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A Paradigm Shift in Medical, Dental, Nursing, Physiotherapy and Pharmacy Education: From Traditional Method of Teaching to Case-Based Method of Learning- A Review

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Authors' contributions

This work was carried out in collaboration between both authors. Author AAAO conceived and designed the study, wrote the protocol, analyzed the data generated and wrote the first draft of the manuscript. Author KOA managed the literature searches. Both authors read and approved the final manuscript.

Review Article

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ABSTRACT

Background: The most commonly used pedagogy in Nigeria and most other countries is the didactic method of teaching. This method is useful for covering underlying concepts, principles and systems. The traditional method of teaching places the burden of promoting learning fully on the teacher, unless it is integrated with other techniques such as problem-based learning and case-based learning (CBL). However, the advantages of CBL over the traditional method of teaching have not been adequately evaluated and this also reflects on the dearth of available literature in this area.
Aim: The purpose of this paper is to critically evaluate, analyze and synthesize the available literature evidence base about CBL in order to highlight its merits/benefits, barriers and possible shortcomings so as to guide Medical Colleges and Faculties of Pharmacy in Nigeria in taking a decision on whether or not to begin to explore the possibility of introducing CBL in their medical, dental, physiotherapy, nursing and pharmacy curricula.
Methods: The study was literature-based. The review was focused on CBL for both preclinical and clinical health professional programmes including Medicine, Dentistry, Physiotherapy, Nursing and Pharmacy. Papers were required to have outcome data on

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effectiveness. The search covered the period from January 1990 to December 2013 and the following databases: MEDLINE, EMBASE, Cochrane Library, International Education Research Database, Web of Knowledge (WoK) and ERIC (Educational Resources Information Center) database.

Results: The traditional modes of teaching of science and medical subjects focus mainly on the transmission of content by disciplinary experts. By nature, these teaching processes by themselves are not effective at equipping the students in the areas of communication, critical thinking, creativity, self-directed and collaborative learning. CBL adequately addresses most of these deficiencies in pedagogy.

In their effort to find solutions and reach decisions through discussion, learners sort out factual data, apply analytic tools, articulate issues, reflect on their relevant experiences, and draw inferences they can relate to new situations that are often not given within the scope of a lecture but that could be very vital in professional practice. In the process, they acquire substantive knowledge, become innovative and develop analytic, collaborative and communication skills.

Conclusion: Colleges and faculties of Medicine and Pharmacy should consider the inclusion of CBL in their curricula for the teaching of medicine, dentistry, physiotherapy, nursing, pharmacy and other allied programmes.

Keywords: Teaching; learning; case-based learning; problem-based learning; medical education; traditional method; didactic method; curriculum.

1. INTRODUCTION

1.1 What is Case-Based Learning?

It is not an easy task to define case-based learning (CBL). There is no consensus among educators on a single definition across different fields. This is partly because cases are used for different purposes in different fields and in various forms. CBL is an established pedagogical method, which is defined in a number of ways depending on the discipline and type of 'case' employed.

It is pertinent to mention that CBL is not an entirely new idea. Storytelling to share history, teach morals and illuminate concepts is ancient. What is modern is the use of narratives developed to provide authentic learning for students [1].

CBL can be regarded as a special kind of problem-based learning (PBL), oriented toward a case, which from different perspectives generates different and equally correct problems. CBL is an elaborated pedagogical model of PBL that engages students and presents them with learning-related and cognitive challenges. Hence, CBL entails choosing, deciding priorities and combining different disciplines.

Though divergent views in CBL illustrate the difficulty of a universal definition, two shared emphases of this instructional design model can still be captured. These two are the cases themselves and the discussion of them [2]. Shulman [3] defined a case as a narrative, a story, a set of events that unfolds over time in a particular place. Cases are factually-based, complex problems written to stimulate classroom discussion and collaborative analysis. They are used as the catalysts for class discussions. Case teaching involves the interactive, student-centered exploration of realistic and specific situations. As students consider problems from a perspective which requires analysis, they strive to resolve questions that have no single right answer. Using methods of inquiry, the class explores a scenario

presented to them. Engaging learners in discussion provides students opportunities to analyze, propose solutions, evaluate potential solutions, solve problems or make decisions. These activities give students an active role in the learning process. Indeed, the content of cases and the process of discussion are inseparable in CBL.

Several colleges and faculties of medicine and health sciences in Australia, United States, Canada, Europe, Middle East (and many other areas) are currently using CBL in this post-PBL era.

1.2 Need Assessment

In the complex setting of a medical school it becomes essential to utilize an approach to teaching and learning that is best suited to the needs of the students. In developing countries, where there is an exponential increase of institutions catering for medical students, it becomes a challenge to teach large number of students per class [4]. This is especially aggravated by poor funding and instability in academic calendar.

