Evidence-Based Teaching (EBT) in Medical Education: Addressing the Challenges of Bridging Didactic Knowledge to Clinical Application

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ABSTRACT

Although evidence-based teaching has been adopted in various learning disciplines, its adoption in medical education remains challenging. To graduate a full-fledged well-rounded physician equipped to face the real-world challenges of diagnosis and treating diseases is the ultimate goal of every medical institution. Medical students' clinical competence is anchored on the approach of facilitators' acquired teaching expertise and how they apply learned techniques to connect basic knowledge to clinical skill enhancement. Are these approaches within the realm of evidence-based teaching? The subsequent discussion will elaborate on proven effective strategies [Problem-Based Learning (PBL), Outcome-Based Education (OBE)] and how a strategic teaching and learning tool [Target-Oriented Clinical Skill Enhancement (TOCSE)] has proven to address the issue.

Key words medical education, evidence-based teaching, student motivation, didactic knowledge, clinical application, Target-Oriented Clinical Skill Enhancement (TOCSE)

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INTRODUCTION

Information and communication technology (ICT) advances have brought enormous medical information into the undergraduate medical curriculum. Although such advances bring new opportunities to medical education, it is faced with significant challenges impacting how faculty staff teaches and how students assimilate the learning.[1] The plethora of information on the web and sprouting of various subspecialties are overwhelming, pulling students and teachers in diverse directions and causing significant struggles to cope with desired goals and objectives, especially in connecting basic knowledge and developing clinical competence.[2,3]

For academic success and proficient clinical practice, teaching and learning in the medical profession requires knowledge of motivating the learner, assessing competence, imparting confidence and giving constructive feedback.[4-7] Therefore, it is imperative that teaching tools to be utilized have been proven effective and, importantly, sparks sustained interest and motivation in both the faculty staff and students. Are doctors qualified to teach? What is evidence-based teaching (EBT)? How can EBT be an instrument to bridge didactic knowledge to clinical skill development? Therefore, it is the objective of this article to discuss the importance of EBT as the relevant culture to develop among teaching medical staff to overcome the hurdle of specific teaching and learning dilemmas in the arena of medical education, most specifically in bridging

didactic knowledge to clinical skill application among undergraduate medical students.

NOVICE TEACHING PHYSICIANS VERSUS TRAINED MEDICAL EDUCATORS

Approaches and Outcomes of Teaching

Generally, there is a big difference between teaching physicians and medical educators. Teaching physicians are clinicians primarily responsible for training medical students and residents in the clinical setting, but generally have received minimal to no training in teaching. Most teachers of this category rely on context of teaching based on their specialty background and personal experience and develop their teaching style by trial and error.[8-10] Medical educators, in contrast, have generally received more extensive, dedicated training on pedagogy, educational theory and potentially medical education research, and their career focus is on best practices in medical education.[11] Extensive workshops, educational intervention seminars and continuous teaching skill development have been afforded to these faculty staff.[12] Some even take Master studies in health education as added degrees to enhance expertise in medical teaching.[13]

Medical students are not routinely taught how to teach, but they suddenly become aware that this is one of their responsibilities after graduation. Practicing doctors teach only in opportunistic settings, such as in clinics or ward rounds.[14] Many doctors thought they could teach after sub-specialization training or apply techniques they recalled and experienced during their undergraduate medical years. Studies have shown that this situation has led to several problematic teaching implementations, such as: 1) unclear objectives, assessment rubrics and expectations, 2) focus on factual recall rather than on the development of problem-solving skills and attitudes, 3) passive observation rather than active participation of learners, 4). "teaching by humiliation", and 5) inadequate supervision and provision of feedback [15]. In an Israeli survey of physicians in internal medicine, pediatrics and obstetrics and gynecology departments, only 35% received training focused on medical education skills. The majority felt that their teaching development needed to be improved.[11]

On the other hand, medical educators understand and utilize educationally sound teaching approaches and strategies to obtain desired goals. Studies on continuous and extensive faculty development have shown changes in teaching behavior and increased knowledge of educational principles and gain in teaching skills.[12] Although there is significant variability in how medical education is implemented worldwide using various teaching techniques, evidence-based strategies with specific theories have been adopted and proven effective.[15,16] In medical education, the anchoring outcome of cognitive learning theory follows certain principles: 1) activating prior knowledge through brainstorming, 2) bridging current and new information, 3) promoting discussion and reflection, and debriefing students with feedback.[15] Furthermore, in the theory of constructivism, the teacher is not viewed as a mere transmitter of knowledge, but as a guide who facilitates learning. The following are observed in this theory: 1) teachers providing learning experiences that expose inconsistencies between students' current understandings and their new experiences, and 2) teachers actively engaging students, using relevant problems and group interactions.[16]

