textbook exercises, and eventually to real-world applications. Often the only motivation students have to learn the subject beyond grades is the promise that it will be important after their graduation. (Kardash and Wallace 2001). [1]

A better way to motivate students is *inductive teaching*, In this, the instructor begins by presenting students with a specific challenge, such as experimental data to interpret, a case base

application of knowledge, or a complex real-world problem to solve. Students grappling with these challenges recognize the need for skills training in conceptual understanding of the subject. Bransford, Brown, and Cocking (2000) [2]. The progressive approaches such as project based approach has generated considerable amount of enthusiasm in innovative practices for teachers as well as students in recent years [3]

The medical curriculum in recent years has promoted the development of problem-solving exercises at the national and international levels with better understanding of reasoning process and intelligence. The medical curriculum is thus changing to student-centered learning in all medical schools of the country [4].

There is no clinic or patient based approach while learning skills in the subject of Microbiology. This approach was changed to hospital based approach for learning Microbiology by Caccavo in 2011 [5].

Microbiology in-spite of being a crucial subject for understanding the basic principles with their application in infectious disease fails to impress the undergraduate medical students probably because they are taught the subject in isolation without much clinical context. To help students learn important concepts of microbiology by shifting the focus from didactic classroom setting to the patient care setting, the hospital based project is introduced by Suman Singh et al (2011) [6].

Significance of Microbiology as a subject of clinical importance cannot be denied and with the fact that the medical students even after spending months in learning Microbiology at undergraduate level fail to use it in clinical practice to the desired expectations [7].

The various innovative hospital based project modules are prepared and evaluated keeping in mind the shift of focus from classroom, didactic learning to hospital oriented, and project based learning.

In the present work, the project based learning in Microbiology from Laboratory bench to Bedside is evaluated through two hospital oriented modules.

AIM

The aim of the present work is to evaluate the project based learning in Microbiology through two hospital oriented modules.

OBJECTIVES

The present study is carried out with following objectives.

1. To compare the Learning gains in laboratory based learning versus hospital based teaching in Microbiology.

2. To evaluate the project based learning modules for teaching Microbiology in hospital oriented setting.

Materials and Methods:

The present study entitled 'Learning Microbiology from Laboratory Bench to Bedside – a project based Learning' is carried out at School for Health Professionals Education and Research, Datta Meghe Institute of Medical Sciencee (Deemed University) (DMIMSDU) and Department of Microbiology, Jawaharlal Nehru Medical Sciences, Sawangi (Meghe), Wardha.

STUDY SETTING

This was an open-labelled, randomized, controlled, parallel group interventional study conducted in IInd MBBS students of 4th semester at Jawaharlal Nehru Medical College, Sawangi (Meghe), Wardha.

DURATION OF STUDY: -

The present study is carried out over a period of one year from July 2013 to June 2014.

STUDY POPULATION: - The present study included 140 students from fourth semester of second MBBS from Jawaharlal Nehru Medical College, Sawangi (Meghe), Wardha. The ethical clearance was taken prior to the study from Institutional Ethics Committee of DMIMSDU. Selected students were grouped in two groups as group A and group B by lottery system method.. Group A was interventional group while Group B was control group. Selected students were briefed about study and objectives of the study. Written informed consent of selected students was taken before their participation in the study.

INCLUSION CRITERIA:-

1. All learners of second MBBS in their fourth semester were included.
2. Students who consented for the study.

EXCLUSION CRITERIA:-Students who did not give consent for the study.

PREPARATION OF MODULES

Two modules were prepared for project based Learning of the students. These modules were

1. Collection and transportation of sputum samples of respiratory tract infections in the wards; and,
2. Disposal of Biomedical waste

These modules were generated by the principle investigator. They were validated for contents by two faculties from department of Microbiology and for format by two faculties from School for Health Professionals Education and research. Only the validated modules were utilized for the study.

PRE TEST

The pre test was taken for all 140 participants. The question paper comprised of 10 brief or short answer questions of 02 marks each. The key to the questions was verified from the standard text books of Microbiology. The highest possible score of the test was 20.

Study Design:-

The students selected for the study were randomly assigned to two groups, Group A (n = 70) and Group B (n = 70). The participants from group A i.e. intervention group were taken to Acharya Vinoba Vhave Rural Hospital, Sawangi (Meghe), Wardha for demonstration and performance of the task for both the modules.

