

Styles of research in ergonomics¹

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Abstract

The paper develops a framework for classification of scientific research styles based on ontological and epistemological assumptions of researchers and on approaches to generate knowledge in the field of ergonomics. Articles sampled from four scientific journals are classified according to the framework and the aspects of ergonomics covered. A positivistic style of research, focusing on physical aspects, dominates. The concluding section calls for broader research perspectives in ergonomics to make it possible to cover all aspects of ergonomics in a better way.

Keywords: Scientific perspective, research style, literature review, ergonomics research

1. Introduction

The paper analyses the way researchers in the field of ergonomics approach their research questions, develop and present their results. Some researchers discuss this topic with references to paradigmatic differences within the scientific community, while others discuss scientific perspectives and styles (Kuhn 1970; Denzin and Lincoln 1994a; Guba and Lincoln 1994).

These differences refer to the way researchers view the world and the possibilities to gain knowledge about it, issues related to ontology and epistemology. The researchers' general approach to get new knowledge and how they design the research projects used in the knowledge creation process are other aspect that need to be discussed. This refers to methodology, methods and techniques.

The aims of the paper are two. The first aim is to develop a framework that could be used to define different paradigms or perspectives. The second aim is to utilize this framework in an analysis of ergonomics research as it is presented in leading scientific journals.

The next section of the paper discusses ontology, epistemology, methodology and methods in general terms. Section 3 presents a tentative framework for classification of the research styles of research. Section 4 presents an empirical (pilot) study of some research articles published in two ergonomics specialized and two ergonomics related journals. The concluding section discusses the results of the analysis of these articles.

This paper is based on a small pre-study made to prepare for a more thorough analysis of ergonomics research. The empirical base is, therefore, limited and all results are preliminary.

2. Styles of research in ergonomics

The styles of research are defined by the view of the researchers on ontological, epistemological, methodological matters and on the design of individual research project. The concepts are shortly introduced in the following paragraphs. In section 3 the concepts are used in a tentative framework for classifying different scientific perspectives or styles.

2.1. Ontology and epistemology

Ontology is about our view of the world. Researchers need concepts and ideas how to categorize phenomena and processes if they are to present a comprehensive description and explanation of (a part of) reality. Ontology is about the essence of things and the essence of being,

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about our assumptions about what is real and not real. These are matters presumed in every scientific theory. Without such assumptions we can not relate to knowledge.

The theory of knowledge, epistemology, studies the fundamental questions about the nature of knowledge, the type of matter that we as humans are able to have knowledge about, and which the sources of such knowledge are. Are we able to have knowledge about an objectively existing reality or could we only rely on our (subjective) experiences? Is our senses the only sources of knowledge or are there also other sources of knowledge?

Our assumptions about ontology and epistemology are related. If we see the world as something that exists without our intervention, we also accept the possibilities to gain knowledge about that world with the help of our senses. If we see the world as something that we are taking part of creating, we tend to look for knowledge from the point of view of subjectivism and social constructivism. The first position is related to realism and empirism. The claims are then that there exist a world out there, irrespective of if we are conscious about it or not, and that we gain knowledge about that world through the use of our senses. The second position is based on a rationalistic tradition that claims that our ability to rational thinking is the source of knowledge.

Daniellou discusses epistemological issues in the field of ergonomics (Daniellou 2001). His conclusions are that there exist no undisputed view among researchers about scientific norms and procedures. The different views partly depend on the type of issues discussed. He distinguishes four levels of description in the field: the biological, cognitive, psychological and the social level. There exist models of man at each level and the theory of knowledge is not necessarily the same at different levels and for the different models of man.

2.2. Methodology, study design and methods

Methodology is about the ways researchers plan, organize and perform the research act. Methodology is not instructions given in a book on research methods, but it refers to more generalized ways of characterizing research activities.

There are many possible ways to classify the way researchers do their work. Some distinctions made are between the roles of the researchers, as an observer and as an active participant, between deductive and inductive, between quantitative and qualitative approaches (Denzin 1975; Denzin and Lincoln 1994a; Miles and Hyberman 1994), and between a tradition of nomological research, searching for general laws, and a hermeneutic tradition, aiming for interpretation and understanding (Alvesson and Sköldberg 1994).

3. A tentative framework for classifying scientific perspectives

It is not easy to make a comprehensive classification of different modes of research. The proposed framework is not the only possible one and researchers sometimes combine different modes and perspectives according to the complexity of a research question. A combination of approaches is sometime preferred.

It would be a mistake to simplify too much. A classification scheme that divides research activities according to the type of data used e.g. qualitative and quantitative data, is relevant but not enough. A qualitative approach, and case studies are often considered as a part of such an approach, allows for both a postpositivistic and a constructivistic perspective, even if case studies seldom are used by researchers with a positivistic perspective. However, Eisenhardt concludes that her propositions how to use cases in theory building after all build on a positivistic perspective (Eisenhardt 1989).

