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Mohsen Tavakol & John Sandars

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AMEE GUIDE

Quantitative and qualitative methods in medical education research: AMEE Guide No 90: Part II

MOHSEN TAVAKOL[1] & JOHN SANDARS[2]

[1]The University of Nottingham, UK, [2]The University of Leeds, UK

Abstract

Medical educators need to understand and conduct medical education research in order to make informed decisions based on the best evidence, rather than rely on their own hunches. The purpose of this Guide is to provide medical educators, especially those who are new to medical education research, with a basic understanding of how quantitative and qualitative methods contribute to the medical education evidence base through their different inquiry approaches and also how to select the most appropriate inquiry approach to answer their research questions.

Introduction

In Part I of this Guide, we discussed the importance of quantitative and qualitative research methods in medical education research. The understanding of the knowledge construction process, from a positivist and naturalist point of view, has been discussed. We highlighted how quantitative and qualitative studies are not contradictory, but complementary. In Part I, we discussed different quantitative research designs to conduct a medical education research study.

The purpose of Part II is to discuss the remaining steps of the research process and we begin with qualitative research designs.

Qualitative research designs

Because qualitative research methods are based upon totally different epistemological and ontological assumptions compared to quantitative research methods, they have different methods to capture the perspectives of participants. Qualitative methods do not have independent and dependent variables, nor do they test a hypothesis or a treatment effect. Qualitative researchers follow the process of 'bracketing', meaning that they need to put aside their own ideas and personal views about the phenomenon being studied. If we do not set aside our own ideas about the research topic, we are less likely to observe experience from the lens of the participants who have lived the experience (Gillis & Jackson 2002). However, researchers cannot easily put aside things which they are unaware and it is essential that they can explore their personal feelings, beliefs and preconceived ideas before doing every step of the research process (e.g. literature review, study design, sampling, data collection, data analysis and interpretation of results). This process of 'bracketing' that is used by researchers is called reflexivity. Researchers can keep a reflexive journal to record and explore how their values

Practice points

- Quantitative and qualitative studies are not contradictory, but complementary. Both develop new knowledge for solving research problems.
- Quantitative research has a positivist paradigm, in which the world to be researched is viewed as an objective reality, but qualitative research has a naturalistic paradigm, in which the world to be researched is viewed as a socially constructed subjective reality
- Qualitative research provides an opportunity to generate and explain models and theories inductively, whereas quantitative research provides an opportunity to test theories deductively.
- When there is little knowledge about the phenomenon of interest, qualitative approaches are suggested to explore and understand the phenomenon.
- In quantitative research, the accuracy of the research results depends on the validity and reliability of the measurement tools, whereas in qualitative research the trustworthiness of the research findings heavily relies on the researcher as a tool, and hence participants should verify their findings.
- Quantitative researchers rely on numerical values obtained from statistical procedures and their corresponding *p* values, whereas qualitative researchers rely on excerpts from the actual voice of participants to describe and support the identified themes.
- All research must consider essential ethical principles to ensure that participants are not harmed, either in the process of data collection or by the presentation of results.

Correspondence: Dr. Mohsen Tavakol, Medical Education Unit, University of Nottingham, Nottingham NG7 2UH, UK. Tel: +44(0)115 823 0014; E-mail: mohsen.tavakol@nottingham.ac.uk

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and beliefs may influence their interpretations. There are many variants of qualitative research methods. Here phenomenology, ethnography and grounded theory are discussed.

Phenomenology

As is implied by the name, phenomenology is the study of events and occurrences from the lens of each human being. The aim of phenomenology is to describe deeply the meanings of lived experience from the lens of participants who have directly experienced the phenomenon under investigation. Phenomenologists, like constructivists, regard the meaning of events as stated by individuals to be socially constructed and these meanings are rooted in an individual's lived experience and perceptions of their world. The phrase socially constructed implies that our meanings and understandings of the world are constructed through social observations or when we interact socially together. Therefore individuals have their own experiences and understandings of the world and they tend to share them with others. For example, a perception of empathy is socially constructed when medical students observe how doctors empathise with patients and also then when they discuss it with their peers. A phenomenologist may be interested in exploring in medical students their lived experience of empathy. By lived experiences (as opposed to second-hand experience), phenomenologists mean the everyday experiences of a particular phenomenon by a person and they are interested in understanding it fully through in-depth interviews and inductive analysis. A phenomenologist seeks to fully uncover the essence (sometimes called an essential structure) of lived experiences (Patton 2002). 'Essence is what makes a phenomenon what it is, and without which it would not be what it is' (e.g. the essence of empathy or the essence of being medical teacher) (Polit & Beck 2014).

