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On boundaries between field experiment, action research and design research

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Abstract

The practice-science gap is often emphasized during the last years. It has also had such a form as competition between relevance and rigor, although both must be taken care. The three research methods (field experiment, action research and design research) are sometimes recommended to be used interchangeable. But we shall show they are quite different. We try to analyze and describe their boundaries and division of labor between practitioners and researchers. We shall also correct some long-lasting misconceptions and propose some further research topic.

Introduction

Mathiassen and Nielsen (2008) studied the articles published in the Scandinavian Journal of Information Systems during 20 years and found that empirical articles have a great share of the all the published articles. Majority of the authors are from the Scandinavian countries. This seems to show that practice is much appreciated among the Scandinavian researchers and practical emphasis is characteristic in the Scandinavian research culture.

We shall in this paper consider three empirical research methods (field experiment, action research and design research). To describe the three methods we give simple characterizations. “In field experiments investigators manipulate one or more independent variables of interest and try to control other variables that might confound the experimental findings” (Benbasat 1985, p. 51). Investigators try to find the predicted relationships between the independent and dependent variables. “Action research merges research and praxis thus producing exceedingly relevant research findings (Baskerville and Wood-Harper 1998, p. 90)”. In their design research portal Vaishnavi and Kuechler (2007) first argue that “design deals with creating something new that does not exist in nature” and thereafter supplement the development of an information technology (IT) artifact with definition: “Design research [also] involves the analysis of the use and performance of designed artifacts to understand, explain and very frequently to improve on the behavior of aspects of Information Systems”.

Baskerville and Wood-Harper (1998, p. 90) found that “discussions of action research in information systems (IS) often proceed as if there were one definitive action research method”. They enlarged the boundaries of action research, and to this end they described and analyzed “the different frameworks, assumptions and goals that characterize the diverse forms of action research.” They found “ten action research forms: canonical action research, information systems prototyping, Soft Systems Methodology, action science, participant observation, action learning, Multiview, ETHICS, clinical field work and process consultation”. We pay attention that Soft Systems Methodology, Multiview and ETHICS have been considered as methods to design information systems, and hence if not as design research methods as such at least close to them. Although March and Smith published their seminal paper on design research in 1995, Baskerville and Wood-Harper did not take design research into account in their paper. Another reason might be that they want to include as

many methods as possible into action research. To our mind, the border line between action research and design research is not clear enough and we must clarify it.

In the defining process of boundaries of an IS action research Baskerville and Wood-Harper (1998, p. 91) state that "action research is a cognitive process that depends on the social interaction between the observers and those in their surroundings. … In its broadest sense, action research resembles the act of researchers conducting a highly unstructured field experiment on themselves together with others." The last part of citation gives us an idea and reason to also clarify the boundary between the field experiment and the action research.

Lee and Hubona (2009) frame different research approaches—positivist research, interpretive research, action research, and design research—in the forms of modus ponens and modus tollens. They will use a framework that they build from some elementary aspects of formal logic. They call it the MPMT framework, where MPMT refers to a specific way of using *modus ponens* and *modus tollens*. They state (p. 238) that "the primary contribution of [their paper] is to demonstrate that the MPMT framework provides a scientific basis for the rigor of research, where the bulk of our examination focuses on rigor in positivist research and interpretive research. A corollary to this examination will be that the MPMT framework can also provide a scientific basis for the rigor of research which focuses on relevance, such as action research and design research." If the field experiment is suitable for positivist research, then Lee and Hubona's MPMT framework differentiates the field experiment from action research and design research, and this finding also encourages us to analyze the boundaries of those three methods.

All the three methods are used to study a part of current or new reality. Because of this direct connection with reality the three methods seem to potentially be very relevant for practitioners. We are interested in the question: Are these three methods similar and exchangeable or different (and how)? In the study site there will be both practitioners and researchers, and we are also interested in the division of labor when a certain method is followed.

In order to study the similarities and differences of those three methods we will analyze a) for which purposes those methods are used and b) which kinds of knowledge and other outcomes they could produce. We shall analyze the outcomes both from the rigor and relevance points of view. Concerning the division of labor in research processes we will divide the research project into three consecutive phases: 1) the beginning, 2) the real process and 3) the end. In the beginning we pay attention to whether the idea of the problems comes from researchers or practitioners. During the research process either researchers or practitioners can act in the dominant role or they can co-operate equally. At the end both participatory groups can evaluate the results of the study by using different criteria. We shall analyze how do the roles of practitioners and researchers differ from each other in those three research processes and in their three phases.

