

Original Article

Development of research skills in medical undergraduates through mentored research project

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ABSTRACT

Objectives: The purpose of this study was to develop research skills in undergraduate medical students through mentored student research projects in medical colleges in North India.

Materials and Methods: This was an educational intervention study. This project was carried out at a medical college in north India. After obtaining ethical clearance from the IEC of our college, this project was carried out. A core team of 5 faculty members was formed. Forty students were enrolled for this project on a voluntary basis. The project involved mentors from multiple departments who had experience in carrying out research projects. A total of 13 faculty members were involved. The core team prepared a module for training undergraduate medical students in research skills. It was validated by the subject's experts outside the medical college. The training program consisted of 20 classes followed by 10 assignments, during which the students completed their research projects. The students were divided into groups of four, and each group took on one project (a total of ten projects). The training methodology included lectures, individual work, and a plenary session. We planned the evaluation of this training by multiple means. The research projects were graded by three reviewers, who were the faculty members assigned to the task of reviewers. In the end, pre and post-retrospective feedback questionnaires were filled out by students.

Results: All 40 students, working in ten groups, submitted their projects (ten projects). Among these research projects, there were seven descriptive studies, two observational studies, and one interventional study. The average self-rating (on a 10-point scale) of skills in conducting research projects by participants went from 3.8 in pre-training to 8.5 in post-training on the retrospective pre-post questionnaire. The average score (out of 90) on structured research project evaluation by two external experts was 58.5. As evident from the quantitative and qualitative data, the participants gained maximum skills in choosing an appropriate title for the project, choosing study participants, preparing a data collection tool, and dealing with ethical issues. About 62.5% of participants rated the overall quality of training as excellent, and 100% of students recommended continuing training for the next batches.

Conclusion: Undergraduate students can be taught skills of performing research through research projects under mentorship, along with interactive sessions on research methodology.

Keywords: Mentored, Research projects, Undergraduate medical students, Assignments

INTRODUCTION

Developing strong research skills and the provision of excellent medical care are inextricably linked. The medical curriculum should stress research during undergraduate years. However, medical research at the undergraduate level has not been given much importance in India.^[1] One of the reasons is lack of training in research and another reason cited is shortage of opportunities

and funding for students to pursue research.^[2] When given the proper environment, students could contribute in a major way to scientific research.^[3] In developed countries, the importance of student research activities is recognised very well, and it is incorporated into the curriculum.^[4] However, in India, we are still struggling on this forum.

Research is traditionally taught through lectures in the disciplines of pharmacology and community medicine. However, whether students learn to do research at the undergraduate level through this method is left to chance. However, students who want to learn or do research have limited opportunities and do not know a structured way to do research. For opportunity, only a few organisations, such as the Indian Council of Medical Research (ICMR) and Kishore Vaigyanik Protsahan Yojana, provide financial support to encourage students' research in India. A limited number of students get the opportunity to do research through these organisations. For learning the structured ways to do research, the role of mentorship plays an important role.^[5,6] Hence, under mentorship and more opportunities, undergraduate students can learn a systematic way of doing research.

As professionals and researchers, one should understand the importance of teamwork. Teamwork not only divides the load and delegates, making recollection of data easier, but also, if used properly, makes research work organised and systematic. Undergraduate medical students must understand the importance of teamwork in research. The importance of teamwork in research work has been stressed upon by many authors, It was noted that in 103 publications in the New England Journal of Medicine in year 2000, none of them was done by a single author.^[7]

Hence, we proposed a model of introducing research skills to undergraduate medical students by not only giving lectures but also performing research, where the students work in groups and take up research projects under the mentorship of trained faculty in our college.

MATERIAL AND METHODS

Study design

This was a non-randomised educational intervention study conducted among undergraduate medical students of a medical college in North India.

Ethics

The project protocol for this educational intervention project was processed through and approved by the Local Institutional Ethics Committee. The project protocols of individual research projects to be completed under this training program were also processed and approved by the Local Institutional Ethics Committee.