Ethnography

This type of study is particularly important in the context of sociological and anthropological research studies in educational environments (Atkinson & Pugsley 2005). For an ethnographer, understanding and exploring members of a cultural group is important. Therefore, the key element of an ethnography study is to explore the way of life in a group of people (the culture). The role of an ethnographer is to 'document the culture, the perspectives and practices of the people in their settings'. 'The aim is to 'get inside' the way each group of people sees the world' (Hammersley & Atkinson 1995). Ethnographers convert sociocultural tacit knowledge to explicit knowledge that is previously so deeply integrated in cultural experiences that participants do not talk about it (Polit & Beck 2014). When the ethnographer works with members of a cultural group, it is essential that they can take a neutral stance so that they can obtain an emic (or insider view) of the experiences and beliefs of members of the cultural group that they are studying. By interviewing group members, observing their behaviour, and collecting cultural artefacts (things individuals create and then put into use, such as written texts)), ethnographic researchers can obtain an insider's view of reality. However, the ethnographer can reflect their own views and interpretations, which is called the etic view or the outsider view (persons who do not participate in the culture being studied) (Speziale & Carpenter 2007). Ethnography research can be used to improve the process of teaching and learning. For example, how medical students communicate with patients. Researchers can provide a 'thick' description of student's behaviour patterns within a particular culture. In addition, ethnographic studies provide useful information about the health beliefs and the cultural practices of health, which in turn, enhance understanding of 'behaviours affecting health and illness' (Polit & Beck 2014). From an ethical perspective, ethnographers should have a great responsibility with respect to their study participants as they have close relationships with their informants. Like other qualitative researchers, ethnographic researchers have an obligation to protect their study participants (Speziale & Carpenter 2007).

Grounded theory

Grounded theory is a qualitative inquiry method and inductive research that looks systematically at qualitative data with the aim of generating theories through the participants' standpoints. Grounded theory is based on the premise that the social process is discovered when individuals communicate with each other in order to create shared meanings. People then construct their own realities based on these meanings. Unlike quantitative inquiry approaches, grounded theory does not begin with an existing theory, but rather generates a theory for the phenomenon being investigated. Unlike phenomenological studies, grounded theory does not describe the meanings of lived experience from the lens of participants, but rather constructs a theory about the basic social process (the process that participants solve their problems or concerns) related to the phenomenon under study (Stern 1980). Here, grounded theorists seek to understand and explain how research participants interact or take an action about their main concerns in order to solve them. For example, what is the process of making a medical diagnosis? In grounded theory, sampling of participants, qualitative data collection, and data analysis take place simultaneously as the study progress to generate a theory (Morse & Field 1995).Grounded theorists become immersed in the newly collected data and then by using the constant comparative procedure they constantly compare the new data with old data for similarities and differences, in order to form theories or core categories. When grounded theorists sense a theory or category has been generated from the data analysis using the constant comparative procedure, they will stop data collection. This means that data saturation has been achieved (data saturation will be discussed in sampling methods). Hence, data collection through in-depth interviews or observations continues until the theory/model has emerged (Polit & Beck 2014). For example, Dickson and Flynn used a grounded theory approach to 'explore the nurses' clinical reasoning and actions critical to the interception of medication errors before they reach the patient' (Dickson & Flynn 2012). They noted that 'after the 50th interview, the data were saturated in that no new data was forthcoming and data collection ended with the 50 medical-surgical nurses from 10 of the 14 hospitals'. This is consistent with the grounded theory approach.

In addition, they identified a model of safe medication administration using the constant comparative procedure. Readers interested in undertaking grounded theory should refer to some publish works to read through further discussions on grounded theory (Kennedy & Lingard 2006; Tavakol et al. 2006; Kennedy et al. 2009).

Population

When researchers make a decision on the research design, they will make decisions about the study population and sampling to investigate the research problem. The population refers to the entire set of study participants to which results of the study are to be generalised (Levy & Lemeshow 2008). Sometimes the terms 'universal population' and 'target population' are taken as interchangeable. The common characteristics of the members of the population, which is called units/elements of the population, are measured. Populations are dichotomised into finite or infinite. The population is said to be finite, if it consists of a fixed number of elements and researchers are able to determine its totality. Two examples of a finite population might be the number of medical students across the UK and the number of academic staff in a particular university. If, on the other hand, researchers cannot theoretically observe all elements, the population is an infinite one (Kothari 2006). An example of an infinite population might be the number of medical students across the world. In a case such as this, we may only guess the number of students.

Medical education researchers are usually interested in the accessible population when they do not have access to the entire population. The accessible population may be finite or infinite. It is a part of the target population. For example, the target population might be all medical students across the United States, but researchers have access to one or two particular schools. Because the measurement of the target population is time-consuming, expensive or impractical, researchers take a sample of the population to represent the target population.

Sampling procedures

A sample refers to those participants chosen for a research study and this should be representative of the target population. In addition, a sample should be representative of all elements (individuals) in the target population. As an example, a population consisting of all medical students could be based on gender or medical year. In the process of sample selection from the target population, the subpopulations (sometimes called strata) are considered in order to enhance the sample's representativeness (Polit & Beck 2014). Researchers use sampling procedures in order to choose a sample of the population in order to represent the entire population. There are two types of sampling procedures: random (or probability) and non-random (nonprobability) sampling. The basic difference between the two is that in probability sampling, each sample (element) in the entire population has an equal chance of being included in the sample, whereas in nonprobability sampling, each element does not have an equal chance of being selected. It is clear that participants that are selected based on nonprobability sampling do not represent the entire population. In addition, nonprobability sampling may contain sources of bias which researchers are not aware of. This is called sampling bias and is addressed later in this section. However, the majority of medical education research studies are based on nonprobability sampling. This is because probability sampling is time-consuming and expensive, and it is also not feasible in some situations (Levy & Lemeshow 2008). Since nonprobability sampling procedures are popular among both quantitative and qualitative researchers, we will begin with these procedures.

