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Desiring the restructuring of physiology laboratories for digital way of teaching: Perceptions of medical teachers in India

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ABSTRACT

Objectives: The medical college curriculum in India has not seen a change for the past several years. An initiative has been taken by the Medical Council of India (MCI) in the Graduate Medical Regulation 2018 to bring a uniform change in teaching-learning methods. This change is necessary in all fields of medical education. Restructuring the physiology laboratories to teach practical procedures using digital computerised equipment and techniques could bring about deeper learning. The past several years have made physiology merely imaginative rather than experiential.

Materials and Methods: A qualitative study was done using a questionnaire to obtain the perceptions of medical teachers of both genders engaged in teaching medical physiology. Desires and opinions of physiology teachers in changing the way physiology is taught were obtained.

Results: Medical teachers felt that a change is necessary to provide better learning experience. More than 80% opined that computerised equipment provide better practical experience with wider understanding of the concepts which students can relate to theoretical concepts. About 85% of teachers supported the move to suggest to MCI on restructuring the laboratories with computerised equipment. More importantly, many teachers expressed that the digital laboratories would make learning very interesting, autonomous and self-directed. The study is not just a platform for opinions but is intended to prompt reflection and bring clarity to the regulatory bodies showing a way forward to change the laboratory setup urgently.

Conclusion: Most of the medical teachers in India are finding it appropriate to employ digital ways in teaching Physiology to have better learning outcomes.

Keywords: Restructuring, Curriculum, Physiology, Practical procedures, Digital

INTRODUCTION

The undergraduate curriculum followed in medical colleges across the country has by and large been uniform for the past several years. An initiative has been taken by the Medical Council of India (MCI) in the Graduate Medical Regulations 2019 to bring a uniform change in the teaching and learning methods. Medical teachers always strive hard to bring in methods to make learning more experiential. Human body provides a wealth of physiological, cognitive and emotional information. This biological data can be converted into an input signal into a computerised system in the form of biosignals from analogue to digital for storage, analysis and retrieval.

Using technology in the society has become widespread as also in human biology laboratories such as experimental psychophysiology and other medical domains. Several researchers have strived to provide a platform for deeper understanding and learning human physiological frameworks and refining these models continuously to obtain positive and strong learning outcomes.[1-4] It is necessary to take this opportunity of utilising this knowledge of computers to improve and make the study of human physiology interesting and interactive by creating user interfaces that allow the users to communicate with the operating system. It becomes a lot easier for the physiologists to explore the biosignals on a computerised platform. In the recent times, several such e-learning platforms are available, like, simulation and integrative models for understanding various systemic physiological processes.[5,6] Several three-dimensional stand-alone models as teaching tools are available giving the student a good visual experience.[7] Simulation laboratories which are mandatory for skills development and training to undergraduate and postgraduate students in a medical college are also incorporating modules on teaching basics before the case scenarios and complex surgical techniques are taught. Physiology simulation modules for teaching have been well accepted by the medical students in some parts of the country.[8] However, experiencing real-time computerised measurement techniques would convert the theoretical learning into a practical experience which would stay in the memory traces of the student on which further knowledge can be built. Medical schools in India are still using the conventional methods for teaching and learning human physiology. While it is necessary to understand the conventional methods of experimental procedures, there is also a necessity for the medical fraternity to explore the recent techniques of experimentation and teaching in the subject to their students. The MCI in the Minimum Standards of Requirement (MSR) has given the opportunity to all medical colleges to adopt and replace the conventional equipment with the computerised models in their laboratories for teaching physiology. However, since, it has not made it mandatory, several institutions have not acquired the computerised systems for this purpose. Physiology teachers have no option but to continue to teach physiology in an abstract manner. Furthermore, due to the strict animal ethics guidelines, it has also become difficult and nearly impossible to perform the conventional experiments to demonstrate to the students about the physiological processes. It is proper to say here that most of the human physiology is learnt in the laboratory. Due to the non-availability of such resources, neither conventional nor computerised in most of the medical colleges in India barring a few, the student is left to imagine most of the physiology that has not only made learning difficult but also given way to lose interest in the subject. Good knowledge of human physiology is no doubt a necessity for the students to become competent doctors with critical analysis and good diagnosing abilities.

The study would also help the authorities such as the managements of medical colleges and medical council to take appropriate steps to introduce such techniques for teaching, learning and assessment of medical students.

