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REVIEW ARTICLE/BRIEF REVIEW

Review article: Medical education research: an overview of methods

Article de synthèse: La recherche en éducation médicale: un aperçu des méthodes

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Abstract

Purpose *This article provides clinician-teachers with an overview of the process necessary to move from an initial idea to the conceptualization and implementation of an empirical study in the field of medical education. This article will allow clinician-teachers to become familiar with educational research methodology in order to a) critically appraise education research studies and apply evidence-based education more effectively to their practice and b) initiate or collaborate in medical education research.*

Source *This review uses relevant articles published in the fields of medicine, education, psychology, and sociology before October 2011.*

Principal findings *The focus of the majority of research in medical education has been on reporting outcomes related to participants. There has been less assessment of patient care outcomes, resulting in informing evidence-based education to only a limited extent. This article explains the process necessary to develop a focused and relevant education research question and emphasizes the importance of theory in medical education research. It describes a range of methodologies, including quantitative, qualitative, and mixed methods, and concludes with a discussion of dissemination of research findings. A majority of studies currently use quantitative methods. This article highlights how further use of qualitative methods can provide insight into the nuances and complexities of learning and teaching processes.*

Conclusions *Research in medical education requires several successive steps, from formulating the correct research question to deciding the method for dissemination. Each approach has advantages and disadvantages and should be chosen according to the question being asked and the specific goal of the study. Well-conducted education research should allow progression towards the important goal of using evidence-based education in our teaching and institutions.*

Résumé

Objectif *Cet article fournit aux cliniciens enseignants un aperçu du processus qu'il faut suivre pour passer de l'idée initiale à la conceptualisation puis à la mise en œuvre d'une étude empirique dans le domaine de l'éducation médicale. Cet article permettra aux cliniciens enseignants de se familiariser avec la méthodologie de la recherche en*

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éducation (a) pour évaluer de façon critique les études sur la recherche en éducation et appliquer de façon plus efficace dans leur pratique un enseignement basé sur des données probantes et (b) pour mettre en œuvre un projet de recherche en éducation médicale ou y collaborer.

Source *Cette synthèse utilise des articles pertinents parus dans les domaines de la médecine, de l'éducation, de la psychologie et de la sociologie avant octobre 2011.*

Constatations principales *La majorité de la recherche en éducation médicale s'est concentrée sur la description des résultats obtenus par les participants. Il y a eu moins d'évaluations concernant l'impact sur les soins aux patients, ce qui n'a pu renseigner que de façon limitée l'éducation fondée sur les données probantes. Cet article explique le processus nécessaire pour développer une question de recherche en éducation, orientée et pertinente, et il insiste sur l'importance de la théorie dans la recherche en éducation médicale. Il décrit une gamme de méthodologies, dont des méthodes quantitatives, qualitatives ou mixtes, et se termine par une discussion sur la communication des résultats de la recherche. La majorité des études utilise actuellement des méthodes quantitatives. Cet article souligne combien l'utilisation de méthodes qualitatives peut apporter d'informations sur les nuances et la complexité des processus d'apprentissage et d'enseignement.*

Conclusions *La recherche en éducation médicale nécessite plusieurs étapes successives, de la formulation de la bonne question de recherche à la décision d'une méthode de communication des résultats. Chaque approche a ses avantages et inconvénients et doit être choisie en fonction de la question posée et de l'objectif spécifique de l'étude. Une recherche en éducation bien conduite doit permettre une évolution vers l'important objectif qu'est l'utilisation de l'éducation basée sur les données probantes dans notre enseignement et nos établissements.*

The increasing focus on evidence, accountability, and quality in healthcare during the past two decades is also evident in the field of medical education. During this time, numerous educational stakeholders have advocated for movement from opinion-based to evidence-based education whereby educational curricula are based on research findings rather than historical and culturally engrained traditions.[1,2] Consequently, there has been a continued increase in medical educational research publications.[3] In the meantime, the profile of researchers has evolved. Geoff Norman has recently identified three generations in the history of medical education research: the first generation came randomly from unrelated disciplines; the second generation came with high-level academic training from related disciplines, and the third generation are healthcare professionals with additional training in education.[4] Medical education is now a stand-alone discipline which faces the challenges of developing the third generation of researchers and of continuing to recruit actively from other disciplines to enrich the field.[4]

While the field of medical education research has developed during the last years with some improvement in methodological rigour, there are many opportunities for further advancement.[5] For example, the focus of the majority of research undertaken has been on reporting outcomes related to participants rather than on assessment of patient care outcomes. Those lower impact results can inform evidence-based education to only a limited extent. In addition, a majority of studies use quantitative methods; further use of qualitative methods can provide insight into the nuances and complexities of the learning and teaching processes in medical education.