Non-probability sampling

There are number of nonprobability sampling methods, but the important methods used in medical education are discussed. These are convenience sampling, purposive sampling and quota sampling.

If the selection of elements (individuals) from the accessible population is based on ease or opportuneness, this is a convenience sample. It is the weakest method, but it is widely used in many disciplines, including medical education. This is exemplified by a medical teacher who hands out self-report questionnaire about computer use to his or her students at the classroom. This method is used both by quantitative and qualitative researchers to examine the phenomenon under investigation.

Another type of nonprobability sampling is the purposive sampling strategy. The selection of individual of the population is criterion-base or purposive (Mason 2002). Although purposive sampling strategy is widely used by qualitative researchers as they seek to select 'an information-rich data source' for their studies (Polit & Beck 2014), quantitative researchers may use this strategy for collecting data. In this strategy, the qualitative researcher handpicks those individuals from the population of interest who have particular experiences and are able to provide a detailed picture of the phenomena under study are selected. This method is also useful when researchers want to construct certain tools (e.g. psychometric scales/questionnaires).

Another type of nonprobability sampling procedures is the quota sampling strategy. Within this strategy, subpopulations are identified and then the number of elements (individual) is selected based on the distribution of subpopulations. For example, suppose you are interested in investigating students' attitudes toward communication skills and you require a sample of 150 students out of 500. You have already noted that 60% of students are female. Quota sampling is used to ensure 60% of the sample is female and the rest is male students. Note that this method does not provide a representative of female or male students who are not available or those who are not interested to participate in the study. Although this strategy is superior to convenience sampling, it is not commonly used by quantitative researchers!

Non-probability and probability procedures are only used by quantitative researchers. For a qualitative researcher, the random sampling procedures do not work. They are interested

in participants who have experienced the phenomena under study.

Probability (random) sampling

Within probability sampling, as already mentioned, the study participants should be selected at a random basis, i.e., each participant has an equal chance of being selected. With probability sampling, researchers can obtain a representative sample of the target population. Using probability sampling, researchers can calculate sampling errors (discussed below). Theoretically, probability sampling has been highly supported, but researchers struggle to use them practically. On the other side of the coin, the resulting data of nonprobability sampling are less conclusive as they are subject to sampling bias. Within random sampling, any difference between population numbers and sample numbers is not subject to researcher biases, but it is due to chance. The interested reader is referred to some textbooks listed in the reference list for a further discussion on probability sampling procedures.

Sample size

Sample size determination is a primary step of the research process in quantitative or quantitative methods. Nevertheless, sample size determination in quantitative research methods is different from qualitative research methods. Therefore sample size determination is separately discussed.

Sample size in quantitative studies

When researchers carefully plan a research study, a typical question that they always face is that 'how many participants do I need to conduct my study?' This is an important question and should be taken seriously in the planning of a research study. If they take a large sample size, which is really not required, they waste their resources. If they take a very small sample size, the results obtained from their studies are of very limited use. There is no a simple formula to estimate how many participants should be in a research study. Several factors can influence sample size in a study. A large sample size is always better than a small sample size as the sampling error is reduced, especially when nonprobability sampling is used in a study. When you expect to observe a large difference between groups, a larger sample size is not required. However, when you expect that the differences are small, a larger sample size is required. In longitudinal studies, when there is an attrition bias (due to loss-to-follow up), a larger sample size is required. The number of variables being studied (set out to control in the analysis) and the type of statistical procedures that will be used can influence the size of a sample. As a rule of thumb, thirty participants per variable may be considered. Some statistical procedures require a large sample size (Cohen et al. 2008). Finally, when sampling from non-normally distributed populations, a large sample is useful. It should be noted that sampling bias and sampling error are the terms that quantitative researchers are always concerned about and hence will be discussed here.

Sampling error

This is the difference between the data obtained from a random sample and the data that would be obtained from the target population. For example, if different sample sizes are randomly taken from the IQ of medical students, the sample means may differ from the population mean. Any difference between the sample mean and the population mean is called sampling error. Sampling error is completely out of the control of the researcher.

Sampling bias

If researchers do not carefully select samples, sampling bias can occur. For example, in a study, if 30% of male students responded to the items of a questionnaire and if we know that 50% of the accessible population is male students, the study results are likely to be biased as the sample is not a representative of the accessible population. Nonprobability sampling results in a biased sample. Researchers need to address response rates (the number of responders divided by the number of the accessible population) in their reports. In addition, the difference between responders and non-responders should be reported (sometimes called nonresponse bias).

