

A Content Analysis of the Highly-Cited Articles in Medical Education: Commitment to Addressing Change and Reliance On Theory

Parisa Malekahmadi

Isfahan University of medical sciences

Ahmad-reza Yazdan-Nik

Isfahan University of medical sciences

Mohammad Amouzadeh

University of Isfahan

Nikoo Yamani (✉ nikooyamani@gmail.com)

Isfahan University of medical sciences

Catherine Compton-Lilly

University of South Carolina

Trudie Roberts

University of Leeds

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Abstract

Background: The medical education community is reflecting increasingly on the role and nature of research in the field. Useful sources of data to include in these reflections are a description of the topics in which we are investing our energies, an analysis of the extent to which there is a sense of progress on these topics, and an examination of the mechanisms by which any progress has been achieved. The purpose of the present study was to provide an insight into the highly cited themes of research into medical education.

Methods: This study is a content analysis of highly cited articles in medical education. An in-depth content analysis was conducted, identifying meaning units, which were compacted and coded with labels.

Results: During a variety of topics, methods and strategies, 764 codes, 24 descriptive themes, and 7 categories were extracted from the content analysis as the most prominent. Categories for future medical education research were: Modern technology updating in medical education; Learner performance improving; Sociological aspects of medical education; Clinical reasoning; Research methodology concerns of medical education; Instructional design educational models; and Professional aspects of medical education.

Conclusions: Medical education is in need of moving to a more theory and discovery driven approach and would profit from broadening its scope and reformation that might bring answers to new concerns. An emphasis on creating more systemic knowledge and theoretical models will nurture the generalizable scientific knowledge and will increase the medical education chance to drive the development of research on learning and instruction.

Background

While the citations received by scientific publications have been used as a representative measurement to assess the impact of researches [1] and to rank researchers based on the differences in their citation indices [1, 2], the numbers of published research papers and their citations have been used as a representation measure to assess the quality of research on national scales and to set it in an international context [3]. This may explain why highly cited publications are usually seen as influential papers [4], not just for authors and journals but also for the universities and the nations where the work was completed [5, 6] in terms of research productivity [6, 7]. In practical terms, in the changing world of academic journals, citation ratings is one of the indexes of lasting, a real achievement, testament to the high quality of the published papers [8], and commitment to the usage of the historical knowledge of struggles tactically [9].

Highly cited articles usually bring to light new ideas or provide novel solutions to long-standing problems or tough questions. A large number of citations may also indicate that researchers rely more on such articles to qualify their methods or legitimize their views [10, 11]. Furthermore, an objective algorithm

based on citation data of high-impact researchers has been shown to help predict Nobel Prize winners [12, 13].

Although the number of citations determines their article and journal impact factor and also researches tendencies and contributions [14], the number of citations does not necessarily reflect how influential an article is in a particular area [15, 16]. An article could be considered most influential when it contributes to shaping aspects in a policy or a program, legislation, clinical practice, surgical procedure, or our understanding of a difficult concept [17]. Also, basic and dominant research methodologies in each domain and at specific time intervals have the potential to receive high citations. As an additional point, these parameters together with social consideration and the role played by media may restrain the influence of an article [18].

Highly cited articles have had a major influence on the evolution of scientific debate, delegation of the dominant discourses, and expansion of current practices [19]. They are also knots in the network of dissemination, acceptance, discussion, and practices of scientific and educational information to identify power relations between knowledge and social practices [20]. Therefore, the identification and analysis of the highly cited articles provide us with a range of information not only about the topics and themes covered, problems solved, and methods used, but also about their prominent properties, what can be learnt from these articles and where to go from here [18]. From an application perspective, by revealing the classified tenets and diverse perspectives of the highly cited articles, educational researchers and educators are stronger, smarter, and better prepared for the challenges [21, 22].

The aim of the present study was a content analysis of the highly cited articles in medical education to develop a unifying portrait of classified themes and contents that could inform a common set of chances and challenges, based on their future roles in academic society. The first medical education research content analysis has covered 1975- 1994 period [22], the second has investigated articles published during the years 1988–2010 [21], and the present 2009-2018 content analysis together have prepared a holistic perspective from 1975 to show prominent themes, order of priorities, and changes over time.

