DOI: 10.7860/JCDR/2020/46389.14172

Review Article

Education Section

# Medical Education in India: Current Scenario of Teaching-Learning Methods

SUNDIP HEMANT CHARMODE[1], SHELJA SHARMA[2], SURYAKANTA SETH[3], SUBODH KUMAR[4], VIVEK MISHRA[5]




## ABSTRACT

**Introduction:** India struggles with poor quality of medical education, incompetent medical workforces, and insignificant research contribution to the world.

**Aim:** Teaching-learning methods form an integral part of any curriculum hence, we aim to review the application of technology in teaching-learning methods at medical institutions across the world.

**Materials and Methods:** An online search for articles and abstracts published from 2000 to 2020 on PubMed Central, Medline, Scopus, Google scholar using the MeSH terms like medical, education, innovative teaching, three dimensional, curriculum, etc., was conducted. A total of 49 articles were shortlisted by applying inclusion and exclusion criteria. A total of 38 articles were finally selected after thorough reading and were analysed and summarised.

**Results:** Four themes emerged from this review: understanding learner characteristics; innovative newer techniques with the incorporation of advanced technology; cast models and plastination; and future trends for medical education. The more specific findings can be further divided into: online digital learning module; flip classroom; 3D printed models; 3D virtual reality-based technology; simulation techniques; real patient learning practical's; medical student collaborative clinics; student-driven undergraduate research committee; patient-family interactive programs; death-and-dying discussions and community-based service project.

**Conclusion:** Amendment in the curriculum and selection of teaching-learning methods should be considered after understanding the student characteristics. Modern technology should be used rationally in teaching-learning methods thereby, restricting its negative impact on the students.


**Keywords:** Anatomy, Cross-sectional, Curriculum, Three dimensional

## INTRODUCTION

India continues to produce the largest number of doctors in the world, but the doctor-population ratio is 1:1456 which falls behind the World Health Organisation (WHO) recommendation of a minimum doctor population ratio of 1:1000 [1]. Medical colleges in India increased from 20 at the time of independence admitting 1500 students to 542 medical colleges (government-270, private/trust -272) in 2020 admitting around 77,928 students annually [2]. In India, pre-clinical subjects like Human Anatomy, Human Physiology, and Human Biochemistry are least preferred subjects for consideration for postgraduation by the students, because India, provides negligible opportunities for research in basic medical sciences due to lack of infrastructure for research-related activities [3].

Medical educators across the world are reforming their respective student curriculum and teaching-learning strategies, to cope up with the present digital world students [3]. Index article presents a present scenario of medical education in India and discusses the innovations in teaching-learning methods of medical education through the use of technology.

## MATERIALS AND METHODS

An online literature search was conducted on articles/abstracts published from 2000 to 2020 in databases like PubMed Central, Medline, Scopus, Google Scholar, using the MeSH terms like medical, education, innovative teaching, use of three-dimensional technology, competency-based curriculum, learner characteristics, future trends in medical education, globalisation/privatisation of medical education. A total of 113 articles and 23 abstracts were identified. The inclusion and exclusion criteria for the shortlisting of articles were established. Articles written by both domestic and foreign authors on innovative teaching methods, use of 3D technology, future trends in medical education were included and remaining were excluded. After applying inclusion and exclusion criteria, 49 articles were shortlisted. Finally, after reading the full text/abstract of the articles, 38 articles were selected that met the criteria for the synthesis of the present review and hence, were included in the study as presented in [Table/Fig-1] [4-41].

## RESULTS

### Medical Education in India

The Medical Council of India (MCI) was established by Ministry of Health and Family Welfare as a statutory body under the provisions of the Indian Medical Council Act (IMC Act), 1933, which was later, replaced by the Indian Medical Council Act (IMC), 1956 and was subsequently amended in 1964, 1993 and 2001 [2]. By its powers, the establishment of a new medical college requires mandatory recognition by MCI, but during the inspection, MCI focuses only on documentation of infrastructure and human resources. There is no inspection of infrastructure proposed for research activities by the institution neither evaluation nor monitoring of student admission procedures, training, teaching-learning strategies, assessment system, student facilities and faculty adequacy, is conducted. (Establishment of Medical College Regulations, 1999: Amendment: July 2018).