THE IMPORTANCE OF EBT IN MEDICAL EDUCATION

Evidence-Based Teaching (EBT) Defined

EBT is the conscientious, explicit and judicious integration of the best available research on teaching techniques and expertise within the context of students, teachers, departments, colleges, universities and community characteristics.[17] EBT strategies are specified teaching methods or tools shown in controlled research to effectively achieve desired outcomes in a delineated population of learners.[18] In medical education, EBT is applied by integrating clinical expertise with best teaching tools proven effective from various systematic researches.

The choice of teaching tools is critical and must take into account the seven principles of holistic systems of teaching, such as: 1) prior knowledge influences current and future learning, 2) how students organize knowledge influences, how they learn and apply and what they know, 3) motivation determines, directs and sustains learning, 4) students develop learning mastery by acquiring component skills and practicing, combining and integrating them, 5) goal-directed practice coupled with targeted feedback facilitates learning, 6)

emotional, social and intellectual climate factors influence learning and 7) metacognitive monitoring of learning facilitates further learning.[19]

The ultimate goal of medical education is to produce well-rounded clinical practitioners, motivated, competent and confident to diagnose and manage medical challenges at various stages of ailments.[20] Abdulghani and colleagues reported that deep learning, mind mapping, learning in skills lab, learning with patients and internal motivation had affected student academic achievement.[21] Medical students' clinical competence encompasses influential elements accrued during the undergraduate period, such as basic knowledge, clinical exposure and clinical experience. Schmidmaier, et al. have demonstrated that performance in procedural knowledge tests has shown to be independent of degree of domain-specific conceptual knowledge; instead, it is fostered by clinical experience.[22] Although didactic knowledge is a basic and vital need in medical education, this alone has yet to be shown to equate to confidence development in clinical practice. Dehmer and his group have shown that development of clinical skills among graduating medical students relied on actual procedural and frequency of experience.[23] Developing self-confidence in a graduate medical student is critical, especially when managing a patient in a life-threatening situation.[24,25] Confidence levels have been reported to correlate to reliable and decisive clinical practice.[26]

Impediments in various clinical capacities have been recognized to be because of confusion about which data to include from the history of present illness, past medical history, psychosocial, personal and family history, as well as relevant data in physical examination.[27] The decline in performance of these clinical attributes among medical students and trainees has long been observed, leading to inaccurate diagnosis and inappropriate management.[28-31] Furthermore, oversights in history taking and physical examination lead to delayed diagnosis, unnecessary and potentially harmful treatment, needless testing, escalating medical costs and potentially life-threatening consequences for patients.[28] Overall, this issue gravitates to the extent of clinical competence a medical student acquired during her undergraduate learning journey. Will EBT be the *"Holy Grail"* of such a predicament? Are there teaching tools proven to ease the transformation of a medical student from a book-based learner to an effective clinical practitioner?

EBT IN BRIDGING DIDACTIC KNOWLEDGE TO CLINICAL APPLICATION: CHALLENGES AND PROVEN EFFECTIVE STRATEGIES

Problem-Based Learning (PBL) versus Outcome-based Education (OBE)

Problem-based learning (PBL) is an instructional (and curricular) learner-centered approach that empowers learners to conduct research, integrate theory and practice, and apply knowledge and skills to develop a viable solution to a defined problem.[32] Critical to the approach's success is the selection of ill-structured problems (often interdisciplinary) and a tutor who guides the learning process and conducts thorough debriefing after the learning experience.[32]

Case-based learning (CBL) and project-based learning are offshoots from PBL with similar structural approaches. A well-constructed case will help learners to understand essential elements of the problem/situation and help learners to develop critical thinking skills in assessing the information provided and identifying logical flaws or false assumptions. When case studies are done in a group, skills in collaboration and communication are developed. This approach is well-manifested in project-based learning, which is focused on organized tasks accomplished with a shared goal/project. For both approaches, teachers serve as instructors to provide guidance, feedback and suggestions.[32,33] The teaching is provided according to learner needs and within the project context. The *team-based approach* has been developed to counteract intense human resource needs of PBL with equal and favorable results.[34]