Sample size in qualitative studies

Sample size in qualitative research is influenced by different factors. These include the scope of the study, the nature of topic, the quality of data, the study design and the use of shadowed data (when study participants tend to talk about other people as well as themselves) (Morse 2000). Sample sizes in qualitative studies are usually small and non-random, with an intention of obtaining a rich description of the phenomenon of interest. A phenomenology study, for example, may use a sample ranging from 1 to 10 participants, or a grounded theory study may use from 10 to 60 participants (Starks & Trinidad 2007). The sample size is 'a matter of judgment and experience in evaluating the quality of the information collected against the issues to which it will be put, the particular research method, and purposeful sampling strategy employed and the research product intended' (Sandelowski 1995). The key factor in evaluating sample size in qualitative research studies is the principle of data saturation (Hewing 2011). As noted earlier, qualitative researchers collect data in order to describe the phenomena under study which is grounded in the participants' perspectives. Theories are constructed during data collection and additional information from new participants may not contribute further to the construction of theory. At this point, the size of the sample has been adequate. In the language of the qualitative research, this is called data saturation meaning that no new information is being uncovered and redundancy is achieved (new data produce redundant information). Data saturation is roughly analogous to sufficient sample size determination in quantitative research methods.

Ethical considerations

Ethical issues exist in any type of research. Both quantitative and qualitative should address ethical considerations of their studies. Most institutions or universities have ethical regulations and researchers should follow it. Such regulations protect study participants, researchers and institutions. Institutions have a particular office for reviewing research proposals, which is called the ethics committee or the institutional review board (IRB). The primary aim of the ethics committee is to protect study participants, especially vulnerable populations such as children, pregnant women and individuals with mental health issues, people from educationally/economically disadvantaged backgrounds or prisoners (Sumner & Cannon 2014). However, concerns regarding IRB decisions on human subjects have been reported. These concerns are poor evaluations of the risks and benefits of participating in research, poor protection of participants, and little or no monitoring of the research once approval is awarded (Rothstein & Phuong 2007).

Prior to commencing any research, researchers should read through the institution/university code of research conduct. These can be usually found at the institutions' websites. For the application to be considered and reviewed by the IRB members (ethics committee), all the required documents, including the application form, the study proposal, the instruments that the researcher will be using (survey questionnaires or interview guides in the case of qualitative study), any poster or letter for recruiting study participants, the information sheet that study participants will be guided with respect to benefits, harm and discomfort of the research and the consent form the study participants will sign, must be submitted. The IRB members usually meet once a month to review all documents and they may request further documents. When IRB members are satisfied that the researcher is fully protecting his/her participants during the research, she/he is permitted to carry out the research. IRBs will ask researchers to report their progress back to them (usually every year, but it depends the IRB chair's perspective in each institution for each project). It should be noted that the researcher should follow exactly the research proposal that has been approved by the IRB members.

The Belmont report

In the United States, the National Commission for the Protection of Human Subjects of Biomedical and Behavioural Research adopted an important code of ethics (Department of Health 1979). In this report four main ethical principles about standards of ethical research conduct are presented: respect for study participants (autonomy), beneficence, nonmaleficence, and justice.

Respect for study participants

Researchers should clearly explain to their prospective participants that they have full rights to decide knowledgably and voluntarily whether or not to take part in the study without any penalty or prejudicial treatment. In addition, researchers should inform their participants that they have rights to raise their concerns or questions, not to provide information, and to withdraw from the study at any time, without giving any reason or consequences of any kind. Therefore, researchers should fully explain the study for their participants which will allow participants to decide whether or not to take part in their study. Respect for participants requires confidentiality and anonymity to be guaranteed by researchers. These rights should be addressed in the consent form.

Beneficence

It is concerned with promoting what is best for research participants. For example, participants should be informed of the potential benefits of the research to them as individuals, such as appealing to their altruistic nature.

Non-maleficence

This principle entails that study participants will not receive harm or discomfort. Harm or discomfort can be physical, emotional (e.g. stress), social or financial (e.g. loss of salary). Qualitative researchers should be very sensitive with respect to the ethical issues that may be raised in their studies. This 'type of research may involve acts of self-disclosure, where personal, private experiences are revealed' (Brich & Miller 2002). Qualitative researchers usually use in-depth interviews with their participants. The ethical codes and guidelines for anonymity and confidentially, therefore, must not be breached (Orb et al. 2001). In qualitative studies, researchers should inform all participants of how the study results will be published. Participants should be aware that their quotations could appear in subsequent papers. Quantitative researchers, on the other hand, are less likely to conduct face-to-face interviews. Therefore, the ethical principle related to confidentiality and anonymity can be maintained, which is very good for both the researcher and the participant.

Justice

The principle of justice is concerned with fairness in distribution. In the selection of prospective participants, justice is a key element that should be followed. The benefits and disadvantages of the study should be fairly distributed among participants (Gillis & Jackson 2002). Researchers should not select participants who may benefit from the research. In quantitative studies, random sampling methods can reduce sources of unfairness in participant recruitment. In qualitative studies, sometimes participants significantly contribute to the development of themes and theories, and ethically, the researcher should acknowledge it in her/his report.

