Outline of a Pattern-Oriented Research Strategy for Complex Learning Scenarios

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Abstract: Describing and explaining learning in complex settings makes high demands on educational research strategies. This paper roughly outlines a pattern-oriented research strategy, aiming to bridge the gap between theory and practice and facilitating improvements in complex social settings like collaborative learning. The ideas underlying this approach are rooted in theory-based evaluation, Realistic Evaluation and explanatory case studies. It is argued for a system-centered view and the role of generative mechanisms as a focal point of inquiry. After an explication of the underlying assumptions a brief description of a pattern-oriented research strategy is presented. Furthermore we discuss strength and weaknesses and propose pattern-oriented research as a reasonable completion to other research strategies.

Motivation

Describing and explaining learning in complex settings makes high demands on educational research strategies. The discussion about appropriate methodologies for the inquiry of complex phenomena in learning environments has recently been resumed by Fischer, Bouillion, Mandl & Gomez (2003). Research strategies aiming to describe and explain processes in complex social situations are challenged by recent trends regarding the object of inquiry as well as divers interests and purposes.

Investigating complex learning environments serves different purposes which are often seen as incompatible: one is the purpose of facilitating improvements in a certain project, another the purpose of generating generalized knowledge. The purpose of facilitating improvements refers to the use of information gained by research or evaluation in order to make better decisions regarding a concrete project. The purpose of generating generalized knowledge refers to the use of research results in order to test a scientific theory or a more general phenomenon. While these two purposes are sometimes discussed as detached from each other, they are strongly interrelated in practice. Learning environments are improved based on concrete research findings as well as generalized knowledge stemming from other investigations. Generalized knowledge in the field of education is not just scrutinized by basic research but also challenged by any real learning environment. There is a need for research strategies that serve both purposes as traditional research strategies do not lend themselves to support both of them simultaneously (cp. Fischer et al., 2003).

Research strategies also have to face challenges arising from the complexity of the object of inquiry. It became obvious that it is no longer sufficient to ask if a certain educational approach works, but how it works (e.g. Dillenbourg, 1999). Methods, which aim to describe and explain complex learning scenarios, have to take into account just this complexity (e.g. Teja, Ganesan, Lundgren-Cayrol & Spector, 2003; Pfister & Wessner, 2000). But given the inevitable complexity of real learning environments it is argued that the capability to replicate findings across different testbeds becomes questionable. Consequently, instead of striving for the prototypical or ideal learning environment, it becomes even more important to understand what is going on within a learning environment under real conditions. With regard to collaborative learning Dillenbourg (1999, p. 129) wrote: "*researchers no longer treat (or should not) collaboration as a 'black box', but zoom in the collaborative interactions in order to gain better understanding of the underlying mechanisms.*" The need for methodologies that allow to crack up the black box of the object of inquiry has also been stated in the field of evaluation (e.g. Weiss, 1998). Theory-based evaluation (e.g. Weiss, 1998; Fitz-Gibbon & Morris, 1996; Rogers, 2000) is one attempt to depict the assumption underlying a given intervention/program and to put them under scrutiny. While theory-based

evaluation approaches seem to be a promising approach, there currently is a lack to address complex underlying structures as feed-back loops or non-deterministic relations (cp. e.g. Rogers, 2000).

To overcome this shortcomings we will outline a pattern-oriented research strategy, that bridges the gap between theory and practice and facilitates improvements. This approach draws on ideas of theory-based evaluation (e.g. Weiss, 1998), Realistic Evaluation (Pawson & Tilley, 1997), and Case Study Research sensu Yin (2003). Beyond these theoretical foundations our perspectives on the matters are based on experiences as evaluators in the Learning Lab Lower Saxony which is part of the Wallenberg Global Learning Network. After a brief explication of the assumptions underlying our work we sketch a pattern-oriented research strategy and depict possible implementations. Finally we discuss this approach and especially focus on the relation to other research strategies such as experimental designs and design-research.

Underlying Assumptions

Due to widespread views on the object of inquiry and due to the focus on gaining context independent knowledge, many research strategies are unable to bridge the gap between theory and practice and to provide concrete practical guidance. Here we will briefly substantiate the assumptions underlying the pattern-oriented research strategy, thereby giving reasons for the theses stated above. In this section we especially draw on the ideas of Pawson and Tilley (1997) regarding evaluation based on scientific realism.

The Relation Between a Program and its Context

When talking about endeavours within the field of education, often a distinction is drawn between a program or intervention on the one hand and the context in which it takes place on the other. While the terms program or intervention refer to a (hypothesized) source of change (like for example the adoption of tools that facilitate collaborative work or innovative methods of learning and instruction) the context is the field where the change will take place. The conceptualization of a program as an entity distinct from the context in which it takes place might be useful to define what shall be achieved and which activities shall take place in order to reach the goals, but this distinction is misleading for the purposes of educational research. It is misleading in the sense that it assumes an effect of a program, which is independent from the context in which it takes place. It assumes an effect which can be attributed to the intervention and which is independent of the context, situational factors as well as the persons involved. Accordingly, effects that can be attributed to the context are conceptualized as noise or error regarding the effects of the intervention. So far one might argue that this argument misses the point as it is commonly agreed that there are tight and complex relations between an intervention and its context (e.g. W.K. Kellogg Foundation, 1998; Rogers, 2000). But even the notion that there are tight and complex interrelations does not overcome the problem as many researchers and evaluators are still trying to identify the effects solely attributable to the intervention.