A need for an adjunct to the routine didactic format of lectures has always been appreciated by medical school faculties. This combination is expected to produce better learning outcomes and also suit the particular institution in terms of composition of students and the infrastructure available.

1.3 Present Method and Its Advantages

The most commonly used pedagogy in Nigeria is the classical, conventional, traditional, lecture or didactic method of teaching. The lecture method has a lot of advantages, especially in poor-resource economies. This is an attractive method for disseminating information to a large body of learners. The lectures can also be recorded for future use. This traditional method is useful for covering underlying concepts, principles and systems. It can be a good means to set the stage and lay the necessary groundwork and parameters for subsequent activities. It is capable of sensitizing and stimulating students. Economical use is made of staff time by this method. It can also save the learner's time by providing an up-to-date summary of the topic from several sources [5,6].

1.4 Shortcomings of Current Mode of Teaching

In the traditional system of medical education, knowledge is mainly imparted by means of didactic lectures, tutorials, practical classes, bed-side teaching and other related modes. All these methods are largely teacher-centered, with minimal active participation by the students and hence, the students are likely to lack critical thinking. In most of the methods currently used, there is very poor interaction between the lecturer and the students; neither is the interaction between the students themselves any better.

There is now a growing concern among medical educators that, conventional modes of teaching medical students (lecture-based curricula) neither encourage the right qualities in students nor impart a life-long respect for learning. Fundamental reforms in undergraduate medical education have been advocated. The lecture-based method of teaching places the burden of promoting learning almost totally on the lecturer, unless it is integrated with other techniques. Medical educators have realized that, the complexity of medicine had already progressed beyond the ability of the teachers to provide everything that students would need to know for good practice. Lecturing skills of a high caliber are required to hold the attention of students for the commonly prescribed lecture duration of one hour. Information may be

presented at the teacher's level of understanding rather than at the learners'. It can lead to learner overload as it is common for teachers to include too much information in too short a time frame. It provides little opportunity for learner independent thinking; can lead to boredom, and has very limited effectiveness in teaching anything other than knowledge. Very often, the material covered by a lecture can be more easily acquired from a textbook and has little if any clinical application. Many students attend lecture classes because attendance is mandatory or because they do not want to incur the wrath of the teacher who might be their examiner [7].

In terms of preparing or equipping students for the complex and highly dynamic situations that await professionals in their various practices, it is doubtful if lecture-based method does any of these to any appreciable level. In the study of Azu and Osinubi [8], only 12% of the Pharmacy students agreed that the present traditional method prepares them for their profession.

1.5 Origin of Current Method of Teaching

The policies and procedures in force at most educational institutions were designed over a century ago during the Industrial Revolution. The Industrial Revolution was a transformation of human life circumstances that occurred in the late eighteenth and early nineteenth centuries (about 1760 to 1840) in Britain, the United States and Western Europe due in large measure to advances in the technologies of industry. The Industrial Revolution was characterized by a complex interplay of changes in technology, society, medicine, economy, culture and education [9].In the very beginning of the Industrial Revolution, education actually suffered a little. The factories needed workers, the families needed money, so children were taken out of school to help support the family [10,11]. Prior to the Industrial Revolution, schools actually planned their school year to accommodate planting and harvest times. Later, there was the introduction of child labour laws which made it illegal for children under 15 to work. When laws regarding mass education took effect, society's pressing need was for assembly-line workers. A primary goal was to instill the attitudes and teach the behaviours needed to succeed in the work force after graduation. The "factory model" of education reflected the idea that schools were originally built to train future workforce for the factories during the Industrial Revolution. The belief was that "the back door of the school leads to the front door of the factory" and students should only be taught the essential skills required to become a successful factory worker. Students were not placed into groups based on their abilities, natural disposition or interest but rather on their chronological age.

The "factory model" of education remains the guiding principle in most modern schools. Accordingly, students are required to sit for long hours in neat rows and are expected to accomplish a fixed amount of work in a fixed amount of time. Creativity and individual initiative, which are incompatible with the requirements of mass production, continue to be minimized and relegated to the background, while following instructions precisely continues to get top priority. Unfortunately, these notions, attitudes, guidelines and principles still pervade almost every aspect of most citadels of learning in various forms and varying degrees.

1.6 Consequences of Present Method of Dissemination of Knowledge

The current paradigm of medical education has been called into question as the demand for the quality and quantity of medical graduates increases [12]. For medical students to make competent clinical decisions based on sound scientific principles, they must be able to retain

knowledge from the preclinical phase of their medical course [13-15]. It is doubtful if present modes of knowledge delivery are able to achieve this.

Moreover, the passive nature of the audience in a traditional learning class and limited opportunity for feedback lead to poor receptivity, poor recall and probably poor results. This does not give room for any critical reasoning and at best, recall is short-term because knowledge is acquired by rote learning.