Quantitative and qualitative data collection methods

Another step in the research process is to gather quantitative and qualitative datasets. Data collection methods in quantitative research differ from data collection methods in qualitative research. In both approaches, the data collection process should be matched to the stated study design and the purpose

of the study. There are several methods that can be used to collect quantitative and qualitative a data, but those which are commonly used in medical education research are: self-administered questionnaires, focus groups and interviews. Self-administered questionnaires are widely used in quantitative research methods. On the other hand, focus groups and interviews are commonly used in qualitative research methods.

Self-administered questionnaire

Questionnaires are probably one of the most frequently used methods for collecting data in quantitative medical education studies. A questionnaire (sometimes called self-reported instrument) is frequently paper-based but their administration through electronic means is gradually gaining popularity. It contains questions or items that study participants are asked to respond to. Researchers should make sure that items make sense for the identified participants and a key issue is to develop a questionnaire to measure one or more constructs accurately and consistently. 'Good questions endeavour to scrutinise, evaluate, translate, illuminate and reflect relationships about the multiple fragment of data assessable on any given topic' (Boswell 2010). There are two types of questions: closed-ended and open-ended questions. The researcher predefines closed-ended questions and this limits both the range and depth of questioning but open-ended questions provide an opportunity for the respondent to freely answer with more depth. Analysis of closed-ended questions is easy compared to open-ended questions, where participants answer to questions in their own words. Using both types of questions, researchers can measure levels of knowledge, opinions, attitudes, beliefs or ideas of the phenomenon being studied. If a questionnaire is too long, participants may become bored. They either may discard the questionnaire or not answer all of the questions. Here, the researcher may be faced with many missing values and low response rates (Roszkowski & Bean 1990; Edwards et al. 2002). Also, low response rates may influence the reliability of the test results because responders may differ from nonresponders. In general, short questionnaires are more likely to be returned than long questionnaires (Edwards et al. 2002). Although questionnaires are cost-effective, they are not appropriate for some populations (e.g. children, elderly). Web-based surveying is widely used in social science and educational research since it can ease the process of disseminating and collecting questionnaires and it also it minimises errors in data entry by the researcher. Response rates tend to be lower in online surveys compared to mailed questionnaires. Anonymous questionnaires are more likely to yield honest responses.

Focus groups (or focus group interviews)

This is one of the collection methods used for collecting qualitative data. A focus group is 'a semi-structured group session, moderated by a group leader, held in an informal setting, with the purpose of collecting information on a designated topic'(Carey 1994). In a focus group, when participants interact with each other, their perspectives regarding the phenomena of interest will be discussed and reviewed. Data generated by focus groups are socially constructed and based on a group of participants and hence may not represent the perspective of each participant. A homogenous group is usually selected to generate data as participants can relate better with one another. A focus group usually consists of 7–10 individuals who can provide qualitative data to explore the construct being studied (Morse & Field 1995). Most studies have only a small number of focus groups but they can be combined with other data collection methods, such as individual interviews or questionnaires, in order to increase the number of participants and the range of attitudes and opinion related to the topic of interest. This mixed approach is a popular method in health education (Kitzinger 1995).

Interviews

Most qualitative research studies are based on interviews (Britten 1995). A qualitative research interviewer aims to explore and describe the experiences of the identified participants in relation to the phenomenon being studied. Qualitative interview studies can be categorised into two groups: semi-structured interviews and in-depth interviews (unstructured interviews).

Semi-structured interviews

Within semi-structured interviews, the interviewer is aware of the questions that must be asked in an interview. The interviewer has a list of preselected questions and asks his or her questions according to the list (sometimes called an interview guide). For example, 'Can you tell me about your teaching experiences? Can you share an experience of how you have minimized the stressful situations in hospital environment?' The semi-structured interviews provide the opportunity for participants to describe a situation according to their own words. During the interview, a conversational dialogue (two-way communication) with the participant will be established (Morse & Field 1995).

In-depth qualitative interviews

Most qualitative approaches use in-depth interviews. This approach is very useful when researchers have little knowledge about the topic of interest. As the qualitative researcher interviews the study participants, she or he begins to obtain insights and understandings about the topic being studied. The importance of in-depth interviews is that 'researchers talk to those who have knowledge of or experience with the problem of interest. Through such interviews, researchers explore in detail the experiences, motive, and opinions of others and learn to see the world from perspectives other than their own' (Rubib & Rubin 2012). In the in-depth interview, the interviewer initially asks open-ended questions, and these are usually followed by more probing questions. For example, 'what it is like to experience PBL? Can you explain your experience for me?' Subsequent questions are based in the interviewee's response. Such questions provide an in-depth opportunity for discussion on PBL. Interviews then need to be transcribed verbatim and analysed.

Measurement and the trustworthiness of data

When using quantitative research methods, the measurement and data collection procedures can influence the study results. The understanding of the term of measurement will help in understanding issues of data collection instruments and quantitative data analysis.

Measurement is concerned with quantitative research methods. 'Measurement is the assigning of numbers to individuals in a systematic way as a means of representing properties of the individuals' (Allen & Yen 1979). We measure because we want to improve data collection instruments in order to make sure about the accuracy and stability of the study results. By measuring, the values of abstract constructs can be identified. For example, suppose you have developed a questionnaire to measure students' attitudes toward medical education assessments. The questionnaire should measure a single underlying construct and the scores generated by the questionnaire items represent the underlying construct being measured.

