Review Article

A Model for the Taxonomy of Research Studies: A Practical Guide to Knowledge Production and Knowledge Management

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Abstract

Context: Due to the increasing research information, knowledge production, development of information technology, and its impact on access to knowledge, the taxonomy of knowledge and information is necessary to manage and use them in the development of science.

Evidence Acquisition: The purpose of this study was to provide a complete model that could achieve the objectives of taxonomy in research. For this purpose, after a critical review of existing taxonomies, criteria were developed based on which a complete and practical taxonomy was presented. After reviewing and analyzing different categorizations of research in different fields of medicine, social sciences, and education, research designs were divided into explicative research, psychometric research, descriptive research, exploratory research, explanatory research, theory research, translational research, synthetic research, prescriptive research, implementation research, and evaluative research.

Conclusions: In the next step, the relationship between them was determined based on their cognitive position and their position in the development of knowledge.

Keywords: Research Taxonomy, Inquiry Model, Research Methodology, Research Design Category, Research Classification

1. Context

Due to the increasing research information, knowledge production, development of information technology, and its impact on access to knowledge, the taxonomy of knowledge and information is necessary to manage and use them in the development of science (1). According to Lambe (2007), taxonomy is the structured names and definitions used to organize information and knowledge. Taxonomy can make the knowledge found in documents and texts clear and usable (1).

Taxonomies are the fundamental components of information architecture, which is why many organizations today use taxonomies for knowledge management. On a larger scale, in scientific fields where knowledge production is highly dependent on the organization of complex information, such as medicine, taxonomy is an important tool for knowledge management (2).

In addition to the points made about the taxonomy of research, we should consider Dewey's definition of knowledge, which defines knowledge as the result and product of research, and defines science as competent research that can lead to credible claims and ultimately lead to the devel-

opment of a theory that is supported by relevant evidence (3). Considering the above, the importance of taxonomy in research can be summarized as follows:

Researchers can use the taxonomy to find their own way to find scientific solutions to their research questions. Scientists could be able to critique and analyze scientific studies and observations using the principles and frameworks formed in the form of taxonomies. Moreover, the position of the knowledge products of each type of research study in the evolutionary path of inquiry could be determined by knowledge management systems. To present a complete and appropriate model, it is necessary to consider the mentioned goals. In other words, a model can be a practical and comprehensive taxonomy that can achieve these goals. For this purpose, criteria were considered according to which the appropriateness of taxonomy with the goals can be objectively evaluated. In addition, it is necessary to critique the existing models according to the criteria so that the proposed model has the least defects.

The formulation of appropriate criteria can be done through an analytical comparison of existing taxonomies with the mentioned goals for taxonomies and an analytical comparison of taxonomies with each other. Therefore,

first, a comprehensive review of complete taxonomies was performed, and then the criteria were developed. After analyzing the existing taxonomies based on the criteria, a new model for research taxonomy was formed.

2. Evidence Acquisition

To find relevant literature, Google, Google Scholar, PubMed, and Scopus were searched for books and articles that categorized research methods. In this process, the classifications of all research in the fields of behavioral sciences, social sciences, education, and medicine were considered and finally, the models that had presented complete taxonomies in different fields of research were included. Complete taxonomy means that the classification of research designs is not limited to one paradigm or one approach and its purpose is to fully cover research methods and designs; therefore, for the selection of models, classifications that cover only part of research studies were not included in the study and only were studies included that aimed to provide a taxonomy for all research designs.

In this paper, the theory synthesis method based on the model presented by Walker & Avante (4). was used to create a new model. The method was that, first, the concepts in each of the mentioned models were extracted and then the methodological approaches related to each of these concepts were searched separately. These concepts were classified into methodological groups. This classification was performed by a combination of experts in the fields of philosophy of science, epistemology of research, and epistemological psychology. To present the final model, it was necessary to create two types of relationships; one is the relationship between epistemological concepts and knowledge output in each group, and the second is the relationship between knowledge outputs of different groups to achieve the knowledge development model. In the end, the final model was presented in a way that has the following features:

(1) It is comprehensive in terms of epistemology.

(2) The relationship between epistemology, methodology, and knowledge output is specified in each methodological group.

(3) The relationship between the knowledge produced in different groups is explained in the form of the path to achieving the goals of knowledge development by research.

2.1. Article Structure

In this review, the following sections are considered to introduce the better stages of the model:

(1) Review of existing models

(2) Criteria for presenting a new model

(3) Introduction of the new model

2.1.1. Review of Existing Models

In this section, seven models whose approaches are to classify all research methods are briefly introduced and critiqued. Other classifications not introduced in this section have similar approaches to one of these taxonomies.