Although cases and projects are excellent learner-centered instructional strategies, they tend to diminish the learner's role in setting goals and outcomes for the problem. When expected outcomes are clearly defined, there is less need or incentive for the learner to set their parameters.[33] In the real world, it is recognized that the ability to define the problem and develop a solution or range of possible solutions is essential. Further, the unprecedented challenge in PBL is that it is human resources intensive.[32]

The shift to *outcome-based education (OBE)* has been one of the most critical trends in health-profession

education in recent years. OBE is an approach to education in which decisions about the curriculum are driven by exit learning outcomes that students should display at the end of the course.[35] It is a realistic approach adopted worldwide today as part of the quality assurance strategy, in which decisions about curriculum and instruction are driven by exit learning outcomes that students should display at the end of a program or course.[35] Curricula with the OBE approach are tailored to specific characteristics and needs of the institution and community. In Dundee Medical School (Scotland, UK), the OBE was designed based on achieving the following competencies: 1) clinical skills, 2) performing practical procedures, 3) investigating a patient, 4) managing a patient, 5) health promotion and disease prevention, 6) skills of communication and 7) retrieving and handling information.[36] The potential benefits of OBE have made it one of the more influential frameworks for medical education today.[35,36]

Although the popularity and acceptability of OBE has grown in the past years because of its apparent advantages, specific challenges and obstacles have also been encountered.[39] Gruppen and his group elaborated that although students with prior experience can shorten learning with the OBE approach, an increase in time is needed for weaker and less experienced learners. Further, OBE verifies all graduates' competence, and with its unique feature of individualization and flexibility, motivation is enhanced. However, individualization is enormously challenging to manage by school administration, and most students who are not accustomed to deciding for themselves end up with the question, "What is important? What is next?" Lastly, although teachers remain decision-makers in defining competencies in OBE, some faculty members feel threatened by giving over more control of learners to students.[39]

PBL and OBE in Bridging Didactic Knowledge and Clinical Learning

As bridging didactic knowledge to clinical skill acquisition remains a significant dilemma in medical education, research on applying PBL and OBE has shown comparable results. In their systematic reviews of PBL in preclinical medical education, Trullas and colleagues have demonstrated that PBL has improved social and communication skills as well as problem-solving and self-learning skills.[40] Further, the satisfaction of both teachers and students was high. Similar observations were obtained by Thammasitboon, et al. among dental postdoctoral graduates when preclinical and clinical skills were assessed. There were enhanced abilities in independent learning, communication and cooperation skills.[41]

Zhao, et al. explored the efficiency of combined PBL-CBL teaching among medical students in thyroid surgery class. Scores significantly improved and were higher in basic knowledge and case analysis. Furthermore, the scores for learning motivation, understanding, student–teacher interaction, the final examination, communication skills, clinical thinking skills, self-learning skills, teamwork skills and knowledge absorption as measured by the survey were significantly higher in the PBL–CBL group than in the traditional group.[42] Similarly, Rich and colleagues have demonstrated that PBL pedagogy in preclinical teaching effectively improved performance among dental students obtaining high scores during formative and summative assessments. However, a similar outcome was not observed among students when dealing with actual clinical examinations on nonsurgical periodontal treatment patients.[43]

Although some benefits in diagnostic accuracy and improved clinical competencies in clerkship, internship and residency have been shown in 22 years and more of outcome research for PBL, the general conclusion so far was limited due to methodological weaknesses and heterogeneity across studies.[40,44] Equally interesting is Albanese's large meta-analysis study on the impact of PBL on knowledge and clinical skills (effect size, ES). In his findings, the average study reported in literature and many commonly used and accepted medical procedures and therapies are based upon studies having lesser ESs.[45]

On the other hand, OBE has been shown to significantly improve domains of skills in seeking information and attention to learning opportunities among medical students by Ramamurthy, et al.[46] On the other hand, Huang and colleagues have demonstrated that with the OBE concept, teaching