MATERIALS AND METHODS

A questionnaire was designed with items framed so as to obtain information on usefulness of computerised systems, their potential benefits including ease of handling, accuracy over the traditional equipment, perceptions about improved learning experience, scope of creating interest among the students, using such techniques for better engagement in the subject and requirement to continue with traditional methods of teaching practical physiology. Questions were framed to obtain information about their knowledge regarding the amendments in MCI and attitude toward replacement of traditional with computer-based systems for practical procedures in physiology. The questionnaire was then made into an online form and was first administered to a test group to check for internal consistency. A link for the online questionnaire was then released to several physiologists across the states of Andhra Pradesh, Telangana and few neighbouring states. A total of 119 physiologists of both sexes responded to the online questionnaire. Participation was totally voluntary and responding to the online questionnaire was assumed as having consented to take part in the study which was clearly mentioned at the beginning of the online form. The institute's ethics committee permission was obtained.

RESULTS

The responses were segregated and analysed using percentages and by applying non-parametric tests to find the significant differences between the early career (EC), mid-career (MC) and senior faculty (SF) groups on agreement or disagreement on the questions. The results were tabulated. A total of 119 physiologists participated in the study. The proportion of participants belonging to MC with experience between 6 years and 15 years was more (47.06%) than the EC (29.41%) and SF (23.53%) [Table 1].

The EC group included postgraduates, tutors and assistant professors who had up to 5 years of teaching experience. The MC faculty was those whose experience ranged between 6 years and 15 years and SF had more than 15 years of experience [Table 2].

The responses to the questions were grouped into three categories of positive, neutral and negative responses expressed in numbers and percentages, as shown in [Table 3].

The questionnaire was validated by estimating Cronbach's alpha using Microsoft Excel software and found the internal consistency to be good (Alpha = 0.718123). As all the items in the questionnaire are unidirectional toward knowing the need to restructure the laboratory teaching in physiology in the digital way, the items were not separately analysed against their responses by the three groups. Rather, responses to all the items were analysed between the EC, MC and SF groups. Responses were ranked as 5 – strongly agree, 4 – agree, 3 – neutral, 2 – disagree and 1 – strongly disagree for further analysis. GraphPad Prism software version 9.0.0 (121) was used for statistical analysis. Using Dunn's multiple comparison tests and Friedman non-parametric test, it was observed that there are significant differences between the groups. There is a significant difference in the agreement and in being neutral on all the questionnaire items between the groups, but no such difference is present in the disagreement on all the items. Even though all the groups showed more of agreement on all the items, most significant ($P < 0.0001$) difference was found between MC and SF groups on agreement, MC group agreeing more compared to SF and EC. Similarly, Dunn's multiple comparisons test showed that the MC and SF groups significantly differ in their neutral responses ($P = 0.0004$) [Table 4].

Further, Friedman test was performed as an equivalent to one-way ANOVA test on the agreement, disagreement and neutral responses between the three groups to all the items in the questionnaire. The results showed that the means of the responses between the three groups were significantly different in their agreement ($P < 0.0001$) on the questionnaire and not significant in the disagreement ($P = 0.1005$) [Table 5].

Table 1: Stratification of physiologists as per years of experience.

Experience in years	Number of physiologists	Percentage of physiologists as per years of experience
0–5	35	29.41
6–10	29	24.37
11–15	27	22.69
16–20	17	14.29
21 and above	11	9.24
Total	119	

DISCUSSION

Physiology experiments for undergraduates using frogs in the amphibian laboratory were performed till two decades ago wherein every student would dissect the frogs and perform the nerve, muscle and heart experiments. In the recent times, the availability of digital modules with user-friendly software is making it possible for the students to replicate the nerve-muscle experimental findings on their own bodies and have the feel of learning. Many faculty workshops felt that experiencing the stimulus and response on their own nerve and muscle gave them a better learning experience which the student would surely recall and apply this experience while learning the subject. About 72% (72.27%) of the participants of the study felt that computer-assisted learning was a good alternative to traditional learning for physiology practical procedures. This is mainly because use of animals in physiology has taken a downtrend in the recent years due to ethical concerns. As a result, the faculty is left with no other option but to simply give a visual projection of the nerve muscle graphs that include a one-way teaching method leaving a lot to the imagination of the student.[9] Several faculties are looking for alternatives to make the teaching-learning experience more productive and fruitful. Studies in the past have shown that students perceive learning physiology as difficult, comparing it with difficult puzzles that need to be solved or making disproportionate efforts to learn the subject.[10] About 84% (84.87%) of the participants of the study recommended replacing the conventional equipment with newer computer simulators. A similar proportion of teachers felt that muscle experiments done on humans provide similar or better learning experience than traditional amphibian experiments. However, they were about 58% (57.98%) of the teachers who did feel that the traditional system should continue for teaching physiology practical classes. This group of teachers mainly belonged to the senior cadres of professors and associate professor who probably had the experience of performing such experiments on animals in the earlier days and, hence, felt the need to continue along with the newer methods. This is justified given the fact that knowledge of traditional methods lays the foundation and helps one to understand the modern equipment. Furthermore, there could be a proportion of faculty who is computer illiterate and not acquainted with