Medical institutions in India struggle with issues like inadequate infrastructure/facilities, inadequate medical/nonmedical personnel, inadequate cadaver availability, inadequate patient intake, inadequate availability of drugs, etc. The MCI, in 2019 implemented Competency-Based Medical Education (CBME) in the medical curriculum [2,3].

### Understanding the Learner Characteristics

This is important because it directly or indirectly influences the development of curriculum, deciding on teaching methods, and guiding students [4,5]. Buja LM in 2019 proposed that today's students score higher on assertiveness, self-liking, narcissistic traits, high expectations, and some measures of stress, anxiety, and poor mental health, and also lower on self-reliance [6]. Changes in the

| S. No. | Name of the article | Name of the author | Year of publication | Topics studied |
|---|---|---|---|---|
| 1 | Generational changes and their impact in the classroom: Teaching generation me. | Twenge JM [4] | 2009 | Studied learner characteristics and its influence on curriculum |
| 2 | First year students' experiences with technology: Are they really digital natives? | Kennedy GE et al., [5] | 2008 | |
| 3 | Medical education today: All that glitters is not gold. | Buja LM [6] | 2019 | Studied learner characteristics. Proposed that today's students score higher. Lower on self-reliance. Have narcissistic traits. |
| 4 | Why today's young Americans are more confident, assertive, entitled and more miserable than ever before. | Twenge J [7] | 2014 | Changes in the culture and society have led to these generational characteristics |
| 5 | Why today's super-connected kids are growing up less rebellious, more tolerant, less happy - and completely unprepared for adulthood. | Twenge JM [8] | 2017 | |
| 6 | Burnout syndrome among medical residents: A systematic review and meta-analysis. | Rodrigues H et al., [9] | 2018 | Burnout is alarmingly high among today's medical students and residents |
| 7 | Burnout in medical students before residency: A systematic review and meta-analysis. | Frajerman A et al., [10] | 2019 | |
| 8 | Multidimensional perfectionism and burnout: A meta-analysis. | Hill AP and Curran T [11] | 2016 | Studied learner characteristics and its influence on curriculum |
| 9 | Perfectionism is increasing over time: A meta-analysis of birth cohort differences from 1989 to 2016. | Curran T and Hill AP [12] | 2019 | |
| 10 | Twelve tips for facilitating millennials' learning. | Roberts DH etal., [13] | 2012 | Studied characteristics of today's medical students including their strengths and vulnerabilities |
| 11 | Become an effective resident teacher and team leader in 10 tried-and-true steps. | Hunter N et al., [14] | 2018 | |
| 12 | Staying up-to-date and managing information overload. | Maggio LA and Artino AR Jr [15] | 2018 | |
| 13 | Student perspectives on the "Step 1 Climate" in preclinical medical education. | Chen DR et al., [16] | 2019 | Studied flip classroom model |
| 14 | The impact of the flipped classroom model on students' academic achievement. | Cabi E [17] | 2018 | |
| 15 | Three-dimensional virtual reality as an innovative teaching and learning tool for human anatomy courses in medical education: A mixed methods study. | Alharbi Y et al., [18] | 2020 | Studied applications of three-dimensional virtual reality-based technology |
| 16 | The virtual temporal bone, a tele-immersive educational environment. | Rasmussen M et al., [19] | 1998* | Studied high-tech simulations (which contain advanced technology) |
| 17 | Human performance using virtual reality tumor palpation simulation. | Langrana N et al., [20] | 1997* | |
| 18 | The history of simulation in medical education and possible future directions. | Bradley P [21] | 2006 | |
| 19 | Low-to-high fidelity simulation-A continuum of medical education. | Maran NJ and Glavin RJ [22]. | 2003 | |
| 20 | Simulation-based medical education. | Mıdık Oand Kartal M [23] | 2010 | |
| 21 | Plastic models: An alternative for veterinary anatomy education? | Gultiken ME [24] | 2012 | Introduced the use of plastic models |
| 22 | The current potential of plastination. | Hagens GV et al., [25] | 1987* | Introduced plastination methods and studied its applications amongst student teaching |
| 23 | How useful is plastination in learning anatomy? | Latorre RM et al., [26] | 2007 | |
| 24 | The anatomy of anatomy: A review for its modernization. | Sugand K et al., [27]. | 2010 | |
| 25 | The use of independent, interactive media for education in dental morphology. | Maggio MP et al., [28]. | 2012 | Introduced innovative methods of teaching-learning and studied its applications |
| 26 | Is there any real virtue of virtual reality? them in or role of multiple orientations in learning anatomy from computers. | Garg AX et al., [29] | 2002 | |
| 27 | Virtual human dissector as a learning tool for studying cross-sectional anatomy. | Donnelly L et al., [30] | 2009 | |
| 28 | Arthroscopy or ultrasound in undergraduate anatomy education: A randomized cross-over controlled trial. | Knobe M et al., [31]. | 2012 | |
| 29 | Direct correlation of radiologic and cadaveric structures in a gross anatomy course. | Phillips AW et al., [32] | 2012 | |
| 30 | How we used a patient visit tracker tool to advance experiential learning in systems-based practice and quality improvement in a medical student clinic. | Chen CA et al., [33] | 2016 | Medical education trends for future |
| 31 | Teaching communication and compassionate care skills: An innovative curriculum for pre-clerkship medical students. | Shield RR et al., [34] | 2011 | |
| 32 | Improving student comfort with death-and-dying discussions through facilitated family encounters. | Schillerstrom JE et al., [35] | 2012 | |
| 33 | A medical student leadership course led to teamwork, advocacy, and mindfulness. | Warde CM et al., [36] | 2014 | |
| 34 | Medical education: Addressing questions that require attention. | Lee HS [37] | 2017 | Present scenario of medical education system across the world especially Korea. |
| 35 | Improvement in medical students' communication and interpersonal skills as evaluated by patient satisfaction questionnaire after curriculum reform. | Oda Y et al., [38] | 2014 | Present scenario of medical education system across the world. |
| 36 | Stages and transitions in medical education around the world: Clarifying structures and terminology. | Wijnen-Meijer M et al., [39] | 2013 | Present scenario of medical education system across the world especially Japan. |
| 37 | The multi-tiered medical education system and its influence on the healthcare market-China's Flexner Report. | Hsieh CR and Tang C [40] | 2019 | Present scenario of medical education system across the world especially China |
| 38 | The history of medical education in Europe and the United States, with respect to time and proficiency. | Custers EJFM and Cate OT [41] | 2018 | Present scenario of medical education system across the world especially Europe |