Cramming, memorization, absence of analytical mind, poor pass rates, disinterested students, signatures-hungry students (rather than knowledge-seeking students) are the order of the day. Some authors have shown that students undergoing lecture-based learning showed less interest in health research (the bedrock of development) than those undergoing a student-centred form of learning [16,17].

There is therefore a great, urgent and pertinent need to continue to search for adjunct methods of instructions to complement those currently being paraded. Hence this review was conducted to critically evaluate, analyze and synthesize the available literature about CBL in order to highlight its merits, barriers and possible shortcomings so as to guide Medical Colleges and Faculties of Pharmacy in Nigeria in taking a decision on whether or not to explore the possibility of introducing CBL in their medical, dental, physiotherapy, nursing and pharmacy curricula.

2. METHODS

The study was literature-based. The review was focused on CBL for both preclinical and clinical health professional programmes including Medicine, Dentistry, Physiotherapy, Nursing and Pharmacy. Papers were required to have outcome data on effectiveness. The search covered the period from January 1990 to December 2013 and the following databases: MEDLINE, EMBASE, Cochrane Library, International Education Research Database, Web of Knowledge (WoK) and ERIC (Educational Resources Information Center) database.

3. RESULTS AND DISCUSSION

3.1 Potential Benefits in CBL

Health professionals need to develop analytic and diagnostic thinking skills and not just a mere accumulation of large volume of facts. Hence, CBL has been advocated in the medical curriculum for this reason, so that the students are exposed to the real medical problems, which help them to develop analyzing abilities [18]. This also helps them in interpreting and solving the problems and in the course of doing this, they develop interest.

Information passed across to a learner or body of learners should be done in such a manner that makes it easily retainable by the learner. Learning should result in some changes or modifications in the learners' ways of thinking, feeling and ways of undertaking a task as a result of practice [18].

CBL makes the students to be actively involved in the process of learning and it thus prepares them for a lifelong self-directed learning process [18,19]. In CBL, the learner is motivated for effective learning rather than just the dispensing of information [20].

Learning should be fun. Students at all levels should willingly attend classes, laboratories, tutorials, seminars and all other educational fora. They should do this effortlessly. CBL is one such approach which can make learning more interesting and at the same effective.

CBL could help in developing an effective learning environment [21-23]. This learning approach may help in developing interest about the subject, as students can be curious and attentive and may motivate them to actively participate [24]. CBL can make a subject easier to learn by students and solidifies their understanding of the subject. It is capable of helping students develop logical thinking, clinical reasoning and diagnostic interpretation [25].

CBL is a pedagogy which helps learners improve higher-order thinking ability and achieve deeper understanding of the to-be-learned content [1]. It is expected that CBL helps students to develop skills in analytical thinking and reflective judgment by reading and discussing complex, real-life scenarios. Professional practice is integrated with theoretical information making the content directly relevant to the students as professionals-in-training and provides them with a framework that makes immediate sense in a real context.

The study by Kassebaum et al. [26] was able to demonstrate several important aspects of students' attitudes to CBL after alternating their teaching methods during several work sessions. They were able to show that students undertaking the CBL format were better able to ask questions and make comments during class and CBL made the learning more enjoyable.

Consolidation and integration of learning activities are also ensured in CBL. Intrinsic and extrinsic motivation is developed, allowing individualized learning. CBL encourages self-evaluation and critical reflection; allows scientific inquiry and the development of support provision for their conclusions; promotes integration of knowledge and practice and ensures the development of learning skills [27,28].

Ertmer et al. [29] were able to show that students' confidence and motivation levels increased as they became more acquainted with problem-orientated learning. CBL allows students to develop a collaborative, team-based approach to their education and their profession. It tends to foster learning for competence and deep level understanding [27] and provides opportunities for vertical and horizontal integration of the syllabus [30].

In a study [31] conducted to elucidate nursing students' experiences of the CBL as an educational tool, the students perceived the CBL as an approach combining theory with practice which provides an overview of upcoming profession. Students were found to gain adequate knowledge about patient care in reality and thereby enabling them to obtain a holistic understanding of patient health problems. Reflections related to case seminars widened students' perspectives, improved their capacity for cooperation and helped them to achieve long-lasting knowledge. The authors further stated that the CBL offered nursing students an opportunity to enhance their judgment and critical thinking skills by applying theory in practice.

Baeten et al. [32] investigated the effects of different learning environments on students' motivation for learning and achievement. Four learning environments were assessed: lectures; CBL; alternation of lectures and CBL; and gradual implementation with lectures making way for CBL. Their results showed the importance of gradually introducing students to CBL, in terms of their autonomous motivation and achievement. Pearson et al.[30], in their own study, concluded that the innovative CBL paradigm appeared to be an effective adjunct to the traditional lecture format.