Table 1 Unique features of TOCSE

1. Giving emphasis to risk factors for the primary disease
2. Formulating the concept map of the primary disease
3. Cropping the pathophysiology of chief complaint from the concept map
4. Writing the narrative of the chief complaint, labeling as "Anatomy of the Chief Complaint"
5. Dissecting the anatomy of the chief complaint to reflect treatment for immediate relief, diagnostic and management approaches for the chief complaint, for the primary disease and for related contributory comorbidities
6. Formulating a table for abnormalities to correct as recognized in the history and physical examination, and elaborated in the concept map in general

reform in internal medicine significantly improved students' theoretical scores from standardized patient evaluation and proficiently analyzed electrocardiographs. Student satisfaction was high with a favorable evaluation of the teaching model of the case in consolidating history taking, physical examination and cultivating clinical thinking.[47] However, their study design did not assess students' basic clinical skills.

Noteworthy are the case studies by Davis and her group on utilizing OBE in four premier medical schools – in the UK (Dundee Medical School, Scotland), US (Mayo Medical School), Singapore (Yong Loo Lin School of Medicine) and Pakistan [Aga Khan University (AKU) Medical College]. [37] There were two essential points noted – varied stages and approaches in the adoption of OBE and curricular designs have been primarily based on desired outcomes. Dundee and AKU have already succeeded while the Mayo approach is evolving and the Yong Loo Lin OBE curriculum is in the planning stage. OBE has been applied on a vertical approach in all four institutions, starting with normal and abnormal structures and functions, transforming into clinical applicability of knowledge as they progress to senior years. All agree that to have an effective patient-based program, biomedical sciences and clinical components must be run in parallel implementation.[37]

Although PBL, OBE and other medical teaching techniques (simulation-based learning, e-learning, peer-assisted learning, observational learning and flipped classroom) have led to improved clinical skill as summarized by Challa and colleagues,[38] literature remains wanting of studies that investigate directly and specifically how basic knowledge can be transformed into clinical proficiency skill in undergraduate medical students with good and sound research design.

TARGET-ORIENTED CLINICAL SKILL ENHANCEMENT (TOCSE): PROVEN TEACHING AND LEARNING STRATEGY TO BRIDGE DIDACTIC LEARNING TO CLINICAL APPLICATION

The University of Santo Tomas Faculty of Medicine and Surgery (UST-FMS, Manila, Philippines) together with earlier reports as elaborated in the foregoing discussion have long recognized the struggles of both teachers and undergraduate medical students as they reach the stage of clinical application in their skill development.[27-31] PBL has been utilized by UST-FMS in the past and currently OBE is being applied in the present curriculum. Although students appreciate and acquire sufficient technical knowledge during the basic clinical subjects of history taking and physical examination, the surmounting anxiety and insecurity primarily come from confusion on which data are relevant to make a sound diagnosis and plan comprehensive management, as has been reported by Faustinella and Jacobs.[27] As has been reported by others, the atmosphere of uncertainty is shrouded by competence issues, disconnection and space for poor organizational skills compounded by differences in the level of clinical mastery by teachers.[5,6]

TOCSE is a teaching and learning tool designed primarily to connect basic medical knowledge to clinical skill development and application among fourth-year medical students.[48] It has outstanding unique features as summarized in Table 1.[48]

In TOCSE, students are the center and active players in learning, and the teacher's role is