We shall show that all the three methods are similar in the sense that in a part of reality some changes will happen. But they differ from each other based on a) who (researcher or practitioner) is an originator of the research process, b) how they co-operate during the research process, and c) how rigor and relevance are emphasized.

The rest of this paper is structured as follows: We shall first describe all the three methods (field experiment, action research and design research), identify and analyze their purposes, outcomes and division of labor. Finally we shall discuss implications of our results.

Field experiment

In this section we shall first shortly describe the purposes of the field experiment and thereafter experiment, especially the natural and field experiments. We shall then analyze which kinds of knowledge and other outcomes it could produce, and which role rigor and relevance play in this approach. Finally, we shall consider the three phases (1) the beginning, 2) the real process and 3) the end) and how division of labor is taken place in the phases.

On purposes of the field experiment

According to Benbasat (1985, p. 51) "case studies, field studies and field experiments study the phenomenon of interest in the setting where it occurs naturally. These three strategies differ in their degrees of experimental design and experimental controls. .. The focus of in field experiments is on testing hypotheses." The field experiment is thus used to study a truthfulness of the predicted relationship between independent and dependent variables in a certain real-world phenomenon. When the expected relationship is studied as many intervening variables as possible are taken into account. The researcher derives the candidate variables and their predicted relationships either from the best existing theory or from individual studies or from her own observations and views or from all these sources. The abstract model presenting all the possible relationships to be tested in the field experiment is called the research model.

The experiment, especially the natural and field experiments

The concept of the experiment is quite simple. By isolating and manipulating a single variable, and at the same time holding all other variables constant, the experimenter is able to measure the effect that the manipulated (independent) variable has upon the behavior (dependent) variable of the subject of the experiment. If the functional dependency holds between a dependent variable and independent variables, the same result is got when the initial state is same and the same manipulations are carried out. In general, if the manipulable objects are under study (Aulin 1982, p. 77), then
(1) *repetition of the initial state is possible* (either an object automatically repeats itself or the object can be replaced by an identical object having the same initial state) and
(2) *the final state can be controlled* (a researcher is able, by varying the initial state, to control the final state of the object).

In practice, the design and execution of experiments in the IS is quite difficult. As Sisk (1973, p. 446) describes "formal organizations are complex with many characteristics potentially capable of influencing the behavior of members. While it may be possible to isolate and vary one of the independent variables; e.g., style of leadership or physical working conditions, seldom is it possible to control and hold constant all the remaining variables that might influence on behavior. The quantity of tasks performed, absenteeism, and job satisfaction are but a few of the dependent variables. Further, experimental studies with living subjects are confounded, or contaminated, by a group of variables known as intervening variables. Included as intervening variables are such factors as the degree of motivation, the ability to learn, and the individual's perception and reaction to the changing independent variable."

The *natural experiment* brings an experimental interpretation to an event or process that has already taken place or that will take place in the future without any proactive effort by the researcher. It may be argued that the natural experiment is not an experiment since the researcher does not exercise control, directly or indirectly, over any of independent variables in the situation. Kraut et al. (1998) investigated the introduction and use of a pair of competing video telephone systems in a company over a period of 18 months as a natural experiment. Both quantitative, time-series analyses and in-depth interviews demonstrate that employees adopted and used the video systems both utility and normative reasons.

The manipulation of the independent variable in the natural experiment is an event not controlled by the researcher, and seldom are control groups available. In the *field experiment* (Sisk 1973, p. 447) "the researcher controls the timing and extent of the change in the independent variable; in addition, control groups may be established as further assurance that any change in the dependent variable (e.g., organizational performance or behavior) that occurs after the independent variable has been manipulated is the result of that specific change and not the result of extraneous, uncontrolled factors." The change caused by the experiment is not intended to be permanent after the experiment.

On outcomes of the field experiment

The relationship in the research model can be supported (or not) by the evidence of the field experiment. The empirical support can either be positive or negative. The negative support means that the contrary direction that expected in the relationship is supported. The positively supported relationship in the research model can be either new or derived from a certain theory. In the latter case the theory is said to be confirmed, in the former case the novel outcome is achieved. The negatively supported and non-supported relationship derived from the theory leads to the claim either to correct the theory or to falsify it.