An understanding of educational research methodology is important not only for researchers but also for all clinicians involved in undergraduate, postgraduate, and continuing education. This knowledge is valuable for two reasons. First, it is important for clinicians to have the skills and knowledge to initiate, or collaborate in, high quality research. Second, clinicians with these skills are able to appraise research effectively and critically and apply evidence-based findings to their teaching and practice.

This article aims to provide clinician-teachers with an overview of the process necessary to move from an initial idea, or hunch, which may arise in their day-to-day teaching, to the conceptualization and implementation of an empirical study. Specifically, the article begins with guidance on how to develop a focused and relevant research question. This is followed by descriptions of a range of both familiar and less familiar research methodologies, an explanation of the importance of theory in medical education research, and lastly, a discussion of dissemination of research findings.

Overview

As for clinical research, medical education research is a highly structured process that involves careful protocol development based on a clear question, subject recruitment, data analysis, reporting, and dissemination of results. The key points on educational research are summarized at the end of the text. Following is an overview of these steps and issues.

Design issues

Formulating research question(s)

The formulation of relevant research question(s) is the cornerstone of good educational studies that need to address key practical or theoretical concepts and issues.

A research question can arise from a clinical issue or from a theoretical perspective. For example, based on observations and experience of medical residents' schedules, one might ask: 'How does sleep deprivation affect resident-physicians' professional lives and personal well-being?'[11] On the other hand, a research question can arise from a literature review of a particular topic where further research is deemed valuable after the identification of content, methodological, and theoretical gaps.[13] For instance, a review of the literature on education formats might lead one to ask: 'Can learning style predict student satisfaction with different instruction methods and academic achievement in medical education?'[7] Research studies can advance the practice and theory of education, and ideally, they should address both of these aims.[13,14] For instance, a study comparing the effectiveness of instructor debriefing with self-debriefing (debriefing without an instructor)[6] addressed a practical question (Are the logistics of having an instructor on site worth the effort?) as well as a theoretical question (Is formative self-assessment effective in improving performance?). To contribute to the existing literature, a research question should address a gap in the literature.

The nature of the research question will determine whether a quantitative, qualitative, or mix-methods approach is appropriate to use. A study that aims to predict outcome through specific hypotheses testing will use quantitative (comparative, correlational, etc.) methods. For example, Arora *et al.* designed a quantitative study hypothesizing that subjects' performance would be negatively correlated with their stress level.[15] An exploratory study that aims to examine the nature of a phenomenon lends itself to qualitative methods (ethnography, phenomenology, grounded theory, etc). For example, Wetzel *et al.* used a qualitative design to determine the surgical stressors, the perceived effects of stress on performance during surgery, and coping strategies.[16] The first step in planning a research study should be the formulation of a research question that addresses key theoretical concepts and practical issues rather than a decision about methods ("I want to do research in medical education; let's do a survey!").

A research question should be suitable for examination and should be meaningful, clear, and relevant to advance both the practice and theory of education.[17,18] A broad question, e.g., 'Does simulation-based education work?' is usually challenging to examine in a single research study. This type of question would be more appropriate for a systematic review that could synthesize the results of a number of studies on this topic.[19] A narrow and focused research question intends to increase the signal:noise ratio when using quantitative research methods. The measure of the signal (outcome) is more likely to appear if there are fewer confounders and variations on the measures (noise). A common initial step to refine the research question is to narrow it down as much as possible until the question becomes appropriate and answerable (Figure).[20]

Thinking about frameworks

A *conceptual framework* (also called a model) can organize and connect the different facets of a research study or research program into a single coherent structure. Importantly, the use of a framework can help classify what type of research study is being designed once the research question has been formulated (see above). Four popular frameworks/models in medical education are discussed below.