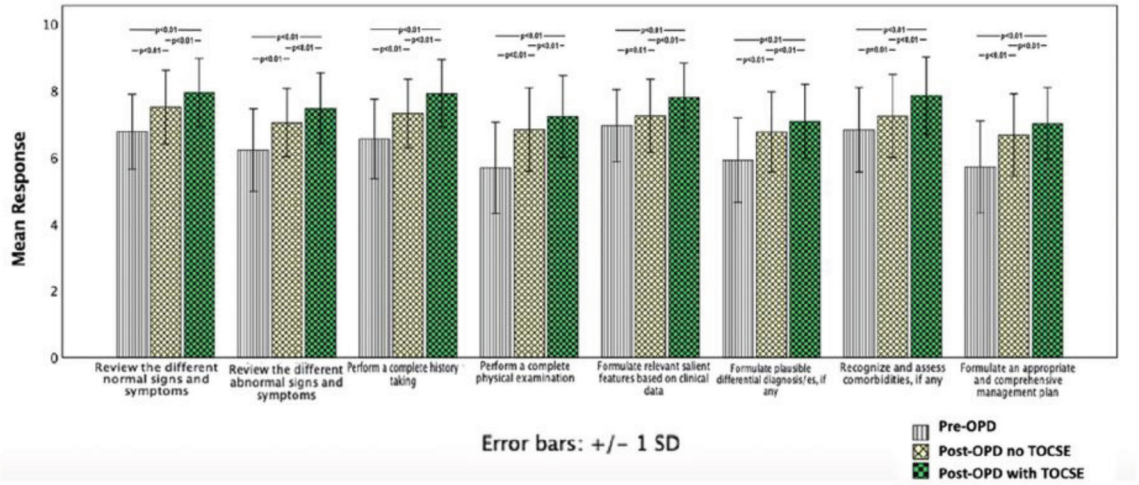

Figure 1 Comparisons of the eight-items in the clinical confidence questionnaire during the three stages of clinical skill performance survey of fourth-year medical students: Pre-OPD, Post-OPD no TOCSE, and Post-OPD with TOCSE. TOCSE; Target-Oriented Clinical Skill Enhancement. Adapted with permission from Mercado-Asis et al, JMUST **2022**;6,S1; *DOI: 10.35460/2546-1621.2022-SP15*

merely for facilitation with provision of immediate feedback.[48,49] In concept mapping, there is a clear pathway to link basic science to clinical skills and development of clinical reasoning. [50,51] Emphasis on risk factors narrows down the differential diagnoses.[52] Chief-complaint-based approach with elaboration of its pathophysiology facilitates accurate clinical assessment and prevents delay in the institution of immediate relief.[53] Moreover, the essence of TOCSE tool is simply identifying abnormalities to correct with institution of appropriate treatment.[48,49]

In a randomized trial, TOCSE has proven its effectiveness in bridging didactic knowledge to clinical skills and enhancing clinical performance of fourth-year medical students.[48] Students who underwent the TOCSE workshop obtained excellent scores statistically higher than the control group who merely utilized the standard teaching method. Notably, perceived usefulness of TOCSE for learning was comparable for both groups.[48]

TOCSE's effectiveness for development of clinical proficiency was doubly challenged by fourth-year medical students whose undergraduate learning was given through online mode during the pandemic.[49] As self-confidence equates to clinical competency,[26] a study was undertaken to determine if TOCSE also facilitates development of confidence in the clinical performance of fourth-year medical students during the first-time patient encounter after online undergraduate classes.[49] The students were blinded that research was being performed to avoid bias in their self-assessment. The Eight-item Clinical Performance Confidence Scale showed a significant increase in clinical confidence level of fourth-year medical students between Pre-OPD and Post-OPD with no TOCSE and Post-OPD with TOCSE, respectively, in all the items from the review of normal and abnormal signs and symptoms to the formulation of appropriate and comprehensive management (Figure 1).

The effectiveness of TOCSE in bridging didactic knowledge to clinical skill application aligns with elements of proven theories of cognitive learning theory and constructivism and with eventual scaffolding of students, such as: activating prior knowledge, bridging current and new information, promoting discussion, reflection and immediate feedback, and teachers providing learning experiences and engaging students using relevant problems and group interactions. [15,16] It remains a challenge, though, to traverse the comfort zone of facilitators in their teaching approach to clinical skill development among fourth-year medical students. Since the early and longer time of clinical experience has been shown to influence effective clinical skill development, the application of TOCSE from primary clinical stage of learning–pathophysiology of signs and symptoms (Medicine 1, physical diagnosis), to diagnosis and management (Medicine 2, clinical

