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Article

Research methodology in educational inquiry: A critical analysis of its core rudiments

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Abstract

This paper critically reviews the basic components of research methodology and its role in developing credible educational and social-scientific investigation. It examines the linkage between research problems, philosophical assumptions, design decisions, and constraints by employing a critical narrative review and conceptual synthesis of existing methodological literature. It discusses the quantitative, qualitative, and mixed methods designs along with positivism, interpretivism, critical realism, and pragmatism. It also considers the selection of study contexts and populations, as well as inclusion/exclusion criteria, sampling frames, sampling techniques, and decisions about sample size. Additionally, it encompasses sources of data, instrument development, pre-testing and piloting, recruitment, operationalisation, data management, and quality control. It is guided by descriptive and inferential statistics, qualitative thematic and grounded-theory analysis, integration of both types of methods, and suitable software. Ethical requirements such as institutional approval, informed consent, confidentiality, data protection and participant welfare are considered integral and not procedural issues. This analysis reveals that methodological quality is not a function of any one preferred methodology; rather, it is a reflection of the clarity of the relationship between the research questions, assumptions, evidence, analysis, and claims. It finds that reflexive justification, technical expertise and ethical accountability are all necessary to produce rigorous, transferable and socially relevant knowledge, but that methodological checklists alone are not enough in a wide variety of research scenarios in different disciplines, research institutions, research participant groups and evolving policy environments.

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Introduction

Research methodology constitutes the backbone of educational and social-scientific inquiry. It represents the systematic framework through which researchers plan, execute, and evaluate their investigations (Bryman, 2016; Creswell & Creswell, 2018). The concept of research method is not monolithic; rather, it is a rich and multifaceted domain that encompasses a wide spectrum of philosophical orientations, strategic designs, tactical procedures, and analytical techniques (Creswell & Creswell, 2018; Tashakkori & Teddlie, 2010). A critical analysis of the

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rudiments of research methodology therefore demands an in-depth examination of these constituent elements, exploring not only what they are, but why they matter, how they interrelate, and what their implications are for the production of credible, valid, and useful knowledge.

The importance of understanding research methodology cannot be overstated. Whether a study seeks to test hypotheses about causal relationships, explore lived experiences, or pragmatically address real-world problems, the method adopted will profoundly shape the nature of the findings produced and the conclusions that can legitimately be drawn (Creswell & Creswell, 2018; Patton, 2015; Tashakkori & Teddlie, 2010). Poorly designed research generates unreliable data; inadequately justified methodology undermines academic credibility; and failure to align methods with research questions produces knowledge that is either irrelevant or misleading (Cohen et al., 2018; Creswell & Creswell, 2018). It is for this reason that educational researchers, students, policy-makers, and practitioners must engage seriously with the foundational principles that govern research design.

This paper undertakes a comprehensive critical analysis of the core rudiments of research methodology. It examines the overall research design, the philosophical paradigm underpinning the inquiry, the study area and context, the population and sampling strategy, data sources and instruments, data collection procedures, the operationalisation of variables, data management and quality control, data analysis techniques, and the ethical considerations that must govern all research endeavours. Each of these sections is treated not merely as a procedural checklist, but as a conceptual domain worthy of rigourous scholarly interrogation.

Materials and Methods

This article adopted critical narrative review and conceptual synthesis approaches. It draws on available methodological textbooks and selected peer-reviewed articles cited in the manuscript to explore the philosophical, design, procedural, analytical, and ethical aspects of research. The analysis is conducted across thirteen areas: research design, research philosophy, study context, population, sampling, data sources and instruments, data collection, operationalisation and measurement, data management, quantitative data analysis, qualitative data analysis, mixed methods integration, and research ethics. Sources were evaluated in terms of their conceptual relevance, internal coherence, contextual usefulness, and contribution to clear connections between research questions, evidence, analysis, and claims. No search protocol, date restrictions, or formal quality-appraisal process was used; therefore, the review does not claim systematic coverage. It is analytical and pedagogical in nature, seeking to illuminate methodological decisions, reveal common oversimplifications, and characterise principles that can enhance educational inquiry.