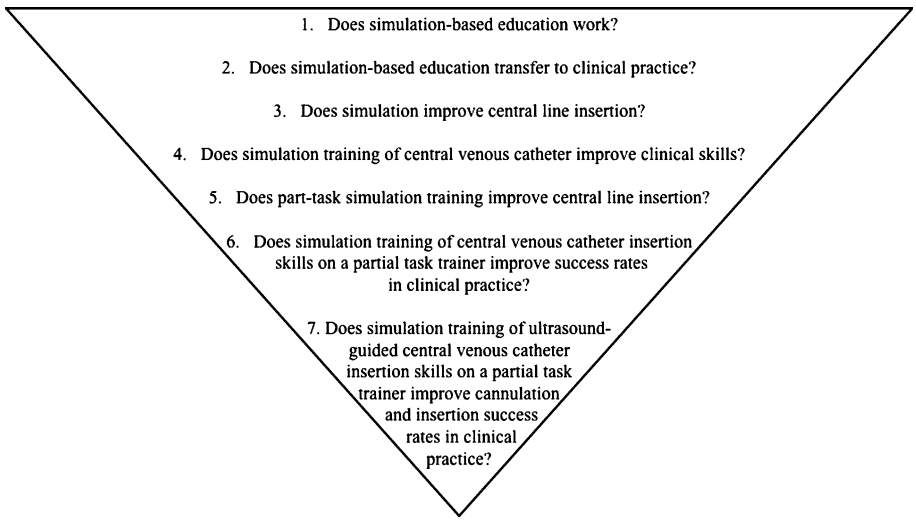

Figure The evolution of a question from a broad idea to an appropriate and answerable research question.[20]

Kirkpatrick framework The conceptual framework most widely used in education is the Kirkpatrick classification that categorizes the impact levels of an educational intervention.[21] The original classification has four levels of educational intervention outcomes: level 1- reaction; level 2- learning; level 3-behaviour; level 4 - results. In the context of medical education, level 2 refers to the learning of skills and knowledge in either a clinical or a non-clinical setting (e.g., simulated environment); level 3 refers to behavioural change of healthcare providers in the clinical setting; and level 4 refers to improved patient outcome.[22]

Researchers have also used a modified six-level Kirkpatrick classification[3,22] in which levels 2 and 4 are divided into levels 2a and 2b and 4a and 4b, as indicated in the Table.[23] It has been suggested that the fifth level is the cost-effectiveness of the educational intervention.[24]

During the past few years, stakeholders have become aware of the need to shift from studying the impact of medical educational interventions on learners' satisfaction and changes in their attitudes to studying the impact on health care processes and outcomes. This move entails greater rigour in the quality of medical education research. In its original design, the Kirkpatrick levels were not intended to be hierarchical; it is now recognized that research should target the higher levels (i.e., how an educational intervention affects patient outcome or cost effectiveness).

Translational science Knowledge translation aims to "promote the uptake of evidence-based practices".[25] Applied to medical education, knowledge translation aims to uptake evidence-based findings in education into educational practice. Medical education research may transfer to practice according to the three translational science levels: T1, T2, and T3.[26] Level T1 refers to a study of an educational intervention in which the outcome is measured in a laboratory setting (e.g., simulation room). Level T2 refers to a study that evaluates the impact of an educational intervention on patient care, as measured by improvements in healthcare providers' performance in the clinical setting. Level T3 refers to studies that demonstrate improvements in patient outcome as the result of an education intervention.

Table Kirkpatrick classification (amended by Barr *et al.*)[23]

Level	Details
1	Perception of training by subjects
2a	Change of attitudes of subjects
2b	Change of knowledge and/or skills of subjects
3	Changes of behaviour of subjects
4a	Change in professional practice
4b	Change in patients' condition

Reproduced with permission from: *Barr H, Koppel I, Reeves S, Hammick M, freeth S*. Effective Interprofessional Education: Argument, Assumption, and Evidence. John Wiley & Sons; 2005

3-P model The 3-P model (Presage-Process-Product) conceptualizes teaching and learning from the perspective of the learner. It supports the learner centeredness movement in contrast to the traditional teacher centeredness model. The general concept of the 3-P model is that learning outcomes result from interactions between the *presage* (the student and teacher contexts) and the *process* (the educational intervention). Student context refers to students' motivation, values and expectations, learning styles, and prior knowledge and skills. Teacher context refers to the class or institutional teaching environment, structure and content of the course and curriculum, and teaching methods and evaluations. The interaction between those two contexts produces a specific approach to learning called process, which can be either deep or surface. In the deep process, students use multiple techniques, such as discussion, reading, and reflection, to create connections between pieces of information learned. Conversely, in the surface process, students reproduce the learning only to pass the assessment. The deep or surface type of process contributes to the *product* (the learning outcome). The 3-P model provides a useful structure to deepen reflection when developing a research project.[27] The 3-P model can help researchers to consider presage issues (e.g., contexts), how they affect process issues (e.g., learner interactions), and how these in turn can impact on product (e.g., reported outcomes from an intervention).