**[Table/Fig-1]:** List of articles selected for the review in the study [4-41].
*Three studies (1997,1998 and 1987) were included in the review study because they stated the basic concepts of the innovative methods of teaching and their observations and statements were considered significant to include in the study

culture and society have led to these generational characteristics which are inbuilt in the students right at the beginning when they enter medical college [7,8]. Motivation can become dysfunctional so that high levels of dedication to a previously enjoyed activity can result in burnout. Burnout is alarmingly high among today's medical students and residents [9,10]. Perfectionism, defined as a combination of high standards and high self-criticism is also on the rise [11,12]. The two may intensify one another. The attributes of the present clinical understudies including their qualities and weaknesses, present exceptional difficulties for workforce occupied with their instruction [13-15]. While these understudies have high IQs, they regularly show little effort [6]. The suggestion for instructive plan (teaching method) is that these understudies probably have advantage from an organised, yet additionally more intelligent learning experience and that guidance should be conveyed in shorter sections and maybe fuse more material in media, for example, recordings and an intuitive organisation. However, in any event, when the study hall hour is utilised for alleged dynamic learning draws near, for example, the flipped homeroom, participation is still frequently poor [16]. Many of today's medical students are opting for elective perusal online of previously recorded lectures and the use of various study aids while minimising direct classroom interaction with professors [6].

