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Effectiveness of pulmonary function test as elective module among undergraduate medical students

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ABSTRACT

Objectives: We selected pulmonary function test (PFT), a widely used investigation for diagnosis and monitoring of patients having respiratory complaints in Block I (preclinical) Physiology as an elective module since exposure of undergraduate medical students to PFT is inadequate in formal medical training. The elective module in medical curriculum was introduced by national medical commission (NMC) to provide ample opportunity to the students to opt for any course of their choice not covered by traditional syllabus. This will help them to enhance their knowledge, skill, lateral thinking, creativity, experiential learning, communication ability, team-based collaborative learning thus developing their personal and professional confidence in dealing with resource-limited unfavorable circumstances. Hence we introduced this elective to sensitize the future physicians about the importance of PFT, attract their interest in the subject of Physiology and motivate them to choose Physiology as a career preference.

Materials and Methods: A quasi-experimental study was conducted in the Department of Physiology to create a time-bound activity schedule on the implementation of PFT as an elective module on 32 Phase III part I M.B.B.S students. We assessed the improvement in knowledge and skill by comparing pre-test and post-test results. We have used the Kirkpatrick evaluation model Level 1 to record the reaction of the students and Level 2 to evaluate their confidence regarding PFT after the course. Thematic analysis was performed on the perception and feedback of students and faculties.

Results: We observed that all 32 participating students showed statistically significant ($P < 0.0001$) improvement in both knowledge gain and skill development. This course helped them increase their confidence to perform PFT independently on patients, interpreting reports, diagnosing various respiratory diseases and enabling them to apply this knowledge to manage the clinical cases in the hospital wards and in the emergency department. Thematic analysis of responses of students pointed out the strengths, weaknesses and suggestions for betterment of the module. The SWOT (Strengths, Weaknesses, Opportunities,Threats) analysis of the perception of faculties guided us to devise a modified framework for the implementation of the PFT module in the future.

Conclusion: The elective module on PFT was implemented successfully in our institution with a positive impact on students, assisting them to progress from basic comprehension of the physiology of lung mechanics to independent interpretation of PFT reports to utilising PFT in clinical reasoning and decision-making.

Keywords: Elective, Pulmonary function test, Perception, Medical students, Physiology

INTRODUCTION

Electives can be defined as a short course for an undergraduate medical student, where they can make preferable selection from the available alternatives depending on their interests and career choices.

The concept of the elective module was first initiated as early as 1819 in the United States in the curriculum of the University of Virginia. Subsequently, Harvard University implemented this concept in 1826.[1,2] Publication of the Flexor Report in 1910 served as the basis of the standardisation of medical training programs in Western countries.[3] Henceforth, this change in the paradigm led to the implementation of an alternate curriculum along with a traditional curriculum. This paved the way for the introduction of elective modules in the medical training course.[4,5]

Electives provide the opportunities to gather new information, experience, concepts and skills beyond the core curriculum, allowing them to choose career options according to their current and future interest.[6,7] This kind of training has been proven to promote transformational learning consisting of communicative and instrumental learning.[8] The elective is the least explored section of a medical curriculum despite the fact that it provides the greatest fortuity for significant 'transformative' learning.[9-11]

The elective module contributes both towards the professional and personal development of medical undergraduate students, enriching them with knowledge, competence, expertise, creativity, critical thinking and problem-solving attitudes in different spheres outside the standard curriculum.[12,13]

Realising the potential benefits of electives, the regulatory body for medical colleges across India – the National Medical Commission (formerly Medical Council of India), incorporated an elective module in the Competency-based Medical Education curriculum in the MBBS admission batch of 2019. Initially, it comprised of mandatory two elective blocks in 2 months (Block - 1 and Block - 2 each of 4-week duration) for undergraduate medical students between Part I and Part II of Phase III M.B.B.S professional examination.[14] According to the Graduate Medical Education Regulation 2023 amendment, the duration of Electives has been reduced to 1 month with 15 days each for two blocks.[15]

The eligibility criteria to appear in the final M.B.B.S examination is successful completion of electives with 75% attendance and logbook submission. Block-1 must be done in a pre-selected pre-clinical, para-clinical, basic sciences laboratory, community set-up, or in the research project. Block 2 is to be done in a clinical department (including specialities, super specialities, intensive care units, blood banks, and casualty wards).[14]