Della Porta and Keating (2008) (5): In this book, two forms of taxonomy are observed. One is the classification of research designs and the other is the conceptual framework of socio-political research. The classification of the types of research designs includes concept formation, comparative analysis, case study, and qualitative analysis.

The second taxonomy is based on designing a research project in the form of a conceptual model with operational sequencing, which is as follows: Selecting a topic, conceptualizing, formation of hypotheses, selecting cases, operationalization of variables, measurement, testing for associations, and causal inference.

Gall et al. (2003) (6): This model first refers to four types of knowledge produced in research, which includes description, prediction, improvement, and explanation.

Creswell (7): What Creswell presents as a classification for research studies is as follows:

- Experimental designs
- Correlational designs
- Survey designs
- Grounded theory designs
- Ethnographic designs
- Narrative research designs
- Mixed methods designs
- Action research designs

Gray (2014) (8): In the taxonomy presented by Gray, there are two types of research classification: Research classification based on methodology and classification based on purpose. In the classification based on research methodology, they are divided into the following groups: Experimental and quasi-experimental research, Phenomenology research, Analytical surveys, Action research, Heuristic inquiry.

In the categorization of research according to purpose, there are four groups of inquiry, which include exploratory studies, descriptive studies, explanatory studies, and interpretive studies.

Ringsted et al. (9): In her taxonomy, used the approaches of Campbell et al. and Cook et al. (10, 11) and various books and articles in the field of medicine and medical education to develop her model. At the heart of the model is the conceptual theoretical framework that is the core of

any study and the basis of all research approaches. The cycle around the core includes four general categories of research, each related to different research objectives.

(1) Exploratory Studies: The first category is exploratory studies that aim at modeling by discovering and identifying the elements of a phenomenon and explaining the relationships between them.

(2) Experimental Studies: Justifying has been cited as the main goal of experimental studies.

(3) Observational Studies: The purpose of observational studies is to predict the consequences.

(4) Translational Studies: Translational studies focus on the implementation of knowledge.

In the taxonomy of Edmonds and Kennedy (12), the inquiry is defined at four levels: Method, research, approach or perspective, and design.

In this classification, methods are divided into three groups: Quantitative, qualitative, and mixed-method, each of which is divided into different sub-branches based on the type of research, approach, and design.

Jalil and Marczyk et al. (13, 14): According to the definition provided by Mohammad Jalil , the research design is the logical structure of research. Research design determines what type of data is needed from what population and how it can answer the research question. The research method refers to the style and method of data collection, such as quantitative, qualitative, or mixed-method. In this article, Jalil first presents a categorization of different research designs and then discusses the role of each type of design in the field of causality. According to the author, the purpose of all research studies is to map and predict the situation in terms of corrective interventions and non-interventions, so that by comparing them with each other, the impact of interventions can be understood. The taxonomy proposed by Marczyk et al. (14) is structurally similar to Jalil's taxonomy.

Stern et al. (15): Stern et al.'s 2012 report is in the field of evaluation, which examines a variety of designs and methods in this field. According to this report, the research design is the logic behind how research is conducted. According to King, Keohane, and Verba (1994), four main components are considered for design: Research question, theory, data, and how to use the data.

The classification performed for different types of designs includes a general division into which specific designs fall. These general categories are:

(1) Experimental studies

(2) Theory-based evaluations (TBE)

(3) Case studies

Shortcomings in existing taxonomies that make it necessary to present a new model can be summarized as follows:

(1) Taxonomies are not based on the relationship between epistemology and research methodology. For this reason, the role of different methodologies in knowledge development is not clear.

(2) Based on the features mentioned in the existing taxonomies, it is not possible to critique research from a methodological point of view. Therefore, these taxonomies cannot play a significant role in the evaluation of research studies.

Currently, research studies are critiqued based on the method of the study, not epistemological and methodological approaches.

(3) Taxonomies have largely failed to take a meta-paradigmatic approach in their classifications, and those with a meta-paradigmatic approach have failed to maintain their comprehensiveness.

2.1.2. Criteria for Presenting a New Model

What can be seen by studying different taxonomies is that there is no single approach in them and there are fundamental differences between different taxonomies. In the analysis of existing taxonomies, three factors were identified as the main causes of the difference, as follows.

The criteria for classifying research are different. Various definitions of research approach, epistemology, methodology, and design are provided. None of the taxonomies are comprehensive, meaning that almost all of them have neglected part of the path to achieving knowledge development goals.