Methods

Search strategy and study design

This study is a content analysis of highly cited articles in medical education. The Science Citation Index Expanded (SCI-Expanded) database of the Thomson Reuters Web of Science search on 12 June 2019 was used for the identification of highly cited articles, because this is the only database that gave us a reliable criterion for elite articles selection. Among the 34 journals were listed in the “Education, Scientific Discipline” category of Web of Knowledge, 19 journals’ scope were related to medical education. The search formulate in the field of publication name was: ((Academic medicine (US)) OR (Advances in health sciences education (Canada)) OR (Advances in physiology education (US)) OR (American biology teacher (US)) OR (American journal of pharmaceutical education (US)) OR (Anatomical sciences education (US))

OR (Biochemistry and molecular biology education (US)) OR (BMC medical education (UK)) OR (CBE life sciences education (US)) OR (European journal of dental education (UK)) OR (Hematology American society of hematology education program (US)) OR (Indian journal of pharmaceutical education and research (India)) OR (Journal of biological education (UK)) OR (Journal of continuing education in the health professions (US)) OR (Journal of surgical education (Canada)) OR (Medical education (Canada)) OR (Medical teacher (UK)) OR (Nurse education today (Australia)) OR (Teaching and learning in medicine (US))).

From 59,030 retrieved results, 77 articles have been classified under the highly cited paper category. As of May/June 2019 this category updating, these highly cited papers received enough citations to place in the top 1% of the academic field, based on a highly cited threshold for the field and publication year (from 6 citations at 2018 to 605 citations at 2009). By omitting three irrelevant articles that have not covered educational aspects of medical sciences, 74 relevant highly cited papers were subjected to content analysis.

Data analysis and credibility

An in-depth content analysis was conducted, identifying meaning units, which were compacted and coded with labels. The process was started through reading each article several times in order to extract both its general and retail concepts and missions. By repeated browsing across extracted codes, the structures of themes were crystallized gradually based on construction and deconstruction tradition. Similarly, themes with conceptual similarities were grouped into categories in a similar way. Each of themes was defined and illustrated with representative quotes from the papers [23- 26].

An international and multi-disciplinary team (from medical education, linguistics, education, and nursing) was engaged in this content analysis as an enlighten preface and part of a lager study in order to cover the most widespread and different points of view. To ensure validity and thoroughness, after content analysis was carried out independently by two authors (PhD thesis's internal supervisors); all were classified and coded by the lead author (PhD candidate) and were second-coded by two of the other authors (PhD thesis's external supervisors). The lead author met with each of the other coding authors to assimilate differences in coding by consensus. If consensus could not be reached, a third author (PhD thesis's advisor) who had not coded that transcript helped to simplify reconciliation. Themes and categories have been evolution in similar ways.

Results

The purpose of the present study was to provide an insight into the highly cited themes of research into medical education. In addition, the journals, organizations, funding agencies, authors, and methodologies most often involved in medical education research were to be identified. Retrieved highly cited articles have been distributed between 2009 to 2018 as Table 1. Such distribution of highly cited articles over the past ten years does not follow a specific pattern.

Table 1
Distribution of highly cited articles by the year of publication

Publication year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Highly cite articles	5	12	3	6	8	12	6	9	5	11

The findings showed that in addition to the selected web of science category, the majority of highly cited papers have overlapped -with other categories as: "Health care sciences services" with 46 papers, "Education, educational research" with 10 papers, "Surgery" with 4 papers, "Physiology" with 2 papers, "Nursing" and "Pharmacy", each with one paper.

There was a relationship between the corresponding journals containing the most highly cited articles and their impact factors, as Table 2. An over representation of 10 USA journals were the half more, while the UK and Canada with respectively 4 and 3 journals, and Austria and India each with one journal were the half less.

Table 2
Distribution of highly cited articles by the journals' name

Journal name	Highly cite articles
Academic medicine (US)	21
Medical education (Canada)	11
Anatomical sciences education (US)	11
Medical teacher (UK)	6
CBE Life sciences education (US)	5
BMC Medical education (UK)	4
Journal of surgical education (Canada)	4
Advances in physiology education (US)	2
Journal of continuing education in the health professions (US)	2
American journal of pharmaceutical education (US)	1
Nurse education today (Australia)	1

Top organizational affiliations were related to USA and Canada respectively, with undisputed domination of organizational affiliations of USA (Table 3).

