

Educational strategies and significant learning of research courses for resident physicians: a view from literature

Estrategias educativas y aprendizaje significativo en los cursos de investigación para médicos residentes: una mirada desde la literatura

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Abstract: Background: the learning of critical appraisal of literature and research is fundamental in the training of resident physicians. Objective: to identify the educational strategies and categories of significant learning according to Fink's taxonomy reflected in critical appraisal and research courses on resident physicians. Method: a review of reviews was carried out. MEDLINE, EMBASE, ERIC, The Cochrane Database of Systematic Reviews and LILACS were searched without date or language restrictions. Citations were reviewed by two independent reviewers and disagreements were resolved by a third reviewer. The overall quality of the evidence was evaluated using AMSTAR. The learning categories were classified according to Fink. Results: 14 systematic reviews were identified. Four reviews were rated as high quality, six as medium and four as low. The educational strategies most used were journal club, followed by seminars and workshop on evidence-based medicine. The most evaluated learnings were knowledge, application, the human dimension and care. There is limited evidence on integration and learning to learn. Conclusions: educational strategies are required that involve planning, application and evaluation focused on interaction of significant learning that promotes both cognitive and human learning of medical practice at research and critical appraisal of literature.

Keywords: Learning; graduate medical education; Evidence-Based Medicine; biomedical research; systematic review.

Resumen: Antecedentes: el aprendizaje de la apreciación crítica de la literatura e investigación es fundamental en la formación de los médicos residentes. Objetivo: identificar las estrategias educativas y las categorías de aprendizaje significativo según la taxonomía de Fink reflejadas en los cursos de bioestadística, epidemiología, investigación o medicina basada en la evidencia (MBE) en los programas de residencias médicas. Método: se realizó una revisión de revisiones sistemáticas en MEDLINE, EMBASE, ERIC, The Cochrane Database of Systematic Reviews y LILACS sin restricciones de tiempo o idioma. Las referencias fueron revisadas independientemente por dos evaluadores y los desacuerdos resueltos por un tercer evaluador. La evaluación de la calidad global de las revisiones fue hecha con la herramienta AMSTAR. Las categorías de aprendizaje se clasificaron según la taxonomía de Fink. Resultados: se encontraron 14 revisiones sistemáticas; cuatro calificadas como de alta calidad, seis como de media y cuatro como de baja calidad. Las estrategias educativas más utilizadas fueron el club de revistas, seguida del seminario y taller sobre medicina basada en la evidencia. Los aprendizajes más evaluados fueron los conocimientos, la aplicación, la dimensión humana y el cuidado. Hay evidencia limitada sobre la integración y el

aprender a aprender. Conclusiones: se requieren estrategias educativas que involucren la planeación, aplicación y evaluación enfocadas en la interacción de aprendizajes significativos que promueva tanto el aprendizaje cognitivo como la parte humana de la práctica médica en investigación y apreciación crítica de la literatura.

Palabras clave: Aprendizaje; educación de postgrado en medicina; medicina basada en la evidencia; investigación biomédica; revisión sistemática

1. Introduction

The global competence called Practice-Based Learning and Improvement described by the Accreditation Council for Graduate Medical Education (ACGME) relates the appropriation and application of medical evidence to correct clinical practice by indicating that residents can investigate and assess their practices of service to patient performing an evaluation of the scientific evidence in order to improve their clinical care (1). In this way, the integration of clinical research in medical practice is reflected by understanding the evidence (2-5) and by publishing research from their own experience.

Each academic program of the medical residencies generates teaching-learning processes in clinical epidemiology, biostatistics, and critical evaluation of the literature (6). The need to connect concepts in these topics with clinical practice reveals the importance of achieving significant learning, defined as that which is assimilated and maintained over time in order to build a relationship with pre-existing knowledge and integrate it into the cognitive structure of the student (7). Medical residents build research learning in undergraduate and these are taken up, during their medical-surgical specialty, in order to generate new knowledge.