Cook classification Cook *et al.* devised a hierarchical classification of medical education research based on the purpose of the study. The three main categories, which are independent of the method and educational outcome, are description, justification, and clarification.[28] The description category, which is the lowest level, refers to studies that present an innovation, such as a new assessment tool or curriculum, where there is no available comparison. The middle category, justification, involves studies that compare the effectiveness of educational interventions. The main question is: 'Which intervention is better?' The top category, clarification, advances the field of medical education by asking the questions: 'How does it work?' and 'Why does it work?' The few studies in this category use findings from previous research and rely on a conceptual theoretical framework that will be tested. Cook argues that the clarification studies in this top category "advance far more understanding of medical education" than the other categories.[28]

The research team

The primary investigator has the responsibility of forming the *winning team*. The winning team is a well-functioning group that has the competencies required to achieve the study goals. One strategy to prevent team conflicts is to determine authorship and contributions at an early stage of the project, and perhaps even to sign a contract.[29–31] If the researcher lacks experience in medical education research, approaching experienced colleagues for advice and assistance should be considered. Novices should not hesitate to contact their "academic idol".

The team should draw on the expertise of a range of relevant education researchers who may not be clinicians but experts in fields such as psychology and social science. Although these researchers may be unfamiliar with specific clinical contexts, they have a wealth of knowledge in theory and methodology that can inform the design and implementation of relevant education research questions. Experienced medical education researchers can support research by providing advice or detailed consultation or by collaborating with the research team. Novices may consider joining an experienced research team. This can be a useful way to receive support and guidance throughout the research process and avoid the pitfalls made by many novice education researchers.

Methods and designs

As previously stated, the research question will determine the study methodology. A methodology underpins how a study will progress, namely, the assumptions, principles, and procedures. There are various methodologies (e.g., experimental inquiry, quasi-experimental inquiry, ethnography, action research) that can be used, and the methodology, in turn, informs the design and methods, including the data collection and analysis strategies. For example, the randomized controlled trial methodology may use questionnaires to gather quantitative data; while in contrast, an ethnographic methodology will utilize observation and interview methods to collect data.[32,33] Following is a range of different designs that can be employed (Box 1).

Quantitative approaches **Surveys:** Surveys add important information to findings from other types of research. They are inexpensive and they can be convenient. Many novice educational researchers consider using a survey - a decision which is often based on the misleading assumption that it is an easier method than others. In fact, it is challenging to devise a valid survey that advances the field. Moreover, institutional ethics approval is required as with any other type of research.[34] Several issues require attention when undertaking a survey. The phrasing of questions should be deliberated carefully as it can influence participants' responses.[35] Sampling should be based on an appropriate sample size calculation, and use of stratification should be well thought out to optimize the efficiency of sampling.[36] Stratification is a sampling technique allowing subjects to be distributed equally in all study groups accounting for one or several parameters in the population. The limitation of the non-response bias is key, and the description of the non-responders is mandatory to make the study valid and reliable.[35] In addition, researchers need to attend to the logistical challenges of obtaining access to the studied population and the ethical issue of incentive.[37] Surveys are employed regularly in many of the research designs described below.

Box 1 Examples of research questions

Do(es)/Is(are)/Can/Should…? questions typically lead to **quantitative methods:**

- Does self-debriefing in crisis resource management improve performance among anesthesiology residents?[6]
- Can learning style predict student satisfaction with different instruction methods and forecast academic achievement in medical education?[7]
- Are E-mail discussions effective in small-group continuing medical education?[8]

What…? questions typically lead to **qualitative methods:**

- What are labour and delivery healthcare professionals' perceptions of each other's roles?[A]
- What are ICU healthcare professionals' perceptions regarding the way acute medical crises affect team interactions?[9]

Why…? questions typically lead to **qualitative methods:**

- Why are newly qualified doctors unprepared to care for patients at the end of life?[10]
- Why are healthcare professionals stressed in an acute situation?[10]

How…? questions can lead to **quantitative, qualitative, or mixed methods:**

- How does sleep deprivation affect resident physicians' professional lives and personal well-being?[11]
- How are intimidation and harassment perceived in surgical education?[12]

[A] *Sharma S, Reeves S, Rees C, Houston P, Morgan P.* Obstetric Teams and the anesthetist: key findings from a qualitative study. Canadian Conference on Medical Education. Toronto, ON, Canada, 2011.