In contrast to this position, which draws a line between a program and its context, we agree with Pawson and Tilley (1997) that intervention and situation as well as people and their actions are the same. Or to put it more pronounced "*a program is its personnel, its place, its past and its prospects*" (Pawson and Tilley, 1997, p. 65). According to this point of view educational settings are social systems and interventions aim to change or preserve the actual state or developmental trajectory of the system. This is also in line with the theory of social systems (e.g. Luhmann, 1995; Willke, 1999). The intervention does not exist without the system, it forms a thin red thread within a specific system. For example an innovative instructional idea can only have an effect within a given learning environment when it is adopted by the teacher and the learners. Adoption means that the stakeholders choose the new approach instead of any other available approach and that the approach bears a meaning within the system. Therefore the "outcome of the intervention" cannot be understood without or abstracted from the concrete context. The system-centred view presented here challenges research paradigms that treat the intervention as a 'black box', which is a view common to most of the traditional experimental or quasi-experimental designs. In fact the system-centred view builds upon what has been called the 'interactions' paradigm (Dillenbourg, Baker, Blaye & O'Malley, 1996). Instead of looking for context independent effects it seems to be necessary to understand what happens within an educational setting as a response to new options introduced.

Generative Relations

One of the most basic roles of research is to explain phenomena occurring in the field of investigation (e.g. Weiss, 1998; Bortz & Döring, 2002). If explaining means to assign a cause to an observed phenomenon then a research strategy has to clarify their understanding of what constitutes a causal relation.

According to Harré (1985) two main theories of causality can be differentiated, the succession theory and the generative theory. "*In the succession theory a cause is just what usually comes before an event or state, and which comes to be called its cause because we acquire a psychological propensity to expect that kind of effect after the cause*" (Harré, 1985, p. 116). This position assumes that the connection between cause and effect cannot be observed directly but can only be inferred on the basis of empirical data. Cause and effect are separate entities that can be described without reference to each other. This position is contrasted by the generative theory of causality, which states that the cause has "*the power to generate the effect and is connected to it*" (Harré, 1985, p. 116). According to this view there is a real connection between causes and their effects. The effect depends on the cause which produced it.

The kind of theory chosen inevitably affects the way phenomena are explained. According to succession theory explanation is limited to the detection of a statistical and temporal relation between an assumed cause and its effect. On the other hand someone who argues for the generative theory will additionally try to understand how cause and effect are linked to each other, i.e. what are the underlying causal mechanisms that generate the effect. While many scientists admit their interest in the underlying causal mechanisms (cp. eg. Harre, 1985; Weiss, 1998; Davidson, 2000), there is a lack regarding methods to investigate these. This is due to the fact, that most research methods of empirical social science are based on the assumptions of succession theory. Both Realistic Evaluation and the pattern-oriented research strategy, presented here, aim to overcome this gap.

The assumption that there are real linkages between a cause and an effect entails that "*causes do not act in isolation*" (Harre, 1985, p. 117). This means that a cause cannot lead to an effect without an appropriate context in which it takes place. An example: a student learnt some basic facts about the French Revolution in his history class. But the history class is not necessary for learning those facts. Additionally attending the history class is not sufficient to learn basic facts about the French Revolution as there are other conditions which have to be fulfilled, e.g. the student has to listen, he must be able to understand the language the teacher speaks. This issue has been discussed by Mackie (1965) as *cause as an INUS condition*: an **I**nsufficient but **N**ecessary part of a condition which is itself **U**nnecessary but **S**ufficient for the result.

Based on the notion that there are real underlying causal mechanisms, which only have an effect within an appropriate context, Pawson and Tilley (1997, p. 58) formulate that: "*causal outcomes follow from mechanisms acting in contexts*". While in general we agree with this formula it seems necessary to make some additional remarks. Both outcomes and contexts are components of the same system. That something is referred to as an outcome does not mean that it cannot be a contextual condition regarding another mechanism at the same time. For example social competences are a prerequisite as well as an outcome within social interactions.

Finally it is important to note that the term causal mechanism as we use it is not restricted to linear causal processes but also includes processes of direct mutuality as proposed in the field of organization science (Dent, 2003) as well as processes that are inherently indetermined from an observers point of view as proposed in the theory of social systems (cp. Willke, 1999). In order to stress that the term causal mechanisms comprises all of them, we refer to them as *generative mechanisms* in the following.

