

New organization of research designs

Nueva organización de los diseños de investigación

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ABSTRACT

Identifying a research design is one of the most common problems when planning a scientific project. In this methodological proposal, we start from the most cited manuals in research methodology to extract, complete and reorganize research designs. The books by Bryman (2016), Cohen et al. (2017) and Hernández Sampieri et al. (2014) are the most cited in the last eight years and occupy the first positions of relevance in Google Scholar Based on them and on the recommendations of the latest edition of the APA Manual, a synthesis of research designs grouped in 12 units is proposed, starting with the most flexible (qualitative) and moving towards the less flexible (quantitative) up to eight levels, and then addressing the particularities of other designs, including mixed designs. In addition, some findings are discussed in relation to the epistemic nature of designs that were not previously classified by methodologists. This proposal aims to provide researchers with a clear and structured guide to identify more specific strategies in the development of their research. By understanding the characteristics and scope of each design, researchers will be able to select the most appropriate approach.

Key words: research design, qualitative, quantitative, mixed

RESUMEN

Identificar un diseño de investigación es uno de los problemas más comunes al plantear un proyecto científico. En esta propuesta metodológica, se parte de los manuales más citados en metodología de la investigación para extraer, completar y reorganizar los diseños de investigación. Los libros de Bryman (2016), Cohen et al. (2017) y Hernández Sampieri et al. (2014) son los más citados en los últimos ocho años y ocupan los primeros puestos de relevancia en Google Académico. Con base en ellos y en las recomendaciones de la última edición del Manual APA, se propone una síntesis de los diseños de investigación

agrupados en 12 unidades comenzando por los más flexibles (cualitativos) y avanzando hacia los menos flexibles (cuantitativos) hasta en ocho niveles, para luego abordar las particularidades de otros diseños incluyendo a los mixtos. Además, se discuten algunos hallazgos en relación con la naturaleza epistémica de los diseños que anteriormente no fueron clasificados por los metodólogos. Esta propuesta proporciona a los investigadores una guía clara y estructurada para identificar estrategias más específicas al desarrollar su investigación. Al comprender las características y el alcance de cada diseño, los investigadores podrán seleccionar el enfoque más apropiado.

Palabras clave: diseño de investigación, cualitativo, cuantitativo, mixto

INTRODUCTION

Up to now, research manuals have typically focused on research approaches and their respective scopes, leaving discussions on research designs until the end. However, what if we prioritize research designs, starting from the simplest and progressing towards the most complex ones? The following is an attempt to explore this approach.

All cultures have been concerned with finding methods that allow them to know themselves and the outside world. In the beginning, these procedures depended on superstitions, as well as on the development of technology, but half a century ago, Farrington (1984) picked up Aristotle's ideas to emphasize that the search for knowledge is not limited to a particular religion, language, or people, but to common cognitive interests that go beyond even practical utilities. To know to feed curiosity is the most important characteristic of science and of the scientist of all times and places.

In the search for knowledge, scientists have invented methods of observation and experimentation that scientific communities endorse or reject for various reasons. Generally, endorsed scientific methods are continually fed back and, on rare occasions, revolutions occur that discard previously accumulated knowledge because, as Bunge (1983) argues, it regularly harmonizes with the bulk of previous knowledge.

In the 19th century, ways of systematically investigating how individuals and society behave were devised (Raynaud, 2022). However, as a reaction to positivism, authors such as Dilthey (2000) argued that there are human and cultural aspects that cannot be explained, but at best interpreted. Under the shelter of philosophical theories such as idealism, phenomenology, existentialism, social constructivism, structuralism, psychoanalysis, symbolic interactionism and postmodernism, inductive research designs such as hermeneutics emerged, ethnography, phenomenology, narrative, critical discourse analysis, action research, among others, tried to understand the perspective of both the participants of the study (emic) and the researchers (etic) (Páramo Reales et al., 2020). This perspective generated a very marked division, since they

defend the thesis that the social and human sciences require their own method, radically different from that of the natural sciences. Therefore, the reliability and validity of qualitative designs is exhausted in a process of triangulation between different sources of information or study categories. Very few researchers in this line have questioned the validity of employing such subjective techniques in which it is impossible to control the researcher's bias and the veracity of the results (Rose and Johnson, 2020). Even though authors such as Weber have made great generalizations and have promoted interpretive research, under the philosophical perspective that shelters them, their findings are usually not generalizable.

On the contrary, the hypothetico-deductive method used in the natural sciences maintained its course with the concern to identify and try to explain reality with techniques that attempt to control the researcher's bias. Many researchers in the social sciences have continued along these lines. The philosophical theories that cover this type of research are positivism, realism, materialism, empiricism, emergentism, as well as systemism. However, Bunge (2005) argues that, although each scientist has his or her beliefs at a personal level, when doing science, he or she tends to make a pact with realism and materialism, consciously or unconsciously, since the principles of these philosophies facilitate research in the natural and social sciences. In this case, research designs are twofold: observational or experimental (Campbell and Stanley, 2015). In both cases, there are research designs that are subject to certain rules such as validity, reliability, randomization of samples, replicability, among others, which demand specialized knowledge to avoid statistical dishonesty (Abril and Abril, 2021). Functionalist authors such as Durkheim, based on these rules of the game, considered that the findings of this type of research are susceptible to generalization.

In the face of the disputes that exist between the quantitative and qualitative approaches, a third way has emerged, hand in hand with pragmatism: mixed methods. "The philosophical basis of pragmatism allows and guides mixed methods researchers to use a variety of approaches to answer research questions that cannot be addressed by a single method" (Doyle et al., 2009). However, it cannot be taken for granted that the above debate has been overcome in this way, since the mismatch between theory and reality is not a problem for a type of research that is not, in principle, guided by theory. Another possibility is to consider mixed methods as part of interpretive studies since they tolerate the error and bias that quantitative research tries to control. However, authors such as Bryman (2016) propose reverse embedded strategies, as according to him, a qualitative design within a cross-sectional quantitative study is possible. Whatever the epistemological background, mixed methods, in practice, are conquering an increasingly common place in the social sciences and health sciences¹.

Depending on the approaches outlined above, the research possibilities may be flexible or not very malleable. However, in a specific research, epistemic discourse is superfluous, since what is important is to explain the method that will be followed or has been followed in the research. Therefore, when designing research, it is necessary to identify specific research designs to avoid major surprises when executing a project. For example, there are designs ranging from tool construction (Carretero-Dios, 2007; Gómez and Dorati, 2017), observational description or the creation of experiments (Campbell and Stanley, 2015; Cárdenas Castro, 2009), to the use of qualitative research (Hernández Sampieri et al., 2014), and often these designs are combined (Creswell, 2013). A research design presents in an orderly fashion the strategies employed throughout an investigation.