In recent times, we have seen a decline in the number of medical students choosing a career in pre-clinical subjects like Physiology. To retrieve the interest of students in the field of Physiology and to sensitise future physicians about the importance of pulmonary function tests (PFT), we decided to introduce PFT as an elective module in the preclinical – (Physiology) Block -1. PFT is an important diagnostic tool for deciding treatment plans for lung disorders. Thus, we undertook an educational approach incorporating the PFT module to ensure that novice learners become well acquainted with relevant principles of physiology so that they can apply this concept in the analysis and interpretation of PFT reports in clinical practice. This PFT elective module will enable the undergraduate Phase III medical students to acquire knowledge about the indications, contraindications, procedures, precautions, interpretation of results and diagnosis of different pulmonary disorders, as well as to develop the skill of performing PFT on subjects and patients independently before entering their actual professional life. This will also enhance their career options in choosing professions such as physiologist, researcher or pulmonologist.

The first objective of our study was to organise an elaborately designed activity schedule in a specific time frame for the implementation of the PFT module as an elective. Second, our intention was to evaluate the effectiveness of the PFT module as an elective. The assessment of the perception and satisfaction of students and faculties about this module was the final purpose of this study.

MATERIALS AND METHODS

A quasi-experimental study involving both quantitative and qualitative methods was conducted to design and implement PFT as an elective module in the Department of Physiology in a Government Medical College in Eastern India. The study was performed on 32 medical students of Phase III part I M.B.B.S who were admitted to this institution in the academic session 2020–21 and selected Physiology in the Block-1 preclinical elective module. Students not giving consent for the study, not having 75% attendance and submitting incomplete questionnaires were the exclusion criteria of the study.

The study commenced after obtaining requisite ethical clearance from the Institutional Ethics Committee and collecting informed consent from participating students. The course duration was 15 days, consisting of 2 h daily sessions from 27th May 2024 to 12th June 2024. The questionnaire (Pre-test and Post-test) on PFT validated by our senior faculty members of the Department of Physiology consisting of 10 multiple choice questions (MCQ) of 1 mark each was used for evaluation of the progress of students before and after the course [Appendix 1]. On the 1st day of the elective course, this questionnaire (pre-test) was distributed among the students through WhatsApp mobile application and email using Google Forms for the assessment of prior knowledge of PFT. The students were also instructed to submit the rating on a pre-course survey for the evaluation of their confidence level regarding PFT through a separate questionnaire based on the Kirkpatrick Level 2 (Learning) Evaluation Model

using a 5-point Likert Scale [Appendix 2].[16] The participant students carried out self-assessment by giving a score on a scale of 1–5 where 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = strongly agree with statements in the survey. Then, lectures were delivered on the physiology of the lung (static and dynamic lung volumes and capacities), different obstructive and restrictive lung diseases and related topics on PFT for 3 days. The topics of lectures were planned in such a way so as to avoid unnecessary repetition of the 1st-year syllabus to ensure constant and intense attention of the students. The technique and manoeuvre of PFT were explained, and PFT procedure on normal subjects was demonstrated. After that, they performed hands on training on PFT on normal subjects under observation of faculties. Next, they performed PFT on ten (10) patients from the outpatient department under the supervision of the preceptors. The practice session continued for 4 days. For the next 2 days, they were taught to interpret the reports of PFT enabling them to diagnose various pulmonary diseases. After completion of the session, the knowledge gained was evaluated with the previously pre-validated questionnaire (post-test) consisting of the same set of MCQs used in the pre-test with the aid of Google Forms. Skill development was assessed through a practical examination of 20 marks with the help of an objective structured clinical examination (OSCE) on PFT procedure and an objective structured practical examination (OSPE) on PFT report interpretation. The seminar presentation on PFT by the students in groups was included in the module to promote active learning, facilitate detailed discussion, improve communication skills, build confidence, share experiences, and exchange perspectives. A feedback questionnaire based on the Kirkpatrick Level 1 (Reaction) Evaluation Model using a 5-point Likert scale along with open-ended questions was administered among the participants to assess their perception and reaction to the implementation of the PFT elective module [Appendix 3]. Finally, the students submitted responses to the post-course survey using the same questions as the pre-course survey for assessment of confidence level at the end of the course. The successful completion of the PFT elective module was accomplished by reflection writing and logbook recording by the students. We also collected the perception of faculties (n = 8) of the Department of Physiology who were involved in the planning and execution of the course.