Based on the primary comparative analysis of existing models, the following criteria were formed to define an appropriate taxonomy. These criteria have targeted various aspects of taxonomy completeness and applicability. Therefore, the presentation of the new model was done in a way that could fulfill the criteria.

(1) Transparency of the criterion for classifying research studies; that is, studies are classified according to epistemological, methodological characteristics, or the type of knowledge produced.

(2) Observe leveling in taxonomic presentation. Research is defined at different levels: Paradigm, epistemology, methodology, research design, research method, and so on. Leveling in a taxonomy means that, first, the desired levels of taxonomy are defined; secondly, the classification at each level is done separately, and third, the lower-level classifications are a subset of the higher levels.

(3) Exhaustiveness and mutual exclusiveness at each level of classification. Comprehensiveness means that at each level of classification, all the groups that define that level are included. Mutual exclusiveness means that one type of research design cannot be categorized into more than one group.

(4) Knowledge output of all types of studies should follow the desired taxonomy, so that the degree of achievement of reality in each research and the position of each type of research in achieving different goals of knowledge acquisition and knowledge management could be assessed.

2.1.3. Introduction of the New Model

In the proposed taxonomy in this article, an attempt has been made to determine the place of various research in the evolution of knowledge in addition to the mentioned criteria (Figure 1). Defining this position helps researchers to have a more accurate and practical view of different types of research studies.

2.1.3.1. Explicative Research

Research is called explicative when its main focus is on identifying the factors that play a role in the formation of a phenomenon or determine that phenomenon. This type of research is used to deepen knowledge in the field of reality because its purpose is to explicate why phenomena are formed. For more examples of explication, we can refer to concept derivation, clarification of characteristics (attributes), and synthesis of concepts (concept synthesis) (4, 16-18).

2.1.3.2. Psychometric Research

Psychometrics is mainly used to assess the state of education, learning, and mental abilities, and psychometric studies are performed to create and evaluate psychometric tools. In general, it can be said that the place of psychometric studies in research is to create measurement tools (such as questionnaires) and evaluate the validity and reliability of tools (19, 20).

2.1.3.3. Descriptive Research

Descriptive research is a type of research that aims to describe the characteristics of a population or phenomenon. These studies can be quantitative or qualitative. Descriptive studies do not answer questions about why and how phenomena or characteristics are addressed, nor do they address causal relationships, but rather questions about what are the characteristics of the population or situation being studied.

Quantitative descriptive studies with two indicators "average" and "percentage" (ratio) describe the selected characteristics of the population. These assessments can be cross-sectional or longitudinal and can be performed in one or more populations. Multi-population studies can be used to compare populations. Qualitative descriptive research describes a phenomenon without using statistical measurements (21, 22).

2.1.3.4. Exploratory Research

If we want to give a place to descriptive studies in the development of knowledge, we can say that their results can be used to discover some potential connections between phenomena and factors related to phenomena. In other words, the best descriptive studies are studies whose output is used as input to exploratory studies.

In this taxonomy, a group of research and models of inquiry are placed in the exploratory group, the aim of which is to discover the connections between concepts, components of phenomena, and phenomena with each other. These connections may or may not have a causal aspect. Therefore, what presenting as the output of these studies is the causal hypothesis (23, 24).

Exploratory research is divided into two groups: Quantitative exploratory studies and qualitative exploratory studies. Quantitative exploratory studies use statistical methods to obtain potential factors influencing phenomena (25, 26). According to the proposed definition, the most important methods of qualitative research (such as thematic content analysis, ethnography, grounded theory, phenomenology) are subject to qualitative exploratory research, as they lead to the production of hypotheses (27-36).

2.1.3.5. Explanatory Research

Explanatory studies focus on why questions. Explanatory studies are the analysis of the causal relationship between hypothetic factors and the phenomenon in question. These studies can compare the possible causes of a phenomenon and determine the best causal explanation for the phenomenon. These causal relationships can be explained quite simply or as a causal chain (37, 38).

Explanatory research is divided into observational, interventional, and modeling groups. In interventional explanatory research, the researcher intervenes on a population to examine the causal relationships between factors or phenomena (39, 40). In observational studies, the researcher collects and analyzes data without interfering with the course of phenomena (41, 42).

Modeling refers to a type of research that creates new causal chains through the integration of mechanism knowledge and provides a more complex model of causal relationships between concepts. This pattern is formed between concrete concepts and creates predictive power in different situations for the same concepts (43, 44).