All the alternative outcomes have practical implications, too. The novel outcome can provide chances to apply it to some improvement or construction task in the future; the controversial outcome might lead to critical thinking of its earlier use in applications, because the direction of the relationship seems to be reverse. The confirmative outcome supports the earlier applications.

Concerning rigor and relevance in field experiments rigor is especially emphasized. Relevance refers to the expected outcomes and their usage in the future. It is wanted that the outcomes from the field experiment can be utilized in some practical applications in the future. This desire has an influence on the design of the experiment.

Division of labor in the three phases of the field experiment

First, we agree with Baskerville and Wood-Harper (1998, p. 107) that "all research should adopt a mutually acceptable ethical framework regarding human subjects". This means that the researcher cannot start her field experiment without the acceptance of practitioners concerned. Next we analyze the roles of the researcher and practitioners play during the study. In the previous section we presented that "the researcher derives the candidate variables and their relationships … into the research model". Hence the researcher dominates at the beginning of the study. Our description of the field experiment above shows that "the researcher controls the timing and extent of the change in the independent variable". We

conclude thus that the researcher dominates also during the study process. At the end the researcher evaluate the results by using scientific criteria and the practitioners evaluate whether the results are suitable to be permanently applied to their organization. The scientific criteria lead to the questions: Which results are novel, which ones support the earlier literature and which ones are contradicting the earlier ones? The roles of the researcher and practitioners are presented in Table 1.

Table 1. The roles of the researcher and practitioners in the three phases of the field experiment.

	the researcher	the practitioners
In the beginning	dominant	non-dominant
During the real process	dominant	non-dominant
At the end	dominant in scientific evaluation	dominant in practical evaluation

Action research

In this section we shall first shortly describe purposes of action research and thereafter outline its special form, namely canonical one. We shall then analyze which kinds of knowledge and other outcomes it could produce, and which role rigor and relevance play in this approach. Finally, we shall consider the three phases (1) the beginning, 2) the real process and 3) the end) and how division of labor is taken place in the phases.

On purposes of action research

Action research is used to solve the client's problem with the help of a researcher. The client or practitioners do not want to change the state of the study object temporarily, i.e., for the period of the study, but permanently. Moreover, we would like to emphasize that the researcher would much respect the practitioners' problem and do not try to change it into her problem, otherwise that study is no more action research.

The canonical form of action research

Baskerville and Wood-Harper (1998, p. 95) found that (author's italics) "one of the following typical researcher involvements is characteristic of the literature on each form of action research. *Collaborative* involvement implies that the researcher is an equal co-worker with the study subjects. The study tasks are shared without distinction and the participants' backgrounds are assumed to be equally valuable. A *facilitative* involvement distinguishes the researcher as an expert among the study subjects. While the work is still cooperative, the task of the researcher and the subjects are quite distinct. The burden of solving the immediate problem setting rests with the study subjects. The task of the researcher is to facilitate or help the subjects with expert advice, technical knowledge or an independent viewpoint. However, the subjects are responsible for determining exactly what interventions will be created. An *expert* involvement also distinguishes the researcher as an expert among the study subjects, and still involves cooperation and distinct tasks. However, the burden of solving the immediate problem setting rests with the researcher. The researcher's decisions will determine to a large degree what interventions will be created."

The expert involvement is closer the field experiment than other action research forms, and in the participant observation, action learning and process consultation the expert involvement is dominant (cf. Baskerville and Wood-Harper 1998, p. 96). To this end we analyze the collaborative and facilitative involvement more carefully. From the other seven potential action research forms (canonical action research, information systems prototyping, Soft Systems Methodology, action science, Multiview, ETHICS and clinical field work) the canonical action research is the only one where the collaborative involvement is dominant; in the Soft Systems Methodology, action science and clinical field work the facilitative involvement is dominant. In the introductory section we evaluated that 'Soft Systems Methodology, Multiview and ETHICS have been considered as methods to design information systems, and hence if not as design research methods as such at least close to them'. The two remaining approaches (action science, clinical field work) are excluded for different reasons. According to Baskerville and Wood-Harper (1998, p.100) "the researcher is involved clearly in a 'helping' mode in action science. The aim of the researcher is to facilitate the explication of tacit knowledge (theories-in-use) and thus enable the subjects to break out of inappropriate frames (associated with espoused theories)." Cook and Brown (1999) demonstrated that it is impossible to convert tacit knowledge to explicit one and vice versa. According to Baskerville and Wood-Harper (1998, p. 102) "a clinical method of inquiry is highly situational, and a concrete set of steps or stages is not prescribed". Hence, we can cannot answer to all of our research questions, if we took the clinical field work as our exemplar of action research method. In the rest we are considering the canonical action research.