Results: Critical Synthesis of Methodological Rudiments

The synthesis identifies methodological alignment, transparency, contextual sensitivity, and ethical responsibility as the recurring criteria through which the quality of research decisions should be evaluated. The principal findings are organised below by methodological domain.

Research design

Research design refers to the overarching plan or blueprint that a researcher employs to integrate the various components of a study in a coherent and logical manner (Bryman, 2016).

It encompasses decisions about the nature of the data to be collected, the methods of collection, and the analytical strategies to be deployed. The three predominant approaches in contemporary research are quantitative, qualitative, and mixed methods. Each of these approaches reflects a distinct epistemological stance and carries specific methodological implications.

Quantitative research is premised on the assumption that reality is objective and measurable, and that it can be captured through numerical data (Cohen et al., 2018). It typically employs structured instruments such as questionnaires with closed-ended questions, and its findings are subjected to statistical analysis. The goal of quantitative research is often to test hypotheses, establish correlations, or determine causal relationships. This approach commonly uses larger samples and deductive reasoning that moves from theory to data; however, generalisability depends on the design, sampling quality, measurement validity, and context rather than on numerical data alone.

Qualitative research, by contrast, operates on the assumption that reality is socially constructed and that meaning is context-dependent (Patton, 2015). It seeks to understand phenomena from the perspective of the participants themselves, using rich, descriptive data drawn from interviews, observations, focus group discussions, and document analysis. Qualitative research is typically inductive in orientation, building theory from data, and is associated with smaller sample sizes, depth of understanding, and transferability rather than generalisability of findings (Leavy, 2022).

Mixed methods research combines elements of both quantitative and qualitative approaches within a single study (Denzin & Lincoln, 2018). It is often associated with pragmatism, which prioritises the method or combination of methods best suited to the research question. Mixed methods designs can be convergent, explanatory sequential, or exploratory sequential, depending on how and in what sequence the quantitative and qualitative strands are integrated.

Justification of design choice and suitability

The justification for a chosen research design must be grounded in the nature of the research problem, the research questions, and the epistemological commitments of the researcher. A quantitative design is most appropriate when the research seeks to measure the extent, frequency, or distribution of phenomena across a population, or when it aims to test a hypothesis derived from existing theory (Creswell & Creswell, 2018). A qualitative design is warranted when the study seeks to explore poorly understood phenomena, generate theory, or understand the meaning that individuals attach to their experiences. A mixed methods design is appropriate when neither a purely quantitative nor a purely qualitative approach is sufficient to address all dimensions of the research problem.

The suitability of the chosen design must also be assessed in terms of its alignment with the available resources, the characteristics of the target population, and the practical constraints of the research context (Tashakkori & Teddlie, 2010). A researcher who has access to large, representative samples and well-validated instruments may find a quantitative approach most feasible. One working in a context where little prior research exists, or where the phenomena of interest are complex and contextually embedded, may find qualitative methods more productive (Saunders et al., 2019). The critical point is that design choices must be explicitly justified, and the justification must demonstrate awareness of the assumptions and limitations associated with the chosen approach.

Research philosophy and paradigm

Research philosophy refers to the set of beliefs and assumptions that a researcher holds about the nature of reality (ontology), the nature of knowledge (epistemology), and the relationship between the researcher and the researched. The dominant research philosophies in the social sciences include positivism, interpretivism, critical realism, and pragmatism, among others.

Patton (2015) explains that positivism holds that the world exists independently of human consciousness and that it can be known through objective, empirical observation. Positivist researchers seek to identify laws and regularities governing the social world, and they privilege quantitative, experimental, or quasi-experimental methods.

According to Mertens (2014), interpretivism, also known as constructivism or the interpretive paradigm, holds that social reality is constructed through human meaning-making and that the task of social science is to understand and interpret the meanings that individuals attach to their experiences. Interpretivist researchers favour qualitative methods and emphasise the importance of empathy, reflexivity, and context-sensitivity.

Critical realism occupies a middle ground between positivism and interpretivism (Yin, 2018). It holds that while reality exists independently of human perception, our access to that reality is always mediated by conceptual frameworks and social structures. Critical realists distinguish between the empirical domain (what we observe), the actual domain (what happens whether observed or not), and the real domain (the underlying mechanisms and structures that generate events).