The detailed structure and day-wise schedule of the PFT elective module as designed by us is illustrated in Figure 1.

Statistical analysis

Data collated from Google Forms were entered in a Microsoft Excel sheet and analysed by Statistical Package for the Social Sciences version 25 (IBM, New York, USA) software.

Quantitative data were expressed as Mean ± Standard deviation (SD), and the qualitative data were expressed in frequency and percentage. The distribution of the data was checked for normality by the Shapiro–Wilk test. The score of pre-test and post-test assessment of the 32 students was analysed by paired t-test. We performed the Wilcoxon rank-sum test to find the statistically significant difference between pre-course and post-course survey ratings. A $P < 0.05$ was considered statistically significant.

Thematic analysis was performed on qualitative data obtained from feedback from students by manually organising the answers to the open-ended questions into codes following Barun and Clarke's six-phase process.[17] The codes generated were then identified into three themes, namely strengths, weaknesses and suggestions for better implementation of the PFT elective module.

Similarly, the responses of the faculties were analysed to recognise the recurrent and essential key themes. We assigned these themes into strengths, weaknesses, opportunities and threats for SWOT analysis. SWOT analysis, originally used as a business tool for strategic planning and decision-making, is at present being applied in fields of medical education.[18,19]

RESULTS

In our study on the PFT elective course, a total of 32 phase III part I undergraduate medical students participated, comprising 18 (56.25%) females and 14 (43.75%) males with mean ± SD age 22.78 ± 0.87 years. Each and every student appeared in all the assessments and submitted their feedback.

The statistically significant difference ($P < 0.0001$) between pre-test and post-test scores of assessments of knowledge regarding PFT indicating cognitive improvement at the end of the course has been represented in Table 1. We also observed that most of the students obtained high scores of 16.56 ±1.24 (Mean ± SD) in practical examinations consisting of OSPE and OSCE out of 20 marks, deciphering the proper attainment of knowledge and skill after the course.

Table 2 depicts the perception of students on the PFT elective module based on the Kirkpatrick Level 1 (Reaction) Evaluation Model using the Likert scale. The responses of the majority of the students (78.13%) were satisfactory regarding the content and teaching-learning process as it paved the way for them to acquire new knowledge and clinical skills beyond the traditional curriculum. However, few students expressed their discontent with the time allotted for practice sessions (25%) and inadequate infrastructure (15.63%). The PFT module was well accepted by the students, as evident from the fact that 75% of them felt motivated in future research work, and 84.38% stated that they would recommend junior students to select the PFT module as an elective.

In Table 3, we have compared the pre-course and post-course survey ratings of perceived confidence regarding