Table 3
Distribution of highly cited articles by top organizations enhanced

Organizations enhanced	Highly cited papers
University of California system	12
May clinic	7
University of Ottawa	
University of California San Francisco	6
University of Toronto	

More than half of the highly cited papers (54/54 %) had no funding. Among the funded articles, top funding agencies were USA based (Table 4).

Table 4
Distribution of highly cited articles by top funding agencies

Funding agency	Highly cited papers
National institutes of health NIH USA	5
United states department of health human services	
Division of general internal medicine Mayo clinic	2
National sciences foundation NSF	
NIH national institute of general medical sciences NIGMS	

The average number of authors per article was 4.98. Undisputed domination of American authors in the most highly cited articles authorship was hegemonic (Table 5).

Table 5
Distribution of highly cited articles by top authors

Author name	Highly cited papers
S. Barry Issenberg, MD University of Miami Miller School of Medicine, Miami, Florida, USA	5
David A. Cook, MD Mayo Medical School, Rochester, MN, USA	3
Richard L. Drake, PhD Case Western Reserve University, Cleveland Clinic, Cleveland, Ohio, USA	
Jason R. Frank, MD, MA(Ed) University of Ottawa, Canada	
William F. Iobst, MD Geisinger Commonwealth School of Medicine, Pennsylvania, USA Accreditation Council for Graduate Medical Education (ACGME)	
Jacqueline M. McBride, PhD Genentech Inc, South San Francisco, California, USA	
William C. McGaghi, PhD Northwestern University Feinberg School of Medicine, Chicago, Illinois, USA	
Bridget C. O'Brien, PhD University of California, San Francisco, California, USA	
Jonathan Sherbino, MD McMaster University, Hamilton, Ontario, Canada	
O. ten Cate, PhD and MD University Medical Center, Utrecht, the Netherlands	

Methodological analysis of the highly cited articles has showed the dominance of archival approaches (Table 6).

Table 6
Distribution of highly cited articles by methodology

Methodology	Highly cite articles
Perspective (Feature)	15
Synthesis of review literature	14
Systematic Review	11
Cohort	7
RCT, Comparative quasi-experimental design, and Cross-sectional	4
Correlational, Content analysis, Initiative productions, and Consensus meetings	3
Model development and Mixed method	2

During variety of topics, methods and strategies, 764 codes, 24 descriptive themes, and 7 categories were extracted from the content analysis as the most prominent. Some descriptive themes were shared among several groups, which were classified under the dominant group (Table 7).

Table 7

Categories, descriptive themes, and themes of meanings of highly cited articles

Categories: number of articles	Descriptive themes: number of articles	Themes of meaning
Modern technology updating in medical education: 22 articles	Multimodal teaching approaches: 9 articles [27–35]	Progressive implementation of computer-based and internet-based learning methods interacted with waves of ongoing curricular changes have been deemed crucial for continuing medical education reforms and providing new challenges and opportunities for medical educators.
	Technology-enhanced Simulation-based mastery learning (SBML): 7 articles [36–42]	Simulation-based mastery learning in medical education can produce downstream results and translational outcomes in terms of improved patient care practices, better patient outcomes, and collateral effects.
	3-Dimensional printing models: 6 articles [43–48]	3DP models are valuable resource for anatomical education, preoperative planning, and surgical training as an excellent adjunct to wet cadaveric or plastinated prosections, demonstrating improved subjective and objective outcomes.
Learner performance improving: 16 articles	Academic performance reform: 5 articles [49–53]	New calls for academic performance reform are emerging for: (1) standardizing learning outcomes and individualizing the learning process, (2) promoting multiple forms of integration, (3) incorporating habits of inquiry and improvement, and (4) focusing on the progressive formation of the physician's professional identity.
	Advancement of educational outcomes: 3 articles [54–56]	Mapping and measuring programmatic outcomes alongside promoting and guiding curricular change were achieved by a structured framework provided by CME activities in order to address issues of competence, performance, and patient health status.
	Erosion of empathy: 3 articles [57–59]	Erosion of empathy occurs during a time when the curriculum is shifting toward patient-care activities, compromises a disagreement striving attempt toward professionalism and clinical competence, and may threaten patients' clinical outcomes and health care quality.
	Burnout: 3 articles [60–62]	An environment in which trainees flourish, achieve high well-being and acquire the skills necessary to promote resilience is clearly needed.