Reio (2021) explains that pragmatism, associated with philosophers such as Dewey, James, and Peirce, holds that the truth value of a belief is determined by its practical consequences. Pragmatist researchers are less concerned with philosophical consistency than with what works in practice, and they are therefore often associated with mixed methods approaches.

Rationale for selection and implications for methods

The rationale for selecting a research philosophy must be grounded in the research problem and the epistemological assumptions that best fit the phenomenon under investigation. For example, a researcher examining the relationship between school funding and student attainment may find a positivist orientation appropriate because it supports quantitative measurement and statistical analysis (Asenahabi, 2019). A researcher exploring refugee students' experiences of inclusion may find interpretivism more suitable because it privileges participants' meanings and narratives. The implications of this philosophical choice are far-reaching: they determine what counts as valid evidence, how data should be collected and analysed, and what kinds of claims can legitimately be made (Creswell & Creswell, 2018).

The philosophical underpinning of a study also has important implications for the relationship between the researcher and the researched (Yin, 2018). Positivism demands that the researcher maintain objectivity and distance from the phenomena under study. Interpretivism acknowledges the role of the researcher as a co-constructor of meaning, and therefore demands reflexivity and transparency about the researcher's positionality. Critical realism encourages attention to both structural mechanisms and human agency, while pragmatism prioritises the practical utility of the research for addressing real-world problems.

Study area and context

The study area or context refers to the specific geographic, institutional, or organisational setting within which the research is conducted. A clear description of the study area is essential for situating the research and enabling readers to assess the extent to which the findings are applicable to other contexts. The study area may be defined in geographic terms (e.g., a particular country, region, city, or neighbourhood), in institutional terms (e.g., a university, hospital, government agency, or non-governmental organisation), or in organisational terms (e.g., a corporation, community group, or professional association) (Chivanga & Monyai, 2021).

A comprehensive description of the study area should include information about its demographic characteristics, socioeconomic conditions, historical background, and any other contextual factors that are likely to be relevant to the research problem (Reio, 2021). For instance, a study examining the effectiveness of a literacy intervention in an under-resourced urban school would need to describe not only the geographic boundaries of the neighbourhood, but also its population size and composition, its staffing, learning resources, and educational infrastructure, and the broader socioeconomic and political context within which the intervention is being implemented.

Relevance to the research problem

The relevance of the study area to the research problem must be explicitly articulated. This involves demonstrating that the setting is appropriate for generating the kind of data needed to address the research questions, and that the characteristics of the setting are aligned with the theoretical framework and research design (Biddix, 2018). A study examining educational inequality, for example, would need to justify the selection of particular schools, districts, or regions by demonstrating that their social and institutional characteristics are relevant to the research problem. Furthermore, the study area may itself be a theoretical construct. In organisational research, for instance, the 'setting' may be defined not by geographic boundaries but by organisational membership, industry classification, or institutional affiliation. Whatever the nature of the setting, its selection must be justified in terms of its theoretical relevance, practical accessibility, and the feasibility of conducting the planned research activities within it.

Population of the study

The population of a study refers to the entire group of individuals, organisations, events, or objects that share common characteristics and about whom the researcher wishes to draw conclusions (Bryman, 2016). A clear and precise definition of the target population is a critical prerequisite for sound research design, as it determines the scope of the study, the composition of the sample, and the generalisability of the findings. The target population may be defined in terms of demographic characteristics (e.g., adults between the ages of 18 and 65), professional characteristics (e.g., teachers working in public secondary schools), geographic characteristics (e.g., residents of a particular municipality), or behavioural characteristics (e.g., individuals who have used a particular online learning platform) (Liu, 2022). The rationale for the chosen population definition must be grounded in the research problem and the theoretical framework guiding the study. It must also be realistic, in the sense that the defined population must be accessible and it must be possible to obtain a representative sample from it.