Validity and reliability in quantitative research

Validity and reliability are two important elements in the evaluation of any measurement instrument. Instruments can be conventional knowledge, skill or attitude tests, clinical simulations or survey questionnaires. Researchers should ask themselves: "how do I know I'm measuring what I think I am measuring in my questionnaire?" Determining validity and reliability of your questionnaire will answer your question.

Validity is concerned with the extent to which an instrument measures what it is intended to measure. What is an instrument really measuring? It is concerned with the accuracy of the interpretation of test scores? How do the test scores accurately reflect the construct being measured? Reliability refers to the ability of a test to measure consistently. If we repeat a measurement instrument several times, the test results should be more or less the same. It is the replicability of a test result. An instrument cannot be valid unless it is reliable. However, the reliability of an instrument does not depend on its validity.

Traditional and modern psychometric methods, such as Classical Test Theory (inter-item and item-total correlation, Cronbach's alpha), Generalisability Theory and Item Response Theory (including the Rasch model) can reveal the validity and reliability of a measurement instrument. These methods have been fully explained elsewhere (Tavakol & Dennick 2011a,b,c, Bloch & Norman 2012; Tavakol & Dennick 2012; Tavakol & Brennan 2013). The interested reader is encouraged to read through these papers in order to obtain a better picture of the concepts of validity and reliability.

Validity and reliability in qualitative research

Qualitative research is equally as concerned about the quality of data as quantitative research (Whittemore et al. 2001). As epistemological and ontological assumptions of research differ from quantitative research, qualitative researchers have substituted these terms with 'credibility', 'dependability' 'conformability' and 'transferability', which are more appropriate for qualitative research studies (Lincoln & Guba 1985), although there is still no a consensus on these terms. Credibility refers to 'confidence in the truth value of the data and interpretations of them' (Polit & Beck 2014). A study is also credible when external readers 'can recognise the experience when confronted with it after having only read about it in a study' (Gillis & Jackson 2002). Dependability is another criterion that is used to evaluate trustworthiness of the study findings. Here the researcher should ask if they would have interviewed again with the same participants or in a similar context, would the study findings be replicated.

Confirmability is concerned with the accuracy of the study findings which are based on the viewpoints of participants. Therefore, the study findings should be clearly grounded in the participants' voice rather than a figment of imaginations of researcher's perspectives. The study findings should not be influenced by the researcher's motivations, interests, bias or views. Here researchers should identify their own biases to establish the trustworthiness of the study findings. Transferability (sometimes called applicability and analogous generalisability) is another criterion to identify how well the study findings can be transferred to other settings, contexts or groups. Here, the researcher should provide a rich description 'necessary to enable someone interested in making a transfer to reach a conclusion about whether transfer can be contemplated as a possibility' (Lincoln & Guba 1985). For example, medical educators might apply to their own assessment strategies the findings of a study demonstrating that simulated video recording of OSCEs help medical students to prepare themselves for their own OSCEs. Here, the qualitative researcher should provide a detailed description of the study methodology, particularly the research approach, study participants, setting and data analysis allowing the reader to determine the transferability of the study's results.

Validation

Researchers should verify or prove their study findings in order to provide validity evidence for the topic that has been studied. Researchers should validate the information participants provided in order to ensure a comprehensive picture of the phenomena under investigation has been captured. Researchers sometime use triangulation and member checking in order to validate the study findings (Lewis et al. 2013). Triangulation refers to the use of different methods (e.g. qualitative and/or quantitative methods) in order to check the validity of the study findings and to minimise source of errors (e.g. researcher's biases) in a research study. Triangulation will also help the researcher to better understand the truth. In member checking, researchers ask the study participants to review the study findings and interpretations that have been provided by researchers. This is a good opportunity for researchers to substantiate the meanings, themes identified and interpretations of their studies.

Quantitative and qualitative data analysis

After the data is collected in quantitative methods or further data collection has failed to contribute to new knowledge (data saturation) in qualitative methods, researchers analyse their data in order to provide evidence for the phenomenon under investigation. Quantitative data analysis differs from qualitative analysis in that data is based on numbers rather than texts. Qualitative researchers are not concerned with numerical values or statistical procedures to explain the results.

Quantitative data analysis

Quantitative researchers use numerical values and statistical procedures (both descriptive and inferential statistics) in order to organise and interpret numeric data. To analyse quantitative data, it is necessary to understand the nature of a variable's level of measurement. They are classified into four groups: nominal, ordinal, interval and ratio measurement. As is implied by the name, nominal measurement consists of naming of observations (data) without any order or structure. Examples include gender, race or blood type. In order to prepare data for analysis using statistical software packages, they should be coded, for example we may code males as 1 and females as 2. These codes do not represent quantity, that is, 2 is not better than 1, or calculating the average of gender using these codes do not make sense.