Table 2: Stratification of physiologists as per experience and cadres.

Cadres	Number	Experience 0–5 years	Experience 6–10 years	Experience 11–15 years	Experience 16–20 years	Experience 21 years and above
Professor	39	Nil	1	16	13	9
Associate professor	24	Nil	13	7	4	Nil
Assistant professor	38	17	15	4	Nil	2
Tutor	10	10	Nil	Nil	Nil	Nil
Postgraduate	8	8	Nil	Nil	Nil	Nil
Total	119	35	29	27	17	11

Table 3: Responses to questionnaire items: Grouped into three categories of positive, neutral and negative responses.

Questions	Positive responses (strongly agree and agree) *n* (%)	Neutral *n* (%)	Negative responses (disagree and strongly disagree) *n* (%)
Computer-assisted learning is a good alternative to traditional learning for physiology practical	85 (71.42)	23 (19.33)	10 (8.4)
It is necessary to continue to teach the traditional methods of practical in physiology	69 (57.98)	21 (17.65)	29 (24.37)
It is advisable to replace the kymographs with computer-based learning software and systems	101 (84.87)	10 (8.4)	8 (6.72)
In electrophysiology nerve muscle experiments done on humans provide similar or better learning experience than traditional amphibian experiments	99 (83.19)	13 (10.92)	7 (5.88)
Digital/computer-based experiments provide a wider scope of understanding physiology by the student in various fields of nerve muscle, cardiovascular, respiratory and psychophysiology	106 (89.08)	8 (6.72)	5 (4.2)
Experiencing the stimulus response by student can make the practical experience to students more understandable	110 (92.44)	6 (5.04)	3 (2.52)
Students enjoy the learning by making the subject more interesting to them through such advanced methods	111 (93.28)	5 (4.2)	3 (2.52)
Traditional instruments should still be used for demonstration purpose and should be a part of history of medicine	89 (74.8)	15 (12.61)	15 (12.61)
Availability of the digital computer systems would enable postgraduates and faculty to involve in research activities in a more objective manner	111 (93.28)	6 (5.04)	2 (1.68)
Would you support the move to suggest MCI to replace the traditional kymographs with computer based experiments in physiology	102 (85.71)	11 (9.24)	6 (5.04)
MCI should consider replacing the conventional methods with computer-based systems for teaching physiology in the laboratory?	99 (83.19)	13 (10.92)	7 (5.88)
Students are technology savvy and would learn better and grasp the subject more if allowed to use the computer based systems for learning physiology in the laboratory	98 (82.35)	14 (11.76)	7 (5.88)
Computer-based systems are easier to use and results obtained are more precise than traditional mechanical devices	98 (82.35)	15 (12.61)	6 (5.04)
Are you aware that the MCI, minimum standards of requirement has given the option of replacing the conventional animal experiments with computer based systems for teaching physiology in the laboratory?	Yes 80 (67.23)	No 39 (32.77)	

MCI: Medical Council of India.

Table 4: Groups' responses on agreement, disagreement and being neutral to all the items.