Teacher-centred education dominates dental education in China. Student-centred education has recently been introduced in the School of Stomatology, Wuhan University, and a study to test the effectiveness of the new method was conducted [33]. The study also compared the learning outcomes of CBL and lecture-based education in an oral medicine curriculum. CBL was found to be more effective than lecture-based education to teach dental students. The authors concluded that CBL should be added in oral medicine curriculum for dental students.

A 2011 study [34] conducted in a Physiotherapy Department compared traditional lecture-based approach and PBL, another student-centred and inquiry-based form of learning. It was found out that the student-centred approach is effective in fostering student's self-directed learning behaviour and the authors suggested that student-centred learning should be implemented and integrated in all physiotherapy and health professional learning and teaching programmes.

In the study [35] that compared lecture-based teaching and CBL as a combined approach in learning general surgery by medical students, it was found out that teaching general surgery via CBL led to a better outcome and students were more satisfied. The author recommended that teaching surgery by CBL should be encouraged.

Despite the preparation time being longer, tutors believed that students developed better problem solving skills under a CBL model compared with a lecture mode [36].

In health professional education, learning activities in CBL mode of learning are commonly based on patient’s history or case. Basic, social and clinical sciences are studied in relation to the case, integrated with clinical presentations and conditions (both health and ill-health) and student learning is therefore, associated with real-life situations.

CBL has its roots in the well-proven apprenticeship method of learning by doing. It is a student-centered learning approach that allows students to take greater responsibility and play a more active role in the learning process than they do in traditional class learning. In the latter, the responsibility of knowledge acquisition rests mainly on the lecturer.

In the study conducted in the Department of Biochemistry, S.B.K.S.M.I. and R.C., Sumandeep Vidyapeeth, Piparia, Gujarat, India, it was found out that 84% of their students felt that CBL exposed them to an experience of logical application of the knowledge which was gained in solving problems and this would be of great help in the future. The authors concluded that CBL is effective in the medical curriculum for a better understanding of Biochemistry among the medical students [37].

There is a dearth of reports on the use of CBL in pharmacy education. However, Cisneros et al. [38] and Azu and Osinubi [8] noted that there was a need for pharmacy educators to place additional emphasis on preparing students for problem solving, critical thinking, ethics, communication and self-directed learning. In the study of Brown et al. [39], conducted on second- and third-year pharmacy students, it was observed that a case-based clinical toxicology elective course that contained topics from two required courses provided a clinically relevant, active-learning experience for the students and also increased their examination scores.

A major shortcoming in the didactic method of teaching (which CBL is capable of addressing) is that presently, students are not motivated to learn, and they only see learning

with respect to mere passing of examinations. It is important that students develop an interest and love for life-long learning. Inspiring and motivating students is critical because unless students are inspired and motivated, teachers' efforts are futile. Once students are inspired and motivated, there are numerous resources available to learn more about a subject. It is imperative that teachers abandon the mistaken notion that unless they "cover the content" students will be unprepared for the future and they will have failed as teachers [40]. Therefore, a very important thing is that students must be empowered to embark on a self-directed and life-long learning. In other words, "give a man a fish; you have fed him for today. Teach a man to fish and you have fed him for a lifetime".

Other major advantages of CBL are that students: actively discuss their learning and articulate understanding through discussion with peers; develop analytical and creative skills; develop ways of organizing and understanding complex situations; establish explicit links between theoretical work and practice in the profession or workplace and develop attitudes appropriate to the workforce and profession. The context of the case may also aid recall when the case is encountered later in the curriculum or in practice [41,42].

3.2 Case-Based Learning (CBL) and Problem-Based Learning (PBL)

CBL is not presentation of clinical cases, case studies or mere stating clinical applications. There are a lot of books available, that have clinical cases but many of these materials do not appear to have been specifically written to reinforce the student's understanding of the subject [43,44].

The differences between CBL and PBLcan be difficult to ascertain. CBL is an educational paradigm closely related to the more common PBL. The uniqueness of each is in the presentation of the problem. In CBL, the problem is accompanied by resource materials and questions, while in PBL, only the problem is provided. PBL consists of carefully designed problems that challenge students to use problem-solving techniques, self-directed learning strategies, team participation skills and disciplinary knowledge. CBL uses a guided inquiry method and provides more structure during group sessions.

CBL's main traits derived from PBL are that a case, problem or inquiry is used to stimulate and underpin the acquisition of knowledge, skills and attitudes. Cases place events in a context or situation that promote authentic learning [45]. Cases are generally written as problems that provide the student with a background of a patient or other clinical situation [28].