2.1.3.6. Theory Research

The theory is defined as propositions that are logically related to each other to explain and predict a group of phenomena (which are grouped by the properties defined in
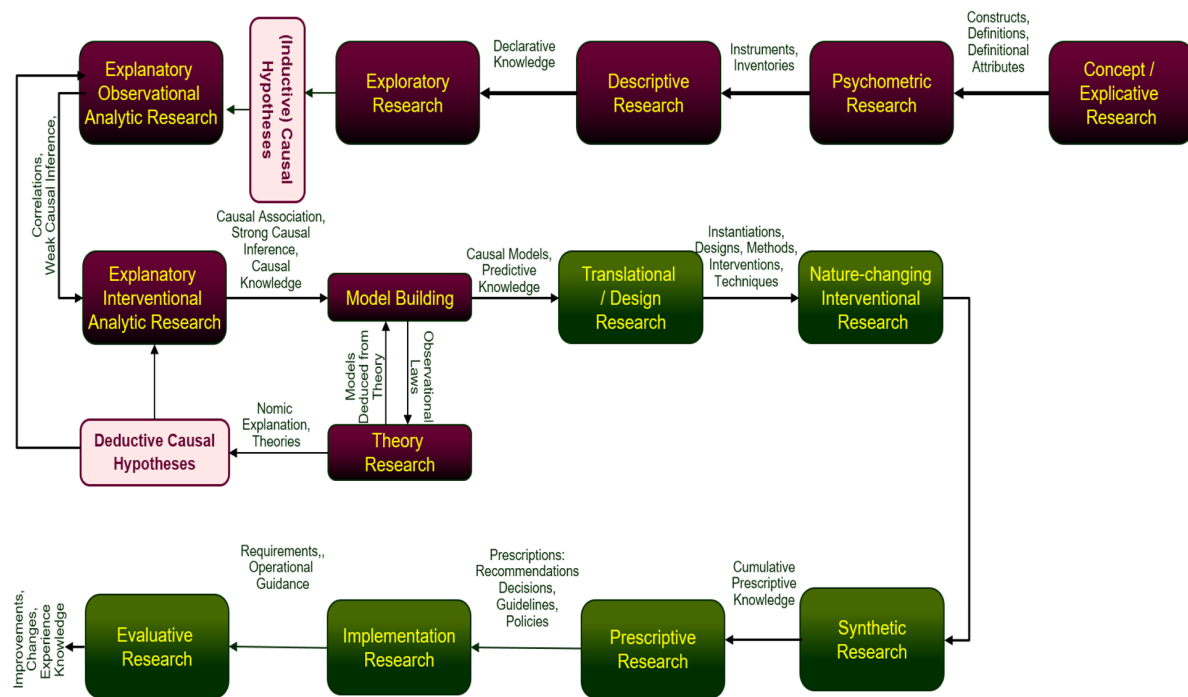
Figure 1. Relationship between types of research designs. In this figure, knowledge output is shown as the main link between various types of research in the form of cognitive development and knowledge development process.

the theory). The theory is used to systematize knowledge, explain, predict, and create new hypotheses (45).

In his study, Carpiano and Daley also identified the difference between conceptual framework and theory in that the conceptual framework identifies a group of variables that cause the phenomenon and does not explain the occurrence of consequences, whereas a theory in addition to causal explanation also includes the direction of the phenomena, their associations, and their logical connections, and leads to the production of new hypotheses (45).

The difference between a model and a theory from Carpiano and Daley's point of view is that the model focuses on more limited variables and assumptions. A model can also be connected to different theories to analyze a particular problem.

According to Beshers, a causal model is the expression of lawful connections between events (46). Therefore, the creation of rules can be considered as the main output of a theory.

2.1.3.7. Translational Research

This type of research in the field of health and medicine is defined as research that uses the results of basic science research and clinical research to improve health out-

comes (47-49). From the perspective of researchers in this field, translational research includes the conversion of basic science research into clinical knowledge and the conversion of clinical knowledge into guidelines that promote the health of individuals in the community or patients.

2.1.3.8. Synthetic Research

Synthetic research is research that results from the aggregation of the results of two or more studies. In synthetic research, analyses are not performed directly on individuals and instead are performed on the results obtained from other studies. The purpose of synthetic studies is usually to arrive at a summary of the results of studies that have worked on a similar subject. Synthetic research can be done on quantitative or qualitative studies. Synthetic research can be divided into three groups based on the type of input studies: Synthesis of quantitative studies, synthesis of qualitative studies, and review studies, independent of the type of primary studies (Table 1) (50).

2.1.3.9. Prescriptive Research

The most important process in prescriptive research is option appraisal. Option appraisal is defined in the literature as a technique for setting goals, reviewing goal-related options, and analyzing their relative benefits (51).