Sometimes observed data can be ranked according to some criteria or attributes, they are said to be the ordinal measurement. For example, social class can be categorised according to income: low, median and high. Here, low may be coded as 1, median as 2 and high as 3. We cannot exactly infer the difference between a ranking of low-income people and middle-income people. We can just infer 1 is less than 2; 2 is less than 3 or 3 is greater than 1 and 2. We do not know whether or not the differences between values are equal.

In the interval measurement, researchers can rank data and infer the differences between values. However, the zero point in the ordinal measurement is arbitrary, it does not mean that something does not exist. For example, 0 degree Celsius does not indicate the absence of heat. It is indeed 32 degrees Fahrenheit. The zero point on a temperature scale is an arbitrary point and chosen based on the freezing point of water. Here we can say the difference between 100 and 120 is equal to the difference between 140 and 160.

The ratio measurement is the same as the interval measurement, but its zero point is absolute. For example, a person with blood pressure of 0 will not live for a long time. A further example, as weight has a true or absolute zero point, a weight of 40 kg is twice as heavy as someone with 20 kilogram. Only interval and ratio numbers can be subjected to mathematical operations (e.g. added or divided). Note that all statistical procedures which can be used for the ratio data can be used for interval data.

Descriptive and inferential statistics

Knowledge of the measurement level of data in a research study will help us to run statistical procedures appropriately. There are many variants of statistical analysis. They are descriptive statistics, bivariate descriptive statistics, bivariate statistical tests and multivariate statistical tests.

Descriptive statistics involve frequency distributions, central tendency and variance (standard deviation). The readers can easily compute these statistical procedures using statistical software packages. In SPSS, for example, this can be achieved (for interval or ratio data) by clicking 'Analyze' > 'Descriptive Statistics' > 'Explore'. The variables of interest are then dragged to the Dependent list' box. This is followed by clicking 'Plots' and then selecting 'Normality plots with tests', before clicking 'Continue' > 'Ok'. SPSS will produce exploratory analysis for the identified variables. Using this command, you will also get some idea about the distribution of your data based on skewness, kurtosis, boxplots and tests of normality.

Bivariate descriptive statistics involve associations between two variables. The association between two variables can be calculated using the Pearson correlation coefficient. To calculate the association between two variables using SPSS, click on 'Analyse' > 'Correlate' > 'Bivariate', and then move the variables of interest to the 'Variables' box and then click on 'Ok'. SPSS will produce the table 'correlations'.

Bivariate and multivariate statistical tests involve inferential statistics. Based on statistical procedures, researchers draw conclusions about a population which is based on a random sample of data. Some popular statistical procedures are *t*-test, analysis of variance, chi-squared test and multiple regressions. SPSS calculates these statistical procedures. Novice researchers are encouraged to consult statisticians or experienced researchers in order to get a greater understanding of the assumptions of these statistical procedures before selecting a particular type. Using inappropriate statistical procedures results in inappropriate interpretations of the study results.

Qualitative data analysis

Qualitative data analysis is a more protracted activity than quantitative data analysis. Unlike quantitative data analysis, there is not a particular formula or rule to analyse qualitative data. In qualitative data analysis, the researcher focuses on meaning rather than measureable phenomena. In addition, the researcher provides a thick description of the phenomena of interest rather than measuring a particular variable. There are different types of qualitative data analysis, but similar process are usually used to ensure that 'analysis takes place on an orderly fashion' (Morse & Field 1995).

The content analysis approach

This is a popular method for the analysis qualitative data. Once data collection commences, interviews and focus groups can be transcribed and the data are ready to be analysed. The researcher's task is to make sense of the data by carefully reading all of the verbatim transcripts. For example, a 40-minute interview may produce 20–25 pages of texts. These texts should be analysed in order to grasp participants' perspectives about the phenomenon of interest. Qualitative researchers should develop their inductive reasoning skills in order to analyse qualitative data. The researcher's overall task is to bunch together the data that are similar in meaning in

order to generate the primary categories and then main categories. In the categorisation process, the researcher breaks down interview transcripts into small meaningful units and uses a coding system to identify meaningful units. In the coding process, each unit is given a label according to the content they signify. To identify the primary categories, codes are clustered based on their shared concepts, and then they are labelled as categories. There are usually between 10 and 15 categories per study (Morse & Field 1995). The meaning of a category is reflected in the meaning of the constituent codes. The primary categories are then collapsed into larger categories (main categories) and then given a label. Finally, categories form themes. A theme refers to 'an abstract entity that brings meaning and identity to a current experience and its variant manifestations. As such, a theme captures and unifies the nature or basis of the experience into a meaningful whole' (DeSantis & Ugarriza 2000). Data saturation is reached when each main category is full, that is, new information is not added to the category (Morse & Field 1995).

A number of interesting alternative methods are available for analysing qualitative data and the method selected is dependent on the research question and the researcher's paradigm (Schutt 2006). Phenomenological, ethnographic and grounded theory studies require a specific data analysis. The interested reader can found them in the references listed in this Guide.