Over periods of three years, the medical schools at the University of California, Los Angeles (UCLA) and the University of California, Davis (UCD) changed first-, second- and third-year Doctoring courses from PBL to CBL formats. Ten months after the shift (2001 at UCLA and 2004 at UCD), PBL and CBL were compared [46] using the students and faculty who had participated in both curricula. A total of 286 students (86–97%) and 31 faculty (92–100%) completed questionnaires. This study [46] showed that CBL was preferred by students (255; 89%) and faculty (26; 84%) across schools and learner levels. Students and faculty overwhelmingly preferred the CBL method; at UCLA, 189 (90%) of students and 18 (78%) of faculty; at UCD, 66 (85%) of students and 8 (100%) of faculty. Between 60 and 80% of students at both institutions identified as comparative strengths of the CBL format that it made better use of time had fewer unfocused tangents and decreased outside work and busy work (required work without perceived benefit). In addition, about half of the learners felt they had more opportunity for clinical problem solving.

The blind spot of PBL is the single disciplinary approach, because this approach often has a single problem as its anchor. CBL takes the preconditions of PBL a step further; it is oriented toward a case, which from different perspectives generates different and equally correct problems.

Generally speaking CBL, in the health science context is centred on (but not limited to) a patient's case history and so issues are often multi-disciplinary in nature. PBL is more generally based on an issue: it can be a medical condition, a public health concern, or anything that presents issues for investigation.

3.3 Expert versus Non-expert Tutors

The teacher's role in CBL fall into two broad general categories: setting up the learning environment and facilitating discussion and exploration [1]. The teacher or instructor or the facilitator (our preferred nomenclature) must pay attention to many details in order to create an environment and ambience that can promote open and unrestricted discussion. Those details may include arranging the room, such as setting up chairs in a circle or horseshoe or some other configuration that is conducive to discussion. The teacher needs to establish a friendly atmosphere for open discussion, making clear the ground rules for open, respectful debate. Another part of that environment is the teacher's own behaviour. The instructor must withhold personal judgments or personal and professional opinions during learners' discussions.

An important issue which had always generated controversies in the conduct of CBL (even in PBL) is the use of "expert" and "non-expert" tutors. The most common area of enquiry relating to desirable CBL tutor characteristics concerns the issue of whether or not the tutor should be an expert in the subject matter related to the problem under study [28]. Hay and Katsikitis [47] argue that students led by experts had higher test scores and greater levels of learner satisfaction, although they acknowledge this was at the expense of student learning where teacher preparation time detracted from total classroom time. The results of knowledge acquisition in the paper by Hay and Katsikitis [47] demonstrated that the mean score was higher in student examination results when facilitated by expert tutors compared with the non-experts. It is strongly recommended that Colleges of Medicine, Faculties of Medicine and Universities must do all that is needful and necessary to retain medical doctors and attract medically qualified staff to basic sciences and preclinical schools.

The main goal of the facilitator is to assist the students through the facts and to engage in analysis and the development of possible solutions or strategies. Garvey et al. [48] reinforce this and add "students assume responsibility for their own learning and the tutors, instead of providing information to students, act as facilitators of their learning".

3.4 Precautions in Using CBL and Potential Challenges

One of the pillars of CBL is the case. It is very important that adequate care should be taken during the selection of the case, in that it should reinforce the students' understanding of the key concepts and the mechanistic processes of the subject matter [18].

The introduction of the inquiry-oriented learning may be a very uncomfortable problem for the students originally exposed to the didactic methods of teaching and learning [8].Starting

medical school can be both exciting and daunting. This is particularly the case when the style of learning is different from that which has been experienced previously. For many students, their first experience of learning through a problem-oriented approach is when they commence their medical student programme [49], so the introduction of CBL needs to be carefully looked at. Appropriate and adequate orientation should be given to the students by experts on the CBL.

Some have posited that assessment and performance evaluation in CBL may seem daunting initially. It is argued that such assessment can be more subjective than some other methods and some teachers may be uncomfortable with that. However, with careful lesson planning and preparation, assessment in CBL can be done efficiently, effectively and fairly.

Students, too, can be uncomfortable with assessment, especially those who are accustomed to multiple choice or other kinds of assessment that always have clear right and wrong answers. Wasserman [50] asserts that the learning goals and objectives established at the beginning are key. Once those are clear, the next step is to establish standards and let students know exactly what is expected of them.

3.5 Case Development

In its original form, CBL relied on cases that were largely self-contained stories written and analyzed through the discussion method in the classroom [51,52]. There are some basic guidelines that can ensure the development of good cases. A good case should: have an attractive title; draw the reader into the story during the opening; build the story around an event of consequence; elevate the tension between conflicting points of view; and motivate the readers to grow to care. A good case should also be believable and end on the “horns of a dilemma” [47].

It is important for every case to have lesson plan that will include amongst others objectives, road map of class discussion plan and discussion questions. These will help to keep the discussion on track and focused on the pertinent issues.