Study timeline

The project was carried out for 1 year:

1. Project protocol development
2. Ethics committee approval
3. Formation of project team
4. Enrolling students for project
5. Formation of module for training students in research skills through mentored research projects
6. Validation of module
7. Implementing the module
8. Conducting classes by faculty along with completion of assignments
9. Submission of project reports by students
10. Evaluation of the project reports by reviewers
11. Feedback from students and faculty
12. Compilation and analysis of data and project report preparation.

Study participants

Eligibility criteria

Undergraduate medical students of MBBS Final Phase 1 who are willing to do research projects.

Selection criteria

The students were asked to draft research questions, and based on that, 40 students were enrolled.

Entry to the training

The participants were given information about the training program on the participant information sheet [Annexure 1], and their written informed consent to participate in this training program was obtained.

The training schedules

Interactive sessions

Twenty interactive sessions on various topics of research methodology were held. The list of topics is as per Table 1.

Assignments

The interactive sessions were followed by hands-on training and assignment submission. The list of assignments is given in Table 2.

The training methodology

The students were provided with reading material in the

form of a soft copy of the module developed. The relevant information on the respective topics was provided to participants through interactive sessions with relevant examples. Then, participants worked in groups (each group had 4 members) on their projects. They were introduced to group dynamics and given tips on how to work in teams. The groups were formed on the basis of a lottery system. After that, sessions on training in research methodology were covered in 20 interactive sessions, along with constant supervision of mentors. Each group, after the assignment of the research question, was assigned a subject-specific mentor.

Table 1: Schedule of interactive sessions.

S. No.	Topic
1.	Introduction to research
2.	Ethics and research
3.	Choosing a research topic
4.	Review of literature using PubMed search
5.	Writing introduction
6.	Aims and objectives
7.	Research design
8.	Methodology in concern to individual projects
9.	Designing of questionnaires and process of validation
10.	Data collection and Preliminary plan for data analysis
11.	Biostatistical tests
12.	Presentation of each topic in large groups
13.	Institutional Ethics Committee: configuration, importance, protocol to be followed and how
14.	Mock ethics committee trial
15.	Data collection
16.	Data analysis
17.	Writing observation and deduction of results
18.	Writing discussion and conclusion
19.	Reference writing
20.	Writing of project report

Table 2: List of assignments.

S. No.	Assignment name
Assignment 1	Submission of research problem
Assignment 2	Submission of title for the project
Assignment 3	Submission of review of literature on the research
Assignment 4	Submission of introduction along with aims and
Assignment 5	Submission of methodology
Assignment 6	Submission of questionnaires pertaining to the project
Assignment 7	Submission of research proposal
Assignment 8	Submission of data collected and analysed
Assignment 9	Submission of observation, results and discussion.
Assignment 10	Submission of project report

Assignment 1–9 is formative. Assignment 10 will be reviewed

In each session, each project was taken up individually by facilitators, and each topic was discussed in relation to the project. Each session was followed by a rest period where groups worked individually on assignments given for that session. The groups submitted the assignment at the start of the next session, where the assignment work was reviewed, and then they received feedback from participants and facilitators. The groups refined their assignments after this session. In this way, 20 sessions and 10 assignments were covered. The 10th assignment was reviewed by 3 external reviewers who were not part of that project. The reviewers graded the project according to a pro forma [Annexure 2].

Validation of the training program

Experience of the team in conducting research methodology workshop: Last year, the team of facilitators facilitated a research methodology workshop at our college for undergraduate medical students. I had done a certified research methodology course from NPTEL (National Program for Technology-Enhanced Learning), which helped immensely to ensure the standardisation of the content. As a team, we designed the course outline and formulated the course content. The whole team also decided on the teaching-learning methodology.

The draft of the training schedule, along with ‘protocol review pro forma’ to be used by external reviewers, was sent to three experts having experience in biomedical research and experience in training health professionals in biomedical research for their validation. The training schedule was modified and finalised based on inputs from these experts.