Categories: number of articles	Descriptive themes: number of articles	Themes of meaning
	<p>Effective Selection policies and methods: 2 articles</p> <p>[63, 64]</p>	<p>Admission policies need to be correlated against best available health outcomes, commitment to explicitly identify health needs, desirable career, and career location uptakes.</p>
<p>Sociological aspects of medical education: 8 articles</p>	<p>Professional Identity Formation (PIF): 2 articles</p> <p>[65, 66]</p>	<p>Identity formation is a dynamic process achieved through socialization; it results in individuals understanding the nature of professionalism and its obligations and internalizes joining the medical community of practice and the value system of the medical profession.</p>
	<p>Social Determinants of Health (SDOH): 2 articles</p> <p>[67, 68]</p>	<p>SDOH serves to reduce health disparities through adoption of a structural vulnerability framework in health care and foster health equity through an active commitment to social justice among medical trainees.</p>
	<p>Gender differences: 2 articles</p> <p>[69, 70]</p>	<p>Institutions must examine the climate for women to ensure their academic capital is fully utilized and equal opportunity exists for leadership.</p>
	<p>Race/Ethnicity differences: 1 article</p> <p>[71]</p>	<p>Successful retention of underrepresented medical (URM) faculty requires comprehensive institutional commitment to changing the academic climate and deliberative programming to support productivity and advancement.</p>
	<p>Sexual Harassment: 1 article</p> <p>[72]</p>	<p>Academic medicine's ability to change sexual harassment must work to begin to establish safe environments for individuals to come forward, to provide training for victims and for bystanders, and to abolish locker room talk that is demeaning to women.</p>
<p>Clinical reasoning: 8 articles</p>	<p>Diagnostic cognition and errors: 4 articles</p> <p>[73–76]</p>	<p>Dual Process Theory (DPT) has immediate application to medical decision making and provides an overall schema for teaching decision theory.</p>
	<p>Trainers trust: 2 articles</p> <p>[77, 78]</p>	<p>Trust allows the trainees to experience increasing levels responsibility and can serve as significant stimuli for learning and also shape the assessment of trainees.</p>

Categories: number of articles	Descriptive themes: number of articles	Themes of meaning
	Trainers feedback: 2 articles [79, 80]	External supported sequential feedback and self-appraisal interact to influence professional development.
Research methodology concerns of medical education: 7 articles	Qualitative paradigm: 4 articles [81–84]	The Standards for Reporting Qualitative Research (SRQR) aims to improve the transparency of all aspects of qualitative research by providing clear standards for reporting and their implications by critically appraising, applying, synthesizing studies' findings, and integrating research experiences into courses.
	Quantitative research: 2 articles [85, 86]	Statistical significance is the cornerstone of quantitative researches, but studies that fail to report measures of effect size are potentially missing a robust part of the analysis. Also despite frequently criticisms, the choice of statistical methods can be utilized without concern for getting the wrong answer.
	Information management research: 1 article [87]	The medical education community has an important challenge to take full advantage of the outstanding new resource as educational research datasets with the potential to radically change the volume and types of research that can be envisaged and, therefore, to improve standards, facilitate workforce planning and support the regulation of medical education and training.
Instructional design educational models: 7 articles	Flipped classrooms: 5 articles [88–92]	Flipped classroom developed students' independent learning strategies and engaged them in deep and active learning.
	Increasing course structure: 2 articles [93, 94]	Increased course structure improves the student achievement through distributed learning and interdependent classroom community.
Professional aspects of medical education: 6 articles	Competency- based medical education (CBME): 4 articles [95–98]	Competency-based medical education, as a resurgent paradigm, relies on continuous, comprehensive, and elaborate assessment and feedback systems which facilitate the developmental progression of competence and has the potential to transform contemporary medical education.
	Interprofessional education (IPE): 2 articles [99, 100]	There is growing interest in IPE and in its education and research agenda to develop best practice models based on evidence of effectiveness that must not be regarded as distinct from the agenda defined by the needs of health care practice and patient care.