Denzin discusses how researchers interpret qualitative data. Researchers make use of different styles of work and interpretation. The styles he discusses are a positivistic/post-positivistic, a constructivistic, a critical (Marxistic and emancipatoric) and a post-structuralistic style. ((Denzin 1994), p 507-511). This paper has not the space necessary for a comprehensive discussion of the scientific backgrounds of the styles, but some notes about what is considered to be scientific knowledge according to three of the styles are, however, made.

A *(post-)positivistic* style or paradigm is based on a realistic and critical realistic ontology and an objectivistic epistemology. Experiments, quasi-experiments and surveys are often used. The methodological perspective contains well defined methods and techniques to ensure high levels of reliability and validity. (Denzin and Lincoln 1994b; Guba and Lincoln 1994)

A *constructivistic* style goes with a relativistic ontology, and alternative realities are considered possible. A subjectivistic epistemology is presumed, and actors (the researcher is such an actor) shape or construct together a common understanding of situation and the world the actors are a part of. A naturalistic methodological perspective and field research are preferred, e.g. in an organization. Reliability and validity is not considered to be the landmarks of good research, but following the criteria of grounded theory (Strauss and Corbin 1998), it is based on concepts of credibility, transferability, dependability, and conformability (Denzin and Lincoln 1994b).

A critical and post-structuralistic paradigm is subjectivistic and based on a materialistic and realistic ontology. Materialistic differences are related to, e.g., class, race, sex and gender of the actors. The methodology favors naturalistic research done in the field. Research is considered to be of good quality if it presents the reflexive, multi-voiced text that is grounded in the experience of oppressed peoples ((Denzin and Lincoln 1994b) p 14).

The tentative framework makes use of only two general styles of conducting research. They are developed from two of the research styles presented above. One way is called a positivistic, or post-positivistic way, while the other way is called the way of the hermeneutic or constructivist. Exhibit 1 depicts the two styles or perspectives.

Perspective on reality and knowledge creation

Ontology "World-view"	Objective	Subjective
Epistemology "Knowledge"	Discovery	Create/Construct
Approach to generate knowledge		
Positivist ↕ Hermeneutic	Positivism ↓ Deductive approach	Hermeneutic/Constructivism ↓ Inductive approach
Type of study		
Aim Type of information source Number of information sources	Testing hypotheses Data (Qual & Quant) Many cases	Understanding Interpretation Many sources
Study design		
Method of data collection Role of researcher Sampling Analysis Generalization Evaluation	Structured, systematic Observing, manipulating SRS, Systematic etc Variable centered Statistical generalization Validity, reliability	Dialog, Being in the field Participating, interacting Interpretation Actor centered Analytical generalization Credibility, dependability

Exhibit 1. The style of the positivist/post-positivist and the style of hermeneutic/constructivist

The first style is called "(post-) positivism". It is based on a view of an objective world that contains phenomena to be discovered by the researcher. The approach to generate knowledge is deduction and research studies are designed in a systematic and structured way with the aim to test hypotheses through analysis of variables and their interaction. The role of the researcher is to observe and to (experimentally) manipulate. Data collection and analysis follow strict rules and generalizations are supported by statistical rules and theory of inference. The quality of the research results are measured in terms of validity and reliability.

The second style is called "constructivism/hermeneutic". This style is based on a view of the world as subjective and constructed by the actors (as e.g. the researcher). The approach is inductive, starting with observation and interpretation of these observations. The aim is not to test but to understand reality. Information is subjective and need to be interpreted. The use of "rich information", and the utilization of many sources are preferred. The role of the researcher is based on interaction and participation. The analysis centers the actor and his/her definition and construction of reality. Analytical generalizations are made to theory and quality is measured in terms of credibility and dependability.

4. Articles published in leading journals in the field of ergonomics

4.1. Sample of leading journals

Dul and Karwowski made a systematic survey of the journals in the field of "ergonomics and human factors" (Dul and Karwowski 2004). They distinguish between three groups of journals. Journals that only publish articles in the field of ergonomics (e.g. Ergonomics), journals with another focus of their publishing but that regularly also publish articles in ergonomics (e.g. Scandinavian Journal of Work, Environment and Health) and, as a third group, journals that seldom publish articles about ergonomics but who publish articles of importance for the development of the field of ergonomics (e.g. Academy of Management Journal).

The journals are also classified according to the "impact factor", a measure based on the number of citations². The higher the impact factor, the more often is an article cited and, therefore, considered to be of influence.

Dul and Karwowski rank order 25 journals in ergonomics, 58 journals that publish articles in the field of ergonomics in a regular fashion, and 142 journals belonging to the third group.

The journals sampled for analysis in this article are among the journals that Dul & Karwowski rank among the most influential journals in the first two groups of journals.³ The journals of the second group have published at least fifteen articles in the field of ergonomics during the last five years.

Journals in ergonomics	Ergonomics related journals
Applied Ergonomics (0,712)	Scandinavian Journal of Work, Environment and Health (1,590)
Ergonomics (0,690)	Behaviour and Information Technology (0,603)

Exhibit 2. The journals and the impact factors of the journals according to Dul & Karwowski ((Dul and Karwowski 2004), p 302-303)

In this study all articles of one volume (2004) of each journal have been analyzed. The articles are classified according to the two general styles of research defined in the tentative framework presented above. The articles are also classified according to the specific aspects of ergonomics covered by the article; physical or psycho-social aspects, individual focus or group/relational focus. The total number of analyzed articles is 69.