The facilitators and mentors for this training

We used the following criteria for selecting facilitators and mentors:

- The facilitators of the program were the local faculty members who were easily accessible to the students
- Facilitator had extensive experience (conducted and attended numerous research methodology workshops) in ‘training others in research methodology’
- The mentors were selected based on the research questions and expertise of the faculty
- The mentors had extensive experience in the subject and were easily accessible to students.

Based on the criteria, the core team of five faculty members was formed. The project involved mentors from multiple departments who had experience in carrying out projects. A total of 13 faculty members were involved. In the core team: Two from the Department of Ophthalmology, one from community medicine, one from Physiology and one from Pharmacology. Two members were part of the Institutional Ethics Committee. Cadre-wise distribution of the facilitators

is three professors and two associate professors. Among the mentors, one from ophthalmology (associate professor also member of core team), one from physiology (Professor also member of core team), one from pathology (associate professor), two from psychiatry, one from each project (one Associate professor and one Assistant Professor), two from microbiology (two Associate Professor), one from Medicine (1 Professor), one from chest and tuberculosis (one Associate professor) and one from community medicine (one Assistant Professor).

Evaluation of the training program

External review of the protocols

We had ten research projects for review. We identified three experts: two were experts in the field of biomedical research for a review of research, and one was a subject expert who was a professor of the subject of the research project (not a mentor). These research projects were sent to these experts for an independent review. This review was done on a structured 'protocol review form'. The form covered nine components of the research protocol, and ten marks were allotted to each component, thus making the total mark 90. Thus, our outcome parameter was to see the average score (out of 90) on the assessment of the research conducted. Protocol Review Pro forma is attached in Annexure 2.

Participants own rating of their competency

We used a retrospective pre-post questionnaire to assess participants' perceptions regarding competency on essential components of skills required for research methodology. This questionnaire was pre-validated. It contained 15 items, which were rated by participants on a 10-point Likert scale. The participants were given this questionnaire at the end of the second workshop. The retrospective pre-post questionnaire is attached in Annexure 3.

Participant feedback

At the end of the training program, the participants were asked to provide feedback on a structured, pre-validated feedback form. The form covered aspects such as the content and organisation of the training and participants' suggestions to improve it. The feedback was taken along with the retrospective pre- and post-questionnaire on skills [Annexure 3].

Working in groups

Students were also asked to comment on how many were able to work effectively in groups and what was better when they worked in groups. They were also asked to comment on what hindrances they faced when working in groups.

Data analysis

The data collected were for ten projects. We used the mean or median for the data measured on a quantitative scale and displayed minimum and maximum values where appropriate. Microsoft Excel and Statistical Package for the Social Sciences 22 software were used for analysis.

The qualitative data collected through the feedback pro forma of 40 students were processed by manual thematic analysis.

Implementation of the training program

The training program was spread over 20 interactive sessions. Each session was 40–45 min in duration. The training program also included ten assignments (nine assignments were formative and one was summative). The training methodology in interactive sessions included lectures, demonstrations on necessary computer applications/software, individual work by students on their projects in the form of assignments and plenary sessions where participants got feedback on their protocols from fellow participants and facilitators. The incremental versions of the projects (assignment 1 to assignment 10) were submitted by students against the deadline for each assignment. In the formative assignments, the review was done by mentors and facilitators. Feedback was given face to face, and after the revision, according to feedback, it was given online in Google groups. Internal Google groups and WhatsApp groups were used for internal communication. The assignments were submitted in Microsoft Word format.

RESULTS

Training need assessment

We received a total of 70 requests from Final Part 1 students for this training program. However, due to a large number of students and being the pilot project, we asked the students to come up with the research questions (after introducing them to how to formulate research questions). Forty students successfully submitted 40 research questions. Those 40 students were enrolled in the study. The next batch was scheduled for the remaining 30 students (who did not submit the research questions were not included in this project, but due to ethical considerations, a second batch was started later). The students were asked about their experience with any research project. Ten students out of 40 students had applied for ICMR projects but were rejected. One student had participated in a research project past year in microbiology (the student helped with data collection in the project).