Dunn's multiple comparisons test	Adjusted *P* value	Significant
MC agree versus EC agree	0.0065	Yes
MC agree versus SF agree	<0.0001	Yes
MC neutral versus EC neutral	0.6536	No
MC neutral versus SF neutral	0.0004	Yes
MC disagree versus EC disagree	0.1551	No
MC disagree versus SF disagree	0.1551	No

MC: Mid-career, EC: Early career, SF: Senior faculty.

the computer software and is resistant to use such electronic resources for teaching. About 83% of the physiologists (83.19%) felt that doing human nerve-muscle experiments in digital physiology laboratories give similar or better learning experience compared to doing traditional amphibian experiments. This shows that many faculties have experienced these procedures on themselves probably through workshops and demonstrations and felt that first-hand experience of the stimulus response leads to better learning outcomes than even the traditional methods done on frogs. A small percentage of about 11% gave a neutral response (10.92%) and another small percentage of about 6% (5.88%) gave a negative response. These participants probably did not get an opportunity of a hands-on experience of the electrophysiology equipment. About 89% (89.08%) felt that digital/computer-based experiments provide a wider scope of understanding physiology by the student in various fields of nerve-muscle,

Table 5: Friedman test results for the agree, disagree and neutral responses between the three groups.

Friedman test	Agree	Neutral	Disagree
P value	<0.0001	0.0001	0.1005
P value summary	****	***	Not significant
Are means significantly different? (*P*<0.05)	Yes	Yes	No
Number of groups	3	3	3
Friedman statistic	22.62	17.64	4.596
Data summary			
Number of treatments (columns/groups)	3	3	3
Number of items (rows)	13	13	13

cardiovascular, respiratory and psychophysiology. A varied experience is provided to the student using computerised platforms wherein different systems can be targeted to obtain the desired learning. Studies on perceptions of students toward using computerised interactive digital platforms have shown that students improved practical competence and were also able to operate these independently.[11] About 92% (92.44%) of the faculty expressed their opinion that experiencing the stimulus response by the student can make the practical experience conceptually more understandable.[11] Enjoying the learning process is an important attribute for gaining interest in a subject. Enjoyment promotes students' interests, effort and engagement.[12,13] The present-day students are technology savvy and can easily manoeuvre the computerised sophisticated equipment with ease and would get more involved in the subject that would promote deeper learning, critical thinking and understanding. Many faculties, about 93% (93.28%) also felt that by making the subject more interesting to them through such advanced methods would make learning more enjoyable. A good proportion of faculty of about 74% (74.8%) did feel that the conventional equipment should be a part of the History of Medicine probably due to the emotional attachment associated with these techniques during their student days. As such historical perspectives lay the foundation for future changes. About 93% (93.28%) expressed their agreement to the statement that postgraduate and faculty research can become more objective with such computerised instruments available in physiology laboratories. About 82% (82.35%) also felt that computer-based systems are more easier to use and results obtained are more precise than traditional mechanical devices. This view was probably taken in the wake of the experience of having to make cumbersome electrical connections and preparations while using mechanical devices. On the contrary, the use of computerised equipment no doubt would save time, energy and provide accuracy and precision in measurement of several physiological parameters. About 85% (85.71%) were in favour of initiating the move to suggest MCI to replace the traditional kymographs with computer-based experiments in physiology. The faculty clearly is of the opinion that unless MCI makes it mandatory for the medical colleges to procure such equipment, it is nearly impossible to convince the managements to implement the same. When an attempt was made to know the awareness of the participants regarding the MCI, MSR clause of giving the option of replacing the conventional animal experiments with computer-based systems for teaching physiology in the laboratory, only 67% (67.23%) were aware of such option. It is generally observed that in many medical colleges, barring a few government medical colleges, very few faculty are involved in the process of procurement of equipment for their department and hence are not aware of the MCI, MSR amendments. Active involvement by faculty in every aspect of procurement and usage will surely motivate them to understand and keep themselves updated with the changes made by MCI from time to time.

CONCLUSION

Overall, the study projects the desire of several faculty to move from the traditional practical methods of teaching physiology to the new and recent computerised methods that would facilitate better teaching-learning outcomes and also motivate students and change their negative perception about the subject to a more positive attitude. A high level of satisfaction and confidence at the teachers end would translate into better learning outcomes. Positive disposition of teachers toward their professional practice causally relates to a positive classroom behaviour motivating students to think and learn in a deeper manner. Hence, it becomes necessary to protect the interests of the teachers for maintaining a strong educational environment in a medical institute.

Practice points

- Urgent need to restructure the medical physiology laboratories in medical colleges.
- Digitisation of equipment needed for experiential learning.
- Regulatory bodies to become more aware of the changing needs of laboratory setup.
- Active involvement of faculty required to bring about timely need-based changes.
- Satisfaction and confidence among teachers would translate into better learning outcomes.

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Declaration of patient consent

Patient's consent not required as there are no patients in this study.

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Conflicts of interest

There are no conflicts of interest.

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