4.2. Analysis of journal articles

Dekker and Nyce state that research results based on experiments have a strong tradition in the field of ergonomics. The research is done in laboratories and the research questions are rigorously defined and tested. The results follow the criteria for what is considered to be good research in the positivistic tradition, but the steps taken to develop new knowledge are often rather small and it is hard to generalize results from a simplified laboratory environment to the complex world of actual work situations ((Dekker and Nyce 2004) p 1626).

The results of the analysis of the articles support the conclusions of Dekker and Nyce. The positivistic style of doing research is very dominant. Just a few articles are designed in a more constructivistic style, utilizing an inductive approach. Exhibit 3 depicts that the ergonomics related journals are even more positivistic than the journals in ergonomics.

	(Post-) positiv-ism	Cons-structi-vism	Experi-ment	Case-study	Sur-vey	Other	Physical Indi-vidual	Psycho-social Individual	Work organization Collective
Appl Erg (n=29)	89%	11%	52%	11%	11%	26%	82%	21%	7%
Ergonomics (n=18)	94%	6%	67%	0%	6%	28%	78%	39%	6%
ScaJWork Env Health(n=10)	100%	0%	20%	0%	70%	10%	70%	50%	0%
Behaviour & IT (n=12)	100%	0%	20%	0%	20%	60%	80%	100%	0%

Multiple responses are allowed; >100%

Exhibit .3 Articles from two ergonomics journals and two ergonomics related journals

The type and the design of the studies differ between the journals. Articles reporting the results of experiments dominate the journals in ergonomics while survey studies are common in Scan-

² The databases used are primarily the Science Citation Index Expanded (SCI-EXPANDED), Social Science Citation Index (SSCI) and the Art & Humanities Citation Index (A&HCI) provided by the Institute of Scientific Information (ISI)

³ The journals used in this article are four of the six journals sampled for a larger article the author plans to publish during 2007. That article will cover six journals and three volumes per journal.

Scandinavian Journal of Work Environment and Health. The number of cases of the studies that the articles report on differs considerably. The number of cases used in, the mostly experimental, studies in the ergonomics journals is on average $n=45$, compared to $n=2513$ in the survey dominated journal.

The column called "other" contains articles of different kinds. They report e.g. on evaluations and tests of different standards, simulations made with the use of a mathematic model, and comparisons of different measurement methods. This is the dominating type of study in the ergonomics related journal Behaviour & IT. The articles discuss the use of some software device of relevance to the field of ergonomics, but the focus of the article is on IT and not ergonomics.

The three right-most columns in Exhibit 3 depict the aspects of ergonomics discussed in the articles. The first two columns are both about articles that discuss physical and psycho-social aspects of individuals, while the third column depicts articles that discuss work organization issues and the relationship between individuals or actors.⁴ The same article may relate to one, two or all three of the aspects, and the sum of the columns, then, exceeds 100%.

Most of the articles discuss individual and physical aspects of ergonomics and to a much smaller degree psycho-social aspects. This is especially true for the journal in ergonomics. The articles in the ergonomics related journals discuss psycho-social matters to a higher degree. The articles in Behaviour & IT contain an IT-aspect (physical), but they also discuss psych-social aspects of the actors using the software.

The individual perspective is very dominating. There are only a few articles in the four journals that report on research done to improve the (collective) work-organization or on relationships between actors. The pattern of the reported research is rather clear: positivism and physical aspects dominate, especially in the journals of ergonomics.

5. Concluding comments

First I would like to make a comment on the domains of ergonomics research. There exist competing views on what should be included in the discipline of ergonomics. One definition of ergonomics is suggested by the International Ergonomics Association (IEA): "Ergonomics is the scientific discipline concerned with the fundamental understanding of interactions among humans and other elements of a system, and the application of appropriate methods, theory and data to improve human well-being and overall performance." ((Karwowski 2001), p 102)

The discipline of ergonomics, according to this definition, is broad, systems and interaction related. The focus is on understanding. The overall pattern of scientific style of the journal articles presented above harmonizes hardly with this definition. The domination of positivism and the strong focus on experiments and physical aspects indicate a bias in the research. More broadly design research projects, including a constructivistic scientific style and a more clear focus on total work systems and on relationships among actors are called for.

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⁴ The domains of specialization within the discipline of ergonomics suggested by IEA are three: (1) **Physical** ergonomics is concerned with the compatibility between human anatomical, anthropocentric, and the static and dynamic parameters of work, (2) **Cognitive** ergonomics is concerned with mental processes, such as perception, human information processing and motor response, as it related to human interactions with other elements of a system. (3) **Social and organizational** ergonomics is concerned with the optimization of work systems, including their organizational structures, policies and processes. (Karwowski, W., Ed. (2001). International Encyclopaedia of Ergonomics and Human Factors, Taylor & Francis.

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