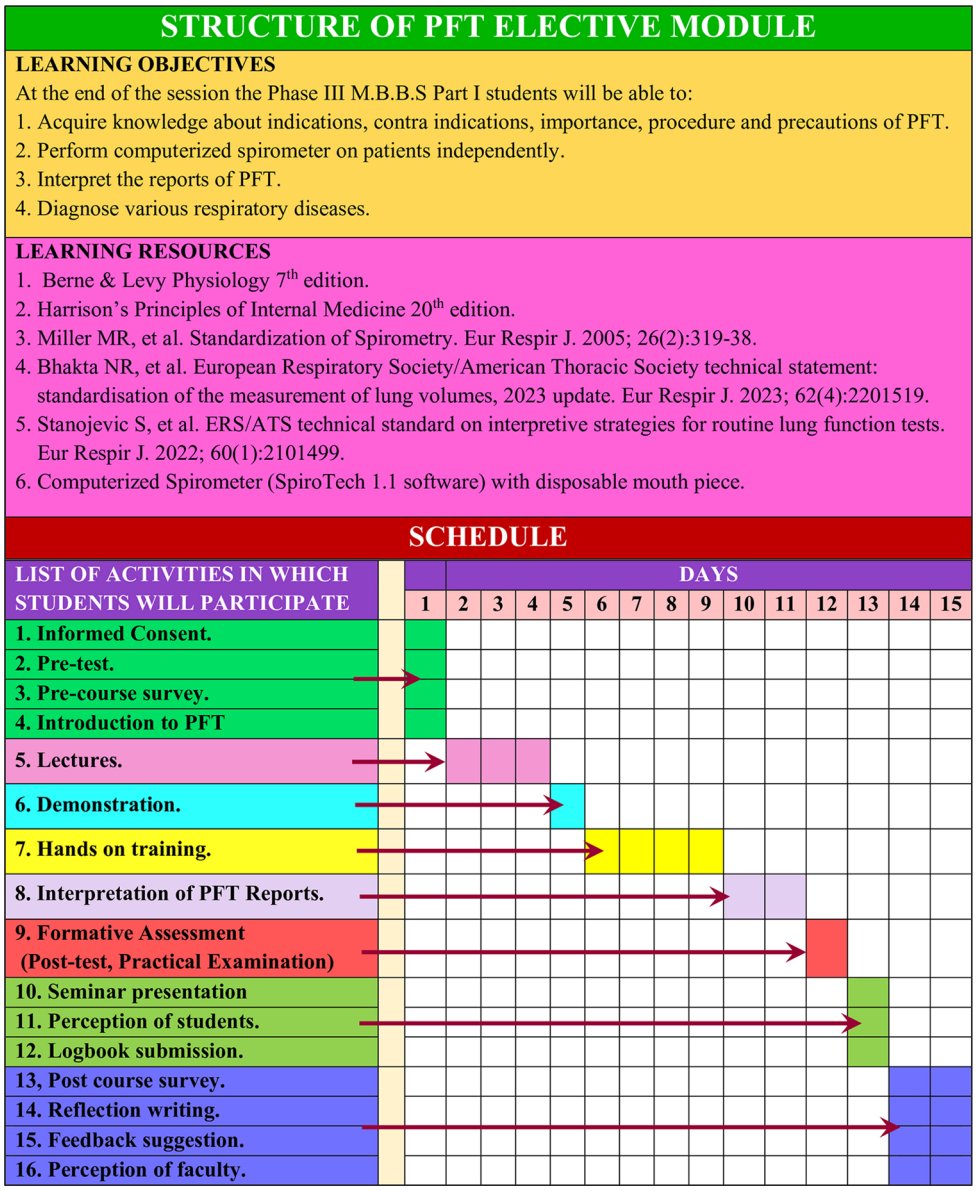

Figure 1: Structure and schedule of pulmonary function test elective module. The color in the legends denotes the day of specific activity. The colors in the left hand show the different activities and the same colors on the right represent the days of those particular activities. PFT: Pulmonary function test

Table 1: Marks obtained as mean (SD) in pre-test, post-test and practical examination of students.

Assessment	Mean±SD	*P*-value
Pre-test	3.72±1.65	<0.0001
Post-test	8.16±1.27	
Practical test	16.56±1.24	

Number of students: 32 students, *P*-value obtained using Paired *t*-test by comparing pre-test and post-test mean (SD) scores of assessments on PFT. PFT: Pulmonary function test, SD: Standard deviation

the PFT module using the Kirkpatrick Level 2 (Learning) Evaluation Model. The statistically significant difference ($P < 0.0001$) between pre-course and post-course survey scores demonstrates marked improvement of the students in achieving the objectives of the module — like knowledge, importance, indications, contraindications, precautions, skill, procedure and interpretation of reports of PFT.

Table 4 summarises the thematic analysis of the responses of the students on the PFT elective module. The strengths of the

Table 2: Perception of students on PFT elective module based on Kirkpatrick level 1 (Reaction) evaluation model using Likert scale.