Under this scenario, the academic programs of the medical residences need to identify if: a) the competencies described in the curriculum are achieved by the students, b) if the learning is significant, and c) what type of learning they acquire during their training. One of the strategies that achieves this last task corresponds to Fink's taxonomy of objectives (8). This taxonomy contains six categories of learning that are fundamental to achieving meaningful learning. The learning categories are: **fundamental knowledge, application, integration, human dimension, caring and learning to learn**. Unlike other taxonomies that reflect hierarchies, this classification considers that there is an interactive nature between its categories and, therefore, generates a synergy (8).

The purpose of research in medical specialties makes real sense when clinical practice is modified to provide comprehensive care. The objective of this review was to identify educational strategies and meaningful learning categories according to Fink's taxonomy (8) reflected in biostatistics, epidemiology, research or evidence-based medicine (EBM) courses in medical residency programs.

2. Methods

For the analysis of the publications, a review of systematic reviews was prepared according to the Cochrane methodology (9) and the PRISMA guideline (10) was followed for reporting the results. The review protocol was recorded in the PROSPERO database at the following link: https://www.crd.york.ac.uk/PROSPERO/display_record.asp?ID=CRD42017057765

The literature search was performed in MEDLINE, EMBASE, ERIC, The Cochrane Database of Systematic Reviews, and LILACS without time or language restrictions until December 2021. The search strategy was as follows: (((Biomedical Research OR Research, Biomedical OR MedicalMachine Research OR Research, Medical OR Clinical Research OR Research, Clinical))) OR ((Evidence-Based Medicine OR Evidence Based Medicine OR Medicine, Evidence-Based OR Medicine, Evidence

Based))) OR ((Critical thinking OR Critical appraisal)) AND ((postgraduate medicine) OR postgraduate medical) OR resident) AND (teach\$) OR Learn\$ AND (metaanalysis[Publication Type] OR metaanalysis[Title/Abstract] OR metaanalysis[MeSH Terms] OR review[Publication Type] OR search*[Title/Abstract])). In addition, a manual search of the references of eligible systematic reviews was carried out in order to identify other studies. Systematic reviews or primary studies with preliminary results, letters to the editor and abstracts were excluded. Systematic reviews of any type of design were included, describing at least one educational strategy and one of Fink's six learning categories (8) and rated as follows:

a) **fundamental knowledge**: corresponds to the content of the course, that is, terms, concepts and theories;

b) **application**: connect concepts and use them creatively to solve problems. This learning was identified when residents demonstrated skills in formulating clinical questions, literature search, and critical appraisal of the biomedical literature;

c) **integration**: refers to the interaction and synergy between subjects. This learning was related to group work or academic discussions;

d) **human dimension**: it is understanding oneself and others, collaborating and taking initiative. This category comprised changes in behavior caused by learning and self-assessment processes learned in the course;

e) **caring**: implies the affective dimension of learning, the evolution of values and the feelings that are generated by a topic. Included in this learning were attitudes toward critical appraisal of literature, satisfaction with content, and reporting the importance of evidence-based medicine, and

f) **learning to learn**: it is the metacognition and development of students to learn continuously and independently. In this case, the incorporation of learning into clinical practice, the increase in the use of evidence in clinical services and continuing to learn research topics were analyzed.

Two raters independently reviewed titles and abstracts of the literature search results; discrepancies were then resolved by a third evaluator. With the full texts selected, two researchers independently applied the eligibility criteria and disagreements were resolved by consensus. The following were extracted from each systematic review: country, objective, population, literature search dates, number of studies included, number of studies in medical residents, designs of the primary studies and number of residents included in the primary studies. When there was inconsistency in the information reported in the systematic reviews, the data from the primary studies were reviewed (9). Two reviewers independently assessed the overall quality of systematic reviews using the AMSTAR tool (11). A systematic review was considered to be of high quality when it fulfilled 8 to 11 domains; medium quality between 4 to 7 domains and low quality from 0 to 3 domains (12). This research project was approved by the Research Committee of the Faculty of Medicine.

3. Results

The literature search returned 6,416 results. After removal of duplicates, the titles and abstracts of 6,168 citations were analyzed. A total of 26 systematic reviews were assessed in full text and 12 reviews were excluded for the following reasons: seven did not include an educational strategy (13-19); two were narrative reviews (20,21); one study did not include medical residents (22); another did not describe the characteristics of the primary studies (23) and the remaining was a letter to the editor (24). Figure 1 shows the flow chart followed.