Inclusion and exclusion criteria

Inclusion and exclusion criteria are the specific characteristics that determine whether an individual or unit is eligible to participate in the study. Inclusion criteria define the essential characteristics that participants must possess in order to be included in the sample (Tobi & Kampen, 2018). Exclusion criteria identify specific characteristics that would make a potential participant ineligible, even if they otherwise meet the inclusion criteria (Mruck & Mey, 2019). The development of clear and well-justified inclusion and exclusion criteria is essential for ensuring the internal validity of the study. For example, a study examining the effectiveness of a digital formative-assessment intervention might include enrolled undergraduate students who have completed the relevant foundation module, while excluding students who lack access to the required platform or who previously participated in the pilot study. These criteria must be justified on both scientific and ethical grounds, and their application must be systematic and consistent across all potential participants.

Sampling technique and sample size

Sampling frame and sampling technique

Liu (2022) affirmed that the sampling frame is the list or set of individuals from which the sample will be drawn. It is the operationalisation of the target population, and its completeness and accuracy are critical determinants of the representativeness of the sample. In practice, the sampling frame is often an approximation of the target population, due to issues of inaccessibility, incomplete records, or practical constraints.

Sampling techniques are broadly classified into probability and non-probability methods. Probability sampling techniques are those in which every unit in the sampling frame has a known, non-zero probability of being selected (Tobi & Kampen, 2018). Common probability sampling techniques include simple random sampling, stratified random sampling, systematic random sampling, and cluster sampling. These techniques are preferred when the goal of the research is to make statistically valid inferences about the target population from the sample data. Non-probability sampling techniques are those in which the probability of selection is not known and cannot be calculated.

Common non-probability techniques include purposive sampling, convenience sampling, snowball sampling, and quota sampling (Bryman, 2016). These techniques are appropriate in qualitative research, where the goal is not to make statistical generalisations but to gain in-depth understanding of a particular phenomenon. They are also used in exploratory research, where the priority is to generate hypotheses rather than to test them.

Sample-size determination and justification

Sample size determination is a critical step in research design, as the adequacy of the sample size has direct implications for the statistical power of the study (in quantitative research) and the depth and richness of the data (in qualitative research) (Leavy, 2022). In quantitative research, sample size is typically determined through power analysis, which calculates the minimum sample size required to detect an effect of a given magnitude with a specified level of statistical power (usually 0.80) and a given significance level (usually 0.05). Power analysis requires the researcher to specify the expected effect size, the desired power, and the

significance level (Wadsworth, 2020). In practice, many researchers rely on rules of thumb for sample size determination, particularly when prior data on effect sizes are not available.

Rules of thumb, such as a minimum number of participants per analytical cell or a fixed ratio of cases to predictor variables, are sometimes used when prior effect-size information is unavailable; however, they should not replace a design-specific power analysis and transparent justification (Symon et al., 2018). In qualitative research, sample adequacy is often guided by saturation, information richness, the study aim, and the heterogeneity of the participant group. The concept of saturation acknowledges that the adequacy of a sample in qualitative research is a function of the depth and richness of the data rather than its volume.

Respondent selection and recruitment

Respondent selection and recruitment procedures must be clearly described and consistently applied. In probability sampling, selection procedures typically involve the use of random number generators, lottery methods, or systematic selection from the sampling frame (Leavy, 2022). In non-probability sampling, selection procedures are guided by the researcher's purposive judgement or by the social networks of existing participants (in snowball sampling) (Bryman, 2016).

Leavy (2022) notes that recruitment procedures must address potential sources of selection bias and must be designed to maximise participation rates while minimising the risk of coercion or undue influence. Effective recruitment strategies typically involve the use of multiple communication channels, the provision of clear and accessible information about the study, and the development of trusting relationships between researchers and potential participants.

Data sources and instruments

Primary and secondary data sources

Research data sources are commonly classified as primary or secondary. Primary data are collected directly by the researcher for the purposes of the study and may include surveys, interviews, focus group discussions, experiments, and observations (Chivanga & Monyai, 2021).

Liu (2022) explains that secondary data are those that have been collected by others for purposes other than the current study. Secondary data sources include government statistics, administrative records, academic publications, organisational reports, and archival materials. Secondary data are often more readily accessible and less expensive than primary data, but they may not be perfectly aligned with the needs of the current study, and their quality and reliability may be more difficult to assess.