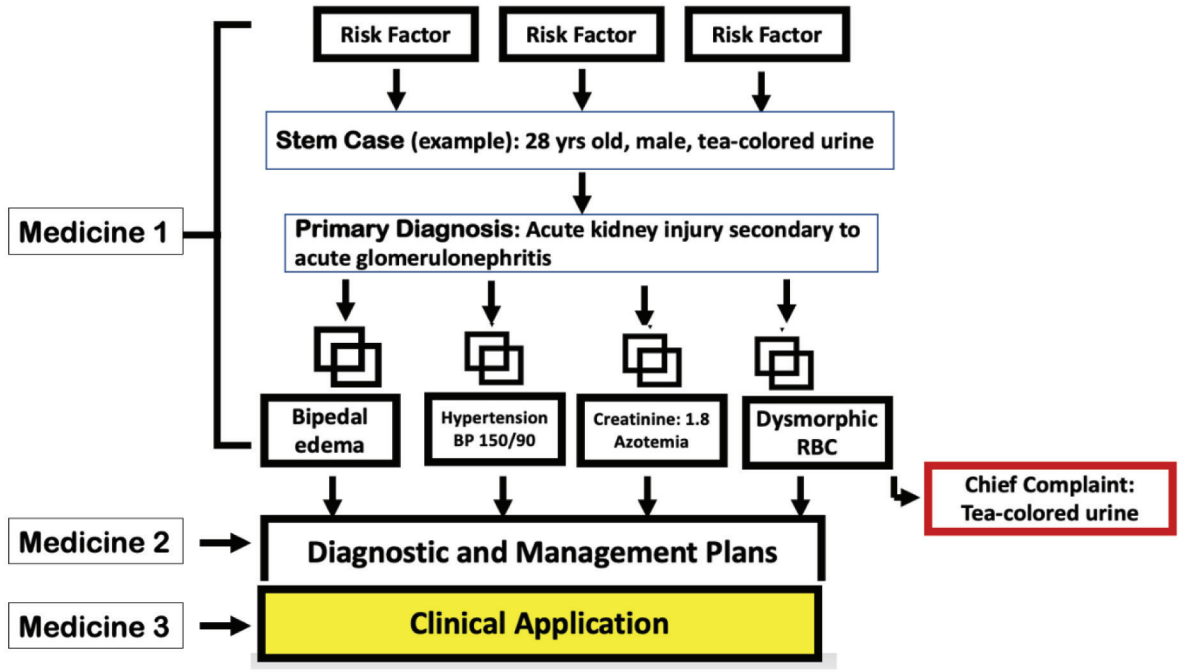

Figure 2 Concept of vertical application of TOCSE from Medicine 1 (physical diagnosis, second-year students) and Medicine 2 (clinical medicine, third-year students) to Medicine 3 (clerkship, fourth-year students).

Table 2 Distinguishing features of PBL, OBE and TOCSE.

Feature	PBL	OBE	TOCSE
Approach	Apply knowledge to develop a viable solution to a defined problem	The curriculum is driven by the exit learning outcomes that students should display at the end of the course.	Specific for bridging basic knowledge to clinical application
Structural approaches	Case-based, team-based, project-based	Competency/outcome-based	Target-oriented
Challenge/s to the approach	Selection of ill-structured problems (often interdisciplinary) Need of tutors who can guide the learning process and conduct a thorough debriefing after the learning experience. Manpower intensive	An increase in time is needed for weaker and less experienced learners. Some faculty members feel threatened by giving over more control of learners to students	Early introduction into the curriculum Facilitator acceptance
Sound methodological research on bridging basic knowledge to clinical skill application	Unclear	Unclear	Yes

medicine), would be promising and ideal as medical students journey to the clinical application arena in clerkship (Medicine 3) (Figure 2).

PBL and OBE are effective teaching tools in medical education, Table 2 depicts their distinguishing features compared to TOCSE. The sound research designs on TOCSE addressed the issue of methodological weaknesses among studies on teaching techniques. [43-45] Further, TOCSE, as a teaching tool, specifically put forward the path how to bridge basic knowledge into clinical skill application among undergraduate medical students.[48,49]

Since teaching is inevitable after graduation, be it in a clinical setting (residency and fellowship) or

basic undergraduate medical learning, the subject of medical education seems imperative to be part of undergraduate medical curriculum.

Does TOCSE answer the call of evidence-based teaching in bridging basic knowledge to proficient clinical skill? Although further application studies are needed, with a robust research design, the discussion on TOCSE shows clear evidence that it does.

SUMMARY AND INSIGHT

The ultimate goal of medical education is to graduate physicians who are able to hurdle various real-world clinical problems. EBT is a challenge for medical institutions to adopt teaching techniques proven to be effective in addressing needs, foremost of which is connecting knowledge of basic medical science to clinical learning. Although various strategies have been reported and elaborated, findings with shortcomings in research methodology and designs hamper generalization of conclusions.

TOCSE as an applied tool has clearly addressed the dilemma of bridging basic knowledge to clinical skill application through sound research methodology.

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