Therefore, it can be said that prescriptive research refers to a type of inquiry in which alternative solutions to a problem or alternative decisions in a decision-making process are criticized and compared with scientific methods. The most important place of prescriptive research is in the decision-making process, but from an epistemological point of view, it can be considered as the main path of critical thinking.

The goals of this type of inquiry can be divided into three groups:

(1) Decision-making

(2) Scientific judgment of options without making a decision

(3) Criticism of decisions made

Therefore, studies in this field should also have the following characteristics:

(4) The existence of a specific problem

(5) Existence of contextual conditions in which the problem is defined

(6) There is more than one solution to solve the problem

(7) The existence of criteria by which alternative solutions are valued

(8) Ability to compare solutions based on any of the criteria

2.1.3.10. Implementation Research

Implementation research is a type of scientific inquiry that answers important questions about the implementation of policies, programs, and decisions. Implementation research can cover all aspects of implementation, including factors influencing implementation, implementation processes and results, how to provide solutions to implementation problems, how to improve processes and implementation consequences, and their sustainability. The main purpose of implementation research is to understand why and how interventions affect the real situation and its reasons and test their promotional approaches (52).

2.1.3.11. Evaluative Research

Evaluation is a systematic process that leads to the production of a reliable conclusion from the orientation and implementation of the program. The reasons for the conclusion are also analyzed in the evaluation. Evaluation can answer these questions: What has been done? why? for whom? how? what are the consequences, and should they be measured, and what do the consequences mean? (53)

3. Conclusions

One of the important features of the proposed classification is that the knowledge and cognitive outputs of each type of research can be used as input of another type. This feature makes the existing taxonomy, in addition to the epistemological and methodological division of research designs, also determine their place in the development of knowledge and knowledge management, which is a unique feature of this taxonomy.

Footnotes

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Table 1. Categorization of Different Research Designs Based on Methodological Groups. In These Examples of Research Design for the Introduced Methodological Groups Are Identified.

Concept Research	Examples
Explicative research	Concept mapping (William Trochim)
	Concept analysis
	Concept derivation
	Concept synthesis
Psychometric research	Instrument development
	Instrument validation
Descriptive research	
Quantitative descriptive research	Simple descriptive research
	Quantitative comparative study
	Case series
Descriptive research	
Qualitative descriptive research	Survey research
	Case study
	Qualitative comparative study
Exploratory research	
Quantitative exploratory research	Ecologic research
	Cross-sectional correlational research
	Exploratory case-control
Exploratory research	
Qualitative research	Thematic content analysis
	Ethnography
	Grounded theory
	Phenomenology
	Framework analysis
Mixed-method exploratory research	
Observational explanatory research	Cohort study
	Case-control study
	Cross-sectional analytic study
Interventional exploratory research	
Experimental research	Randomized controlled trials
	Field trials
	Community trials
	Factorial design
	Randomized block design
	Covariance design
	Solomon four group design
	Switching replication experimental design
Interventional exploratory research	
Quasi-experimental research	Single-group pre-post-test design
	Non-equivalent group design
	Nonequivalent multiple levels design
	Regression-discontinuity design
	Proxy pretest design
	Separate pre-post samples design
	Double pretest design
	Switching replication design
	Nonequivalent dependent variables design
	The pattern matching NEDV design

	Regression point displacement design
	Interrupted time series design
	Controlled time series design
	Multiple time series design
	Repeated intervention design
	Alternate treatment design
	Counterbalanced design

Interventional exploratory research

Non-experimental research	Single-group post-test-only design

Synthetic research

	Systematized review
	Systematic review
Synthesis of quantitative literature	Meta-analysis
	Educational practice guideline
	Educational technology assessment

Synthetic research

	Critical interpretative synthesis
	Meta-ethnography
Synthesis of qualitative literature	Meta-synthesis
	Meta-narratives
	Framework synthesis
	Ecological triangulation

Synthetic research

	Critical review
Non-synthetic reviews	Umbrella review
	Scoping review
	State of the art review

Implementation research

	Awareness study
	Attitude to change research
	Adherence study/compliance
	Feasibility study
	Accessibility/acceptability study
Implementability research	Stakeholder analysis
	Political analysis
	Fidelity study
	Appropriateness research
	Costing study
	Sustainability study

Implementation research

	Development of operational guidelines/standards
Implementation guidance research	Intervention mapping
	Implementation mapping
	Program evaluation/accreditation
Evaluation/goal attainment research	Institutional evaluation/accreditation
	System evaluation