Post-course designs: Post-course design is popular in medical education research where data collection occurs at the end of an educational intervention. Typically, surveys are employed that usually comprise closed and open-ended questions to elicit both numerical and text-based data. This design has the main advantages of being inexpensive, straightforward, quick to conduct and analyze, and often with high response rates. This is largely because there is only one point of data collection; participant investment of time is relatively small; contacting potential participants presents few problems; and data can be analyzed readily. However, Skeff *et al*. have written, "when training influences participants' criteria for their self-ratings (response shift), the validity of the traditional pre/post comparisons is suspect".[38] Instead, they propose an alternative model called retrospective pre/post self-assessment ratings in which pre and post self-rating occurs only after the teaching intervention. They found this model to be more accurate than the traditional one.

Even with this type of model, a post-course design is a weak design, and as there is no collection of baseline data, it is difficult to account for reported change convincingly. Also, if data collection occurs in the final session of medical education activity, as is frequently the case, the longer-term impact of the education on practice cannot be assessed. Short post-course questionnaires devised for these studies are sometimes described as "happy sheets" because they capture little more than participants' immediate reactions to a learning experience.

Before and after studies: Another popular design is the before and after study where the researcher collects data shortly before and after a learning opportunity. Again, the use of surveys (and sometimes interviews) is commonplace. This design is more robust than a post-course design, as it can detect changes resulting from a learning activity more accurately because there is data collection at two points in time, i.e., before and after the activity. If possible, obtaining paired data (where a respondent's pre- and post-course responses can be linked) for numerical measures or ranks permits the use of more powerful statistical tests than obtaining unpaired data alone. The close proximity of data collection to course delivery makes tracking participants easier than in studies that also collect follow-up data.

Despite gathering data at two time points, a before and after study design is still limited in providing a rigorous understanding of change as it cannot state accurately whether the change was attributable to the intervention or some other confounding influence. This is where the use of a control group is helpful (see below). Also, by using the before and after study design, you cannot ascertain whether positive (or negative) change is sustained over time.

Controlled before and after studies: The controlled before and after research design is a quasi-experimental technique that can help detect whether a change occurred as a result of an intervention or some confounding influence, i.e., unrelated changes in the practice or learning environment. Controlled before and after designs provide a more robust understanding of outcomes than the post-course and before and after designs described above, but controlled before and after studies still have a number of limitations. Ensuring the equivalence of control and intervention groups regarding important learner characteristics demands careful attention to prevent the design of the study and the analysis of findings from being compromised. Also, the inclusion of a control group increases the amount of data collection and analysis, and hence cost. While controlled before and after studies can measure change robustly, they share the same limitations as before and after studies, namely, an inability to assess whether reported outcomes are sustained over time as well as problems ensuring that respondents complete questionnaires or attend interviews at both time points. Loss to follow-up may be greater in control groups, especially when the control group is relatively disengaged by not having received the intervention.

Randomized controlled trials: Controlled before and after studies can be redesigned to become randomized controlled trials (RCTs) by randomly selecting learners for inclusion in either the intervention or the control groups. Randomized controlled trials can provide a more robust understanding of the nature of change associated with an intervention. The randomization of participants in a course means that bias related to selection or recruitment is minimized. Although RCTs are used widely in clinical research—in which they are often considered the gold standard—they are not common in educational research.[19] Randomized controlled trials require a precise sample size based on the hypotheses to be tested. Attempts to randomize individuals and control for confounding variables may encounter objections that one group is favoured over the other**,** for example, a situation where a new teaching intervention is tested against a control that receives no teaching whatsoever.

Longitudinal studies: Longitudinal design can be employed to assess the impact of a medical education activity over time and to understand how this type of learning translates into clinical practice. In studies that use a longitudinal design, data is collected (over months or years) following an intervention. Longitudinal research is particularly helpful to overcome problems understanding the longer-term effects of medical education associated with the post-course, before and after, controlled before and after, and RCT designs described above. Longitudinal research is a good design to establish the relevance of education to subsequent clinical practice. Nevertheless, undertaking a longitudinal study can be difficult as learners

often change jobs and move location over time. Attrition rates can be high, and the longer the time period a study tracks participants, the higher the attrition rate may be. Moreover, long-term data collection may become increasingly intrusive or burdensome to participants.

Qualitative approaches Although used widely in social science research, qualitative methods are used less often in clinical research.[39] Qualitative research methods seek deep understanding of a phenomenon rather than aim to predict an outcome,[40] and these methods have contributed to our understanding of important clinical and educational issues.[39] The differences between quantitative and qualitative research are more complex than the presence or absence of numbers.