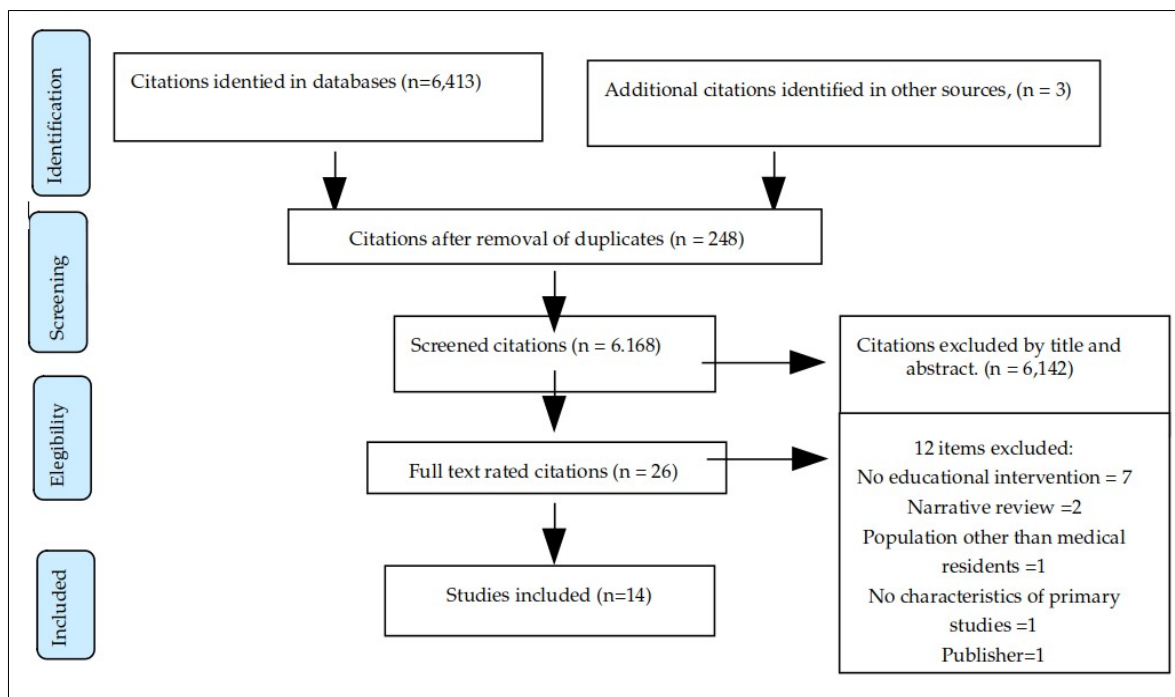


Figure 1. Flow diagram of the PRISMA process selection.

3.1. Synthesis and evaluation of the evidence (Table 1).

Fourteen systematic reviews published between 1983 and 2014 (25-38) were included. Five systematic reviews were developed in the United Kingdom (27, 28, 30-32), three in Canada (26, 36, 37), two in Australia (35, 38), and the rest in France (25), the United States (29), Spain (34) and in various countries (33). The systematic review with the largest number of primary studies was published by Coomasaramy and Khan (32). According to the AMSTAR system, the most frequent failures in the methodological aspects of the reviews were not assessing publication bias ($n=12$), not referring to a pre-publication protocol ($n=11$), not listing excluded studies ($n=10$) and not reporting conflicts of interest ($n=10$). Based on these parameters, the four reviews that scored high were Hyde (28), Ebbert (29), Flores-Mateo (34), and Horsley (36). Six reviews were rated as intermediate (25, 27, 30, 31, 37, 38) and four as low (26, 32-34).

A total of 31 primary studies were found in the 14 systematic reviews, of which Gehlbach (39) and Kitchens (40) were included in six reviews. The academic programs with the highest number of primary studies were internal medicine, general surgery, and pediatrics (Table 2). Meta-analysis was not possible due to heterogeneity in educational strategies and research designs including randomized controlled ($n=7$), nonrandomized controlled ($n=9$), before and after ($n=13$), and observational studies. ($n=2$).