The participants were further divided in two batches of 35 each. The first batch of 35 participants was taken to Pulmonary Medicine ward for teaching self learning bedside module on 'collection and transportation of sputum sample of Respiratory tract infections" while second batch was taken to Medicine wards for teaching self learning bedside module on "Disposal of Biomedical Waste Management"

The participants were further subdivided in two groups consisting of 18 and 17 participants in each group. The time duration allotted was two hours for this teaching learning process.

Control Group

The participants from the control group (group B) were given conventional laboratory teaching on these two modules . They were not exposed to hospital oriented project based learning.
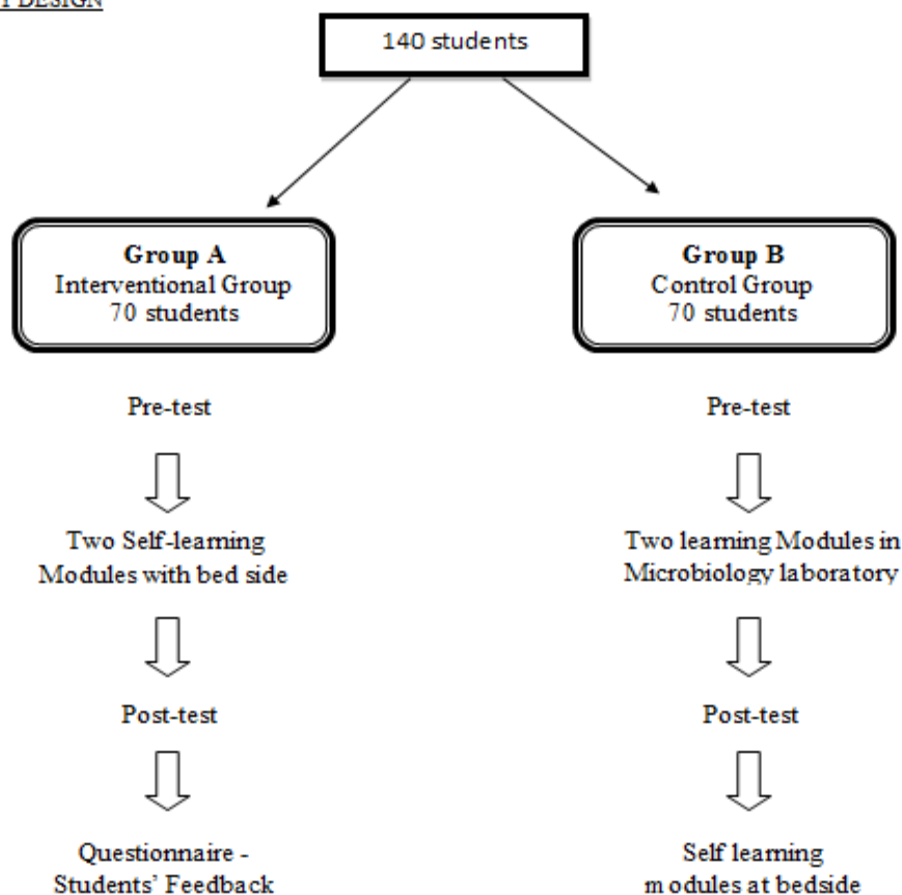
STUDY DESIGN

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                              ┌─────────────────┐
                              │  140 students   │
                              └─────────────────┘
                         ↙                        ↘
        ┌──────────────────────┐          ┌──────────────────────┐
        │      Group A         │          │      Group B         │
        │ Interventional Group │          │   Control Group      │
        │    70 students       │          │    70 students       │
        └──────────────────────┘          └──────────────────────┘

               Pre-test                          Pre-test

                  ⇩                                  ⇩

         Two Self-learning                  Two learning Modules in
         Modules with bed side              Microbiology laboratory

                  ⇩                                  ⇩

               Post-test                         Post-test

                  ⇩                                  ⇩

           Questionnaire -                     Self learning
           Students' Feedback                 modules at bedside
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Fig. 1: Schematic presentation of Learning Microbiology from Laboratory to Bedside

POST TEST

The post test was taken in all 140 participants from group A (70) as well as group B (70) after the completion of teaching learning activity. The results of pre and post tests were analyzed.