According to Kirshenblatt-Gimblett (2006), choosing a research design selects a general guideline for logically and coherently integrating different components of a study to ensure that the research problem is effectively addressed. This course includes a plan for data collection, measurement, and analysis. For their part, Creswell, and Creswell (2017) explain that a collection of procedures and techniques is used to collect and analyze the variables specified in the research question. Under this concept, the type of study, the research problem, the hypotheses, the independent and dependent variables, the data collection methods, and the statistical analysis plan are described. According to Hernández Sampieri et al. (2014), a research design is defined as "...a plan or strategy conceived to obtain the desired information in order to respond to the problem statement..." (p. 128). A research design, in addition to specifying the path, facilitates the replicability of the project to address the research problem in other places and at other times.

Almost all projects that adopt the hypothetico-deductive method select designs prior to the research, so that their new research, in practice, is guided mainly by theory and/or the imagination of new hypotheses (Bunge, 2005). Sometimes, when confronted with real-world data, novice scientists are forced to replan their research. "Re-planning" does not necessarily mean "re-planning", but rather adjusting the original design. It has happened to more than one researcher that he or she has had to reconsider the sample or the measurement instruments. However, if there is no fraudulent intent to offer something and then deliver something else, this should be considered a process compatible with scientific fallibilism when it is not possible to find an advanced state of the art due to the originality of the research. In other cases, addressing novel problems involves the creative and critical adaptation of existing research designs. After all, the methods of the social sciences, like those of the natural sciences, lie in testing possible solutions to their problems (Popper et al., 2008). In this sense, avoiding planning or replanning may imply

¹ Regarding the similarity between social science and health science research designs, there is at least one proposal developed by Supo (2012),

who argues that there are no major differences between epidemiological and social science research when it comes to developing quantitative research.

attempts to force reality to conform to theory, i.e., a lack of critical attitude on the part of the researcher. Thus, if a researcher believed it possible to conduct an explanatory study and only managed to conduct a relational study, or if he intended to conduct an experiment but did not achieve adequate control and ended up conducting a quasi-experiment, his honesty should be translated into identifying the new research design. The same cannot be said of those who adopt the inductive and interpretative method, since in their case they are not guided by theory but by particular facts that shape ways of interpreting reality (Bunge, 2005). In this case, the designs constitute fewer rigid referents, but this does not mean that the possibility of having designs to guide the researcher should not be ruled out.

To understand the above point of view, it is necessary to analyze two situations: 1) Sometimes, research designs such as instrumental research can contribute to the qualitative research of those who seek to formulate questions based on psychometric reliability and validity. 2) Other designs, such as sentiment analysis, once exclusive to hermeneutics, have been extrapolated to the field of data analysis to study the public opinion of millions of users who express themselves on social networks, which has given way to quantitative research designs that will be discussed below.

In practice, it appears that research designs can develop much more conciliatory strategies than theoretical or philosophical antagonisms.

A recurrent problem faced by new scientists is the scarcity of unifying solutions that facilitate understanding and methodological decision-making in the face of research problems. In this sense, the advantage of demarcating research in a research design is to assume the rigor of procedures that have been tested by other scientists to avoid improvisation. This situation becomes even more inevitable

when biological studies applied to the health sciences have very well defined research designs and it is easy for them to guide students, masters, or doctoral students in conducting research, while in the social sciences, methodologists still debate whether to apply research designs in qualitative or mixed fields.

As we have seen, these discussions are very productive in the epistemological field. However, in the practical field of research, they are a burden, as young researchers are often preoccupied with defining the typology, approach, level, and type of research, when they could provide greater precision in pinpointing a research design. A research design is derived from a focus and is precise in scope. The research approach can be quantitative, qualitative, or mixed. The research design is a plan of methodological strategies recognized by the scientific community to address research problems. While the scope of a research can be broad or narrow, depending on the objectives and limitations of the researcher.

Identifying a research design becomes much more important if we consider that one of the most prestigious systems of writing and writing, such as the APA (American Psychological Association, 2019), in its principles of academic writing and publication points out this typology for articles and papers: quantitative, qualitative (including case studies), mixed, replication, meta-analysis, literature review, theoretical, methodological, student papers, dissertation and thesis, others (reports, commentaries, letters, abstracts, essays, etc.).

When the design is quantitative or mixed, the APA itself states that the research design must be identified. However, don't the remaining eight in which the manual requires methodological transparency constitute designs with possibilities of delimitation in themselves?

Table 1

Most relevant research methodology sources in English and Spanish according to Google Scholar

Relevance	Spanish		English	
	Author	Quotations	Author	Quotations
1	Pimienta-Prieto y De la Orden (2017)	875	Wan, (2022)	1209
2	Quezada Lucio (2021)	1960	Stokes y Wall (2017)	109
3	Oberti y Bacci (2018)	363	Harris et al. (2019)	73
4	Villanueva Couhg (2022)	105	Patten (2017)	2918
5	Toscano (2018)	78	Bryman (2016)	73772
6	Arias González y Covinos Gallardo (2021)	958	Marvasti (2018)	71
7	Balboa Barreiro (2018)	87	Lankoski et al. (2015)	168
8	Bisquerra Alzina et al. (2019)	6757	Walliman (2021)	3109
9	Luciano (2020)	252	Busetto et al. (2020)	622
10	Hernández Sampieri et al., (2014)	146279	Cohen et al. (2017)	80593

Note: In the case of Hernández Sampieri, although there are records on the Internet that there is a 2016 edition, the sixth confirmed edition is from 2014, it was decided to keep it given the relevance of the citations of this source in Spanish. The number of citations does not necessarily reflect the quality of the work, which is why it is necessary to analyze this indicator with caution, but without losing sight of the criterion of relevance offered by the search engine.

A review of the most cited books on "research methodology" in Google Scholar shows the impact of some sources in both English and Spanish. Table 1 summarizes the author, the relevance according to Google's algorithm and the number of citations. Because of their relevance,

those in the first 10 positions, i.e., on the first page, as of 2015 are selected. The search was performed with all the words in Spanish: "metodología de la investigación" and, in English: "research methods". These two terms are equivalent in the sense that their exact translation generates an imbalance in the number of citations.