Susman and Evered (1978) described the cyclical process of action research called canonical action research (CAR) (Figure 1).

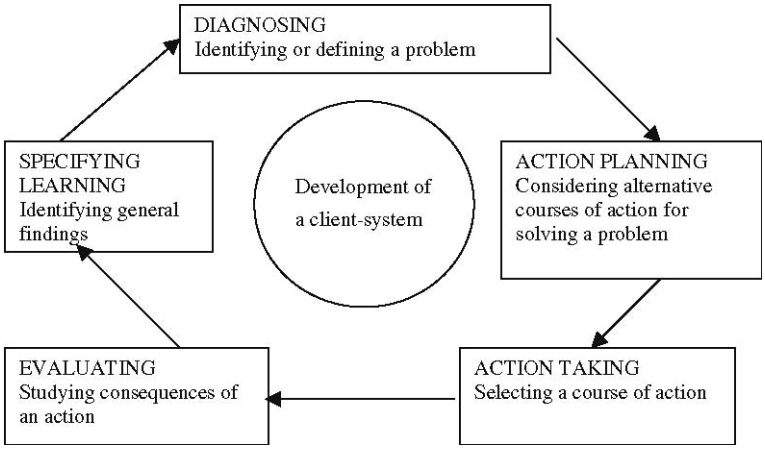

Figure 1. The cyclical process of action research (Susman and Evered, 1978).

The cyclical process with the five steps (1.diagnosing, 2. action planning, 3. action taking, 4. evaluating and 5. specifying learning) resembles a general problem solving process. Baskerville and Wood-Harper (1998, p. 97) describe those steps as follows (author's italics):

"*Diagnosing* corresponds to the identification of the primary problems that are the underlying causes of the organization's desire for change. This involves self-interpretation of the complex organizational problem, not through reduction and simplification, but rather in a

holistic fashion. This diagnosis will develop certain theoretical assumptions (i.e., a working hypothesis) about the nature of the organization and its problem domain.

Researchers and practitioners then collaborate in the next activity, *action planning*. This activity specifies organizational actions that should relieve or improve these primary problems. The discovery of the planned action is guided by the theoretical framework, which indicates both some desired future state for the organization, and the changes that would achieve such a state. The plan establishes the target for change and the approach to change.

Action taking then implements the planned action. The researchers and practitioners collaborate in the active intervention into the client organization, causing certain changes to be made. Several forms of intervention strategy can be adopted. (For example, the intervention might be directive, in which the research 'directs' the change, or non-directive, in which the change is sought indirectly. Intervention tactics can also be adopted, such as the recruiting of intelligent laypersons as change catalyst and pacemakers. The process can also draw its steps from social psychology, e.g., engagement, unfreezing, learning and reframing.)

After the actions are completed, the collaborative researchers and practitioners undertake the *evaluating* of the outcomes. This includes a determination of whether the theoretical effects of the action were realized, and whether these effects relieved the problems. Where the change was successful, the evaluation must critically question whether the undertaken action, among the myriad routine and non-routine organizational actions, was the sole cause of success. Where the change was unsuccessful, some framework for the next iteration of the action research cycle (including the adjustment of the hypotheses) should be established.

While the activity of specifying *learning* is formally undertaken last, it is usually an ongoing process. The knowledge gained in the action research (whether the action was successful or unsuccessful) can be directed to three audiences. First, what Argyris and Schön (1978) call 'double-loop learning', the restructuring of organizational norms to reflect the new knowledge gained by the organization during the research. Second, where the change was unsuccessful, the additional knowledge may provide foundations for diagnosing in preparation for further action research intervention. Finally, the success or failure of the theoretical framework will provide important knowledge to the scientific community for dealing with future research settings."

On outcomes of action research

The most relevant outcome is the solution of the practitioners' problem and in the intended manner. The success of problem-solving can be sometimes measured by an increase of organizational efficiency or effectiveness.