Discussion

The purpose of this study was to examine the highly cited articles on medical education and to identify dominant trends in this body of research. In addition to which areas are relatively more or less valuable, it is equally important to address why the community might see them as noteworthy and how we could take advantage and see the value-added of the results. Rather, the objective of such research is not, by itself, to effect change, through this will come. The attempt is to provide some kind of framework in which informed change could result, with the conviction that when change is the result of the best evidence available in the format of highly cited articles, it is more likely to produce the desired outcome than if it is based on untested assumptions or benefits. Administrators and lobbyists can work jointly toward the accrual of political and economic support for key areas of research and development. Researchers and developers also must do their part to work programmatically, both individually to pursue promising ways of thinking and lines of research and collaboratively to build mutual understanding.

First, twenty-three descriptive themes of highly cited articles in seven categories were identified. More than thirty percent of the articles counted deals with modern technologies and their implications in one way or another. Categories for future medical education research were: Modern technology updating in medical education; Learner performance improving; Sociological aspects of medical education; Clinical reasoning; Research methodology concerns of medical education; Instructional design educational models; and Professional aspects of medical education. These seven areas suggested for further research inquiry represent a continuum of processes and technologies in medical education and practice. Research in medical education in the future should be focused on the inter-relationships of such educational processes with technological, sociological, and professional aspects.

As medical schools become increasingly committed to and involved in direct responsibility for providing care to a variety of populations, it becomes increasingly urgent to understand how various educational processes and technology-based innovations affect each other and do or could influence the career patterns, learning outcomes, and performance behavior of the trainees and graduates of medical education while investigating how modern technologies and their implications, sociological and professional aspects, and methodological concerns influence such characteristics. This broad scope of topics has the advantage of providing many opportunities for diverse range of research and discovery, but it also generating a sense that the field lacks coherence and communal effort toward the resolution and advancing of big questions.

Second, the US journals, organizations, funding agencies, and authors were produced most of the highly cited researches in medical education. This was to be expected because medical education research created and expanded in this country first, the number of medical schools and organizations in the US is sizable, and US medical schools tend to be research intensive and this attitude tends to spill over to the departments of medical education. In addition, the editors of each of the journals have been active in their pursuit of promoting and shaping the face of medical education research. It is, therefore, surprising to note that Canadian journals, organizations, and authors were appeared in the top of highly cited

articles with a stark difference from US. Clearly, in spite of gross premier of medical education research in US, medical education research is a more international endeavor than many other medical domains.

The most highly cited papers were reviews of the literature rather than research articles. The archival approaches including perspectives, synthesis of review literatures, and systematic reviews, with 44.6 percent of highly cited articles was dominant. This recent trend is seen as a very positive outcome that will assist policymakers, investigators, and teachers to adoption, development and evaluation of new educational approaches.

Research methodological concerns approved the need for continuing feed- in of good research that is problem oriented, comparative, and longitudinal, focused on qualitative paradigm and information management methods. Also, most of the highly cited articles (54/54 %) reported outside funding support. The half less incidence of external sources may be compatible with the picture of school-sponsored educational studies at an individual institution (Table 4).

The average number of authors per article was 4.98. Undisputed domination of American authors in the most highly cited articles authorship was hegemonic (Table 5).

The average number of authors per article (4.98) has grown over the past decades, and this growth may be an indication of increased collaboration between medical educators with faculties of basic science and clinical teaching.

Third, it is interesting to compare the distribution of topics regarding the pursuit of knowledge-building in a community of scholars with the recommendations in previous essays. A majority of the medical education's articles between 19975-1994 fell into three broad categories: curriculum, teaching, and student assessment. A large percentage of them focused on performance assessments, assessments of medical student competence, or studies designed to compare educational methods [22]. These three topics were surprisingly under presented in the 1974 essay's five areas including selection of physicians, medical school socialization process, house officer training, medical schools as social institutions, and physician performance [101].