Where the focus of quantitative research is to answer questions of causality, the focus of qualitative research is to answer the whys and the hows.[39] Qualitative research allows for the generation of rich data and the exploration of real-life behaviour.[39] Qualitative studies often aim to "study things in their natural setting, attempting to make sense of, or interpret, phenomena in terms of the meanings people bring to them", and they use "a holistic perspective which preserves the complexities of human behaviour".[40]

Qualitative studies usually involve smaller sample sizes due to the more in-depth nature of data collection and analysis, which, while time-consuming, allows for the generation of rich data. Rather than absolute sample sizes, the concept of saturation (expanded later in the article) is used often to determine when data collection is complete (see Box 2 for information about this and other key qualitative terms). There are several qualitative methodologies (described below) that guide study design and methods.

Ethnography: Ethnography uses observations of social groups in their real environment as well as interviews and document analysis, rather than quantification, to focus on the meanings of actions and explanations of phenomena.[44] The goal of ethnography is to develop a depiction of the phenomena under study which is plausible yet allows for the inductive development of more general theories.[45,46]

Phenomenology: Phenomenology uses observation and interviews as well as personal documents, such as diaries, to gain insight into subjects' life experiences.[47] Studies that use phenomenology concentrate on exploring how individuals make sense of the world in terms of the meanings and classifications they employ.[47]

Grounded theory: This approach can employ a variety of qualitative data collection methods, such as observations, interviews, and/or focus groups. Its overall aim is to generate theories about a social phenomenon from the collection and analysis of qualitative data.[43] Researchers develop a theory from their data using this grounded (or inductive) approach.[48]

Case studies: Case studies examine a particular unit, e.g., individuals, groups, organizations, events, roles, or relationships.[49] Case studies allow the investigation of complex phenomena,[50] and data are collected to provide an in-depth picture of the case under study. Thematic data analysis is then carried out throughout the cases in order to draw meaning.[51]

Action research studies: In action research studies, researchers work together with participants through cycles of action and research to plan change, guide participants through change, and study the change that occurs.[43] Researchers help participants to develop, deliver, study, and ultimately improve their practice. In action research studies, the researcher is more active and responsive in problem solving during the study than when employing other research designs where s/he records problems and reports on them.

Mixing quantitative and qualitative approaches A mixed-methods study involves the use of both qualitative and quantitative methods. Many authors have argued for years about the superiority of quantitative *vs* qualitative approaches (and vice versa).[52] The combination of both methods is recognized increasingly as a useful technique.[53,54] Combining qualitative and quantitative methods can provide a more detailed understanding of the processes and outcomes associated with a medical education activity.[43] This approach has been advocated for the opportunities it provides to address different questions in a research study and thus to present a more comprehensive understanding of particular phenomena. On the other hand, mixed-methods study has also been noted as a problematic endeavour because each approach is based on competing considerations. Data triangulation, which refers to the comparison of findings about the same research question using different methods (this concept will be expanded upon later in the article), can occur between the different sources of data. Mixed-methods studies can be more resource intensive in terms of cost, time, and work. Mixed-methods studies remain rare in medicine, perhaps because they are more complex and require greater expertise.[55]

Implementation issues

Securing ethical approval

The principles related to the ethical conduct of research in medical education are no different than other types of research with humans. Issues to consider include potential vulnerability of students as participants due to a hierarchical relationship with the investigators,[14,56] informed consent, the absence of coercion, anonymized data, and confidentiality.[57] Egan-Lee *et al*. have published an article

Box 2 Some key elements of Qualitative Research Methodology Terms[31]

- **Inductive approach:** Inductive approach refers to the process of interpretation of qualitative research data. This process involves identification of themes and patterns from which qualitative researchers then draw hypotheses and develop a theory. This process is the opposite from the deductive approach of quantitative research which tests hypotheses, generated from an existing theory, to be confirmed or disconfirmed.
- **Iterative approach:** Iterative approach involves repeated cycles of analysis. Data collection and analysis occur together, the latter informing the former. For example, as data accumulates and emerging themes are identified, decisions are made about further interview participants, and additional questions are explored. The iterative process of data collection and analysis can continue until saturation has been achieved (i.e., no new themes are generated).[41]
- **Thematic analysis:** This analytical method involves a two-step process. First, data are "open-coded" by generating emergent categories and relationships called themes. The categories are coded with the intent that they will facilitate the comparison of data within and between categories and will aid in the development of theoretical concepts. This is known as a "constant comparative" method.
- **Reflexivity:** Qualitative researchers believe that all researchers bring bias to a research study, and therefore the goal is to recognize and appreciate how this influences the research process. Reflexivity is a concept used to describe the process of reflecting upon the influences individuals bring to **a** study. These include one's training, assumptions, sex, ethnicity**,** etc. An awareness of these issues allows researchers to understand the potential impact they have on the research design**,** data coll**e**ction, and analysis.[42]
- **Representativeness:** Refers to the use of appropriate sampling techniques to ensure adequate representation in the research sample. For example, maximum variation sampling occurs when representativeness of all aspects of the topic are sought in terms of participants. Homogenous sampling consists of selection according to specified criteria.[42]
- **Saturation:** Refers to the situation when no new data emerge from additional data collection. Saturation is a common technique used by researchers to help determine sample size in qualitative studies.[43]
- **Triangulation:** Involves the convergence of multiple data sources to enhance the credibility and validity of the findings. Triangulation is considered a technique for checking the integrity and sophistication of evaluation findings by examining data and interpretations from more than one vantage point, including multiple datasets, researchers, or theories. Sometimes triangulation is also referred to as "cross-examination".
- **Resonance:** Consists in confirming the findings with the participants who were interviewed in order to verify researchers' coding and interpretation of data.