## Use of Technology in Teaching

Teaching human anatomy using audio-visual aid is routine. Teacher centric (didactic) approach of conventional classroom lectures is replaced by innovative newer techniques with the incorporation of advanced technology [6].

### a. Flip classroom model

In the flip classroom model, a prerecorded video of a concerning topic that is to be taught is posted on a digital platform (well in advance) to the students. Related content is also taught through this platform outside the classroom. Inside the classroom, an active, collaborative, interactive session on the same topic is conducted. To incorporate this model, many premier institutes have formed a digital platform of learning management system like google classroom, zoom, etc. This model has revolutionised the learning of human anatomy. The disadvantage of this model is that the preparation of flipped videos takes enormous time and effort. Few resistant students who come to class unprepared even after prior instructions, spoil the interactive sessions occasionally [17].

Cabi E suggested that understudy's inspiration and status level to learn outside the homeroom ought to be recognised and fundamental game plans are done before applying the flip classroom model [17].

### b. Three-dimensional virtual reality-based technology

Learning anatomy through cadaveric dissection is undoubtedly the best method. The new idea of problem-based learning or clinically-oriented learning demands a constant correlation between normal and pathological anatomical conditions. Three-dimensional virtual reality-based technology complements the classical classroom teaching and is immensely helpful in studying cross-sectional anatomy, three-dimensional images, surface anatomy, radiological anatomy and to study the relationship between anatomical structures. CT images from actual patients in normal and pathologic conditions can be uploaded in the system and correlated.

Three-Dimensional Virtual Reality (3D-VR) is a software program that can be installed on smartphones and tablets, by the students. Alharbi Y et al., proposed 3D-VR to be an effective learning tool for short- and long-term knowledge retention among medical students compared to the traditional method. In his study, medical students described 3D-VR as a learning tool, with a great deal to offer in learning human anatomy as compared to traditional methods and helped improve their comprehension and knowledge retention, promoted teacher-student learning engagement, and helped students have real-like, self-directed learning experiences [18].

### c. Teaching through simulation:

Simulation tools are routinely used for teaching anatomy and follow the basic principle of bioethics 'first do no harm,' as students get many attempts at trying new procedures and can practice without any kind of apprehension. Low-tech simulations (which don't contain advanced technology) include the use of nondigital physical three-dimensional organ models like skeletal models, heart, lung, larynx, etc. are already in use. Basic plastic mannequins are used for conducting training on physical examination and interventional training. Animal models for training of physiology [19].

High-tech simulations (which contain advanced technology) include Screen-Based Simulations which are computer-assisted education. Rasmussen M et al., presented the three-dimensioned structure of the temporal bone virtually which made the difficult and complex structure of this bone easier and comprehensible by the virtual media [19]. Langrana N et al., generated a simulator that enabled the examination of a variety of cancer types [20].

**Realistic, high-fidelity procedural simulators:** These simulators imitate human body parts and focus on certain responsibilities [21-23].

**Realistic high-tech interactive human simulator:** These are models resembling human and using computer assistant, they give the opportunity of managing these complex clinical situations to the students [23].

**Virtual reality and haptic systems:** This requires high-level computer assistance which is used especially in surgery education [22,23].

### d. Education using cast models and plastination

The use of three-dimensioned plastic models in anatomy education raises the learning performance [24]. Gultiken ME suggested that subjects presented by plastic models are simpler to be learned and grasped by the understudy contrasted with bodies arranged by formaldehyde [24]. The utilisation of virtual materials in training makes the ideas concrete, straightforward, and encourage the opportunity of perception and re-utilising [24].

Plastination is a method that is formed by banishing oil and water from the subscribed body tissues and replacing them with polymerised materials and hardening the samples by shaping them out. Being unwatered, scentless, and substantial, the plastinised samples preserve even their structural properties at the histologic level [25]. Past studies indicate that students are more sensitive to models that are prepared by plastination. At the same time, it is concluded that the material prepared by plastination increases the learning ability [26]. Another determining fact is that the plastinates are less damaged than plastic models [27].