Questions	Strongly agree *n* (%)	Agree *n* (%)	Neutral *n* (%)	Disagree *n* (%)	Strongly disagree *n* (%)
1. Whether objectives of PFT elective module are clearly stated?	24 (75.00)	5 (15.62)	3 (9.38)	—	—
2. Whether content of PFT module adequate?	22 (68.75)	3 (9.38)	2 (6.25)	5 (15.62)	—
3. Whether procedure of PFT was explained properly?	30 (93.75)	2 (6.25)	—	—	—
4. Whether teaching and demonstration was interesting and informative?	26 (81.25)	4 (12.50)	2 (6.25)	—	—
5. Whether adequate time was given for practical session?	16 (50.00)	4 (12.50)	4 (12.50)	5 (15.62)	3 (9.38)
6. Whether proper infrastructure was available?	19 (59.38)	3 (9.38)	5 (15.62)	4 (12.50)	1 (3.12)
7. Whether the module enhanced my knowledge and skill?	27 (84.38)	5 (15.62)	—	—	—
8. Whether I am satisfied with the choice of PFT as elective module?	25 (78.12)	3 (9.38)	4 (12.50)	—	—
9. Whether PFT module motivates me to do further medical research on PFT?	18 (56.25)	6 (18.75)	5 (15.62)	3 (9.38)	—
10. Would I recommend other students to take PFT as elective module?	21 (65.63)	6 (18.75)	5 (15.62)	—	—

Total number of students: 32, *n*: Frequency, %: Percentage, PFT: Pulmonary function test

Table 3: Comparison of pre-course and post-course survey score of perceived confidence in knowledge and skill of PFT module based on Kirkpatrick Level 2 (Learning) evaluation model using Likert scale.

Statements	Pre course score mean±SD	Post course score mean±SD	*P*-value
1. I am aware of the different kinds of PFT.	2.97±0.31	4.53±0.57	<0.001
2. I understand the importance of PFT as diagnostic tool in patients with respiratory disorder.	2.75±0.84	4.47±0.62	<0.001
3. I have knowledge about definitions and normal values of the different parameters used in PFT.	3.03±0.78	4.44±0.56	<0.001
4. I am aware of the indications of PFT.	2.25±0.67	4.25±0.98	<0.001
5. I am aware of the contraindications of PFT.	2.34±0.65	4.38±0.75	<0.001
6. I have a clear idea about the different types of respiratory diseases.	2.28±0.73	4.03±0.82	<0.001
7. I am able to differentiate between obstructive and restrictive lung diseases.	1.25±0.44	3.96±0.69	<0.001
8. I know the precautions to be taken during PFT.	2.56±0.50	4.63±0.55	<0.001
9. I feel confident in performing PFT on patients.	1.06±0.25	3.78±0.83	<0.001
10. I am able to interpret the results of PFT.	1.16±0.37	3.84±0.77	<0.001

P-value obtained using the Wilcoxon rank sum test. PFT: Pulmonary function test, SD: Standard deviation

module in terms of effectiveness, relevance, enhancement of knowledge and skill, in-depth understanding of the subject and satisfactory guidance by the faculties are given in this table. Responses of students regarding mandatory attendance, fewer practice sessions, logbook completion and extra burden on preexisting final-year courses were identified as the weaknesses. The suggestions given by the students included the incorporation of clinically oriented interactive sessions, increased involvement in group activity, infrastructure improvement and focus on research methodology.

SWOT analysis performed to identify strengths, weaknesses, opportunities and threats by sorting the perception and opinion of faculties on the implementation of the PFT elective module is presented in Figure 2.

DISCUSSION

We observed that phase III Part I M.B.B.S students showed statistically significant improvement ($P < 0.0001$) in knowledge gain, as evident from the comparison of the pre-test (3.72 ± 1.65) and post-test (8.16 ± 1.27) mean scores. The skill development was satisfactory, as indicated by the results of the practical examination (16.56 ± 1.24). From pre-course and post-course surveys, we found that most of the students achieved the desired objectives regarding indications, contraindications, precautions, procedures, importance and interpretation of PFT.

Feedback suggestions from students directed us to include more focused group discussion/small group discussion sessions incorporating problem-based learning and case-based learning and emphasising evidence-based Medicine. These novel teaching-learning strategies will enhance critical thinking, clinical reasoning, problem-solving and decision-making attitude in every student.

The increased confidence in performing PFT independently on patients, comprehension of reports and diagnosis of various respiratory diseases will enable them to apply this

Table 4: Responses of students on PFT elective module (thematic analysis).