Profile of the training participants

The participants were final part 1 students. Twenty-one

(52.5%) were female and 19 (47.5%) were male. Out of 40 students, 10 students had some prior experience in carrying out research projects.

Profile of the facilitators

Core team: Designation-wise distribution: 3 Professors, 1 Associate Professor and 1 Assistant Professor. Their department-wise distribution is given in Table 3.

Profile of mentors

Among mentors (10 in number), two were professors, six were associate professors, and two were assistant professors. Their department-wise distribution is given in Table 4.

Characteristics of the developed protocols and their quality assessment by external expert

Ten projects were carried out in total. The characteristics of the study design and the titles of the research projects are given in Table 5.

Participants' self-assessment of perception of gain in research skills

Data were collected from students on their perceptions of their competency on a list of 15 essential skills for research. The median pre-training score ranged from 2 to 5, while the median post-training score ranged from 6 to 9 out of 10. Data are shown in Figure 1.

Table 3: Department-wise distribution of core team members ($n=5$).

Department	Number of faculty members in core team
Ophthalmology	2
Physiology	1
Pharmacology	1
Community medicine	1

Table 4: Department-wise distribution of mentors ($n=10$).

Department	Number of faculty members as mentors
Ophthalmology	1
Community medicine	1
Psychiatry	2
Microbiology	2
Chest and TB	1
Medicine	1
Physiology	1
Pathology	1

TB: Tuberculosis

Figure 1 shows the component-wise perception of students on skills required for performing research before and after the training program based on retrospective pre- and post-feedback questionnaires on skills required for research methodology. Hence, the students perceived that they acquired gain in their research skills after the training program ($P < 0.001$).

External assessment of the protocols

Three independent experts reviewed the research projects. The review was done using a protocol review pro forma divided into nine sections, with each section carrying 10 marks. Thus, the protocols were given marks out of 90. The mean marks were 58.4 (minimum 40 and maximum 70). The average marks in each component of the research project are given in Figure 2.

Participants' feedback about the training program

Participant feedback was taken on a structured feedback form at the end of both workshops.

Quantitative feedback

As part of the quantitative analysis, the participants were asked to rate the overall quality of the training at the end of the training program. Figure 3 shows that all participants rated the training from excellent to good. Out of 40 students, 62.5% found the program excellent, and 37.5% rated the program good.

Working in groups: 90% of the students were able to work in groups effectively. All the students felt that working in groups divided their work, and they were able to complete their projects despite time constraints. About 10% felt that working in groups was difficult for them. Among the reasons cited for causing hindrances in working in groups, 55% felt that some students did not do any work assigned to them and they had to do extra work. About 10% cited that they were not able to work because they did not have a working chemistry. Among other reasons cited: We can work better with friends. I would have liked to do the project alone rather than in groups.

Qualitative feedback

As part of the qualitative feedback, we asked the students what they would like to change from the current version of the training program when we go for subsequent batches. The following is the analysis of their feedback.

Opinion regarding what they liked about the training program

About 90% of students liked the teaching-learning methodology and the work ethics followed by teachers and

Table 5: List of titles of research projects completed by students ($n=10$).

No.	Title of research projects	Department	Type of study design
1.	Stethoscope: An important source for nosocomial infection	Microbiology	Interventional
2.	Knowledge, attitude and public perception for HIV/AIDS in various college going students in a city in North India	Medicine	Descriptive
3.	Awareness of eye donation among patients, attendants and staff of medical college and hospital of North India.	Ophthalmology	Descriptive
4.	Prevalence and perception of selfie taking among staff and students of Medical College in north India	Psychiatry	Descriptive
5.	Eating disorders in medical students of Punjab: A cross-sectional study	Psychiatry	Descriptive
6.	Hand hygiene knowledge, attitude and practices among nursing staff and nursing students in a medical college	Microbiology	Observational and descriptive
7.	Comparison of blood indices in vegetarians and non-vegetarians in community	Pathology	Observational
8.	Assessment of views on dietary supplements among physically active gym members of a city in North India	Community Medicine	Descriptive
9.	Blood pressure changes seen in nursing staff of a medical college from time reporting and time of departure	Physiology	Observational
10.	Knowledge attitude and perception of TB among patients visiting Chest and TB OPD	Chest and TB	Descriptive