Student assessment, clinical and communication skills, clinical clerkships, and problem-based learning were the most prominent domains of 1988-2010, in which the community has been investing its energies. Assessment of students, with reliability and validity of the measures employed, were the premier concern. Some of themes, such as multiple-choice examinations or computer-assisted instruction seemed to have had their day, whereas other topics, such as the study of clinical clerkships, clinical reasoning, and scholarship in education were on their way up [21]. Perspectives concerning a field-based inquiry approach to medical education were offered in the 1988 essay. This approach required that inquiry tactics more closely match educational and clinical processes. It was concluded that understanding of social and educational phenomena had too long been determined by research and evaluation frameworks that define concepts of what is good and what is bad in medical education and that have

limited those concepts. Most medical education research organized by constructs, typically psychological or behavioral, that were used to explain or predict certain patterns of human behavior [102].

During the process of reflecting on the medical education research literature since the turn of the 21st century, four themes jumped out as being very apparent including curriculum and teaching issues, skills and attitudes relevant to the structure of the profession, individual characteristics of medical students, and the evaluation of students and residents. The lines of research related to the content area of professionalism and those related to the development of the OSCE were obvious, at least in part because of their apparent coherence as a domain of research and development [103].

Fourth, there was very little evidence of overarching theories of education that direct and inform the individual studies between 1975-1994. One of the concerns since the turn of the 21st century was that the field did not seem to be advancing on “big questions” and expanding systematic or productive programs of research. The lack of research studies that incited and appraised by useful theories or the absence of “functional” theories were resulted to the difficulty of aggregating findings into consistent themes. One solution for this issue would be to look at domains, themes, and mechanisms where the medical education community has recently invested their research and development energies through community-level reflective practice by which improvement has been achieved and theory has played a role.

Fifth, it is interesting to note that assessment as a key domain identified from 1975 to 2010 does not attract much attention. It is possible that this has been studied extensively in bygone eras and has not any longer been considered problematic. Although assessment is still counted but its hegemonic prominence and axial role were marginalized and the power and authority of clinical assessment were delegated to modern technologies’ implications, especially in anatomical sciences education. The same may apply to the use problem-based learning, in the nineties and first decade of 21st century as a core issue in medical education. Comparing the chronological of PBL affirmation and the relative lack of emphasis on lectures and computer-assisted instruction with multimodal teaching approaches, its special attention to the tension of clinical and basic sciences instruction, and finally its prominent elimination are perhaps witness of the amount of enthusiasm and controversy that PBL approach to medical education surrounds. Interestingly, methods based on modern technologies such as multimodal teaching approaches, technology-enhanced simulation-based mastery learning (SBML), and 3-Dimensional printing models now emerge as approaches deserving notice. Such modern technologies served through instructional design educational models such as flipped classrooms (FC) or increasing course structure (ICS). Healthcare and medical training have no immunity to universal and rapidly changing technology. In medical education, advances like multimedia applications through modern educational models (FC and ICS), simulations (integrated simulators with part-time trainers, and virtual reality), and 3D printing models (immersed in various technologies) have evolved as pedagogical strategies to facilitate an active and learner-centered teaching approach.

Professional aspects of medical education category consist of competency-based medical education (CBME) and inter-professional education (IPE) in order to performance improvement. Within the broader learner performance improving category, most articles have been devoted to academic performance reform, advancement of educational outcomes, erosion of empathy, burnout, and effective selection policies and methods. Therefore, issues of optimizing clinical competence, both in terms of diagnosis and management and in terms of the clinical and interpersonal skills, are vital to those involved in such education. The medical education highly cited articles show an overwhelming emphasis on the effectiveness of modern technologies in medical education reforms and direct preparation of students for improved professional practice and outcomes. Modern technologies can address the educational goals in medical education include facilitating basic knowledge acquisition, improving decision making, enhancement of perceptual variation, improving skill coordination, practicing for rare or critical events, learning team training, and improving psychomotor skills.