Theme	Sub-theme	*n*	%	Salient perception of students in their own words.
Strength	1) Effective and relevant content.	20	62.50	'I found the content informative and interesting.'
	2) Enhanced knowledge and skill.	18	56.25	'It provided me an opportunity to learn a new skill.' 'I gained new information.'
	3) Satisfied with endeavour of preceptors and faculties.	17	53.13	'The faculties were helpful.'
	4) Good experience unlike traditional curriculum.	15	46.88	'Superb experience.' 'I had a pleasant and enjoyable experience.'
	5) Met expectation.	14	43.75	'Increased my concept understanding.'
	6) Great opportunity for hands on training.	12	37.50	'I could link the theoretical knowledge with clinical application.'
	7) Helpful in depth understanding of the subject.	7	21.88	'Integration of learnt information.' 'I could clear my doubts.'
	8) Contributed to personal and professional development.	4	12.50	'Enhanced my communicative skill.' 'Improved my analytic skill.'
	9) Enabled to opt for future career preferences.	2	6.25	'Inspired me for further study on respiratory physiology.'
	10) Scope for development of time management skill.	1	3.12	'I learned to utilize time properly.
Weakness	1) No weakness	18	56.25	'Nothing. Everything was helpful' 'It was well organised.'
	2) Practice session less.	9	28.13	'More time should be allotted for practical.'
	3) Extra burden on pre-existing course.	2	6.25	'Time consuming.'
	4) Compulsion of 75% attendance.	2	6.25	'Attendance should not be mandatory.'
	5) Logbook complete and signature of faculty	1	3.13	'I had to spend a lot of time to prepare for seminar and logbook.'
Suggestions	1. Elective should be clinically oriented.	22	68.75	'The course should be more patient oriented' 'It will be better if larger number of practice session on patient could be arranged.'
	2. More interactive session are to be conducted.	8	25	'I feel student-teacher interaction was not enough'
	3. Improvement of infrastructure.	6	18.75	'In my opinion appropriate measures are to be taken so that we can access spirometer equipment easily.'
	4. Inclusion of research Methodology.	3	9.38	'I suggest to include the data analysis of the PFT results to enable us for future research.'
	5. Relaxation in attendance and assignments.	2	6.25	'I did not like the mandatory 75 % attendance.' 'I found log book entry and getting signature of the faculty tedious job.'

Total number of students: 32, n: Frequency, %: Percentage, PFT: Pulmonary function test

knowledge to manage the clinical cases in the hospital wards and emergency department. The elective module will improve the capability of students to select rationally and judiciously appropriate diagnostic tests for the patients to alleviate their ailments in a cost-effective way and provide high-quality patient care services.

We designed, planned and implemented this PFT elective module in such a way that the undergraduate students could correlate the conceptional knowledge of preclinical basic science subjects like physiology with real-life situations, thus opening up a new perspective of pre/non-clinical subjects. Students do not find physiology interesting due to the prevailing misconception that it lacks a direct impact on patients. It has now been realised that a profound understanding of the fundamental principles of Physiology is necessary for comprehending the inherent complexities and acquiring mastery in clinical disciplines such as medicine, surgery, gynaecology and paediatrics. We framed a detailed structure of the PFT elective module to make it (S)pecific, (M)easurable, (A)chievable, (R)ealistic and (T)ime-bound i.e. SMART to ignite a spark of curiosity and instil a profound passion for the captivating and elegant subject of Physiology.

This elective will provide an opportunity for both professional and personal development in the realm outside the traditional medical curriculum. It plays an important role in developing transferable skills of attitude and ethics besides knowledge and skill. The students will be able to improve communication skills, teamwork and leadership qualities. It will motivate the student to take up research work. The elective will inspire the autonomy and autodidaxy amongst students, promoting self-directed learning and