It is important to note that the first page returned by the search engine contains texts such as book chapters, a syllabus of a university course, a scientific article, and slides. In all other cases, books are found. In fact, it is books that have the highest number of citations. In Spanish, the text by Quezada Lucio (2021), in third place; Bisquerra Alzina et al. (2019), in eighth place; and Hernández Sampieri et al. (2014), in tenth place, stand out. However, if the number of citations is considered, the positions would be reversed, with the text by Hernández Sampieri et al. being extremely higher with respect to all the others. In English, the three most cited books are Walliman's (2021), which occupies the eighth position; Bryman's (2016), which is in the fifth position; and Cohen et al. (2017), which is in the tenth position. In this case, the texts of Bryman and Cohen et al. have a close number of citations, but they are much higher than those of Walliman.

These books present some differences that could generate confusion in researchers when offering the name of a research design. Bryman exclusively highlights observational and experimental designs as research designs, while explaining the workings of the qualitative approach and mentioning techniques such as ethnography, interviews, virtual document analysis and focus groups. Cohen et al. similarly mention the previously mentioned designs, but also include systematic review and meta-analysis as research designs and refer to netnographic designs. Hernández-Sampieri et al., for their part, identify the quantitative research designs mentioned above, but also indicate qualitative designs and several mixed designs. However, this author does not point out theoretical designs, nor reviews, nor data science. It is risky to speak of a historical design, since there is still a debate as to whether it belongs to the qualitative, quantitative, or mixed approach, but Cohen points out strategies for its employment. In contrast, none of the books cited identifies theoretical, methodological, instrumental, and epidemiological designs (although the latter is to be expected as it has specialized literature). In these sources, quantitative designs are always presented before qualitative designs. In view of this, it is necessary to develop an organization that resolves the designs starting from the most flexible to the least flexible, in an ascending order of control and complexity. It is important to bear in mind that these sources directly or indirectly identify the research designs that should be recognized, since, as will be seen in the proposal, they are not always declared as such.

Based on the above, the present study proposes to organize the research designs according to the criterion of flexibility in the use of methodological research rules, starting from the most flexible (qualitative) to the least flexible (quantitative), but adding other designs that, due to their nature, are difficult to classify in this order.

METHODOLOGY

The purpose of this article is to identify common research designs to facilitate decision making when researchers are faced with real-world problems. The methodological design is described, discussed, and organized in a didactic way so that the reader can judge its relevance.

Instead of dividing science into quantitative and qualitative research or proposing the holistic use of mixed methods, research designs are presented with relevant properties that characterize them and that can be used regardless of the approach.

Most of the designs are collected from the sources referenced in the introduction (Bryman, 2016; Cohen et al., 2017; Hernández Sampieri et al., 2014), as well as from other research designs that exist in the literature.

The methodological proposal is divided into 12 units of study. It begins with highly flexible research designs, such as qualitative design (1) and data science (2), which are more inductive in their approach.

This is followed by designs more closely aligned with the realm of scientific publications, which include theoretical (3) and bibliographic (4) designs. Next are the methodological (5) and instrumental (6) designs that propose paths or tools for research.

Then the quantitative designs themselves are addressed, namely those that are observational (7) and those that are experimental (8). Before concluding the proposal, a clarification is made on two types of designs that are difficult to classify: historical designs (10) and case studies (11). Finally, we return to a flexible perspective with mixed designs (12).

This methodological proposal seeks to provide researchers with a variety of research designs to address problems of reality, allowing them to select those that best fit their needs and research objectives.

PROPOSAL

This section presents the proposal following the order proposed in the methodology, describing design by design and indicating when each one should be used. The enumeration of research designs, instead of being ordered according to the three research approaches (quantitative, qualitative, and mixed), proposes an alternative of starting with flexible qualitative research to gradually increase the rules and conditions required by the quantitative approach and, only after that, mixed designs are listed.

1. Qualitative: This is a general group that includes various qualitative research approaches.
2. Data science: Different data analysis approaches used in research are listed, such as netnography, sentiment analysis, bibliometrics, big data, and others.
3. Theoretical: Research designs based on the construction or development of theories.
4. Bibliographic: Research designs that focus on the review and analysis of bibliographic sources.
5. Methodological design: Research designs that involve the application of a specific methodology to address a research problem or question.
6. Instrumental: Research designs that make use of specific instruments or tools to collect data.
7. Observational: Research designs in which the researcher observes and records phenomena as they occur in their natural environment.
8. Experimental: Research designs in which variables are manipulated to establish causal relationships.

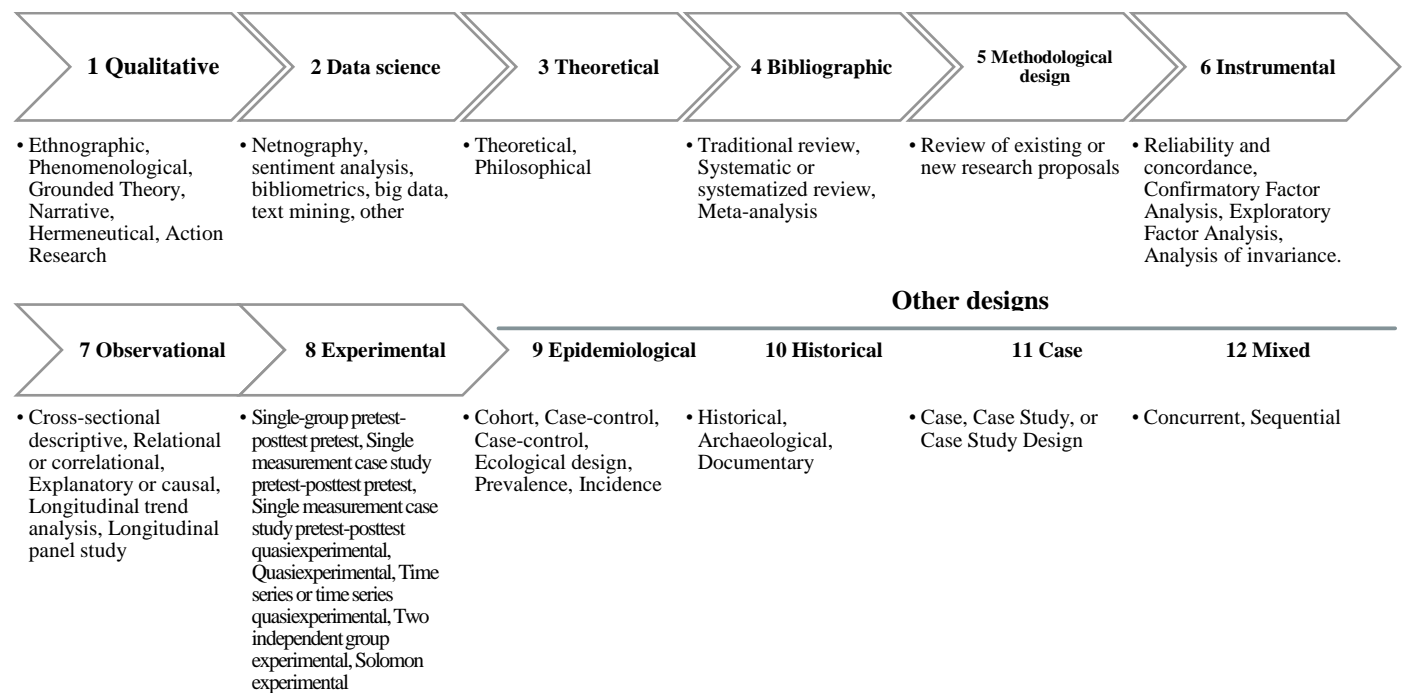
9. Epidemiological: Research designs used in the field of epidemiology to study the distribution and determinants of disease in a population.
10. Historical: Research designs that focus on the study of past events and their influence on the present.
11. Case: Research designs that focus on the study of individual or specific cases.
12. Mixed: Research designs that combine qualitative and quantitative elements in their approach.