The key factor in creating 'scientific' outcomes is the theoretical framework collaboratively developed by the practitioners and the researcher in the planning phase. This theoretical framework contains relationships between variables assumed to help the problem solving. These relationships are derived from two sets of theories brought both practitioners and the researcher. Here we refer to Sanchez and Heene (1997) who reinvented strategic management by proposing a new theory and practice for competence-based competition. They write that (p. 311) "from the competence perspective, both researchers *and* managers are engaged in processes of theory building. The essential difference between the two theory building efforts is that researchers try to develop theories about the nature of competences that will *generally*

lead to good firm performance in various competitive contexts, while managers try to develop theories about what kinds of competences will lead to good firm performance in the *specific* competitive contexts of individual firms." In the citation above managers refer to practitioners, the main message of the citation is that also practitioners can bring their theories into discussion and as a potential alternative to the theoretical framework.

Baskerville and Wood-Harper (1998) emphasize the intended change in action research as a difference from the positivist and/or interpretive approach. They state that (p. 91) "passive observation filtering either requires an a priori framework, such as a classification scheme for speech acts, or an a posteriori framework, such as grounded theory categories. With action research, the filter is defined by the state change represented in the stimulus-reaction pairs. A certain action is taken in a social setting and the social setting changes state. Action research observes the social setting in motion after a defined event. This motion provides the filter for critical data in action research: things that changed after the event." Before the stimulus is activated certain relationships are thought and based on that some reactions are predicted. The relationships are included into the theoretical framework. Realized reactions are recorded after the event. Those data form a basis for post-analysis. The stimulus-reaction pairs can support some relationships in the theoretical framework. The similar discussion about (novel, controversial, supportive) scientific outcomes as in connection with the field experiment is applicable here too.

Action research is a very relevant approach for practitioners, for their problem will be solved and they play an equal role with the researcher in the research process. The relevance is the guiding principle in action research (Lee and Hubona 2009). The scientific results, the supported relationships, are demonstrated to hold in this special case and context. The proof is not based on statistical calculations but demonstration (Nunamaker et al. 1991). The latter is not less valuable than the former.

Division of labor in the three phases of action research

We assume that the three phases are grouped as follows: 1) the beginning is diagnosing, 2) the real process consists of action planning, action taking and evaluating, and 3) the end phase is learning. Next we analyze the roles of the researcher and practitioners play during the study. At the beginning practitioners ask help from the researcher. During the real process practitioners and the researcher are working collaboratively. At the end the practitioners gain new knowledge, in the unsuccessful case both practitioners and the researcher receive "the additional knowledge for diagnosing in preparation for further action research intervention", and "the success or failure of the theoretical framework will provide important knowledge to the scientific community". The scientific criteria lead to the questions: Which results are novel, which ones support the earlier literature and which ones are contradicting the earlier ones? The roles of the researcher and practitioners are presented in Table 2.

Table 2. The roles of the researcher and practitioners in the three phases of the action research.

	the researcher	the practitioners
In the beginning	non-dominant	dominant
During the real process	collaborative	collaborative
At the end	dominant in scientific evaluation	dominant in practical evaluation

There is a certain case where the whole problematic situation, practitioner- vs. researcher-guided will vanish. That takes place when a practitioner and a researcher is one and the same person, as in cases Coghlan (2001) and Lallé (2003). Coghlan described the special characteristics of action research when he was both researcher and manager. “Insider action research has its own dynamics, which distinguish it from an external action researcher approach. The manager-researchers are already immersed in the organization and have a pre-understanding from being an actor in the processes being studied. Challenges facing such manager-researchers are that they need to combine their action research role with their regular organizational roles and this role duality can create the potential for role ambiguity and conflict. They need to manage the political dynamics, which involves balancing the organization's formal justification of what it wants in the project with their own tactical personal justification for the project. Manager-researchers' pre-understanding, organizational role and ability to manage organizational politics play an important role in the political process of framing and selecting their action research project. In order that the action research project contribute to the organization's learning, the manager-action researcher engages in inter-level processes engaging individuals, teams, the inter-departmental group and the organization in processes of learning and change. Consideration of these challenges enables manager-action researchers to grasp the opportunities such research projects afford for personal learning, organizational learning and contribution to knowledge.” (p. 49) Lallé (2003, p. 1097) complemented the Coghlan’s view by describing “some of the epistemological and methodological implications involved in positioning the ’actor-researcher’, permitting him or her, on the one hand, to play a directly useful role in an organization, and on the other hand, to generate new scientific knowledge”.