### e. Innovative methods of teaching-learning

An online independent digital learning module for providing educational instructions to the students should be created in addition to classroom teaching. Maggio MP et al., found that such practice kept students positively engaged. Three-dimensional computer anatomical models of complex joints of the human body or embryonic foetal development should be prepared and shared with the students on a digital platform [28]. Garg AX et al., stated that they have an obvious educational advantage over standard 3-D view book presentation [29]. A Virtual Human Dissector software incorporated in a computer suite should be developed and can be used for giving self-directed learning activities to students for studying cross-sectional anatomy [30]. Knobe M et al., proposed that short arthroscopy tutorials held by medical experts using simulators should be added to the standard macroscopic dissection sessions in the first year undergraduate medical course. Such tutorials have shown to increase anatomical knowledge of students particularly regarding complex joint anatomy compared to standard macroscopic dissection sessions. In addition to this, first-year

students should be taught basic skills in musculoskeletal ultrasound performed by medical experts. Such arthroscopy and ultrasound tutorials certainly raise their interest in surgery [31]. Phillips AW et al., proposed direct co-relation sessions of radiologic and cadaveric structures to teach anatomy. In such sessions, students reviewed pre-specified structures in both radiographic images (on X-ray view box) and cadavers every day for 20 minutes during dissection in small groups focusing on the three-dimensional spatial relationships and tissue densities in both [32].

### Medical Education Trends for the Future

Medical care in India is currently directed towards population health outcomes. This needs to transform and become patient-centered care or family-focused consideration. This will energise dynamic cooperation and the shared-dynamic between patients, families, and suppliers. Therefore, medical education should be restructured to expose students to the patient and their families early in the curriculum.

Real patient learning practices should be integrated into preclinical classes which will enable them to examine actual patients and contextualise the theory classes. Medical student-faculty collaborative clinics should be started which will allow students to engage in the systems-based practice, design care processes first-hand, and create solutions for inefficiencies in clinic operations through a patient visit tracker tool [33]. A student-driven undergraduate research committee can be established in the institution which will encourage research-oriented thinking within the students and mentor them accordingly. Patient and family interactive programs should be incorporated in the curriculum of third and final year students in which the students would regularly have real case discussions with patients, their families in the presence of the attending physician/surgeon or nurse. This will improve the communication skills of the students and prove beneficial to them in interacting with the patient and their families [34]. Death-and-Dying discussions: Medical students would interact with family members of the recently deceased and with mental health and psychiatric medicine faculty members. This will help students to comprehend end-of-life issues and will inculcate empathy in their minds for the patients [35]. Community-based service project should be longitudinally incorporated in student curriculum in which the students (under the able guidance and with proper permission) will regularly interact with the community by conducting health surveys, organising health awareness camps, organising voluntary organ/body donation camps, participating as volunteers in various government-run health programs, etc. This will promote relationship-based leadership qualities in the students making them realise the importance of mindfulness and coordination as characteristics of effective and resilient leaders [36].

## DISCUSSION

Lee HS stated that in Korea the medical degree program involves academic education based on research allowing the medical students to complete these two different types of programs simultaneously. This pattern has inevitably resulted in a structural shortcoming with the poor quality of both leading to a crisis in academic education and the research function of graduate schools thereby, seriously hindering the development of medical science in Korea [37].

In the United States, advances in medical care and technology are the driving forces that are declining the relevance of traditional curriculum and shifting it to competency-based education, time-based medical education, an accelerated medical education. The ideal is a fully integrated curriculum in place of the traditional curriculum, characterised by spiral integration encompassing both horizontal and vertical integration combining integration across time and disciplines [5].