This new organization, according to the author's criteria and experience, facilitates the understanding and

identification of the different designs in the methodological proposal. In this regard, instead of focusing on a theoretical definition that can be expanded in the methodology books presented in Table 1, the design or group of designs is identified according to the researcher's need to adhere to an already developed research design. For each case, an example is given to illustrate processes carried out by researchers in various parts of the world to solve their research problems, or a combination of these. Figure 1 illustrates the content of each of the groups of research designs.

Figure 1

Resumen de la propuesta de organización de los diseños de investigación agrupados según su flexibilidad



Note. The order from the most flexible to the least flexible only goes up to point 8. The epidemiological designs indicated are not included in the other designs indicated in this proposal, while clinical trials and community trials can be recognized as experimental designs. On the other hand, replications, reports, commentaries, letters, book summaries or essays have not been classified as designs due to the personalized nature that each author can offer.

1. Qualitative designs: When it is assumed that social reality cannot be explained numerically or logically, but only by interpreting individual meanings, a qualitative design is used. If the purpose is to understand the particularities of small groups considering their cultural, linguistic, religious, origin, etc. context, an ethnographic design is used. For example, in a study on the mismatches between family and teachers' perceptions of parental involvement, the author (Alonso Carmona, 2021) recounts the points of view by quoting relevant statements, paying special attention to the culture of those involved. For its part, the phenomenological design attempts to reveal what individuals feel and think about a particular experience (Hernández Sampieri et al., 2014). They are very useful for understanding those who have gone through painful processes such as a natural catastrophe, an illness, or the unexpected loss of someone (Palacios-Ceña and Corral Liria, 2010). Grounded theory is another qualitative design widely used to analyze social interactions, for which it identifies patterns that intertwine producing categories,

leading to synthesize an information or generate a new theory (Charmaz, 2014). For example, the study conducted by Barandiarán Irastorza et al. (2022) shows that, by asking questions to politicians, officials, and organizations of a program, it proposes some key ideas to explain what moves to trust in collaborative governance in a community. Another widely used qualitative design is the narrative, in this case it is the life stories and memories of the participants that give an account of circumstances that allow a better understanding of a period. For example, the study on the human rights violations of a military operation through the narration of the victims (Mantilla Millán et al., 2022). A design used to interpret texts and images is hermeneutic, for example, Tomaylla Quispe and Gutiérrez Aguilar (2023) in their study interpreted the personal notebooks of the artist Nereida Apaza pointing out some characteristic aspects of a decade. Finally, the action research design not only tries to understand a reality out of scientific curiosity, but also assumes an active role to transform a reality, thus, when evaluating a process, the researcher is also considering his or her actions as part of a group (Bryman, 2016). For

example, a group of researchers in South India assessed the nutritional status of five families and found that most of the women suffered from anemia. To address this problem, the researchers engaged with the families and taught them organic farming and food preparation techniques to find practical solutions. This approach involved making modifications to the daily activities of the families.

On the other hand, given the flexibility of the interpretive method, it is not surprising that some qualitative studies imitate quantitative studies in certain strategies. For example, a study conducted on 25 Argentine writers to compare their commercial perceptions over 20 years, in which, the author (Rimoldi, 2019), instead of employing a design with an already known name, decides to use the name longitudinal study which is very common among quantitative studies. There are other research designs of which examples are not developed such as semiotic and critical discourse analysis that are also part of the qualitative approach.

In the choice of sample size in qualitative research designs, a precise value cannot be determined, since it depends on the research objectives, unless it is desired to control for error. However, it is suggested to use theoretical saturation as a guide to know when to stop, i.e., when participants no longer contribute new information about the problem. This allows informed sample size decisions to be made based on theoretical completeness rather than statistical criteria.

2. Data science: When working from an interdisciplinary perspective in which computer science is combined with statistics, not only to analyze information but also to collect it, data science is employed. This is a booming field for which there is little philosophy and theorizing, however, some particularities can be identified that could lead to specific research designs. For example, when a qualitative database is very large, it is impossible to interpret each of the collected data (interviews, texts, images, network data, multimedia data), so it becomes inevitable to transform them into quantitative data. This transformation is done with pattern recognition techniques using coding (like grounded theory design) that can be replicated by computers using artificial intelligence (Bryant and Charmaz, 2019). When a researcher wants to understand the interaction behavior in social networks on the Internet, the content of web pages, online interviews, or blogs, obtained through application programming interfaces (APIs), he or she can resort to a netnographic design whose name is an acronym of "net" with "ethnography" (Jeacle, 2021). For example, two researchers set out to analyze insecurity in some Mexican cities through what was published in the digital press between 2010 and 2019 by collecting certain predominant terms in newspaper articles (Soto-Canales and Padilla-Herrera, 2023). Another interesting example is that carried out by Ceron et al. (2016) who have made ex ante electoral forecasts with an error level not far from the electoral trend polls, for which they employ sentiment analysis, text mining, big data, supervised machine learning and the use of algorithms to identify patterns and trends in hundreds of thousands of microblogs

published on Twitter. When you want to know what is most consumed in bibliographic terms, it is possible to apply a bibliometric design. This is the case of a study by Xu et al. (2021) who studied 1,044 documents published in Web of Science, but since it is almost impossible to read them all, they used artificial intelligence to identify the most outstanding characteristics of the literature on entrepreneurship and crises over 36 years. Data science can be very useful to study a wide range of behaviors such as marketing, biology, psychology, language, sociology, among others. The sample sizes in these cases have no limits, however, the designs depend on the strategies used to collect information, because once structured data are available, the analysis is performed according to statistical rules. Indeed, when databases are structured, many researchers prefer to declare that they have used the big data design which, apart from variety, speed, and veracity, is finally subject to statistical analysis.