3.2. Educational strategies

A great variety of educational strategies were identified, the majority used the magazine club (12 primary studies) in which they taught critical appreciation of literature; the time range of the training ranged from two hours (41) to four years (42). The second most used strategy was the seminar and its content was related to research designs and the use of evidence-based medicine; seminar time ranged from one hour (43) to three days of training (44). The workshop was the third educational strategy and the training focused on the construction of clinical questions and literature search. For this strategy, the maximum reported training time was 10 hours (45), however, Bradley (46) does not report it specifically because the workshops were developed during patient care and

included the formulation of the question, literature search, review of the results and subsequent decision making (Table 2).

3.3. Learning categories according to Fink

When evaluating the systematic reviews and their primary studies according to the learning categories following Fink's parameters (8), the analysis was as follows:

Fundamental knowledge

Knowledge was the most evaluated category in educational strategies (20 of 31 primary studies). Of these 20 studies, 15 focused on learning critical appraisal of literature or evidence-based medicine (2, 39-41, 45, 47-56) and five on learning statistics, epidemiology, or research (44, 57-60). Fourteen investigations report an improvement in knowledge. In the remaining six investigations, various reasons were found for the change not to be significant; in the case of the studies by Kulier (54) and McLeod (55) they indicate that their results point to the magazine club being carried out in person and not virtually. In the other investigations, the reasons for no change were: a) short time (50); b) small sample size (51), c) type of course coordinator (teacher versus chief resident) (59); and d) course with a structured approach and with greater intensity (58).

Application

Fourteen of the 16 primary studies related to application as a category indicated change in residents (2, 42, 43, 46, 48, 53, 56, 61-67). To achieve these skills, the most used educational strategy was the implementation of critical appraisal of literature using evidence-based medicine. As evidence of this learning, research reports: a) assimilation of evidence, b) use of checklists, c) change in reading habits, d) increase in the number of articles read, and e) ability to critically evaluate the research articles.

Integration

Only three investigations (45, 52, 62) shed light on integration as a category; all presented learning changes. In the study by Grad (62), the formulation of clinical questions during patient care and a constant review of the topics with colleagues generated a change in learning. Similarly Haidet (52) support their pedagogical practice during the MBE seminar on learning through small group discussions. Ross (45) recorded the interactions during the workshops between the teacher and the student in order to identify the use of EBM terms.

Human dimension

Seven of the 10 studies described by self-report a change in behavior towards EBM (41, 43, 45, 46, 62, 63, 68). In most of the studies it is not clear to which specific behaviors they refer, for example, Baum (43) evaluated the behavior after the workshop in goals designed by the students themselves. In the case of Haines (68), sharing evidence evaluations in a repository achieved changes in patient care. In three investigations, an evaluation of the behavior by teachers or researchers was added to the self-report (45, 46, 68).

Caring

Six of the 10 primary studies that assessed attitude showed a change (43, 46, 48, 52, 62, 63). In most studies the change was recorded by self-report (2, 43, 46, 52, 62, 63, 66). Both the Bradley study (46) and the Green study (63) refer explicitly to the attitudes of residents during decision making in clinical practice.

Learning to learn

Haidet's study (52) refers to the evaluation of the residents after the application of the educational strategy of the seminar as a continuous process of self-management of their learning.

4. Discussion

The critical appraisal of the literature constitutes one of the key elements in learning about research in medical residencies; this competition is necessary due to the excess production of publications and the need to choose the best evidence that generates appropriate clinical judgments. However, it was not until 1993 that the first systematic review related to critical appraisal learning was recorded (25) and from that time on, the Association of American Medical Colleges recommended its introduction in the curriculum in order to develop in residents critical thinking. For this reason, each academic program must outline its competencies with the design of educational strategies that identify learning outcomes through categories that go beyond theoretical concepts and represent a practical application in their specialties and subspecialties capable of interrelating the social meaning of education. education. In relation to teaching and learning theories, very few systematic reviews support or discuss this topic; the review by Harris et al. (23) emphasizes the importance of including pedagogical theories that involve the principles of adult learning and the study by Hyde (28) indicates the need to include adult teaching theories in educational research.