3.6 Some Common Attributes of a CBL Classroom

Case-based studies can be used in both small and large classes. The facilitator or instructor directs the student discussion but is not an authoritarian. Discussion questions should be structured and sequenced in a way that will provoke developmental analysis.

Begin with an examination of the events, issues and characters. Identify the protagonist, and move to an analysis of what lies behind the surface of events. Pull the students deeper into the case with generative questions that call for evaluations and judgments, applications and proposed solutions [49]. It can be helpful to use the same cases from more than one perspective to help students understand the multi-dimensionality of real-life situations.

The facilitator will ensure that students: define the nature of the problem as they perceive it, dividing a complex dilemma into manageable issues; bring their own background knowledge and principles to bear upon the case; formulate strategies to analyze the data and generate possible solutions; raise points and questions and defend their positions. Students may not agree on every issue and sometimes a compromise is reached. However, collaboration and cooperation are key, while competition is minimized (Table 1).

Table 1. Summaries of the major papers that compared case-based learning (CBL) with other methods of teaching

Authors	Purpose and nature of study	Sample	Setting, design, data collection and level of statistical significance	Key findings
Nair SP, Shah T, Seth S, Pandit N, Shah GV (2013)	This study compared the academic perform-ance of the undergrad-uate medical students using CBL and traditional lecture method.	Total sample size was 100. The study group (n = 50) had students who were self-motivated by giving them a clinical problem. The other group (n = 50) had the same teacher teaching the topic in a didactic lecture form.	Setting was the Department of Biochemistry, S.B.K.S.M.I. and R.C., Sumandeep Vidyapeeth, Piparia, Gujarat, India. The statistical significance was defined as a *P* value of < .05.	The majority (98%) of the students rated “agree” on a 4-point Likert scale for CBL. They were motivated by CBL to study and enjoyed CBL more, compared to didactic lectures; CBL facilitated interaction between the staff and students through discussion sessions and CBL helped in improving the diagnostic skills and lateral thinking. When the future application of this experience was asked, 84% of them felt that this exposure would be of great help in the future also.
Srinivasan M, Wilkes M, Stevenson F, Nguyen T, Slavin S (2007)	This research compared faculty and medical students’ perceptions of traditional PBL with CBL after a curricular shift at two institutions.	A total of 286 students (86%/University of California, Davis (UCD)–97%/University of California, Los Angeles (UCLA) and 31 faculty (92%/UCLA–100%/UCD) completed questionnaires	Study was conducted in the Medical schools at the University of California, Los Angeles (UCLA) and the University of California, Davis (UCD), USA. Levels of significance were *P* = .01, when “unfocussed tangents", "less busy work" and "more opportunities", were assessed, while *P* =.002 when "opportunities for clinical skills application" was	CBL was preferred by students (255; 89%) and faculty (26; 84%) across schools and learner levels. Between 60-80% of students at both UCLA and UCD identified as comparative strengths of the CBL format that it made better use of time, had fewer unfocused tangents and decreased outside work and busy work (required work without perceived benefit). In addition, about half of the learners felt they

			assessed.	had more opportunity for clinical problem solving.
Forsgren S, Christensen T, Hedemalm A. (2013)	The purpose of the study was to elucidate nursing students' experience-es of the CBL as an educational tool in order to find out if it supports students' learning.	Qualitative content analysis was used and performed on the statements from nursing students' course evaluations. Content analysis is a method of systematically analyzing with a focus on differences and similarities in the text.	Study data were based on evaluation from two courses among year two nursing students at a university in Western Sweden. Course evaluations were carried out anonymously, and data were gathered by summarizing 103 course evaluations from the students.	Students perceived CBL as an approach combining theory with practice which provides an overview of upcoming profession. Students gained adequate knowledge about patient care in reality and thereby enabling them to obtain a holistic understanding of patients health problems. Reflections related to case seminars widened students perspectives, improved their capacity for cooperation and helped them to achieve long-lasting knowledge.
Papanna K, Kulkarni V, Tanvi D, Lakshmi V, Kriti L, Unnikrishnan B et al. (2013)	A cross-sectional study conducted to understand the preferences and perceptions of medical students about the current methods of teaching, aids used for teaching and also identify barriers in learning as perceived by the students.	A total of 286 students (56.6 % females and 43.4% males) participated with a dropout rate of 10.6%. Study participants included 2nd and 3rd year medical students.	Perceptions and preferences of medical students regarding teaching methods in Kasturba Medical College, Mangalore India, was carried out in May 2012. The statistically significant differences in preferences were set at $P <$ .05.	The findings of the study suggested that a combination of traditional methods with other methods such as problem-orientated learning, video lectures and mannequins could be an effective way of teaching theory and clinical skills.
Reicks M, Stoebner T, Hassel C. (2003)	The purpose of this article was to evaluate student reactions to a case-based instruction	The researchers utilized both quantitative and qualitative methods in the study. Two hundred (200) secondary	Three instruments were used to measure the effects of a decision-based case on students: (a) a pre-/post-assessment of attitude related	Students were more aware how biotechnology affects their life after working through the case. Most students reported both positive and learning experiences