HIV: Human immunodeficiency virus, AIDS: Acquired immunodeficiency syndrome, TB: Tuberculosis, OPD: Out-patient department

the students during the program. About 10% felt that through this program, they were able to get awareness regarding the health problems in the community.

Following are some of the comments made:

- Unbiased
- The learning experience
- The variety of ideas that flowed
- It gave us an insight into the research methodology in the UG period, which will help us to prepare our thesis during our PG course
- Data collection and analysis
- The team works
- A great way of learning and getting aware and creating awareness among others regarding pertaining health problems. A great way for developing interaction between doctors and their students and between students and public
- Improves knowledge and information about research
- Conclusion writing
- The way each step was explained efficiently
- My favourite part was collecting sample with the help of swab stick because I did it for 1st time
- Conducting research
- Everything was explained in a simplified way
- I liked the fact that our methodology was very practical. It was based on knowing the complete knowledge attitude and practice of people on various aspects and then forming conclusions
- Research on a particular subject evolves curiosity in us knowing the results and help creating awareness to improve further
- Preparing data analysis.

Opinion regarding what could be added to the module

About 90% students felt that the training program should be continued as such. About 10% commented that strict deadlines should be followed along with more topics on which research can be done. Some of the comments were as follows:

- Deadlines
- More topics which could be searched on
- Sample research as a blueprint
- As such no additions required
- I do not think so we need to add anything else because we have done out
- More sessions and monitoring. Otherwise, it is effective
- Possible measures to reduce the burden of problem for which research is being carried can be propagated and mentioned at end of final report
- It builds a confidence in beginners like myself to do more researches.

Other comments and suggestions

- It has been nice working with my team mates and collecting data in different locations under our mentor's guidance
- A great experience which accounts so much for future research projects
- It was amazing to learn under the guidance of amazing teachers
- Research work is an exciting project.