The mean average score in pre test and post test in intervention as well as control group was calculated. Based on these scores, the statistical significance in the difference of two scores, the absolute learning gain ALG), relative learning gain (RLG) and class average normalized gain (g factor) was calculated as per the guidelines given by Gaikwad & Tankhiwale (2012) [8] and Colt et al (2011) [9] . The ALG more than 30% and class average normalized gain more than 30 % was considered as significant.

Students' Feedback on the process of project based learning

In the intervention group, the response and reaction of the participants to the process of project based learning was taken using the structured proforma.

a) The responses were assessed on five point likert scale. The lowest score was 1 for strongly disagree. Score 2 was for Disagree, 3 for neutral or no response, 4 for agree and 5 for strongly agree. The rating average was calculated on the various points on close ended questions of likert scale. The

rating average was calculated as per the guidelines given by Gaikwad & Tankhiwale (2012) [8] and Rating average more than 3 was considered as significant.

STATISTICAL TESTS

Statistical analysis was done using Microsoft Excel and SPSS as statistical software.

RESULTS

1. Analysis of Pre and Post test

The pre and post test was taken in both group A and group B.

Intervention group

The mean pre test score in intervention group was 6.45 (32.25%) and mean post test score in this group was 17.55 (87.75%). This difference between the pre test and post test was statistically significant (p =<0.0001) The absolute Learning was 55.5%; the relative learning gain was 172.09 and the class average normalized gain was 0.819 (81.9%). All these values were statistically significant.

Control Group

In the control group, the mean pre test score was 6.21 (31. 05%) while mean post test score was 13.85 (69.25%). This difference in the pre test and post test was statistically significant (p <0.0001) The absolute learning gain was 38.02% while relative learning gain was 41.70 and the class average normalized gain was 0.604 (60.4%).

The post test scores of group A and group B were compared (87.75% versus 69.25%). There was a significant improvement in post test in group A as compared with group B. (p<0.0001). this indicated that learning gain was more in project based learning group compared to conventional laboratory teaching.

Table 1: Pre-test scores, Post-test scores and Learning gain

Groups	Pre test score (Mean ± SD)	Post-Test Score (Mean ± SD)	Absolute Learning Gain	Relative Learning Gain	Class average Normalized gain	t value	p value
A (n = 70)	1.45 ± 1.30 (32.25%)	17.55 ± 1.39 (87.75%)	55.5%	172.09%	81.90%	70.55	P<0.0001 Si.
B (n = 70)	6.21 ± 1.39 (31.05%)	13.85 ± 3.17 (69.25%)	38.02%	41.70%	60.40%	18.46	P<0.0001 Si.
t -value	20.92	8.94					
P - value	P 9< 0.0001 Si.	P < 0.0001 Si.					

STUDENTS FEEDBACK

The students' feedback was taken from interventional group. The feedback was taken on both the modules. It was assessed on five point likert scale.

The rating average was calculated for each parameter for both modules. The rating average ranged from 3.94 to 4.25 with the mean rating average as 4.13 for module one while it ranged from 3.87 to 4.47 with the mean rating average as 4.15 for module two..
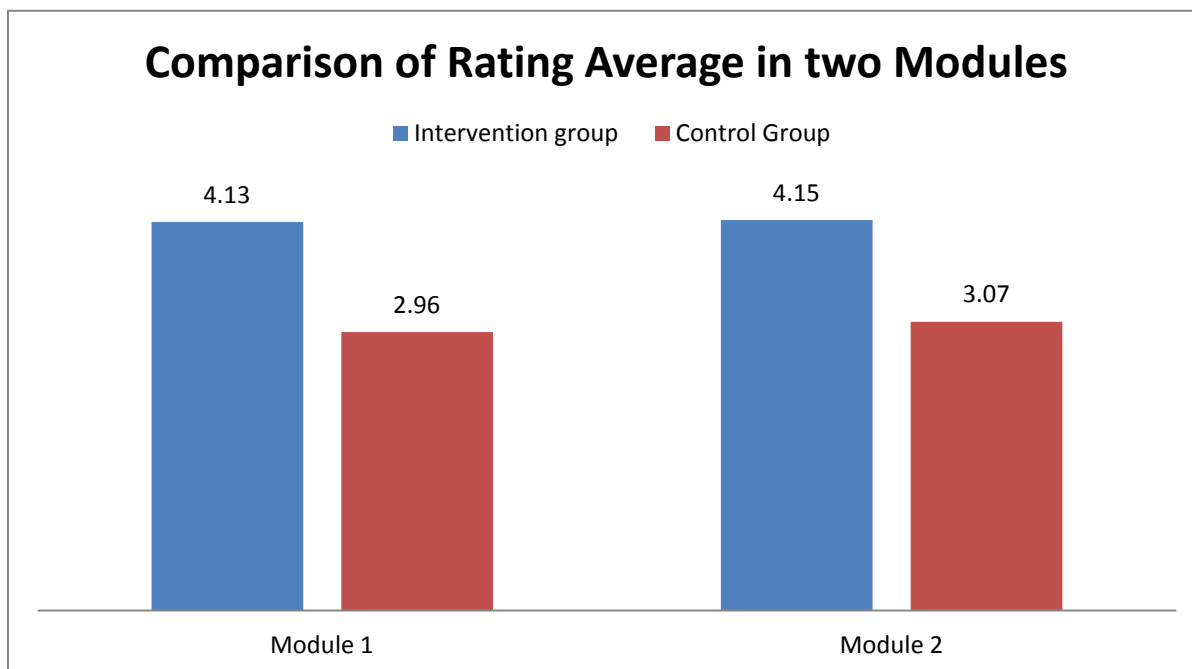
The mean rating average in the control group and intervention group was compared. The difference in the gain was statistically significant.