Description and development of instruments

According to Creswell and Creswell (2018), research instruments are the tools through which data are collected. The most common instruments in social science research include questionnaires, interview guides, and observation protocols. The development of research instruments is a complex and iterative process that requires careful attention to the conceptual domain being measured, the target population, and the mode of data collection.

Questionnaires typically consist of a series of structured questions with predefined response options (closed-ended questions) or open spaces for participants to provide their own answers (open-ended questions) (Biddix, 2018). The development of a questionnaire involves the operationalisation of theoretical constructs into measurable indicators, the selection or development of appropriate response scales, and the organisation of items into a logical and coherent structure. Interview guides are used in semi-structured or unstructured interviews and consist of a series of broad, open-ended questions designed to explore participants' perspectives, experiences, and meanings (Mruck & Mey, 2019). Observation protocols are structured frameworks for recording what researchers observe in naturalistic settings, and may include checklists, rating scales, or narrative descriptions.

Pre-testing and pilot-study procedures

Pre-testing and pilot studies are essential components of instrument development. Pre-testing involves administering the instrument to a small group of individuals who are similar to the target population, in order to identify ambiguities, redundancies, or other problems with the instrument (Patton, 2015). The feedback from pre-testing is used to revise and refine the instrument before it is deployed in the main study. Yin (2018) stated that a pilot study is a smaller-scale version of the main study, conducted with a subset of the target population, with the aim of testing not only the instrument but also the data collection procedures, the recruitment strategies, and the analytical methods. The outcomes of the pilot study inform revisions to all aspects of the research design and protocol. Reporting the outcomes of pre-testing and piloting is a critical component of methodological transparency, as it provides evidence of the rigour with which the instruments and procedures were developed and refined.

Data-collection procedures

Data-collection process and timeline

The data collection process should be described in sufficient detail to allow replication of the study. This requires a step-by-step account of how data will be collected, from initial participant contact through to data entry and storage. The timeline for data collection should be realistic and should account for potential delays due to participant unavailability, logistical challenges, or the need for additional ethical approvals (Field, 2018; Reio, 2021). Mertens (2014) explains that a well-structured data collection timeline typically begins with the preparation phase, which involves finalising instruments, obtaining ethical clearance, training data collectors, and establishing data management procedures. The active data collection phase involves the implementation of recruitment strategies, the administration of instruments, and the monitoring of data quality. The post-collection phase involves data entry, cleaning, and preliminary analysis. Clear timelines and milestones help to ensure that the research is completed on schedule and that potential bottlenecks are identified and addressed proactively.

Ethical clearance, consent, and confidentiality

Ethical clearance from the relevant institutional review board (IRB) or research ethics committee is a prerequisite for data collection in most research contexts (Yin, 2018). Once

ethical approval has been obtained, researchers must implement procedures for obtaining informed consent from participants. Informed consent requires that participants be provided with sufficient information about the study to make a free and voluntary decision about whether to participate. Consent must be obtained prior to data collection and must be documented in accordance with the requirements of the relevant ethical authority (Creswell & Creswell, 2018).

Confidentiality measures must be implemented to protect the privacy and anonymity of participants. These measures typically include the use of participant codes or pseudonyms in place of real names, secure storage of data in password-protected systems, and restricted access to identifiable data. Where data are to be shared with third parties or published in academic outputs, additional measures may be required to ensure that individual participants cannot be identified.

Measurement and operationalisation of variables

Definition of key variables and constructs

Operationalisation is the process by which abstract theoretical constructs are translated into measurable, observable indicators (Yin, 2018). It is one of the most challenging and critical steps in quantitative research design, as the validity of the study depends on how well the operationalised variables capture the theoretical constructs they are intended to represent. A clear and precise definition of each key variable and construct is therefore an essential starting point for operationalisation (Field, 2018). Patton (2015) explains that variables may be classified as independent (predictor), dependent (outcome), moderating, mediating, or control variables, depending on their role in the theoretical model. Constructs are latent variables that cannot be directly observed but must be inferred from observable indicators. For example, 'academic achievement' is a theoretical construct that might be operationalised as grade point average, examination scores, or a composite index of multiple academic performance indicators.