with specific tips for the application of ethics in educational research.[57] Procedures for obtaining consent will vary depending on the type of data involved**.** For example**,** the process for obtaining consent for an interview will involve different details than the process for obtaining consent for access to medical records, test scores, or prescribing data. Educational research studies require ethical approval from the organization where the research will be conducted and/or managed.

Accessing data

Data may be collected directly from participants or from existing sources, such as a database. Examples of the former include videotapes of simulation sessions, interviews and focus groups with health care providers who have participated in an educational program, or surveys of patients recently discharged from hospital. Examples of the latter include student examination results and medical residents' assessments by staff clinicians. In both of these situations, the research team must negotiate access to the participants or to the data via gatekeepers. Negotiation usually requires support from key individuals, such as senior physicians, clinical or educational managers, program directors, deans, or committee leaders. Without support from such key people, participant recruitment and data collection will become an arduous, if not impossible, task. Generally, negotiation needs to precede application for ethical approval since evidence of support from key gatekeepers will be required.

Considering the resources

As for clinical research, securing resources to study medical education can be difficult. Nevertheless, wherever possible, the research team should seek to obtain funding for all stages of the research process, including literature review, question formulation, selection of methodology and methods, research instrument development, ethical approval, data collection/analysis, and dissemination of findings.

Addressing data collection issues

Numerous factors must be considered at the fieldwork (data collection) stage of a research study.

Researcher influence Researchers need to acknowledge their own influences (e.g., preconceived ideas, paradigm in which they work, methods they use) in their research work, which are unrelated to the type of methodology they choose. In qualitative methodology, this is commonly referred to as *reflexivity* (see Box 2). In biomedical and clinical research, the positivist paradigm is the most common. In the positivist

paradigm, there is an assumption of a single objective truth, and the aim of the research is to find disproval of testable hypotheses via deductive methods.

In the interpretive paradigm, there is a belief that reality is in a continuous process of construction, which allows for the existence of a plurality of meaning in content. In this approach, the researcher is immersed in the qualitative data to produce an inductive interpretation. Throughout both paradigms, researchers must keep in mind that they influence many aspects of the study, including the boundaries of the study, study design, data collection methods, measurement tools, and approach to data analysis.

Insider and outsider positions Researchers should reflect on their internal or external (outsider) research approach. Each has advantages and disadvantages. Nowadays, many teachers and researchers in medical education are also healthcare professionals.[4] As insiders, they can benefit from extensive knowledge of the history and context of the program, but that can make it difficult for them to interpret the data in a neutral manner. Insider researchers may also suffer from lack of time and resources to undertake empirical work. The need to deliver the program nearly always overrides the need for empirical study. Nevertheless, insider researchers are well placed to contribute their findings to course development and to formulate relevant preliminary research questions.

In contrast, outsider researchers generally will have dedicated the time and resources for their purpose. It may be easier for outsiders to view an intervention from a more neutral viewpoint and to obtain more candid data from participants. However, they often need to spend time developing an in-depth understanding of presage and process issues related to the activity they are studying. External research studies are often accorded greater weight because they are seen as more impartial and/or more authoritative. The differentiation between an insider and an outsider position may not always be clear. Both insider and outsider views are important in the collection and interpretation of data if a comprehensive picture is to be obtained.[58]

Rigour and quality issues

Any method of research is rigorous when well conducted. Researchers should be aware of all potential biases (defined as a systematic error in the study which makes the results differ from the truth) in order to prevent or avoid them.