In the case of research and critical appraisal of the literature, these competencies are expected to become visible during clinical care by applying the principles of evidence-based medicine and exercising clinical judgment in communities of practice. This is why educational strategies such as journal clubs, seminars and workshops strengthen understanding and collective dialogue in patient care. In this sense, the teacher has the challenge of developing a pedagogical practice that achieves learning that is significant and this is achieved with the integration of learning categories that are not hierarchical but synergistic, such as the one proposed by Fink (8), in his words: "Teachers do not have to automatically give up one type of learning to achieve another. Instead, when a teacher finds a way to help students achieve one type of learning, he or she may actually enhance, not decrease, student achievement in the other types of learning" (p. 37).

It is not surprising that the majority of primary studies (64.51%) state knowledge as their favorite type of learning; concepts and theories that support the cognitive sense are required. However, when analyzing the categories of integration and learning to learn, the studies have little or no explanation of the interaction between students and teachers or in the way in which students autonomously and independently continue their training in research or critical appraisal. of literature. In this case, the advancement of research with a qualitative or mixed approach will shed light on the development of these skills in students, as indicated by Horsley et al. (36) and Harris et al. (23). These types of studies could help clarify whether social and environmental factors influence clinical research learning that impacts decision-making in medical practice. In this same sense, Young et al. (69) points out that the conditions in the teaching of evidence-based medicine must be evaluated according to the location, depth and style of teaching, as well as the format and structure of the course.

In the case of the application category, the literature indicates that 51.1% (16 of 31 studies) state the formulation of questions, literature search, use of checklists and changes in reading habits as tracer skills in integration from research and critical appraisal to their individual clinical practice. To develop these skills requires the support of an expert (26). This expert, in most cases, turns out to be the teacher who is the bridge that combines theory and practice and builds effective learning scenarios alongside the student. The importance of a motivated teacher is one of the elements of educational strategies, which according to Borrelli (70), can lead to change in student behavior - described in Fink (8), as the category of human dimension learning.

Despite the importance of competence in the appreciation of literature and research by medical residents, there are still limitations in the design and conduct of both systematic reviews and

primary studies. For example, it is noteworthy that of the 14 systematic reviews found, only 57% (n=8) evaluate the quality of the evidence of the primary studies.

From the methodological point of view, some flaws were evidenced in the primary studies, such as: a) the difference in the definitions of outcomes and educational strategies (23), b) there is a large number of interventions that do not present significant changes (29), c) the measurement instruments are inadequate (29, 35), d) the learning was described by means of self-report, which restricts the validity of the results and, e) there is insufficient power to demonstrate a statistically significant difference (29). Given this heterogeneity in the studies, it is impossible to carry out a meta-analysis. Therefore, the conduct of a primary study of this topic must be clear in the competencies and learning categories that are to be developed in residents through an educational strategy that integrates both the process and its learning results through interrelated planning, implementation and evaluation.

As a strength of this review, it can be mentioned that learning is analyzed exclusively in medical residents; an exercise of the analysis of the literature of only studies concerning this population allows educational decisions to be made in university hospitals. Although similar to the review by Young et al. (69) and Bala (71), in this systematic review the study by Ilic and Maloney (38) was included and the study by Green (15) was excluded because the latter was considered outside the scope of the review given that its rationale it focuses on revising the curriculum and not on learning or the results of educational strategies. Another strength consists in the description by learning categories where a greater concentration can be evidenced in those related to integration and self-learning, a fact that highlights the importance of tools that allow evaluating these two learnings because in clinical research learning is developed based on the patients who are in the services and whose decision making presents uncertainty (23,37).

This review has limitations such as the wide variety in the type, time and evaluation of educational strategies, which made quantitative analysis by means of a meta-analysis impossible. On the other hand, due to the scarce information of the primary studies described in the systematic reviews, it was necessary to analyze the original investigations, complete the missing data or reclassify the learning categories. This last activity, although it was carried out in consensus by the authors, is not free of judgments that can be arbitrary to a certain extent.

The report and analysis of the best educational strategies in critical appreciation and research will generate an opportunity in educational management and teaching planning of the academic programs of the residencies. Finally, what is relevant in the use of research is to strengthen trust in the doctor-patient relationship by achieving monitoring of the patient's physical, mental and social state.