Measurement scales and indicators

Measurement scales determine the nature of the quantitative data generated by a research instrument (Tashakkori & Teddlie, 2010). The four levels of measurement are nominal, ordinal, interval, and ratio. Nominal scales classify observations into mutually exclusive categories without implying any order or magnitude. Ordinal scales rank observations in order but do not specify the intervals between ranks. Interval scales specify equal intervals between ranks but do not have a true zero point. Ratio scales have equal intervals and a true zero point, allowing for the computation of meaningful ratios.

The selection of appropriate measurement scales is critical for ensuring that the data generated can be analysed using appropriate statistical techniques (Cohen et al., 2018). Many constructs in social science research are measured using Likert scales, which are ordinal scales consisting of a series of statements to which respondents express their level of agreement or disagreement. While Likert scales are widely used, they are often treated as interval scales for the purposes of statistical analysis, an assumption that has been the subject of considerable methodological debate.

Construction of indices or composite measures

When a theoretical construct is too complex to be adequately captured by a single indicator, researchers often construct composite measures or indices by combining multiple indicators (Bryman, 2016). The construction of composite measures requires careful attention to the dimensionality of the construct being measured, the internal consistency of the indicators, and the weighting scheme used to combine them. Factor analysis and principal component analysis are commonly used statistical techniques for exploring the dimensionality of a set of indicators and for reducing a large number of indicators to a smaller set of composite dimensions (Patton, 2015)

The validity and reliability of composite measures must be rigorously assessed. Reliability refers to the consistency or stability of the measure, and is typically assessed using Cronbach's alpha or test-retest reliability (Saunders et al., 2019). Validity refers to the extent to which the measure actually captures the construct it is intended to measure, and encompasses content validity, construct validity, convergent validity, and discriminant validity (Bryman, 2016). A high-quality composite measure should demonstrate both high reliability and strong evidence of multiple forms of validity.

Data management and quality control

Strategies for reliability, validity, and trustworthiness

Reliability and validity are the two fundamental criteria for assessing the quality of research data and findings. Reliability refers to the consistency and stability of measurements over time, across raters, and across contexts (Patton, 2015). Internal consistency reliability is most commonly assessed using Cronbach's alpha, although conventional thresholds such as 0.70 should be interpreted in relation to the construct, the number of items, and the purpose of the measure. Test-retest reliability is assessed by administering the same instrument to the same participants on two occasions separated by a short interval. Inter-rater reliability is assessed by comparing the ratings or codings of two or more independent raters using statistics such as Cohen's kappa or intraclass correlation coefficients (Denzin & Lincoln, 2018).

Validity encompasses a range of concerns about the extent to which the research instruments and findings accurately represent the constructs and phenomena under study (Chivanga & Monyai, 2021). Content validity is assessed through expert review of the instrument to ensure that it adequately covers all relevant aspects of the construct. Construct validity is assessed through factor analysis and through the examination of convergent and discriminant validity. Criterion validity is assessed by comparing the instrument's scores with those from an established criterion measure (Patton, 2015). In qualitative research, trustworthiness is assessed through criteria such as credibility, transferability, dependability, and confirmability.

Handling missing data and outliers

Missing data and outliers are ubiquitous challenges in quantitative research, and the strategies for handling them have important implications for the validity of the findings. Missing data may arise due to non-response, item non-response, data entry errors, or dropout from longitudinal studies (Liu, 2022). The three principal mechanisms of missingness are missing completely at random (MCAR), missing at random (MAR), and missing not at random

(MNAR). The appropriate strategy for handling missing data depends on the mechanism of missingness and the extent of the missing data (Biddix, 2018).

Common strategies for handling missing data include listwise deletion, pairwise deletion, mean imputation, multiple imputation, and full information maximum likelihood estimation (Field, 2018). Multiple imputation and full-information maximum-likelihood estimation are often preferable when their assumptions are met because they preserve more information and avoid the artificial reduction in variability associated with simple imputation. Outliers are extreme values that deviate substantially from the rest of the distribution and may distort the results of statistical analyses. Outliers should be identified through graphical and statistical methods, and their causes should be investigated before any decisions are made about whether to retain, transform, or exclude them.