In Japan, an integrated medical education curriculum was proposed by the 'Coordinating Council on the Reform of Medical and Dental Education' in 2001 and implemented in 2005 in the majority of the medical schools. Problem-based learning was implemented as early as 1990. The standard Japanese undergraduate medical education program is six years long (India's- 5.5 years) and is composed of four years of preclinical medical education followed by two years of clinical training. Regarding student assessment, a Common Achievement Test (CAT) was established in 2005 composed of two phases: a Computer-Based Testing (CBT) phase and an Objective Structured Clinical Examination (OSCE) [38].

Wijnen-Meijer M et al., described six different models of medical education systems across the world and stated the education received and the level of the medical student or graduate can't be judged by merely comparing the stages and degrees of each country as the nomenclature of each stage and degree varies country to country [39].

In China, a multitiered education system is functional to train physicians since the 1950s which has led to substantial differences in the quality of medical education. The first tier (degree-oriented medical education program) which provides five years of undergraduate medical studies followed by three years of residence. The second tier (tertiary medical education) which provides a vocational diploma after the candidate completes three years of study after high school. The third tier (secondary-level medical education) which provide medical training after junior middle school imparting a secondary vocational diploma. This multi-tiered medical education system was advantageous to China as it quickly trained the doctors, but it lowered the overall quality of physician training and hence, the quality of healthcare [40].

In Europe, an average medical doctor spends four to six years in medical school, followed by a competitive specialist training scheme lasting from three to six years. Only a few European institutes provide exceptionally good learning approaches in terms of methodology and infrastructure. All the European countries adhere to this heterogeneous nature of medical education where incorporation of research into the curriculum is deficient as a result of which medical students with an interest in research are often identified very late or are presented with insufficient career options that encourage them to pursue training in basic medical research. There is no single overarching institution to ensure coherence and global quality controls. There are also no comparable standards among countries or even among schools within the same country in Europe, potentially leading to heterogeneous educational outputs [41].

## CONCLUSION(S)

Medical education should resolve to produce medical students with profound knowledge, skills, and professional behaviour with a humanistic approach to patients. Amendment in the student curriculum and selection of teaching-learning methods should be considered after thoroughly understanding the student characteristics. Modern technology should be used rationally in teaching-learning methods thereby, restricting its negative impact on the students. Further studies on the application of three-dimensional technology in teaching-learning methods are required to develop a pedagogical technology to enhance student's learning skills. Long-term and comprehensive research studies are required on medical students, medical educators, and medical college administrators to get a deeper insight into the quality of medical education imparted and the competency of physicians produced.

## REFERENCES

[1] Samiksha Goel. Economic survey: The doctor-population ratio in India is 1:1456 against WHO recommendation. Deccan Herald. (Business Edition) [Internet]. 2020 Jan 31 [cited 2020 May 01]; Budget: [about 1p]. Available from: https://www.deccanherald.com/business/budget-2020/the-doctor-population-ratio-in-india-is-11456-against-who-recommendation800034.Html.