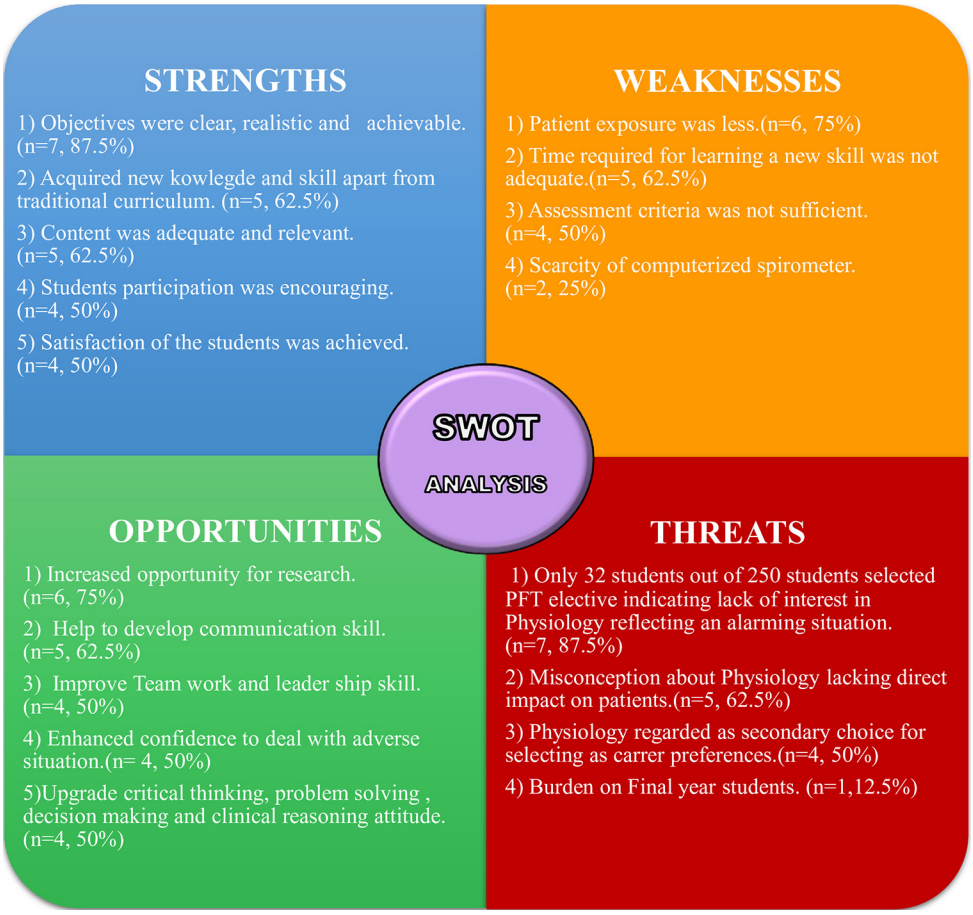

Figure 2: Perception of faculties on conducting the pulmonary function test elective module (SWOT Analysis). Where total number of faculties = 8, n = Frequency.

ensuring continuous lifelong learning so that they can apply advanced knowledge to cope with adverse situations. The elective module will prepare the final-year students for a smooth transition from undergraduate to postgraduate medical training. This experience will help them to gain confidence in practising medicine and dealing with patients, although the module is preclinical.

Various studies documented that the concept of electives is innovative, interesting and relevant academic activity.[4,6,9,12,13,20-22] However, elective on PFT in the preclinical block is a comparatively new topic, while detailed studies are available on Yoga, Radiology, Medical research, International Health, Global Health, Internal medicine- paediatrics, Ophthalmology, Neurosurgery, Social Medicine and Emergency Medicine.[6,9,12,13,20,21,23-30] The perception and satisfaction of students, as well as feedback and opinions of faculties, bear testimony to the successful implementation of our PFT module. The positive response obtained from our study serves as an inspiration for us to continue the PFT elective module in the future.

Limitations

We conducted our study only on a small number of students – however, the inclusion of a large number would have led to detailed and reliable information on the perception of students about the PFT elective.

We did not administer the Kirkpatrick Level 3 (Behaviour) Evaluation Model to pursue long-term retention of knowledge, change of attitude and behaviour and application of skill in working place to demonstrate the ultimate effectiveness of the elective module.

CONCLUSION

The elective module on PFT was successfully executed in our institution with an overall satisfactory experience. This enhanced knowledge and skill development met the expectations of the students. Based on the feedback suggestions of the students and recommendations of the faculties, we intend to modify the course to evoke interest in more students to choose PFT as an elective module in physiology.

Acknowledgment

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Ethical approval

The study was approved by the Institutional Ethics Committee vide Ref. No EC-CNMC/2023/371 dated December 16, 2023.

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 writing or editing the manuscript.

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