3. Theoretical designs: When there are no general principles to explain the phenomena or when a reflection and adjustment of existing principles is required. Borsboom et al. (2004) proposed an interesting methodology for theory building. Although the designation as a specific design is proposed by the author, it is possible to include philosophical approaches in this design, since both focus on the analysis of fundamental postulates of a theory. Moreover, in both cases empirical evidence can be dispensed with. Theoretical design does not contain strict rules, since it is often dressed in essayistic styles, but what cannot be lacking are written assertions in the form of reasoning that, in the best of cases, can be identified as axiomatic propositions, or simply as hypotheses, theoretical propositions or logical inferences of one or several disciplines. Theoretical design formulates relevant concepts that explain how reality works. For example, cognitive theory, feminist theory, evolutionary theory, the standard model of particle physics, neoclassical microeconomics, and so on. The principles of these theories guide research and their validity will depend on their compatibility with empirical evidence; therefore, proposals of this nature are fundamental to guide the hypothetico-deductive methodology that will devise ways to test hypotheses (Bunge, 2005). Contrary evidence may lead to adjustments in the theory or to its discrediting. While it is true that theoretical designs are used to develop theories that explain reality, not all theoretical designs formulate relevant concepts that can be empirically verified. Some may be more focused on the elaboration of mathematical or logical models within a formal science that are not compatible with verification.

4. Bibliographic designs: When there is an abundant scientific production that needs to be synthesized to draw the most general conclusions, bibliographic designs are used. The bibliographic design is not carried out by means of direct empirical evidence, but its units of analysis are scientific publications (Petticrew and Roberts, 2008). If the way this review is conducted is neither methodical nor transparent, it is considered a traditional review (or non-systematic review). But if it is reliably identified by

establishing a time frame, inclusion and exclusion criteria, and a systematic search using strings or formulas and evaluations of the information collected are performed, it can be said to be a systematic or systematized review (Codina, 2018). For example, in the article 'Bibliographic review of control systems for micro-grid energy management' by Sampietro Saquicela and Pico-Valencia (2018) or the one conducted on studies of electoral forecasting through big data (Cabrera-Tenecela, 2021) or through surveys (Andrade-Bayona, 2021). Generally, systematic reviews are limited to describing this information; however, when the sample is considerable, more advanced statistical techniques can be used to explain what may be occurring with respect to a theory. This type of design is no longer known simply as a systematic review, but as a meta-analysis (sometimes both terms are used) (Codina, 2018). For example: Effect of the low-calorie ketogenic diet on body composition in overweight and obese adults: systematic review and meta-analysis (Díaz Muñoz et al., 2021). Note the similarity of this design to the bibliometric design described in data science.

5. Methodological designs: When existing methods are insufficient or when new procedures have been discovered to address a research problem, methodological designs are used, which can be found as innovative methodological design or research design with new methods. These designs involve a systematic and organized approach to gathering information and analyzing the data collected (Ezzy, 2002). Research designs guide the way in which information can be effectively obtained or processed. There are methodological designs as open-ended as the present case, as well as very specific designs that show step-by-step how to download information from Twitter APIs to process it through algorithms in the R programming language to finally provide a route to perform ex ante election forecasts without surveys (Ceron et al., 2016). Another example of methodological design could be to generate new software to select study samples attending to the statistical power of the tests to be used to contrast hypotheses (Faul et al., 2007). When it is not clear how to proceed, it is important to review a methodological design before committing to the objectives of a research study.

6. Instrumental designs²: When existing observation instruments are insufficient, artifacts, tests, questionnaires, observation sheets, etc. are created or adapted with the instrumental design (Carretero-Dios, 2007). This is used in both mechanical and behavioral processes in living beings (including humans). In the mechanical case applied to oral health, for example, both an engineer and a health researcher can test whether a 3D scanner is reliable, concordant, accurate and valid before using it for intraoral measurements, as shown in the study by Soto-Alvarez et al. Another example, two psychologists (Cosentino and Castro Solano, 2017), instead of focusing on pathological aspects want to focus on emotionally positive aspects of human

beings for which they have created a new instrument, the High Five Inventory, whose construct has been validated by confirmatory factor analysis (CFA) and internal consistency. But not only are tools being built, but they are also being adapted. For example, an adaptation of an instrument to assess metacognition in a cultural context different from the one originally proposed (Zhunio-Falcones and Cabrera-Tenecela, 2022). Another example is the reconfiguration and creation of a short version of a tool to measure work ethics that was originally extensive (Zúñiga et al., 2022). Statisticians usually classify CFA among explanatory designs; however, the goal of instrumental designs is not to explain the causes of things but to ensure the quality of the measurements. In these cases, it is advisable to have samples of at least 200 data or at least 10 observations for each question (item) to facilitate model fitting (Hair et al., 2010). When working with ordinal or categorical variables, there are often problems of multivariate normality, so there are estimation techniques such as robust maximum likelihood (MLR), unweighted least squares (ULS), diagonally weighted least squares (DWLS), among others, which use polychoric correlations and are available in free platforms such as R or Python. However, instead of using Cronbach's alpha, McDonald's omega can be used to verify internal concordance. The possibilities of this design are broad because, in addition to validating in a population, factorial invariance evaluations can be performed to verify if the instrument is not biased in any subgroup, as well as to compare with other instruments to test concurrent or discriminant validity. If the study is very new, it is advisable to start by designing a good instrument by means of an exploratory factor analysis (EFA), which will be discussed in one of the observational designs.