Feedback of mentors on program

All the mentors gave favourable view regarding the training

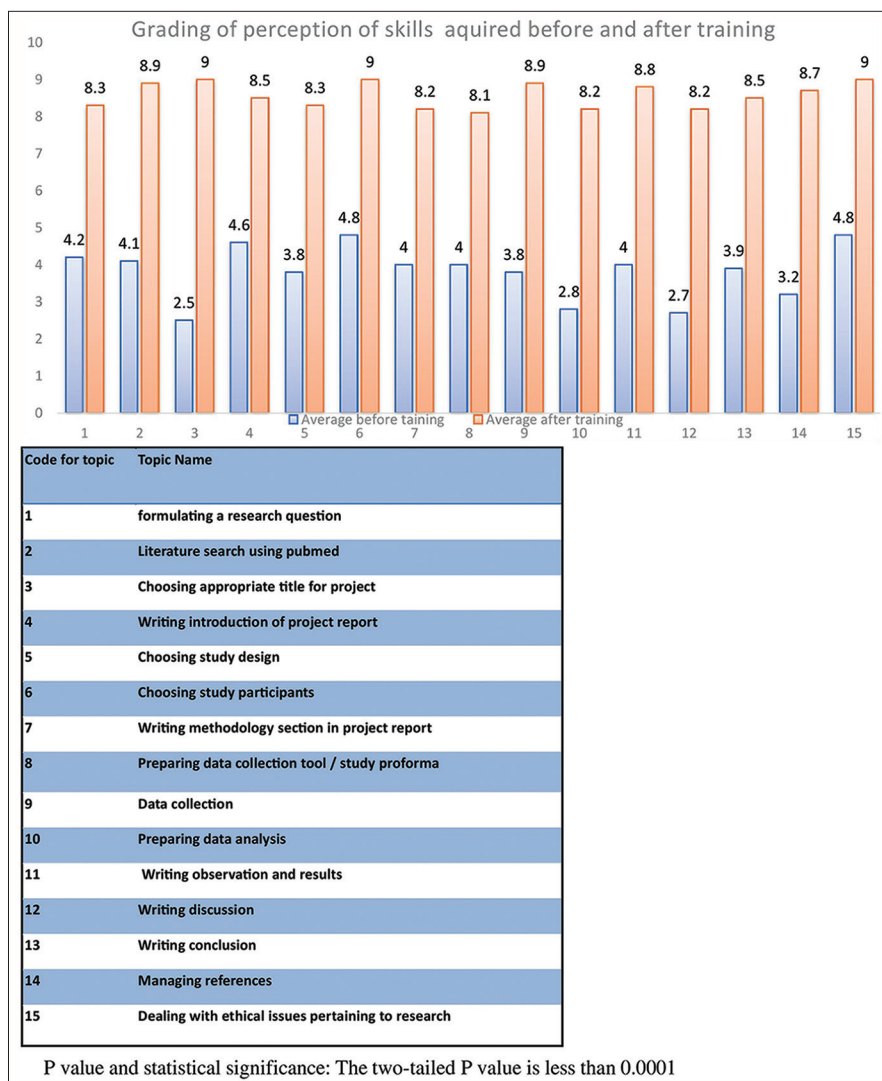


Figure 1: Perception of students of competencies required for research methodology before and after implementation of training program.

program and all the mentors agreed that the training program should be continued for interested students in future.

Some of the comments made by mentors:

- 'The students were completely involved throughout the journey of their project'
- 'This module helped the students get a whole picture about the research methodology and would help in their future projects'
- 'Involving students in research can help in our research projects also'
- 'I wish we had something like this at our time'
- 'This program should be continued for future batches and I wish to be a part of the team in future too.'

Feedback of reviewers on program

All the reviewers gave favourable response to continuation of the training program.

Some of the comments made by reviewers:

- 'The research projects were very thorough and looked like a post graduate thesis'
- 'With a little more fine tuning in biostatistics they would do much better in research methodology'
- 'The scope of this program can be great if more batches can be involved.'

DISCUSSION

The Indian medical graduate should have the skills to research and for doing so he should be trained in his undergraduate years. But in the process of training an undergraduate for doing research on his own, the module followed only includes

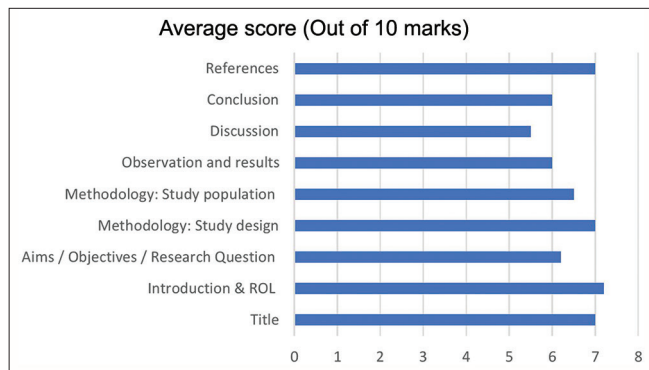


Figure 2: Average marks in each component of research project as rated by assessor. ROL: Review of Literature.