Table No 2: Feedback of students from Intervention group (A) on Module one (n =70)

S/No	Items	1 (poor)	2 (Questionable)	3 (acceptable)	4 (Good)	5 (Excellent)	RA
1.	Knowledge of Process of collection of sample in Respiratory tract Infections after the learning session	0 (0%)	5 (7.14%)	15 (21.43%)	20 (28.57%)	30 (42.86%)	4.07
2.	Precautions to be taken during collection of sample	0 (0%)	1 (1.43%)	14 (20%)	24 (34.28%)	31 (44.28%)	4.21
3.	Precautions during t-ransportation of sample to Laboratory	0 (0%)	5 (7.14%)	16 (22.86%)	27 (38.57%)	22 (31.43%)	3.94
4.	Characteristics of properly collected sputum sample	0 (0%)	0 (0%)	15 (21.43%)	25 (31.71%)	30 (42.86%)	4.21
5.	Method of collection of sputum sample in suspected case of Pulmonary Tuberculosis	0 (0%)	2 (2.85%)	13 (18.57%)	20 (28.57%)	35 (70%)	4.25
	Total	0	13	73	116	148	4.13

Table No. 3eedback of students from Intervention group (A) on Module two (n =70)

S/No	Items	1 (poor)	2 (questionable)	3 (acceptable)	4 (Good)	5 (Excellent)	Rating Average
1.	Knowledge of Types of Biomedical waste	3 (4.29%)	2 (2.85%)	15 (21.43%)	22 (31.43%)	28 (40%)	4.0
2.	Knowledge of different color codes for biomedical waste	1 (1.43%)	2 (2.85%)	17 (24.28%)	25 (35.72%)	25 (35.72%)	4.01
3.	Knowledge of different methods of disposal of various types of Biomedical waste	0 (0%)	2 (2.85%)	3 (4.29%)	25 (35.72%)	40 (57.14%)	4.47
4.	Precautions to be taken while dealing with highly infectious waste	0 (0%)	2 (2.85%)	1 (1.43%)	34 (48.57%)	33 (47.14%)	4.4
5.	Knowledge about Biohazard symbol and disposal of highly infectious waste	2 (2.85%)	5 (7.14%)	18 (23.71%)	20 (28.57%)	25 (35.72%)	3.87
	Total	06	13	54	126	150	4.15

Comparison of Rating Average in two Modules

■ Intervention group   ■ Control Group

Module 1: Intervention group 4.13, Control Group 2.96

Module 2: Intervention group 4.15, Control Group 3.07

Students reactions to the process of project based learning

The analysis of the close ended questions showed that 78.57% students agreed or strongly agreed on enjoyment and working of the project as well as relevance of the project. Understanding the concept of project work and better understanding of Microbiology by Hospital based project was agreed by 92.85% each, Further 94.28% participants agreed that project based learning was a better learning experience in team and fostered team. Total 94.28% participants agreed on fostering of team work in this type of learning. The 100% participants strongly agreed on the Satisfaction with the participation in project based learning.