7. Observational designs: When the aim is to learn about behavior without manipulating reality, the observational design, also known as non-experimental, is used (Campbell and Stanley, 2015). If the information is collected on a single occasion, the design is known as cross-sectional, in which case the designs can be specified as exploratory, descriptive, relational, and explanatory. If the problem is new and there is little state of the art (or the researcher does not agree with the measures used in the state of the art), it is necessary to develop an exploratory design. For example, a researcher wanted to measure blended learning in higher education, but the variables to be assessed were not clear. He invented an instrument and tested it on a group of 413 teachers. In addition, he conducted an exploratory factor analysis (Anthony Jr., 2022). Exploratory designs should not be conceived for their level of difficulty because they require a great deal of creativity to understand the problem and devise solutions without sufficient information, for this reason, the exploration can be carried out with simple descriptive statistical models up to complex analytical models. The descriptive cross-sectional design is one of the most used designs to present its results in

² Instrumental design for validation and reliability, as in the present case, should not be confused with instrumental variables used to solve endogeneity problems.

percentages, measures of central tendency and variability without establishing probabilistic relationships between variables. An example can be the pathological description made by a group of researchers to the testes of 11 fatal cases of Covid-19 (Duarte-Neto et al., 2022). Another example is the description of genital tract infections in a group of women attending obstetric consultation (Loachamin, 2023). The samples in this design can be as small as the previous example to as large as the results of a national census. When the researcher has an acceptable sample (with a statistical power of at least 80%), relational hypotheses can be established. To carry out this process, a relational design, also known as a correlational design, is used. It is important to note that the term "relational" refers to the connection or association between variables, and should not be confused with the correlation coefficient, which is a specific measure of the relationship between two variables. Within the "relational design", a term that the author prefers to use, various statistical testing techniques can be used to make comparisons between groups and analyze the association between variables (correlation is just one of them). An example of this design is the one used by Kuru Alici and Ozturk Copur (2022) who measured anxiety and fear of Covid-19 in 234 undergraduate nursing students showing that these two variables were highly correlated. Up to this point, it is worth mentioning a characteristic of exploratory, descriptive, and relational observational designs: in their ultimate objectives they use independent variables because they are not concerned with measuring the dependence or causality of one variable on another. However, studies are often found that claim that their design is relational when they incur in causality, which, as will be seen below, may occur due to modesty, fear, or ignorance of explanatory designs.

When researchers attempt to model dependence on one or more independent variables, they refer to explanatory or causal designs (erroneously classified as correlational-causal). These designs usually make use of linear, ordinal or logistic regressions to establish the level of explanation of the independent variables with respect to the dependent variables. There is a wide variety of statistical models in this respect, such as multivariate regression, multivariate regression, multilevel analysis, confirmatory factor analysis, among others. One of the most useful is the use of structural equation modeling (SEM), which allows complex information to be modeled. A good example is the study by Kakemam et al. (2022) who determined how professionalism and systems thinking explain the safety competence of 358 nurses caring for Iranian patients. While it is true in their design, they modestly point out that their design is a cross-sectional survey (which would be a part of the design), statistically they cannot avoid writing the explanatory level of their model in terms of regression. An example opposite to the previous one, in which they use the name explanatory design without hesitation, indeed they combine it with the exploratory design, is that of Rajbhandari et al. (2022) who examined the relationship of some variables, including skilled labor, with respect to technological innovation, mediated by government

intervention, in 287 industries in Nepal. An important reflection before closing this section is that, although some philosophers of science, such as Pearl (2012), consider that observational methods serve to model causality, as is the case of those who point out that an SEM model infers the underlying causal relationships (and not only correlations), most researchers avoid using the name explanatory or causal design because they are aware that the level of control of an observational design is not always sufficient to provide a conclusive explanation, even more so when dealing with low predictive levels, common in the social sciences. For this reason, social scientists often state that their study is relational or correlational, however, when researchers seek to demonstrate causality, they can add more control through longitudinal designs.

Finally, within the observational designs is the longitudinal design. This is like the previous ones, but with a difference: there are several measurements over time to several samples over time, to different age groups or to the same sample on several occasions. When one wants to know the changes in a population by working with different time samples, the trend design is used. For example, a study conducted in Brazil at four points in time (waves) showed that fear of crime is positively associated with support for less democratic forms of government (Pereira and de Andrade Dornelles, 2021). When studies are conducted to know the evolution according to age, the cohort, group evolution or accelerated longitudinal design is used. An example of this is the study conducted on 2,278 children from 4 to 14 years of age, which showed that there is a significant relationship between sports participation and social competence (social skills), especially in late childhood and early adolescence (Bedard et al., 2020). Finally, when the same sample is evaluated over time, on the other hand, it is called a panel design. An example of such a study is the one conducted on 396 Filipino adolescents through a three-wave panel structural equation model, with which the researchers demonstrated the association between the valuation of happiness and positive affect (Datu et al., 2021). Longitudinal designs control error and bias better than cross-sectional designs, however, they tend to be more costly and time-consuming. While it is true that the models used tend to employ statistics like explanatory designs, they do not have the naming conflict.

8. Experimental designs: When the researcher intentionally manipulates variables to control the internal and external validity of his results, he employs the experimental design. For Campbell and Stanley (2015), if the researcher only has a group of participants in which the design intervenes, it can be called pre-experimental. Within this design the most common is the pre-test and post-test of a single group. For example, researchers at an institute of medical sciences tested a self-instruction module on parental drug administration in 50 nurses, achieving an increase from 64% (pre-test) to 88% (post-test) of appropriate practices. Pre-experimental designs are also considered to be those that apply only a post-test, this would be the case study with a single measurement or the comparison with a static group, in both cases, the control is

minimal because there is no pre-test, so it is impossible to evaluate the differences (Jaen et al., 2022).

When working with groups that were formed prior to the researcher's intervention, pre-testing and post-testing are performed, a quasi-experimental design is used. One of the most used quasi-experimental designs is when the pretest and posttest are used in an intervention group and in a control group, this is called a separate sample design in pretest and posttest in intact groups, which are also known as non-equivalent control groups (Cohen et al., 2017). For example, at one university they wanted to provide better mentoring to culturally and linguistically diverse students, for which they designed a blended program and compared mentoring competencies before and after the training to an intervened group of 49 students who received the training including an additional component and a non-intervened one of 62 students who only received the training (Oikarainen et al., 2022). Another quasi-experimental design is that of time series or time series that consists of making observations at different moments over time to the same study units, in which natural or artificial events can occur that can affect the behavior of the variables being evaluated every so often (daily, monthly, quarterly, etc.). A good example is the study by Chiatchoua et al. (2020) who studied some econometric indicators, including governmental economic intervention, before and after Covid-19 in Mexico, managed to calculate the effect of the pandemic on the economy as well as to propose a forecast with the ARIMA model. The design of the time series is debatable if it belongs to longitudinal studies, however, as it studies the impact that certain events have, they are regularly identified as quasi-experiments. Although less common, there is a quasi-experimental design with a separate pretest/posttest sample that compares a group that has been previously evaluated but not intervened with one that has been intervened and evaluated only afterwards. A study that is intended to be a pure experiment, but fails to meet the control, can be reduced to a quasi-experimental or pre-experimental study.