5. Conclusions

- The evidence indicates that educational strategies in research or critical appraisal of literature, focus more often on knowledge than on learning guided towards integration and self-learning. In this sense, to reach a meaningful and quality learning, it is necessary to plan a course based on the interaction of learning, through activities, evaluation and feedback that promote the theoretical and the human in medical practice.
- The critical appraisal of the literature and the development of research require a connection with clinical practice in the training of residents of specialties and medical subspecialties.
- Meaningful learning is a way of retaking pre-existing knowledge and integrate them into the student's cognitive structure during training in residencies.
- Fink's taxonomy weaves together categories of learning to achieve competencies not only cognitive and skills but of integration, care, behaviors and self learning
- Educational strategies in medical residency programs in research and critical appraisal of the evidence are heterogeneous in terms of duration, evaluation and types of learning.

- It is important to plan courses that enhance learning interaction significant in the critical appreciation of the literature and research in the programs of medical residencies.

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Table 1. Characteristics of the systematic reviews.

Revision year, country (ref.)	Objective or research question	Population	Date of search	AMSTAR-Points (quality level)	Number of studies (in residents)	Study designs	Number of residents included
Audet, 1993, Francia ²⁵	Assess studies of the teaching effectiveness of analytics critic in scientific publications in medical students	Undergraduate and graduated medical students	1980 - 1990	5 (Intermediate)	10 (3)	3 NACs	203
Norman, 1998, Canada ²⁶	To examine the evidence that teaching the skills of critical appraisal (evidence-based medicine) to students of medicine or residents will result in earnings significant gains in knowledge and greater use of literature in clinical decision making	Undergraduate and graduated medical students	1966 - 1995	2 (Low)	10 (3)	3 NACs	203
Taylor, 2000, UK ²⁷	To carry out a descriptive systematic review of the effectiveness of critical appraisal skills training for clinicians.	Health professionals	Until 1997	7 (intermediate)	10 (2)	2 NACs	118
Hyde, 2000, UK ²⁸	Assess whether teaching critical appraisal has effects beneficial to health workers and patients, taking into account the results of the patient's health, the up-to-date professional behavior, the behavior of decision making, critical appraisal skills, knowledge and attitudes, and increased satisfaction	Participants in any clinical setting, medical students, professional managers and medial care users.	Until 1997	10 (High)	16 (5)	2 NACs; 3 AD	231
Ebbert, 2001, Estados Unidos ²⁹	For postgraduate physicians in training, medical clubs and magazines are an effective way to improve patient care, teach critical appraisal skills, improve learning habits reading, increase knowledge of clinical epidemiology and biostatistics, and increase the use of the medical literature in clinical practice?	Graduated doctors	Some: 1999, other: 2000	8 (High)	7 (5)	3 NACs; 1 AD; 1 EO	176
Garg, 2000, UK ³⁰	Evaluate what effect the training of health professionals has health (from one to eight hours) in search skills and recovery, when using health databases electronics.	Profesionals and health care students.	Until 2002	6 (Intermediate)	3 (1)	1 AC	31
Coomarasa my, 2003, UK ³¹	Evaluate the effectiveness of evidence-based medicine and the teaching of critical evaluation at the level of postgraduate and continuing education.	Postgraduate	Until 2001	4 (Intermediate)	17 (12)	7 NACs; 5 AD	435
Coomarasa my, 2004, UK ³²	To examine the effects of postgraduate teaching on MBE and explore the effect of teaching methods (independent or integrated into clinical practice) on various outcomes.	Postgraduate	Until 2004	3 (Low)	23 (17)	1 AC; 8 AD; 8 NACs	543
Nabulsi, 2007, Diversos países ³³	Summarize the current status of attendance evaluation evidence-based healthcare.	Medicine students, residents, doctors, nurses and physiotherapists	1980-march 2006	2 (Low)	15 (1)	1 AD	Sin dato
Flores-Mateo, 2007, España ³⁴	To assess the effectiveness of teaching practice based on the evidence (EBP) by improving knowledge, appraisal skills, attitudes, and behavior of postgraduate health workers	Healthcare workers (postgraduate)	1966 - 2006	8 (High)	24 (10)	2 AC; 3 AD; 5 NACs	337