Data-analysis techniques

Descriptive statistics and visualisation

Data analysis is the process of examining, transforming, and modelling data in order to discover useful information, draw conclusions, and support decision-making (Field, 2018). Descriptive statistics are the first step in data analysis and involve summarising the characteristics of the dataset using measures of central tendency (mean, median, mode), measures of dispersion (range, variance, standard deviation), and measures of distribution (skewness, kurtosis). Frequency distributions and cross-tabulations are used to describe the distribution of categorical variables.

Data visualisation is a powerful tool for communicating patterns, trends, and relationships in the data. Common visualisation techniques include histograms, box plots, scatter plots, bar charts, pie charts, line graphs, and heat maps (Leavy, 2022). The selection of appropriate visualisation techniques depends on the nature of the variables, the level of measurement, and the specific patterns or relationships that the researcher wishes to communicate. Effective data visualisation enhances the interpretability of findings and facilitates communication with both academic and non-academic audiences.

Inferential, qualitative, and statistical models

According to Wadsworth (2020), inferential statistics are used to draw conclusions about the target population from the sample data. Common inferential techniques include hypothesis testing (t-tests, chi-square tests, ANOVA), correlation analysis, regression analysis, and factor analysis. The selection of appropriate statistical tests depends on the research design, the level of measurement of the variables, the distribution of the data, and the sample size. Multiple regression analysis is used to examine the simultaneous effects of multiple independent variables on a dependent variable, controlling for confounding factors. Analysis of variance (ANOVA) is used to compare the means of three or more groups. Factor analysis is used to identify the underlying dimensions of a set of observed variables and is commonly used in scale development research (Symon et al., 2018).

Leavy (2022) explains that qualitative data analysis involves the systematic examination of textual, visual, or audio data in order to identify patterns, themes, and meanings. Thematic analysis is one of the most widely used qualitative analysis methods, and involves the

identification, coding, and interpretation of patterns (themes) in the data. Grounded theory involves the systematic generation of theory from data through constant comparison, theoretical sampling, and the development of categories and concepts (Liu, 2022). Discourse analysis and narrative analysis are used to examine the role of language and narrative in the construction of social reality. Framework analysis is a matrix-based approach that is particularly useful in applied research where specific policy-relevant themes are of interest (Mruck & Mey, 2019).

Software and mixed-methods integration

The choice of analytical software is an important practical consideration in research design. In quantitative research, the most widely used software packages include SPSS (Statistical Package for the Social Sciences), Stata, R, and SAS. SPSS is user-friendly and widely used in the social sciences, but is limited in its capacity for advanced or custom analyses (Biddix, 2018). R is a powerful open-source statistical computing environment that offers a vast range of packages for both standard and advanced analyses, but has a steeper learning curve. Stata is widely used in economics and epidemiology and offers a good balance of user-friendliness and analytical power (Liu, 2022).

In qualitative research, software packages such as NVivo, ATLAS.ti, and MAXQDA are used to facilitate the management and analysis of large volumes of textual or multimedia data (Reio, 2021). These packages support the coding, querying, and visualisation of qualitative data, but they do not perform qualitative analysis in the sense of developing interpretations; that remains the intellectual work of the researcher. In mixed methods research, integration strategies determine how and at what stage the quantitative and qualitative findings are brought together. Integration may occur at the design level, the methods level, or the interpretation level, and may take the form of convergence (comparing findings from both strands), explanation (using qualitative findings to explain quantitative results), or exploration (using qualitative findings to inform the development of quantitative instruments) (Saunders et al., 2019; Yin, 2018).

Ethical considerations

Ethical approval and review

Research ethics encompasses the principles and rules governing studies involving human participants, animals, or sensitive data (Asenahabi, 2019). In most countries and institutions, research involving human participants must be reviewed and approved by an independent ethics committee or institutional review board (IRB) before data collection can begin. The IRB reviews the research protocol to assess its scientific merit, the appropriateness of the research design, the adequacy of participant protections, and the balance of risks and benefits.