With regard to teaching methods, focus is transforming from clinical phase to the basic sciences phase of medical education with its increasing technological potential. Teaching of clinical phase is also transforming from the clinical and communication skills and the clinical clerkships to broader clinical reasoning category including diagnostic cognition and errors, and trainers trust and feedback. Clearly, clinical reasoning, continue to attract interest over time. Cognitive psychology with technology acceleration role influences on the attempting to identify how information is learned by students and later retrieved in clinical contexts. Research methodological concern is the third transformation focusing on qualitative paradigm based on information management technological approaches. Yet, not all of today's medical trainees or educators are equally adept and comfortable with technology in the basic sciences and clinical education and research. Educators are tasked with selecting and filtering appropriate technology-based curricula.

The fairly recent interest is sociological aspects of medical education that categorized into professional identity formation (PIF), social determinants of health (SDOH), gender differences, race/ethnicity differences, and sexual Harassment. Topics such as professionalism in medicine and the possible role of the humanities in medical education were already noticeable in the 1988- 2010 literature. This seems to be largely due to politico-cultural distinctions between the new and the old world. Technologies are some of the techniques available to administer the changing educational and social environment and can supply and support the infrastructure and basis for operating many of the challenges in preparing medical education community for the future.

Sixth, the most highly cited researches conducted in medical education seems to be effectiveness-driven and checks the comparative effectiveness of existent approaches rather than discovery-driven and detect new ones. Four innovations including multidisciplinary-multimodal teaching approaches, technology-enhanced simulation-based mastery learning (SBML), 3-Dimensional printing models, and flipped classrooms (FC) educational models have emerged from the highly cited medical education articles. These innovations have been fallen prey to the same effectiveness virus and are aimed at justification of ideas rather than clarification. A domain such as clinical reasoning, which has shown consistent and

monotonic growth about four decades is a prototype of a progressive research domain that arise from a change to new paradigms that create new and interesting questions.

Inquiry processes operate in a fashion parallel with the nature of social and human practice and systems. All forms of educational and social inquiry seem to be focusing on the field as a framework and basis for inquiry. The description of medical education instruction is based on research that combines concepts germane to adult learning theory and medical education. The key point is that there is a legitimate match among certain features of medical education, clinical practice, and inquiry that justify use of a less "scientific" more field-based research approach in medical education settings.

Conclusions

Commitment to change educational emphasis and concerns, transformation of competencies and processes, and reformation of educational systems and designs were repeatable component of highly cited articles content. Reliance on theory and theoretical frameworks were the second turning point of this content analysis that has provided rich archive of valid evidence for education and research. Overall, medical education is in need of moving to a more theory and discovery driven approach and would profit from broadening its scope and reformation that might bring answers to new concerns. We have realized that the system is flawed and science change will take time. An emphasis on creating more systemic knowledge and theoretical models will nurture the generalizable scientific knowledge and will increase the medical education chance to drive the development of research on learning and instruction. The ultimate goal of medical education is to find better ways to teach, to modify some aspects of performance, and to improve interventions or programs within medical education. So we first need to make sure that we develop explanatory theories, identify and cluster instructional support methods into theoretically related ones, and finally investigate them systematically.

Abbreviations

Science Citation Index (SCI), Accreditation Council for Graduate Medical Education (ACGME), Simulation-based mastery learning (SBML), 3-Dimensional printing models (3DP Models), Continuing Medical Education (CME), Professional Identity Formation (PIF), Social Determinants of Health (SDOH), Under-Represented Medical faculty (URM faculty), Dual Process Theory (DPT), Standards for Reporting Qualitative Research (SRQR), Competency-Based medical education (CBME), Inter-Professional education (IPE)

Declarations

• **Ethics approval and consent to participate:** It has been attached as related files

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- **Consent for publication:** Not applicable
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- **Authors' contributions:**

PM, AY, MA, NY, CC, TR: have made substantial contributions to the conception and design of the work, the acquisition, analysis, and interpretation of data

All of the authors have approved the submitted version (and any substantially modified version that involves the author's contribution to the study). All to have agreed both to be personally accountable for the author's own contributions and to ensure that questions related to the accuracy or integrity of any part of the work, even ones in which the author was not personally involved, are appropriately investigated, resolved, and the resolution documented in the literature.

All authors have agreed to the submission to the journal and that the manuscript is not currently under submission in any other journal.

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