Ilic, 2009, Australia ³⁵	Review the current literature and analyze the impact of the environment (undergraduate or postgraduate) for the teaching of EBP and its impact in the PBE competition.	Medical graduates	1996 - september 2008	3 (Low)	7 (1)	1 NAC	55
Horsley, 2010, Canada ³⁶	Assess the effectiveness of interventions in order to increase the frequency and quality of questions asked by health professionals in practice and in the context of self-directed learning.	Medical care providers, including nurses and other health professionals	1950 - august 2008	10 (High)	4 (1)	1 AC	10
Ahmadi, 2012, Canada ³⁷	Evaluate the teaching methods of the MBE process in surgical residents.	Surgery Residents	Until july 2010	4 (Intermediate)	12 (7)	2 AC; 4 AD; 1 EO	588
Ilic, 2014, Australia ³⁸	Identify the most effective type of educational method for increase the competence of the MBE trainee (knowledge, skills, attitudes, behaviors) in doctors (both in graduate and postgraduate studies).	Doctors in training (undergraduate and posgraduate)	Until february 2013	7 (Intermediate)	9 (1)	1 AC	82

AD: Before and after studies; NAC: Non-randomized controlled; EO: Observational study; CA: Randomized controlled

Tabla 2. Primary studies included in the systematic reviews

Study Primary Year, country (ref.)	Academic program (number)	Course objective	Educational strategy (Time)	Assesment toll	Learning type(Fink)						Design
					1	2	3	4	5	6	
Baum, 2003, USA ⁴³	MI; Pe (73)	Change attitude, confidence and behavior to immediate and short term based on a course on evidence-based medicine (EBM) using adult learning principles	Seminar (0.5 day)	Multiple and self-report choice questionnaire		C		C	C		AD
Bazarian et al., 1999, USA ⁴⁷	U (32)	Compare the performance of an MBE approach and a traditional approach to teaching skills critical appraisal of emergency medicine residents	Journal Club (12 hours)	Answers of Free text, self appraisal	C			NC			CNA
Bradley, 2002, USA ⁴⁶	MF;Pe;U (10)	Improve the MBE search skills of the residents in MEDLINE by means of instructions of library staff	Workshop questions and search (During the clinical practice)	Score and assessment by reserachers		C		C	C		CA
Cabell, 2001, UK ⁶¹	CG (48)	Increase the activiy of medical literature search.	Workshop (1 hour)	Data collected in OVID		C					CA
Caudill et al, 1993, USA ⁴⁸	CG (70)	Improve critical appreciation of literature	Seminar + journal club (11 hours)	Score and self assessment	C	C			C		AD
Cheatham et	GO (9)	Improve knowledge in statistics	Journal Club	12 question suvey	C						AD

al., 2000, USA ⁵⁷			(12 sesiones)									
Dinkevich et al., 2006, USA ⁴⁹	Pe (60)	Improve skills in MBE	Course on Evidence-Based Medicine (8 hours)	Fresno test	C							AD
Erickson, 1998, USA ⁵⁰	GO (31)	Determine the impact of individual tutoring on MEDLINE	Workshop on search (1 hour)	Score and self assessment	NC							CA
Fu et al., 1999 UK ⁵¹	Ps (24)	Teach critical appraisal skills and their transfer of those skills to clinical settings.	Journal Club (18 hours)	Multiple choice test and self assessment	NC	NC		NC				CNA
Gehlbach et al., 1980, USA ³⁹	MF (35)	Provide residents with skills to interpret medical studies critically	Seminar (8 hours)	Multiple choice test	C							CNA
Grad, 2001, Canadá ⁶²	PF (86)	Encourage residents to seek answers based on in evidence to your clinical questions and incorporate this evidence in practice.	Seminar (8 hours)	Self assessment		C	C	C	C			AD
Green, 1997, USA ⁶³	MI (34)	Improve decision-making and advice from residents for individual patients through acquisition, evaluation and application of the evidence of medical literature.	Tutorship on EBM (7 hours)	Multiple choice test and self assessment		C		C	C			CNA
Haidet et al., 2004, USA ⁵²	MF; MI; Pe (82)	Examine the attitudes and learning process of an EBM course	Seminar (unclear)	Multiple choice test and self assessment	C		C		C	C		CA
Haines, 2003, USA ⁶⁸	SQ (Sin dato)	Incorporate the principles of EBM in the specialist medical training.	Journal Club (4 hours)	Assessment by researchers				C				AD
Hillson, 1993, USA ⁶⁴	CG (29)	Assess the critical appreciation of literature	Journal Club (7 hours)	Self assessment		C						AD
Kellum, 2000, USA ⁴¹	MI; PF; CG; A (12)	Improve skill and confidence in assessing medical literature	Journal Club (2 hours)	Surveys and self assessment	C			C				AD
Khan et al, 1999 UK ⁵³	GO (8)	Improve the practice and knowledge of appreciation literature criticism in postgraduate training	Journal Club (no data)	Validated survey	C	C						AD
Kitchens et al., 1989, Canadá ⁴⁰	MI (83)	Teach about the principles of clinical epidemiology necessary for the critical reading of the medical literature	Seminar (8.5 hours)	Multiple choice test	C							CNA
Kulier et al., 2009, Países bajos/UK ⁵⁴	GO (61)	Teach EBM through an e-learning course compared to a traditional course	Online course (4-6 weeks)	Validated survey	NC					NC		CA
Langkamp et al., 1992, USA ⁵⁸	Pe (27)	Increase knowledge in clinical epidemiology and biostatistics	2 sessions + 8 journal clubs (no data)	Multiple choice test	NC							CNA