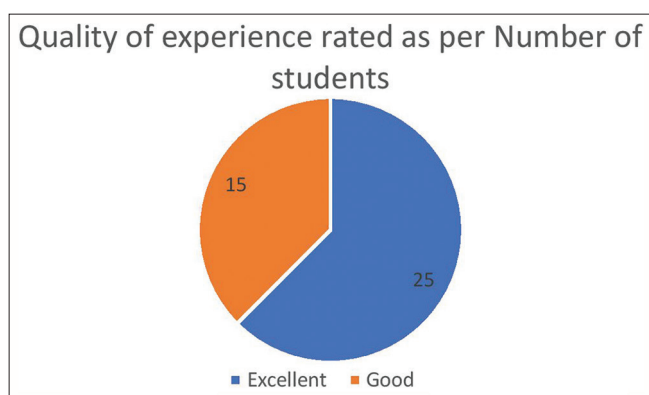


Figure 3: Rating of overall experience as regard to training program quality.

lectures and no practical work. They get a minimal chance to do research projects during undergraduate years.^[8] This project emphasises the scope of mentored research projects for teaching research skills to undergraduate medical students. This training program was intended to introduce skills for doing research and to evaluate their perception regarding acquiring skills necessary for research after the training. Many articles have shown that involving students in research projects is a better way to teach research skills.^[9-11]

Students showed high levels of satisfaction and gain from the training program, the great majority regarded it as valuable, enjoyable, giving them research skills and at the same time developing interaction between teachers, students and community.

Mostafa *et al.*^[9] also reported that involving students gave them both research skills and sensitisation to benefits of engaging undergraduate medical students in research activities. Some students perceived that doing projects under this type of training program can help in careers. Frishman^[12] also reported that medical school research project under mentorship impacts favourably on future careers. Students

perceived that their research skills improved after that training ($P < 0.001$) through mentored research projects along with the interactive session on various competencies required for doing research.

All the faculty members involved in this project presume that the experiences gained through this training program will help students to understand and make use of these skills in their future projects. Other studies in different medical colleges have also reported similar views of teachers.^[6,8,13]

Working in groups was also a new experience for the students. Most of them were able to work effectively in groups and reported that working groups increased their efficiency and helped them complete their research projects in time. The importance of teamwork in research has already been established^[7] and the same was encouraged in our project. However, there were some hindrances but all the students were able to complete the task given to them in groups.

Mentorship held an important key to successfully completing this project. Both faculty and students felt that mentorship built an effective relationship between them. The students also reported that this kind of supervision helped them push their goals beyond what they thought possible by encouraging them to complete their projects despite all the hindrances, learn from mistakes and re-evaluate their mistakes as learning experiences. Many studies have also highlighted that the importance of mentorship in helping building effective mentoring relationships has benefited trainees regarding research aptitude.^[14,15]

The student's research projects were reviewed by independent reviewers and were scored 65.4% on the criteria decided. The reviewers commended the projects as a great endeavour by beginners. They also remarked that with more sessions on biostatistics student's performance can be even better. The authors felt the need of independent reviewers to keep the process unbiased and scrutinised properly. Kelly *et al.* also have mentioned that peer review is fundamental in making the articles credible, high quality, novel and interesting research papers to publish in scientific journals and to ensure the correction of any errors or issues present in submitted papers.^[16]

We recommend combination of interactive sessions on various components of research methodology along with mentoring for research projects which students will do themselves as an effective approach to teach research skills for medical undergraduates.

CONCLUSION

A training module with step-wise sessions and formative assessments can be a helpful tool in teaching research methodology to undergraduate medical students. This type

of module can make students confident in doing various steps of research in a systematic manner. Undergraduate students can be taught skills of performing research through research projects under mentorship along with interactive sessions on research methodology.

Limitations

Sample size was small, due to time and logistics constraint.

Acknowledgments

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Ethical approval

The research/study approved by the Institutional Review Board at Punjab Institute of Medical Sciences, number PIMS/DP/GEN-163/20821, dated May 28, 2018.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent.

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Nil.

Conflicts of interest

There are no conflicts of interest.

Use of artificial intelligence (AI)-assisted technology for manuscript preparation

The authors confirm that there was no use of artificial intelligence (AI)-assisted technology for assisting in the writing or editing of the manuscript and no images were manipulated using AI.

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