Design research

In this section we shall first shortly describe design research and thereafter its phase. We shall then analyze which kinds of knowledge and other outcomes it could produce, and which role rigor and relevance play in this approach. Finally, we shall consider the three phases (1) the beginning, 2) the real process and 3) the end) and how division of labor is taken place in the phases.

On purposes of design research

As Hevner et al. (2004, p. 78) put it: “The design-science paradigm has its roots in engineering and the sciences of the artificial. It is fundamentally a problem-solving paradigm. It seeks to create innovations that define the ideas, practices, technical capabilities, and products through which the analysis, design, implementation, management, and use of information systems can be effectively and efficiently accomplished.” “The key differentiator between routine design and design research is the clear identification of a contribution to the archival [scientific] knowledge base of foundations and methodologies.” (p. 81) The purpose of design research is to build a new IT artifact that satisfies the determined specifications.

Design research

In their seminal paper of design research March and Smith (1995, p. 258) describe that “Research activities in design science are twofold: build and evaluate. Build refers to the construction of the artifact, demonstrating that such an artifact *can* be constructed. Evaluate

refers to the development of criteria and the assessment of artifact performance against those criteria. …
We *build* an artifact to perform a specific task. The basic question is, does it work? Building an artifact demonstrates feasibility. These artifacts then become the object of study. We build constructs, models, methods, and instantiations. Each is a technology that, once built, must be evaluated scientifically.
We *evaluate* artifacts to determine if we have made any progress. The basic question is, how well does it work? Recall that progress is achieved when a technology is replaced by more effective one." - The authors do not give more detailed description of phases for design research.

Hevner et al. (2004, p. 77) describe "the boundaries of design science within the IS discipline via a conceptual framework for understanding information systems research and by developing a set of guidelines for conducting and evaluating good design-science research". Peffers et al. (2007) developed the six steps methodology based on the earlier literature, concretely on the 7 earlier design research methods. The methodology consists of 6 activities: 1. Problem identification and motivation, 2. Define the objectives for a solution, 3. Design and development, 4. Demonstration, 5. Evaluation and 6. Publication. We could not find the division of labor between researchers and practitioners in the methodology developed by Peffers et al. Hence, we shall mainly base our analysis below on March and Smith (1995) and Hevner et al. (2004).

On outcomes of design research

The constructed new IT artifact is supposed to fulfill the specifications state at the beginning. Design research differs from the normal information systems development that it produces an innovative product that is either novel or significantly better than the best one this far. March and Smith (1995, p. 256) present that in addition to the novel or better instantiation constructs, model and/or methods can be outcomes of design research. Similarly as in action research one or more relationships are used in building a certain artifact. The feasibility and workability of the artifact is then proved by demonstration as in action research. This workability also proves or gives support for the predicted relationships used in the building process. The opposite is valid for falsification of certain relationships.

The relevance is also the guiding principle in design research (Lee and Hubona 2009). The artifact is built some practical application or a certain business need in mind (Hevner et al. 2004). The scientific results, the supported relationships in models, are demonstrated to hold in this special case and context. The new methods in the building and/or evaluation processes either work or do not. The proofs are not based on statistical calculations but the demonstration (Nunamaker et al. 1991). The latter is not less valuable than the former.

Our consideration above mainly concerns the IT artifact that is new in the scientific sense. March and Smith (1995) proposed that we evaluate the IT artifact to determine if the researcher has made any progress. She can then use the old criteria, if they can be measured after the construction process. The measurements depend on different factors like range, context, platform, potential users and their capabilities etc. We shortly elaborate these factors after the next sub section.

Division of labor in the three phases of design research

As Hevner et al. (2004, p. 78) put it: “The design process is a sequence of expert activities”, i.e., thus at the beginning the researcher derives the requirements of the new IT artifact, she also has a tentative idea and key factor (e.g., a new technical advancement) for the solution and she defines the specifications that differs from the earlier ones in the archival [scientific] knowledge base of foundations. During the real process the researcher constructs the new IT artifact. Demonstration that the new artifact works can be performed by the researcher in the laboratory, but if the more realistic context is desired, practitioners are needed to help the researcher in her experiment and demonstration. At the end the new artifact is evaluated and both practitioners and the researcher will perform evaluation. The roles of the researcher and practitioners are presented in Table 3.