Informed consent, anonymity, data protection, and participant welfare

Informed consent is a cornerstone of research ethics. It requires that participants be provided with comprehensive, accurate, and understandable information about the nature and purpose of the study, the procedures involved, the potential risks and benefits, and their rights as participants (including the right to withdraw at any time without penalty) (Tashakkori & Teddlie, 2010).

Anonymity means that the researcher does not know the identity of the participants; confidentiality means that the researcher knows the identity of the participants but commits to not disclosing it to others (Yin, 2018). In practice, many research studies can only guarantee confidentiality rather than full anonymity, since the researcher must be able to contact participants and link data across time points. Researchers must implement robust data protection measures to safeguard participant confidentiality, including secure data storage, restricted access, and the use of participant codes or pseudonyms in all research outputs.

Participant welfare is a fundamental ethical obligation that requires researchers to take all reasonable steps to protect participants from harm (Mertens, 2014). This includes minimising the risk of psychological distress, social harm, or physical injury; providing access to support services for participants who experience distress during the research; and debriefing participants at the conclusion of data collection.

Discussion

The central implication of this review is that methodological quality is relational rather than formulaic. No design can be evaluated as scientific per se, without consideration of the research question it seeks to answer, the knowledge claims it is based upon, the context of the design, and the context of its participants. It is then important to not put quantitative, qualitative, or mixed methods in a hierarchy of inherent quality. They are considered adequate when aligned, executed, transparent, and when the researcher accepts limitations (Creswell & Creswell, 2018; Leavy, 2022).

The second implication is that familiar methodological differences are prone to be misinterpreted as dichotomies. Objectivity and reflexivity, breadth and depth, or generalisability and transferability, numerical and interpretive evidence are not opposites. Educational issues are often multi-level in nature, spanning individual, classroom, institutional and policy levels, and a single methodological approach can therefore reveal some mechanisms, while concealing others. Although mixed methods can help to expand explanation, this expansion must be planned and the connection between strands must be described as a philosophical relationship and not as an aggregation of various types of data (Liu, 2022; Tashakkori & Teddlie, 2010).

The analysis also reveals the importance of methodological checklists but why they are not enough. Sample, pilot, clean, measure, analyse and ethically review the data are crucial safeguards but an exercise of contextual judgement is required for each. For instance, normal rules for sample size and reliability may produce the illusion of precision when there is no conceptual validity, and standardised measurement tools may fail to provide conceptual validity. These risks are exacerbated in educational research, because of institutional power relations, the involvement of children or other vulnerable groups, and the potential for the results to inform consequential decisions. Researchers need to relate the technical aspects to participants' wellbeing, fairness and responsible interpretation of research evidence.

The article has limitations. It is a critical narrative synthesis rather than a systematic review, so its findings are limited to the literature selected for the manuscript. It does not compare methodological approaches across different parts of the education sector, nor does it examine whether specific reporting requirements enhance research quality. Future systematic reviews, meta-research, and comparative analyses of published educational studies could explore recurring design shortcomings, the quality of philosophical justification, the transparency of analytical decisions, and the relationships among these dimensions.

Conclusion

Research methodology is not a set of steps but a theoretical, technical and ethical approach to the production of valid knowledge. The results of this review reveal that a well-designed study of education requires an explicit link between the research problem, the philosophical perspective, the design, the context, the sampling strategy, the instruments, the analysis and the claims. It also illustrates how rules and thresholds need to be used with a critical perspective rather than as a rule of thumb. Validity, reliability, trustworthiness, pre-testing, piloting, transparency in data management and analysis are still important, but they take on significance only when related to the purpose and context of the study. Ethical responsibility also plays a crucial role as methodological decisions affect who gets represented, who takes the risks and how evidence might affect education practice and policy. A good methodology thus has to include reflexive justification, technical competence, contextual sensitivity, and an openness to limitations. The principles offer a practical basis for students, researchers and practitioners in the design, evaluation and communication of credible, transferable and socially acceptable educational research.

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