Satisfaction with the support from the team members for learning was agreed by 85.91% participants. Similarly 97.14% participants strongly agreed on the effort of facilitators to make learning possible through project work.

The analysis of the students' reactions to the process of project based learning showed that 92.86% participants either strongly agreed or agreed on various parameters. These observations were statistically significant (p < 0.0001).

The rating average was evaluated to find out the significance of the project based learning. The rating average ranged from 3.97 to 4.64 with the mean of 4.36. This indicates that the students' reaction towards the process of project based learning was towards agreeable or strongly agreeable level.

The individual parameters were also evaluated on the rating average. The highest rating was for assessing better understanding of Microbiology thro the hospital based project. Total rating average was 4.64. This strongly indicates that the hospital based projects give better understanding of the subject.

The overall response showed that out of 70 participants, 90.14% participants rated the project based learning as very useful or useful. This indicates that the project work learning in Microbiology evaluated in the present work was proved to be useful by most of the participants.

Qualitative Analysis based on Open ended questions

The qualitative evaluation of the project based learning was done by open ended question. The students opined on both the modules. The results are summarized below.

Table No 4: **Facilitating factors for Project based learning**

S/No	Students Response	No. Of Students responded	Percentage
1.	Interactive and useful learning sessions	66	94.28%
2.	Focused Application based learning	62	88.57%
3.	Increased confidence level & hence better knowledge learning skills.	57	81.42%
4.	Better understanding of subject and concept building Bio-Medical waste treatment	52	74.28%
5.	Improvement in Behavioural and Attitudinal skills	52	74.28%
6.	Excellent team work amongst the group	40	57.14%
7.	Cooperative and collaborative learning with paramedical hospital staff	39	55.71%
8.	Good time management	38	54.28%
9.	Development of Long term memory in stress free atmosphere	34	48.57%

DISCUSSION

In the present work, the effectiveness of project based learning was assessed for learning Microbiology from Laboratory bench to Bed side using pre-test, post-test, learning gain and students' feedback. Interventional group showed significant improvement in post-test score as compared to control group. Although, control group also showed significant difference in pre and post-test score, but, absolute as well as relative learning gain was more in interventional group as compared to control group.

The students were randomly allotted in group A and group B. Group A was interventional group while group B was control group. Each group consisted of 70 students. The compliance of the students towards activity in intervention group was 100% while it was 92.86% in control group.

The pre and post test was taken in all the participants from both the groups. The mean pre-test score was 6.45 (32.25%) and the mean post test score was 17.55 (87.75%) in intervention group. This was statistically significant. The absolute Learning gain was 55.5%. The relative learning gain was 172.09.

In the control group, the mean pre test score was 6.21 (31. 05%) while mean post test score was 13.85 (69.25%). This was statistically significant ($p < 0.0001$). The absolute learning gain was 38.02% while relative learning gain was 41.70
The post test scores of group A and group B were compared (87.75% versus 69.25%). There was significant improvement in post test in group A as compared with group B. ($p < 0.0001$)
Suman Singh et al (2011) introduced hospital projects focusing on selected concepts of microbiology to help students learn important concepts of microbiology by shifting the focus from didactic classroom setting to the patient care setting. Total 103 students were included in the study. The students were divided in two groups as control and intervention group. In their study,

after implementation of the project, when the average scores of the project and control group were compared, there was remarkable improvement in the average scores of project group, from 9.64±4.55 to 16.28±4.22.

Pre-and post-test scores provide information on whether or not participants have learned from the training. In addition, a well-designed pre-and post-test can help trainers understand which concepts or competencies were well taught during the training and which ones need additional time, or need to be covered using alternative methods.

Pre-test/Post-test measurement in educational intervention is often associated with extraneous variables like Hawthorne effect (One may know that he/she is being tested may affect results) and halo effect (Human tendency to respond positively or negatively to a situation) and the practice effect (effect of a pre-test on a subsequent post-test). These limitations are inherent to most measures of knowledge acquisition in social research.

Colt et al (2011), in their study also pointed out that the class-average normalized gain of 30% is significant and determines curricular effectivement. In the present work also the class average normalized gain was more than 30% at all parameters suggesting significant effectiveness.