	approach to teaching biotechno-logy awareness related to the labeling of genetically engineered products.	students and eight (8) teachers from six separate schools participated in this study.	to biotechnology, (b) a post-intervention survey of learner reactions to the related group work, and (c) a pre-/post-assessment of changes in abilities related to critical thinking and decision making.	in reaction to the group work. These data reflected high correlations between positive experiences and learning experiences, as well as high correlation between self-reported level of involvement and both types of experiences.
Surapaneni KM (2010)	This work compared the academic performan-ce of the undergrad-uate medical students on the traditional curriculum with didactic lectures with that of the students who followed an innovative curriculum with CBL in bio-chemistry	The participants (n = 150) were 1st year MBBS students studying in the Medical College, during the academic year 2008-2009. All the 150 students were divided into two groups as the control group and the study group.	The setting was in Saveetha Medical College and Hospital, Saveetha University, Chennai, Tamil Nadu, India. Outcomes assessed were the marks in the written examination on the traditional curriculum with didactic lectures and those on the curriculum with CBL. The data were expressed as mean + SD. *P*< .05 was considered as significant.	The performance of the students on CBL was found to be significantly better when compared to the performance of the students on the traditional curriculum, in terms of clinical knowledge. The students opined that CBL trained them in self-learning skills and improved their attitude towards the newer trends in medical education. The students perceived the CBL method to be a valuable learning tool in biochemistry which improved their reasoning skills and motivated them to learn.
Kassebaum D, Averbach R, Fryer G (1991)	The purpose of this study was to evaluate student and teacher satisfaction and perceptions of CBL. Based on their specialty, 40 students were divided into 4 groups equally. Members in every group had sub-	Forty 5-year or 7-year system students majoring in oral medicine were involved in CBL from 2006 to 2007. Participants consisted of thirty-two (32) students in grade 6, who had just entered secondary disciplines of a master's degree with	The study was conducted in the College of Stomatology, Shanghai Jiao Tong University, China. After the class, questionnaires were delivered to students and young teachers to evaluate the teaching effect, find problems, and make suggestions for improvement. The respondents ranked their	The mean score of all evaluated projects was above 3 (agreement), which indicated that the CBL course approach won students' high acceptance. The mean scores were 3.6 in the vivacity of curriculum form ("more interesting and challenging") and 3.5 in stimulating enthusiasm ("made me highly concentrated", "promoted communication and

	disciplines and were in various grades.	certain clinical experience, and eight (8) students in grade 5, who had just finished theory study and were going to participate in clinical practice.	agreement with items on a scale of 1 to 4, representing strong disagreement, disagreement, agreement, and strong agreement, respectively.	interaction between teachers and students", and "enhanced my diagnostic skills and treatment thinking").
Baeten M, Dochy F, Struyven K. (2013)	The purpose of the study was to investigate the effects of different learning environme-nts on students' motivation for learning and achievem-ent.	First-year student teachers (n = 1,098) studying a child development course completed questionnaires assessing motivation and perceived need support. In addition, a prior knowledge test and case-based assessment were administered.	A quasi-experimental pre-test/post-test design was set up consisting of four learning environments: (a) lectures, (b) CBL, (c) alternation of lectures and CBL, and (d) gradual implementation with lectures making way for CBL.	Autonomous motivation and achievement were higher in the gradually implemented CBL environment, compared to the CBL environment. On achievement, students in the lecture-based learning environment scored higher than students in the CBL environment, and students in the gradually implemented CBL environment scored higher than students in the alternated learning environment.
Du GF, Li CZ, Shang SH, Xu XY, Chen HZ, Zhou G (2013)	The purpose of this study was to compare the learning outcomes of CBL and lecture-based education (LBE) in an oral medicine curriculum.	Forty (40) 4th year dental students participated in the study. First, they were presented to basic knowledge of oral leukoplakia and related oral mucosal diseases. Then, they were divided into a CBL group (n = 20) and an LBE group (n = 20) by random numbers.	The setting was the School of Stomatology, Wuhan University, China. Level of significance was $P < .01$	The test scores of the CBL group (90.00 ± 6.69) were significantly higher ($P < .01$) than those of the LBE group (83.00 ± 6.77). The percentage of high test score (test score ≥ 85) of the CBL group (85%) was also significantly higher ($P < .01$) than that of the LBE group (45%).
Bistegani MM	This study compared	Study was a quasi-	The study was conducted in	The mean final mark of students'