Finally, when a researcher randomly groups the samples to ensure that the groups evaluated are equivalent, the pure experiment is chosen. In this case, the most used experimental design is the two independent groups experimental design or also known as control group with pre- and post-test. For example, a study that tested a vaccine for Covid-19 worked with 450 individuals, convalescing from the disease, who were randomly assigned to two groups, one experimental (n=344) and one control (n=86) and was able to demonstrate that the dose applied safely reinforced the pre-existing natural immunity (Ochoa-Azce et al., 2022). Another interesting example was applied to online gamblers to assess their behaviors when betting on soccer or online roulette games, who were given a monetary endowment warning them that the excess would be for them. In this case the intervention group (n=254) received colored warnings about the safety of the game and the control group (n=252) did not receive such warnings. However, the protective effect of the safer play message was not tested (de Vries et al., 2022). Sometimes when the intervention is

educational in nature and students may be biased by receiving a pretest, two more groups (one intervention and one control) are added to the above design in which the pretest is not applied, but the posttest is retained in all of them, and is referred to as the Solomon design. An example of such a study was developed by Golaki et al. (2022) to test knowledge retention by employing the inverted classroom. For this purpose, four Solomon groups were randomly assigned, a pre-test was administered to an intervention group and a control group, and then all four groups received a follow-up post-test of knowledge retention. The intervention groups used the inverted class, and the control groups the conventional class, however, when evaluating the results two months after the treatment and comparing the results with the pre-test, as well as with the control, there was no significant increase in the test. There are other designs such as A-B-A-B that collect baseline information, implement the treatment, and evaluate its effects, and then re-evaluate the return to baseline by withdrawing the treatment and then reapplying it to measure the changes. Another design encountered is the factorial design, but it refers more to the statistical technique that can be used interchangeably in various designs. The samples of the experimental designs usually vary as they can be small as well as large, being advisable to identify the statistical power of at least 80% for the statistical tests that are intended to be performed.

9. Epidemiological designs: When you want to study public health behavior in a population, the epidemiological design is used. Different designs mentioned above can be used to describe or analyze reality. The most common designs in epidemiology are the prevalence design and the incidence design, which make it possible to examine the frequency of a disease in a population at a given time or during a given period. In addition, epidemiology also employs other specific designs that are not commonly used in other fields, which are relevant and deserve to be mentioned in this section. If the researcher has access to information that summarizes the behavior of one or more populations (and cannot directly access data from individuals), he or she can make use of the ecological (sometimes also called cluster) design (Cataldo et al., 2019). For example, one researcher conducted an analysis of Covid-19 mortality in 30 countries by taking data from the Our World in Data organization from the time the first case appeared until two years later and demonstrated the impact that vaccination had had on reducing such mortality (L. M. Cabrera-Tenecela and Macancela-Sacoto, 2022). When there is direct information on individuals (whether retrospective or prospective) and it is desired to compare those who present a disease with those who do not, the case-control design is used. This design uses a type of categorical statistic to separate those who present certain health conditions (with which the level of risk posed by certain characteristics can be studied) from those who do not present those health conditions. For example, a study on risk factors for child pregnancy conducted among 180 adolescents showed that those who were victims of domestic violence were 6 times more likely to become pregnant than

those who had not been victims (Castañeda Paredes and Santa-Cruz-Espinoza, 2021). Another example may be the comparison of dopamine production between cannabis-using students and non-using students (Acuff et al., 2023). These types of studies are not limited to presenting the results in a descriptive way, but often use biostatistics to model the information using bivariate or multivariate inferential techniques.

10. Historical designs: When seeking to investigate past events and write or rewrite history, use is made of historical design, which is based on the analysis of secondary sources and primary documents (Bloch, 2018). Bloch suggested that historian must involve other disciplines but that the historian's interpretation is fundamental. This interpretation can be flexible and open according to the principles of hermeneutics, or it can be rigorous and logical, even statistical-inferential, depending on the approach taken by the historian. For example, the work of Vásquez Ruiz (2014) is an interpretive study that analyzes the uprising that occurred in 1932 in El Salvador. Although the black legend had been spread that radical communists were responsible, the author reviews the contribution of other groups in that anti-government rebellion. Another example is the work of Carretero Poblete and Samaniego Erazo (2017), which is based on primary archaeological sources to explain the Puruhá culture's trade relations with the Cañari and the Coast through the careful analysis of 2,198 pieces, including ceramics, lithics and bones belonging to the late Late Formative phases of the Ecuadorian Central Highlands. This study could be considered an archaeological design. Another historical design is the documentary design, which involves the analysis of past records. Although these historical designs are not well known, those who engage in them agree that a triangulation of different sources and the comparison of multiple perspectives are required to approach the validity and reliability of the results.

11. Case designs: When one wants to offer a detailed and exhaustive analysis of one or some cases with the aim of understanding a fact, event or problem, the case design, case study, or case study is used (Cohen et al., 2017). Popov et al. (2019) made a study of four canine patients in the recovery of bone defects after resection of osteosarcomas, in their study they provide a detailed review of the process employed by them to conclude that all operated animals began to actively use their restored limbs and showed good functional results. According to Yin (2017) case studies are like experimental studies in that they argue how it was done and why it was done, unlike observational studies where it is difficult if not impossible to answer. While case studies tend to have small samples, this is due to their in-depth and comprehensive approach to a specific case, which allows for a detailed and contextualized understanding of the event under study. Through rigorous and systematic analysis, case studies seek to provide solid evidence that, through broader studies, can be made generalizable.