Table 3. The roles of the researcher and practitioners in the three phases of the design research.

	the researcher	the practitioners
In the beginning	dominant	
During the real process	dominant	in the real experiment non-dominant
At the end	dominant in scientific evaluation	dominant in practical evaluation

On an evaluation of an IT artifact in context

In this sub section we describe the problematicality of evaluation by enlightening it from different angles: universal metrics, range, 5 problems in accounting, types of IT innovations and the various roles of evaluators. March and Smith (1995) give , p. 258) state that “evaluation requires the development of metrics and the measurement of artifacts according to those metrics. Metrics define what we are trying to accomplish. They are used to assess the performance of an artifact. Lack of metrics and failure to measure artifact performance according to established criteria result in an inability to effectively judge research efforts.” Evaluation of instantiations according to March and Smith concerns the two ‘universal’ metrics, "the efficiency and effectiveness of the IT artifact and its impacts on the environment and its users".

Kling (1987) differentiated the discrete-entity models from the web models. The discrete-entity model focuses on relatively formal-rational conceptions of capabilities of information technologies and social settings in which they are developed and used. These conceptions focus on explicit economic, physical or information processing features of the technology. The second class of models, web models, is a form of 'resource dependence' models. They make explicit connections between a focal technology and the social, historical and political context in which it is developed and used. Computer systems, in this conception, are developed, operated and used by an interdependent network of producers and consumers and cannot be analyzed solely according to their discrete features and components. To our mind, Kling in his web model emphasizes the wider range and longer paths of the impacts of computing systems than done normally in discrete-entity models.

Kling paid attention to the role of the range for the measurements in evaluation. We sometimes count costs and benefits but it is not so simple. In fact, Virkkunen (1951) had the

5 problems: 1. The range problem – which costs and benefits are included?, 2. The measurement problem – how to measure costs and benefits?, 3. The valuation problem – how to give value to costs and benefits?, 4. The division problem – how to divide costs and benefits to products and services?. The latter can be divided into two sub-problems: The allocation problem – how overhead costs are allocated to products and services?, and The periodicition problem – how is a lot cost divided to periods? Other problems concerning problems in measuring, valuating, dividing, allocating and periodicizing even increase the difficulties in evaluation.

Swanson (1994) suggests three types of IT innovations: Type I innovations confined to the IS task (Ia - Admin; Ib - Tech); Type II innovations supporting administration of the business; and Type III innovations imbedded in the core technology of the business (IIIa process, IIIb product, IIIc integration). Type I innovations concern the IS function in organizations. Type II innovations concern all kinds of supporting functions (personnel, economic and technical ones) in organizations and they are quite similar everywhere. The industries differ based on their primary processes (Type IIIa innovations) and their products and services (Type IIIb innovations), and IT can be applied in various ways to them. To evaluate IT artifacts in those circumstances and compare the results achived might be difficult.

Reeves and Bednar (1994) try to define the quality concept. They provide the four definitions of quality: I. Excellence, II. Value, III. Conformance to specifications and IV. Meeting and/or exceeding customers' expectations. These four definitions reflect the different roles or viewpoints from which evaluation is performed. The 'excellence' view emphasizes a mark of uncompromising standards and high achievement; the 'value' view focuses attention on a firm's internal efficiency and external effectiveness and allows for comparisons across disparite objects and experiences; the 'conformance to specifications' view (that we apply above) facilitates precise measurement, leads to increased efficiency is the most parsimonious and appropriate definition for some customers; and the 'meeting and/or exceeding expectations' view evaluates from customer's perspective and is responsive to market changes.

Based on application of some different framework on evaluation of the IT artifact in the realistic context we can conclude that evaluation requires much work and the results are not easily comparable. Much further research is necessary.

Discussion

In this section we shall discuss on similarities and differences of the field experiment, action research and design research, on the types of scientific knowledge produced, the implications to science, and limitations and further research.

On similarities and differences of the three approaches

We asked: Are these three methods similar and exchangeable or different (and how)? Based on our analysis above we can say that all the three methods are similar in the sense that in a part of reality some changes will happen. But they differ from each other based on a) who (researcher or practitioner) is an originator of the research process, b) how they co-operate during the research process, and c) how rigor and relevance are emphasized.

In the field experiment and design research the researcher is an originator of the study, and the researcher is dominant in co-operation. But in the action research the practitioner is the originator, and researchers and practitioners co-operate at the equal basis called collaboratively. In the field experiment rigor is emphasized and relevance is expected in the future. In the action research and design research relevance is guiding the study and rigor is taken care as well as possible. Relevance in those two approaches mostly refers to utility like effectiveness and efficiency but also new types of desires like entertainment (Van der Heijden 2004), art enjoyment and accompaniment (Iivari 2007) are proposed.