[2] Medical Council of India. Official website: About MCI: Introduction. [Internet] [cited 2020 May 21] Available: http://www.mciindia.org/.
[3] City News. Few takers for PG in non-clinical branches at Medical colleges. The Times of India. [Internet]. 2017 Jun 18 [cited 2020 May 01]. Available from: http://timesofindia.indiatimes.com/articleshow/59184208.cms?utm_source=contentofinterest&utm_medium=text&utm_campaign=cppst.
[4] Twenge JM. Generational changes and their impact in the classroom: Teaching generation me. Med Educ. 2009;43(5):398-405.
[5] Kennedy GE, Judd TS, Churchward A, Gray K, Krause KL. The first-year students' experiences with technology: Are they digital natives? Australas J Educ Technol. 2008;24(1):108-22.
[6] Buja LM. Medical education today: All that glitters is not gold. BMC Medical Education. 2019;110:1-11.
[7] Twenge J. Generation Me. Why today's young Americans are more confident, assertive, entitled- and more miserable than ever before: Atria Books; 2014. Simon and Schuster, Inc. New York; 2014.
[8] Twenge JM. I Gen- Why Today's super-connected kids are growing up less rebellious, more tolerant, less happy- and completely unprepared for adulthood: Atria Books. Simon and Schuster, Inc. New York 2017.
[9] Rodrigues H, Cobucci R, Oliveira A, Cabral JV, Medeiros L, Gurgel K, et al. Burnout syndrome among medical residents: A systematic review and meta-analysis. PLoS One. 2018;13:e0206840.
[10] Frajerman A, Morvan Y, Krebs MO, Gorwood P, Chaumette B. Burnout in medical students before residency: A systematic review and meta-analysis. European Psych. 2019;55:36-42.
[11] Hill AP, Curran T. Multidimensional perfectionism and burnout: A meta-analysis. Personal Soc Psychol Rev. 2016;20:269-88.
[12] Curran T, Hill AP. Perfectionism is increasing over time: A meta-analysis of birth cohort differences from 1989 to 2016. Psychol Bull. 2019;145:410-29.
[13] Roberts DH, Newman LR, Schwartzstein RM. Twelve tips for facilitating millennials' learning. Med Teacher. 2012;34:274-78.
[14] Hunter N, Smith CC, Reynolds EE. Become an effective resident teacher and team leader in 10 tried-and-true steps. J Grad Med Ed. 2018;10:488-90.
[15] Maggio LA, Artino AR Jr. Staying up to date and managing information overload. J Grad Med Ed. 2018;10:597-98.
[16] Chen DR, Priest KC, Batten JN, Fragoso LE, Reinfeld BI, Laitman BM . Student perspectives on the "step 1 climate" in preclinical medical education. Acad Med. 2019;94:302-04.
[17] Cabi E. The impact of the flipped classroom model on students' academic achievement. International Review of Research in Open and Distributed Learning. 2018;19(3):203-21.
[18] Alharbi Y, Al-Mansour M, Al-Saffar R, Garman A, Alraddadi A. Three-dimensional virtual reality as an innovative teaching and learning tool for human anatomy courses in medical education: A mixed methods study. Cureus. 2020;12(2):e7085.
[19] Rasmussen M, Mason TP, Millman A, Evenhouse R, Sandin D. The virtual temporal bone, a tele-immersive educational environment. Future Generation Computer System. 1998;14(1-2):125-30.
[20] Langrana N, Burdea G, Ladeji J, Dinsmore M. Human performance using virtual reality tumor palpation simulation. Computers & Graphics. 1997;21(4):451-58.
[21] Bradley P. The history of simulation in medical education and possible future directions. Med. Educ. 2006;40(3):254-62.
[22] Maran NJ, Glavin RJ. Low-to-high fidelity simulation-A continuum of medical education. Med Educ. 2003;37(Suppl.1):22-28.
[23] Mıdık O, Kartal M. Simulation-based medical training. Marmara Medical Journal. 2010;23(3):389-99.
[24] Gultiken ME. Plastic models: An alternative for veterinary anatomy education? Animal Health Prod and Hyg. 2012;1:53-58.
[25] Hagens GV, Tiedemann K, Kriz W. The current potential of plastination. Anat Embryol. 1987;175(4):411-21.
[26] Latorre RM, Garcia-Sanz MP, Moreno M, Hernández F, Gil F, López O, et al. How useful is plastination in learning anatomy? Journal of Veterinary Medical Education. 2007;34(2):172-76.
[27] Sugand K, Abrahams P, Khurana A. The anatomy of anatomy: A review for its modernization. Anatomical Sciences Education. 2010;3(2):83-93.
[28] Maggio MP, Hariton-Gross K, Gluch J. The use of independent, interactive media for education in dental morphology. J Dent Educ. 2012;76(11):1497-511.
[29] Garg AX, Norman GR, Eva KW, Spero L, Sharan S. Is there any real virtue of virtual reality?: Them in or the role of multiple orientations in learning anatomy from computers. Acad Med. 2002;77(10Suppl):S97-99.
[30] Donnelly L, Patten D, White P, Finn G. Virtual human dissector as a learning tool for studying cross-sectional anatomy. Med Teach. 2009;31(6):553-55.
[31] Knobe M, Carow JB, Ruesseler, M, Leu BM, Simon M, Beckers SK, et al. Arthroscopy or ultrasound in undergraduate anatomy education: A randomized cross-over controlled trial. BMC Med Educ. 2012;12:85.
[32] Phillips AW, Smith SG, Ross CF, Straus CM . Direct correlation of radiologic and cadaveric structures in a gross anatomy course. Medical Teacher. 2012;34(12). e779-84.
[33] Chen CA, Park RJ, Hegde JV, Jun T, Christman MP, Yoo SM, et al. How we used a patient visit tracker tool to advance experiential learning in systems-based practice and quality improvement in a medical student clinic. Med Teach. 2016;38:36-40.
[34] Shield RR, Tong I, Tomas M, Besdine RW. Teaching communication and compassionate care skills: An innovative curriculum for pre-clerkship medical students. Med Teach. 2011;33:e408-16.
[35] Schillerstrom JE, Sanchez-Reilly S, O'Donnell L. Improving student comfort with death and dying discussions through facilitated family encounters. Acad Psychiatry. 2012;36:188-90.
[36] Warde CM, Vermillion M, Uijtdehaage S. A medical student leadership course led to teamwork, advocacy, and mindfulness. Fam Med. 2014;46:459-62.
[37] Lee HS. Medical education: Addressing questions that require attention. Korean J Med Educ. 2017;29(3):199-201.
[38] Oda Y, Onishi H, Sakemi T, Fujimoto K, Koizumi S. Improvement in medical students' communication and interpersonal skills as evaluated by patient satisfaction questionnaire after curriculum reform. J Clin Biochem Nutr. 2014;55(1):72-77.
[39] Wijnen-Meijer M, Burdick W, Lonneke A, Burgers C, Cate OT. Stages and transitions in medical education around the world: Clarifying structures and terminology. Med Teach. 2013;35(4):301-07.
[40] Hsieh CR, Tang C. The multi-tiered medical education system and its influence on the health care market-China's Flexner Report. Hum Resour Health. 2019;17(50):01-13.
[41] Custers EJFM, Cate OT. The history of medical education in Europe and the United States, with respect to time and proficiency. Academic Medicine. 2018;93(3):S49-54.