Qualitative components

There is often an assumption that qualitative methodology maintains a bias toward verification, understood as a tendency to confirm the researcher's preconceived notions.[59] Methodological criteria that apply to quantitative work, such as validity, reliability, and empirical generalizability, usually are not applied to qualitative work.[42] However, scientific rigour is also crucial in qualitative research. A number of techniques and concepts, such as reflexivity, representativeness, saturation, triangulation, and respondent validation (also called resonance), can be used to ensure rigour (see Box 2 for definitions).[39,42]

Quantitative components

Some of the many common biases include selection, sampling, and randomization biases.

Two biases more specific to educational research are the halo and Hawthorne effects.

The Halo effect The halo effect is defined as "the influence of a global evaluation on evaluation of individual attributes of a person".[60] A century ago, Thorndike noticed that raters tended to rely on general perceptions even when they were asked to evaluate specific characteristics of individuals. Typically, a halo effect may be suspected when a rater gives the same score or similar scores to all the individual items of an assessment tool. A halo effect may affect the results and conclusion of the study, but it may also bring about an artificial increase in the inter-rater reliability or in the inter-item reliability of any assessment tool.[61] It has been suggested that at least part of the halo error could be removed by explaining the rationale of the assessment tool to the assessors through training them on the use of the scale.[62] Therefore, authors report training used to familiarize the raters with the assessment tool, for example, running a calibration session between raters of performances on videos.[6]

The Hawthorne effect The Hawthorne effect describes a phenomenon of positively changed behaviour or performance resulting from awareness of being a part of a study.[63] This phenomenon is also known as reactivity. Assessing the impact of the Hawthorne effect on one's research work is difficult, but researchers need to acknowledge its potential presence. For example, self-training using the virtual fibreoptic intubation software has been shown to improve trainees fibreoptic intubation skills when compared with traditional teaching with no virtual training.[64] One could argue that the improved performance of the trainees who received the software might simply have resulted from a Hawthorne effect. However, where a researcher does become involved with participants for longer periods of time, for example, undertaking observations of medical students for several months, it has been argued that altered behaviour tends to revert to normal behaviour.[65]

Using assessment scales A separate review article in this theme issue of the *Journal* focuses specifically on *Assessment in anesthesiology education* [66].

Dissemination Issues

Education research aims to improve patient care and/or better inform education activities. As for clinical research, this can be achieved only with dissemination of the results, which is the final step of a study. The range of dissemination strategies include local dissemination (e.g., feedback to participants in a study, research presentations), national or international conferences (posters or articles), peer reviewed articles indexed in international databases (e.g., Google Scholar, Web of Science®, and PubMed), book chapters, websites (https://www.mededportal.org), and online reports. The use of two or more dissemination strategies will facilitate a wider sharing of key research messages.[67] Given the importance of knowledge translation as integral to educational research, working with educational committees may help to inform educational leaders involved in educational changes and may help to disseminate the findings of research and reinforce evidence-based education.

A common question in medical education research is whether the study should be published in medical education journals or specialty journals. Medical education journals have the advantage of reaching a large community of educators across specialties, while specialty journals target mostly clinicians within a specialty. *Medical Education* (http://www.wiley.com/bw/journal.asp?ref=0308-0110), *Medical Teacher* (http://www.medicalteacher.org/), and *Advances in Health Sciences Education* (http://www.springer.com/education+%26+language/journal/10459) are the leading English speaking medical education journals. *Pédagogie Médicale* (http://www.pedagogie-medicale.org/) is published in French. A foremost criterion for authors is to publish their work in the journal where their article will have the most impact according to their objectives. The research team will decide on the most appropriate journal according to their target audience and their personal agenda/goals.

Conclusions

As for clinical research, research in medical education requires several successive steps, from the formulation of the correct research question to the decision regarding the method of dissemination. More specific to research in education, it relies on multiple types of rigorous methods that could be a challenge to master. It is important to recognize that even experienced clinicians and educators may not possess the necessary skills to conduct a rigorous well thought-out education research study. Each method has its advantages and disadvantages and should be chosen according to the research question and the specific goal of the study. This article scratches merely the surface of the many methodologies and conceptual and theoretical frameworks in the field of education research. Clinician-teachers should become familiar with these methods in order to appraise research studies critically and apply evidence-based education more effectively in their practice. We stress the importance of formulating a precise question, choosing the correct methodology (even if initially unfamiliar), and harnessing the expertise of experienced researchers in the field. Without well-conducted education research, we cannot move toward the important goal of using evidence-based education in our teaching and institutions.

Key points

- Think about conceptual and theoretical frameworks when formulating research question(s).
- There are many methodological choices – select the most appropriate approach to answer your research question.
- The study is often only as good as the outcome measure.
- Publish the study in the journal that will be read by your target audience.

Footnote

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