On types of scientific knowledge produced

In this paper we use the classification of the three types of knowledge (novel, supported and contrasted) and apply it to the outcomes of the three methodological approaches. In the field experiment a certain predicted relationship between two variables can achieve either support or refutation. The relationship is rarely new but it is then added by the researcher and based on her own observations.

In the design research the new or improved artifact is the main result. The researcher can develop a new language in the form of constructs (March and Smith 1995) to better describe the topic under study. The researcher can also develop a new model that can either be descriptive (the initial state) or prescriptive (the desired state) (Hevner et al. 2004). The key components of the models are the relationships between variables, and the design research can give support or refutation for the predicted relationships. The latter are based on the earlier literature. [Methodological] design knowledge concerns (van Aken 2004, p. 226) "three designs: an *object-design*, the design of the intervention or of the artifact; a *realization-design*, i.e. the plan for the implementation of the intervention or for the actual building of the artifact; and a *process-design*, i.e. the professional's own plan for the problem solving cycle, or, put differently, the method to be used to design the solution to the problem". The known method can be applied to an object-design, a realization-design and/or a process-design. The new method can also concern one of these three designs.

In the action research the solved (or unsolved) problem is the main result. The similar new constructs, models and methods can be also found in the action research as in the design research. The special opportunity to that we like to pay attention in connection of action research is the practitioners' theories. These can much enrich scientific literature.

Implications to science

Our analysis much clarifies the boundaries between field experiment, action research and design research. In our consideration with action research we show that some of those forms that Baskerville and Wood-Harper (1998) in 1990s proposed do not belong to the action research category but perhaps to the design research one or to some other class.

Iivari (1991, 2007) sees action research one of the ideographic research methods. But the latter are searching the truth. In their literature survey Chen and Hirschheim (2004) considered action research as an interpretive method. Our analysis shows that action research does not primarily emphasize the truth but utility or some other goal behind of the practitioners' problem to be solved. The relationships used in the problem-solving to predict the consequences of the action to be taken can be tested in connection with action research, but that kind of tests are positivist types, not interpretive ones.

Hevner (2007, p. 89) presented the three cycle model of design science research (relevance, design and rigor cycles) and described that "the output from the design science research must be returned into the environment for study and evaluation in the application domain. The field study of artifact can be executed by means of appropriate technology transfer methods such as action research (Cole et al. 2005; Järvinen 2007)." Iivari (2007) supported Hevner as follows: "Action research may well be used to evaluate artifacts developed in design science, and it may also provide information on how to improve those artifacts. … My [Iivari's] claim is, however, that artifacts developed in design science should first be tested in laboratory and experimental situations as far as possible. One should not start with testing in the real situations, except perhaps in very exceptional, special situations." It is easy to understand Hevner's and Iivari's proposals in such a way that the researcher will be the originator of that kind of 'action research'. But our view differs from theirs in such a way that practitioners must be the originators of the action research. The field experiment as such is not suitable as the research method for evaluation of the new IT artifact, the output from design research, because in the field experiment we shall study whether the predicted relationship between the two variables holds or not. The field experiment must be adjusted to be suitable for studying the utility of the new IT artifact in its context. Some goal function like efficiency, effectiveness, net value, etc. must be selected for measurements.

Limitations and further studies

We bypassed an opportunity to use the field experiment as a method for measuring the utility of the new IT artifact in a certain realistic context. To contribute accumulation of the archival [scientific] knowledge base of foundations and methodologies, it should be studied in the future.

We concentrated on the canonical action research only. We however believe that in the literature there are other action research approaches, too, and they must be compared with the canonical one and with the design research and with field experiment.

We took a rather narrow scope on design research, the researcher-dominant one. Peffers et al. (2007) propose that the good practical IT instantiations can be scientifically studied afterwards. This guideline must be warmly followed.

Conclusions

We conclude that we have succeeded to clarify the boundaries between the field experiment, action research and design research. The rather crude division of labor seems to play a central role in differentiating those approaches. We have also corrected some misconceptions to which many researchers much referred. This shows that science is correcting itself.

To show some concrete results we like to emphasize that the relationships between two variables play a central role in the field experiment, in the action planning and in designing some functionalities of the new IT artifact. This kind of the almost functional relations are easily left in the background.

We have proposed some important topics to be studied in the near future.

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