(2013)	lecture-based environme-nt and CBL as a combined approach in learning general surgery by medical students.	experiment performed on two consecutive groups of 33 and 36 students who were studying general surgery course using two styles of teaching, lecture-based and real case teaching methods, respectively.	Shahrekord University of Medical Sciences, Iran. Level of significance was *P*< .0001.	who received real case based education was 16.8/20 ± 1.8 and for the lecture group was 12.7 ± 1.7. There was a significant difference between the two groups (*P*< 0.0001).
Engel F, Hendricson W. (1994)	This report described a case-based, student-centered instructional model designed to mimic orthodontic problem-solving and decision-making in dental general practice.	Groups of ten junior students met in a series of one-hour seminars. One week prior to each seminar, a set of diagnostic data was distributed to every student and instructor for advance preparation.	Setting was the Department of Orthodontics, University of Texas, Health Science Center at San Antonio 78284, USA. Level of significance was *P* < .01.	Students reported significantly higher (*P*< .01) levels of confidence after the seminars. Authors concluded that CBL can be applied to other dental areas to better develop the clinical reasoning skills of future dentists.
McRae MP (2012)	This was a descriptive research. Purpose was to describe an instructional approach to using clinical case studies in a first trimester human biochemist-ry course.	Students in a first trimester biochemistry course in a chiropractic doctoral program were presented with four clinical cases. Each case focused on a specific topic in biochemistry (protein, carbohydrate, lipid and nucleic acid metabolism).	Setting was a biochemistry course in a chiropractic doctoral program in the National University of Health Sciences, Lombard, USA.	The paper showed that clinical case studies are a valuable addition to the traditional methods of lecture, textbook reading and laboratory for teaching biochemistry. More importantly, clinical case studies help remind students that what they are learning has relevance in the real world, and may help motivate students to pay more attention to the numerous facts faced in biochemistry.
Brown SD, Pond BB, Creekmore	This research assessed the impact	The class was opened to 60 students,	Study involved a case-based clinical toxicology elective that	Scores on the toxicology subsection of the PCOA of

KA. (2011)	of a case-based toxicology elective course on student learning in related required courses and student performance on the Pharmacy Curriculum Outcomes Assessme-nt (PCOA) examinati-on.	composed of Pharm D students in their second (P2) and third (P3) years of study. As a 2-hour course, the class met once a week for 2 hours. Approximately 50% of class time was used for lecture and discussion, while students spent the remaining time working in small groups to develop answers to patient cases.	contained topics from 2 required courses, Pharmacology III and Pharmacothera-py II, offered in the spring 2009 to 2nd and 3rd year pharmacy students, in Gatton College of Pharmacy at ETSU, Department of Pharmaceutical Sciences,Johnson City, Tennessee, USA. All comparisons involved two-tailed unpaired *t*-tests, with a significance level of $P < .05$.	students enrolled in the elective (which is case-based) were higher than those of students not enrolled (91.3% ± 4.1 vs. 67.2% ± 5.7). Enrollment in the elective was related to increase examination scores among Pharmacotherapy II students (89.5% ± 2.0 vs. 83.9% ± 1.8). The case-based toxicology elective provided a clinically relevant, active-learning experience that boosted academic performance.

4. CONCLUSION

The traditional teaching of science subjects focuses mainly on the transmission of content by disciplinary experts with limited skills in facilitating students to become active learners. By nature, these teaching processes by themselves are not effective in achieving current educational mission of empowering students in learning. Students may not acquire the skills and attitudes to link knowledge with society and to make informed decisions based on evidence. CBL adequately addresses these deficiencies in pedagogy.

Learning environments are critical to the achievement of learning objectives. CBL could create effective learning environments and thus help in achieving the learning objectives. In the CBL, each student is typically required to first go over the case individually, then collaboratively merge individual perceptions into an improved comprehension of the case through facilitated group discussion and finally communicate his/her insights in a debate with the whole class. As such, the learning outcomes, in addition to the subject knowledge constructed by the student from the case, include the acquisition of the generic skills of communication, critical thinking, creativity, self-directed learning, collaborative or group learning, literacy of information technology and other resources and the development of higher order thinking skills.

Cases add meaning by providing students with the opportunity to see theory in practice. Since cases are usually based on contemporary or realistic problems, the use of cases in the classroom makes subject matter more relevant.

Moreover, by engaging themselves in collaborative learning and provocative group discussion, students are coached to become accustomed to taking responsibility and respecting different views.

The end justifies the means. Our doctors, dentists, nurses, physiotherapists and pharmacists can be better prepared for the challenges and realities in their various endeavours by complementing present modes of teaching with CBL.

Faculties of Medicine and Pharmacy can therefore consider the inclusion of CBL in their curriculum for the teaching of medical, dental, physiotherapy, nursing, pharmacy and other allied programmes.

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COMPETING INTERESTS

Authors have declared that no conflicting interests exist.

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