The feedback from intervention group on both the modules have shown that the learning has occurred significantly in both the modules of project based learning. The feedback of students from intervention group was also taken on module two i.e. Management of biomedical waste. The rating average ranged from 3.87 to 4.47 with the mean rating average as 4.15 in the intervention group while the rating average in the control group ranged from The rating average ranged from 2.86 to 3.71 with the mean rating average as 3.07 in the control group. This difference in the rating average in the intervention group and control for both the modules was statistically significant. This indicated that the hospital

oriented project based learning was more effective compared to the conventional laboratory teaching of Microbiology.

Suman Singh et al (2011) concluded that the students enjoyed the process of learning in a hospital environment. It was very interesting to note that 60% students felt that, this was a practically feasible concept and can be implemented for undergraduates as a regular feature as it made the subject interesting. Most of the students could understand the practical significance and relevance of theory taught to them in classrooms but found it difficult to manage time.

The qualitative evaluation of the project based learning was done by open ended question. The students opined on both the modules taught during the sessions. The students opined that the hospital oriented project based teaching is more useful than the laboratory teaching. It gives better learning gain. Thus based on the qualitative analysis of students feedback it can be concluded that the hospital oriented project based learning in Microbiology has definitely better impact on the learning compared to the laboratory based learning. The participants have rightly pointed out that more time be given for teaching Microbiology in the clinical context. The participants expressed this modality of teaching learning as more interactive and helped in increasing the confidence level of participants.

Microbiology is considered as subject of para-clinical sciences but the clinical relevance of the subject is important in view of the applications of Microbiology in various clinical situations. The reform in the curriculum of Microbiology is essential in view of the application of the subject in clinical scenarios. It is necessary for the students to understand various topics in Microbiology in clinical context. The project based hospital oriented learning of the subject is therefore the need of the day to improve the teaching learning process in Microbiology [10].

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The cognitive learning is often done in conventional methods of teaching in almost all medical colleges. However behavioral and attitudinal skills learning as well as working in team is not taught in this subject.

The hospital oriented project based learning is therefore of use to impart the cognitive, attitudinal and behavioral skills training in this subject.

Introduction of such projects is also helpful for collaborative, transformative and reflective learning in the subject.

CONCLUSION

The Pre and post test analysis showed significant improvement in the learning gains in project based group compared to laboratory learning. The students' feedback to project based learning was satisfactory in 100% students and had better impact on the learning compared to the laboratory It is concluded from the present study that the hospital oriented project based learning of Microbiology is better and more effective compared to laboratory room learning.

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BIBLIOGRAPHY

1. Kardash, C., and M. Wallace. The perceptions of science classes survey: What undergraduate science reform efforts really need to address. *Journal of Educational Psychology 2001:*93 (1): 199–210.

2. Bransford, J.D., A.L. Brown, and R.R. Cocking, eds. 2000. *How people learn: Brain, mind, xperience,and school.* Washington, DC: National Academy Press. Available online at *www.nap.edu/ ooks/0309070368/html.*

3. Laura Helle;Paivi Tymjala; & Erkki Olkinuora; project based learning in higher education; Higher Education; 2006; 51; 287-311

4. Maia Lorias & Alexandra Simmons; Implementation of service Learning Module in Microbiology; I of Microbiology & Biology Education;2011; 12(1); 29-37

5. Caccavo F; Project based learning for undergraduate students- An open-ended, inquiry-based approach to environmental microbiology; Tha American biology Teacher;2011; *73*(9), 521-525.

6. Suman Singh, Pravin Singh and Sunil Trivedi: Application based Learning through Hospital projects for teaching Microbiology to Medical Students: National Journal of Integrated Research in Medicine; 2011;2(3);11-15.

7. Neu HC: How is the Medical student being trained in Microbiology and Infections: Annals of Internal Medicine: 1978: 89:818-20.

8. Gaikwad & Tankhiwale: Crossword Puzzle – a self learning tool in Pharmacology: Perspect Med Edu (2012: 1: 237-248

9. Colt HG, Davoudi M, Murgu S, Zamanian Rohani N. Measuring learning gain during a one-day introductory bronchoscopy course. Surg Endosc 2011; 25(1):207-16.

10. Gili Marbach-Ad,1,* J. Randy McGinnis,2 Amy H. Dai,2 Rebecca Pease,2 Kelly A. Schalk,2 and Spencer Benson1: a curricular and pedagogical innovation in an undergraduate microbiology course, Microbes and Society, for non-science majors J Microbiol Biol Educ. 2009; 10(1): 58–67.