12. Mixed designs: When the researcher considers that the hypothetico-deductive method or the interpretative method is insufficient and assumes that in the combination of the two there is a better solution to his problem, then he

opts for the mixed design. These designs have the possibility of combining all the designs they consider pertinent, and can be exploratory, descriptive, relational or explanatory. Let us consider an example. A study related to adherence to antiretroviral treatment in 86 women with HIV used a mixed quantitative and qualitative method. This study started with an explanatory design in which they contrasted variables such as age, educational level, and income to explain adherence to treatment. They then used the phenomenological (qualitative) design, only in women who did not adhere to treatment to find out why they did not adhere. If the researcher employs one design in order to then employ the other, as in the present case, the design is sequential, it is clear that the first design is an explanatory one and the second is a phenomenological one, in which case, the name usually given is sequential explanatory mixed. Let us look at another example in which neither method depends on the other to exist, i.e., the application of one design or the other is independent. In a poor urban district, several methods were combined to promote health literacy, empowerment, citizen participation and intersectoral collaboration. To this end, de Jong et al. (2019) provided evidence regarding the application of health literacy questionnaires, documentary, and photographic analysis, as well as, interviews, to answer four research questions. As the qualitative design work independently, this design could be called concurrent mixed action research-action research, while other authors would prefer to call it concurrent transformative mixed, however, the authors of the cited article have preferred to call it action research-guided mixed methods. There are also authors who would call the first example QUAN-which, due to the importance of the quantitative method, while the second would call it QUAL-which, also due to the importance of the qualitative method. However, in view of the very wide possibilities of naming a design, and the impractical options offered by methodologists, it is preferable to indicate whether the design is mixed sequential or concurrent and then, as in our second example, to mention the designs traditionally used, as this would offer greater precision to the reader.

DISCUSSION

The qualitative approach provides a solid basis for the organization of research designs, as its flexibility allows for a more accessible methodological understanding. As constraints and levels of complexity are added to designs, a gradual increase in the quantitative approach can be seen. While it is true that qualitative designs require experience and disciplinary training (designs are minimalist and flexible and gradually adapt to the context according to Bisquerra Alzina et al., 2019), their ability to make decisions in a flexible manner is remarkable and contrasts with the rigidity inherent in the quantitative approach. The adoption of this initial organization based on the qualitative approach improves the overall understanding of research designs,

allowing a more effective approach to methodological aspects. This order has not been considered by Hernández Sampieri or by the other methodologists mentioned above.

Interesting techniques have emerged from these designs, which today can be worked on by means of data science. On the other hand, although it is true that theoretical and philosophical designs are characterized only by stating the principles guiding the research, and their validity depends on their compatibility with empirical evidence, bibliographic studies are a channel for verifying whether the hypotheses derived from these theories are plausible, as Popper would say. However, even though Bryman, Cohen et al. (2017) and Hernández-Sampieri et al. (2014) make suggestions on how to structure theoretical frameworks and states of the art, they do not recognize that research designs of this nature exist, as has been done in the present case. This aspect has been worked on by Borsboom et al. (2004) who suggest the use of certain rules to design theories to guide research and scientific practice. Of course, the structuring of theories is a problem widely studied by epistemology (Popper, 2008; Popper et al., 2008), a branch of philosophy that discusses the importance of the structuring of theories and how it relates to the acquisition of scientific knowledge.

Authors who have published the most influential recent works in research methodology, in terms of citations, cannot ignore the important work of Campbell and Stanley (1963), who published experimental and quasi-experimental designs in social research. These authors present a range of research designs that allow causal relationships to be established and address the challenges of conducting experiments in uncontrolled settings. The authors discuss key concepts, such as randomization, control of extraneous variables, and internal and external validity, that are fundamental to establishing reliable conclusions in empirical research.

It is interesting to note that historical designs are not widely mentioned in the most cited works. Although history and archaeology are disciplines with very particular methods, it is increasingly evident that, through interdisciplinary approaches, these should be considered and included in classifications of research designs in science in general. Historical research provides a unique perspective to the study of past events and their influence on the present, which can enrich and complement other forms of research. It is important to foster a broader dialogue and recognition of historical designs within the scientific community to embrace the diversity of methodological approaches more fully to research.

Finally, regarding mixed designs, Hernández-Sampieri summarizes the ideas of Creswell and Creswell (2017) to mention eight research designs. However, when looking for examples, there is no such abundance of designs. Most researchers prefer to note whether it is a concurrent or sequential design. In the face of the great confusion that may be involved in combining research designs such as those proposed by the above researchers, to avoid ambiguous or subjective labels, it is preferable to specify whether the design is sequential or concurrent and then mention which

designs stand out or are equivalently combined. In any case, the choice of mixed design should be guided by the specific needs of the study. Whatever the designation used, it is essential that investigators provide a clear and detailed description of the methods used in the mixed design. This will ensure methodological transparency and allow readers to assess the validity and reliability of the results.

One of the most revealing findings of this study is the tendency of many researchers to confuse data collection or analysis techniques and instruments with the research designs themselves. For example, the structured questionnaire design (instrument) or the confirmatory factor analysis design (statistical technique) are mentioned as if they were designs in themselves. In the context of methodological design studies, it is crucial to address this aspect, otherwise any resource could be misinterpreted as a research design. To avoid this confusion, it is essential to understand that tools and statistics are tools that are at the service of research designs, not the other way around. Each research project should make clear the scope and limitations, emphasizing the importance of using techniques and instruments appropriately within a sound research design.

Finally, it is important to reiterate the importance of organizing and classifying research designs, since, at the time of publication, journal editors, guided by systems such as APA or Vancouver, seek to be as clear as possible about the method adopted by the researcher. In this sense, a methodology that does not contain research designs would only reflect epistemologically on the approach adopted or confuse it with logistical elements of the research, such as tools or techniques for information analysis.

Limitation. This study offers an approach to research designs, but it is important to emphasize that it is not intended to be exhaustive in its coverage. Rather, it is presented as an overview of the most consulted methodological sources, especially in the social sciences. In the future, it would be advisable to develop an interconnected structure of research designs, employing a broader coding process that considers the specific purposes of each, particularly as they relate to the health sciences. In this way, a fuller and deeper understanding of the different approaches and methodological designs used in research could be achieved.

CONCLUSION

This article has presented various research designs grouped into 12 categories, showing the wide range of approaches used by researchers in the social sciences and health sciences. These designs go beyond mere observation and experimentation, including also theoretical, bibliographical, and instrumental study.

An original contribution of this proposal is the didactic organization of designs from the most flexible to the least

flexible up to eight levels, an approach that has not been previously explored in the methodological literature. It is essential that researchers become familiar with these different designs and understand their applications and limitations. Choosing the appropriate design is crucial to effectively address research problems and obtain valid and reliable results.

It is also important to emphasize the need to provide a clear description of the techniques used in each design, avoiding confusion between the tools and statistics employed. It should be recognized that these statistical tools and methods are at the service of the research designs, and not the other way around.

In short, this study highlights the importance of understanding and applying the various research designs available, considering their characteristics, scope and limitations. This understanding will enable researchers to address their research questions and contribute to the advancement of knowledge in their respective disciplines more effectively.

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