Lee, 2006, USA ⁶⁵	Of (29)	Teach and assess the skills of practice based on learning	Journal Club (no data)	Self assessment		C						AD
Linzer et al., 1987, Canadá ⁵⁹	MI (85)	Teach principles of epidemiology and statistic	Journal Club (no data)	Multiple choice test	NC	NC						CNA
Markert, 1989, USA ⁶⁰	CG (24)	Teach residents many of the concepts and important principles involved in Medical Investigation.	Journal Club (10 months)	Self assessment	C							EO
McLeod et al., 2010, USA/Canadá ⁵⁵	CG (441)	Determine Critical Appraisal Skills	Journal Club (8 months)	Written test and validated quiz	NC					NC		CA
Ross, 2003, USA ⁴⁵	PF (Sin dato)	Increase knowledge and use of the principles of EBM	Workshop (10 hours)	Multiple choice test and behavior of interaction	C		C	C				CNA
Schoenfeld et al., 2000, USA ⁴⁴	G (24)	Assess basic knowledge about basic concepts statistics and research methods	Seminar (3 days)	Self assessment	C							AD
Seelig, 1991, USA ²	MI (14)	Change the attitudes, behaviors and literature reading skills	Seminar + journal club (8 hours)	Self assessment	C	C				NC		AD
Smith et al., 2000, USA ⁶⁶	MI (55)	Teach four essential EBM skills	Course (14 hours)	Written test and a behavior appraisal		C			NC	NC		CNA
Stevermer, 1999, USA ⁵⁶	MF (59)	Improve the reading of articles.	Lectures (2 months)	Percentage of articles read	C	C						CA
Thurnau y Fishborne, 1989, USA ⁴²	GO (26)	Learn about critical reading and understanding designs experimental, research protocols	Journal Club (1 montly session for 4 years)	Protocol subduced, session presentations and publications		C						EO
Toedter et al., 2004, USA ⁶⁷	CG (14)	Develop and refine surgery skills based on the evidence in clinical practice club (No data)	Seminar plus jorurnal club (no data)	Written work		C						AD

Academic Programs: A: Anesthesiology; FP: Family Practice; MF: Family medicine; G: Gastroenterology; CG: General surgery; MI: Internal medicine; GO: Gynecology-obstetrics; Of: Ophthalmology; N: Pulmonology; PS: Psychiatry; Pe: Pediatrics; SQ: surgical subspecialty; U: Emergencies. Educational outcome: C: Statistical change; NC: No statistical change. Design: AD: Study before and after; CNA: Non-randomized controlled; OS: observational study; CA: Randomized controlled. Learning Types (Fink): 1, Knowledge fundamental; 2, Application; 3, Integration; 4, Human dimension; 5, Take care; 6, Learning to learn.