Computer-assisted qualitative data analysis software (CAQDA)

Qualitative analysis packages can manage and speed up the process of qualitative data analysis, especially when there is a large amount of data However, it is important to remember that these applications cannot produce codes and categories without involving 'creativity, intellectual discipline and analytical rigour and a great deal of hard work' (Patton 2002). A package cannot analyse qualitative data as 'it lacks the capacity to think, reflect and analyse' (Laccy & Luffy 2001). The researcher's task is to name a code, category or theme and these applications do not tell the researcher how to analyse his or her data. There are a variety of soft programs for qualitative analysis, for example, ATLAS is available at: www.atlasti.de and NVivo available at http://www.qsrinternational.com/products_nvivo.aspx.

Data interpretation, dissemination and utilisation

A final step in the research process, both in quantitative or qualitative studies, involves making an interpretation, dissemination and utilisation of the study findings. Both qualitative and quantitative studies should also acknowledge the limitation of the study that might have affected the study findings. In quantitative studies, medical education researchers begin to make sense of the study results. As an example, suppose that the data of a quasi-experimental study were subjected to a *t*-test to compare the scores of two groups (e.g. PBL and non-PBL students) on a clinical performance using OSCE. Assume that the value of t was 4.2 and it was significant (p value = 0.004). These results may be interpreted that the PBL method, on average, produced higher clinical performance levels than the non-PBL method, and it is very unlikely to have arisen purely by chance. It should be noted that further experimental investigations are required to add this finding to existing knowledge. Such interpretations should be addressed in the discussion section where researchers tried to compare the data obtained from previous studies with those from their own study. If the findings are not supported by previous studies, the possible reasons should be discussed and explained. The nature of participants must be kept in mind at all times, especially if it is a convenience sample, so that they are not inappropriately generalised. Finally you need to address the implication of the study findings for medical education and future research on the topic. Based on the interpretations of the study finding, the possible direction for any further research is recommended.

In qualitative studies, the interpretations of codes, categories and themes rely on the subjective interpretations of the researcher. Therefore the credibility of qualitative results and researchers are important as readers can read some excerpts from participants, and they trust researchers' activities to verify findings through triangulation and member checking (Polit & Beck 2014). In interpreting qualitative findings, the core idea is what lessons have been learned from codes, categories, themes which have been grounded in the participants' perspectives. Meaning sometimes emerges based on comparison with previous studies or theories. Here researchers report their findings are in agreement with previous studies or theories. As noted earlier, some qualitative researchers address the literature at the end of the study. Therefore, 'interpretation in quality research can take many forms; be adapted for different types of designs; and the flexible to convey personal, research-based, and action meanings' (Creswell 2014). In addition, the transferability of findings needs to be addressed. Like quantitative, the implications of the findings for medical education, practice, policy and future research on the topic are addressed

Dissemination and utilisation

The final step of the research process is to share your study results with the wider local, national and international medical education community and also associated health professions. This may be by publication in journals or presentations at conferences. Research utilisation refers to the use of the study findings in practice to improve medical education. Medical education decision makers always wish to improve medical education practice, such as teaching and learning, clinical performance, student assessment, decreased educational costs, tomorrow's doctors, higher student satisfaction of educational environments or student admission. Ultimately, improving medical education will lead to the best available patient care.

Conclusion

This Guide (Part I and Part II) shows the importance of quantitative and qualitative research studies in medical education. The ultimate goal of both methods is to obtain new knowledge and then add it to a body of existing knowledge in

order to develop unique insights and create more useful knowledge to solve a problem. Although quantitative research differs from qualitative research, both methods enable medical educators to generate new knowledge to better the credibility of medical education theories and practice, which in turn leads to improve patient care. This is the most important aim for conducting medical education research. Quantitative researchers are concerned with the objectivity of the phenomenon being studied. They control, manipulate and test hypotheses in order to generalise study results to target population. Qualitative researchers, on the other hand, are concerned with the subjectivity of the phenomenon being studied. They are not interested in quantifying associations or in seeking cause and effect inferences. They are interested in capturing insight and understanding, which is grounded in participants' experiences and interpretations, in order to explore the underlying meanings of the phenomenon under investigation. When researchers have little knowledge about new phenomena or new meanings of phenomena, qualitative inquiry methods are the best for gaining a deeper understanding of the phenomenon from the participant's perspective. There is a growing body of evidence that suggests the combination of qualitative and quantitative methods are important, although it may take time to understand that both methods do not contradict each other, yet they complement each other. The challenge may be selecting the right research approaches in order to answer questions about the phenomenon of interest. We hope this Guide will help medical educators to minimise their own challenges when choosing the right research method.

Notes on contributors

MOHSEN TAVAKOL, PhD, MClinEd, is a Lecturer in Psychometrics. His main interests are in medical education assessment, psychometric analysis (Classical Test Theory, Generalisability theory, Item Response Theory Models), robust statistical methods, multivariate statistics, quantitative and qualitative research methods and communication skills.

JOHN SANDARS, MD, MSc, FRCGP, FAcadMEd, MRCP, Cert Ed., is an Associate Professor at the Leeds Institute of Medical Education, University of Leeds, UK. His main interest is in developing teaching and learning by a scholarship approach, in which real life problems are investigated by both quantitative and qualitative research.

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