**PARTICULARS OF CONTRIBUTORS:**
1. Assistant Professor, Department of Anatomy, AIIMS Gorakhpur, Gorakhpur, Uttar Pradesh, India.
2. Assistant Professor, Department of Anatomy, AIIMS Gorakhpur, Gorakhpur, Uttar Pradesh, India.
3. Assistant Professor, Department of Anatomy, AIIMS Gorakhpur, Gorakhpur, Uttar pradesh, India.
4. Additional Professor, Department of Pulmonary Medicine, AIIMS Gorakhpur, Gorakhpur, Uttar Pradesh, India.
5. Additional Professor, Department of Anatomy, AIIMS Gorakhpur, Gorakhpur, Uttar Pradesh, India.

**NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:**
Dr. Sundip Hemant Charmode,
Assistant Professor, Department of Anatomy, AIIMS Gorakhpur, Kunraghat,
Gorakhpur-273017, Uttar Pradesh, India.
E-mail: sundip.charmode@yahoo.com



**PLAGIARISM CHECKING METHODS:** [Jain H et al.]
- Plagiarism X-checker: Aug 22, 2020
- Manual Googling: Sep 01, 2020
- iThenticate Software: Sep 28, 2020 (8%)

**ETYMOLOGY:** Author Origin

**AUTHOR DECLARATION:**
- Financial or Other Competing Interests: None
- Was informed consent obtained from the subjects involved in the study? NA
- For any images presented appropriate consent has been obtained from the subjects. NA

Date of Submission: **Aug 19, 2020**
Date of Peer Review: **Sep 02, 2020**
Date of Acceptance: **Sep 09, 2020**
Date of Publishing: **Oct 01, 2020**