Theories and Models

In a very general sense research tries to elicit the relationship between the ideal and the real. Or as Trochim (1985, p. 575) puts it: "*Typically there is a theory, however well articulated, and the research essentially consists of an attempt to determine the degree to which the observations correspond to or 'fit' this theory*". The ideal and the real thereby are not necessarily unrelated. Especially when the object of investigation is at least partially shaped by humans, the relation between the ideal and the real is usually very complex. For example, theories of learning guide the design of educational interventions as well as their investigation. Consequently theories lead to practices which lead to theories (cp. Checkland & Holwell, 1998). The notion of strong interrelations between ideas and their use might lead to the assumption that there is no need to expose the framework of ideas in research, but instead we agree

with positions which state the need to define the framework prior to data collection, as it provides the opportunity to recover and reconstruct the process of research and evaluate the validity of findings.

As we state the need to describe the framework of ideas, the relevant question is: How to model complex systems such as educational settings. Models of complex systems have to face two main problems: A model of a complex system inevitably has to be built on divers theories as we are not aware of any comprehensive theory that allows to explain phenomena in any field such as psychology, sociology and information sciences consistently. Secondly there is a fundamental contradiction between the need to address complexity and the essential characteristics of models to reduce complexity.

In contrast to recent approaches which aim to reduce the complexity by focussing on selective sets of variables (e.g. dependent, independent and control variables or inputs, activities, outputs and outcomes) and assuming simple linear relations between them we are stressing the idea of generative patterns and underlying mechanisms that relate the variables to each other. The term generative pattern, as we use it here, refers to any generative mechanism including the set of conditions that is necessary and sufficient to trigger the mechanism as well as the (potential) outcomes generated by the mechanism (1). The set of generative patterns forms the model underlying a specific inquiry, which is tested against the empirical data collected. This set might also include alternative generative patterns. These alternative patterns might produce similar outcomes but depend on disjunctive sets of conditions. Taking pattern as a focal point yields the advantage that complexity is not a threat but an opportunity. "*Pattern matching implies that more complex patterns, if matched, yield greater validity for the theory.*" (Trochim, 1989, p. 357). Furthermore the focus on generative mechanisms lends it self more directly to practical guidance. Summarizing, instead of trying to avoid complexity we propose to search for patterns in the complex and often confusing scenery of learning instead of trying to find universal laws.

A Pattern-Oriented Research Strategy

Based on the theoretical considerations stated above we outline a pattern-oriented research strategy. The pattern-oriented research strategy reflects the same underlying logic of inquiry that is widely common in social science. It is the understanding of scientific inquiry as a cyclic process that starts with a set of more or less formal theories. These theories form the base on which specific hypotheses are build. These hypotheses are tested by means of empirically derived data. And finally the data is analysed and interpreted in order to judge if they support or challenge the theories. The eventually revised theories might then be the starting point for another cycle of inquiry (c.p. Pawson & Tilley, 1997; Krathwohl, 1998). Therefore it is not the basic logic of inquiry but the specific form of theories and models under scrutiny that constitute the most significant difference between the pattern-oriented research strategy and other research strategies, such as randomized experiments. Accordingly, we focus on these models in order to outline a pattern-oriented research strategy. After concretizing the concept of generative patterns in the context of complex learning scenarios we depict ways to derive hypothetical generative patterns and ways to match them with empirically derived patterns.

Generative Patterns

Generative patterns are the most important constituent of the models tested by the pattern-oriented research strategy. According to the notion that the relation between variables is not due to an abstract law-like regularity but to an real process, the strategy aims is to answer the question how a specific result has been produced and not primarily if a certain outcome has been achieved and if this effect could be attributed to a certain treatment. To put it more pronounced, by drawing on generative patterns the question is not whether a certain educational treatment is associated with certain effects, but how do actors involved deal with a situation that to some extent is shaped by an educational program. Therefore it is necessary to model the hypothetical set of generative patterns deemed to be triggered in a certain educational situation. For example, the object of inquiry might be an educational situation where students are asked to discuss possible causes for a certain phenomenon, such as the emergence of slums in developing countries. The primary intent of the corresponding educational intervention might be to foster a process of shared-knowledge creation and thus to improve the students' communication and critical thinking skills, e.g.. In order to gain an understanding of how the assigned task might contribute to an improvement of these skills within this educational situation it is necessary to identify the underlying generative mechanisms. With regard to this example the set of relevant generative mechanisms might include the externalization of task-related information, the interpretation of communicative statements, challenging others about their views, cognitive restructuring and ignoring contradictory information. Each of these generative mechanisms will produce specific outcomes if the

conditions that trigger the mechanisms are fulfilled. The generative mechanisms might be related in that way, that a certain outcome of one mechanism might constitute a condition for another one. For example the mechanism to challenge others about their views might be triggered if a student comes to the conclusion that the statement of another student is inconsistent with former information. The outcome of the mechanism might be a question to gain additional information. This question again might be assumed to be one of the conditions that trigger the externalisation of task-related information. The set of generative patterns forms the model to be tested in the pattern-oriented research process. Figure 1 depicts a hypothetical, and with regard to the noted conditions very simplified, network of mechanisms mentioned in this example. The example also shows that the generative mechanisms might be located on different levels. While cognitive restructuring refers to a mental activity challenging others is a interpersonal phenomenon.
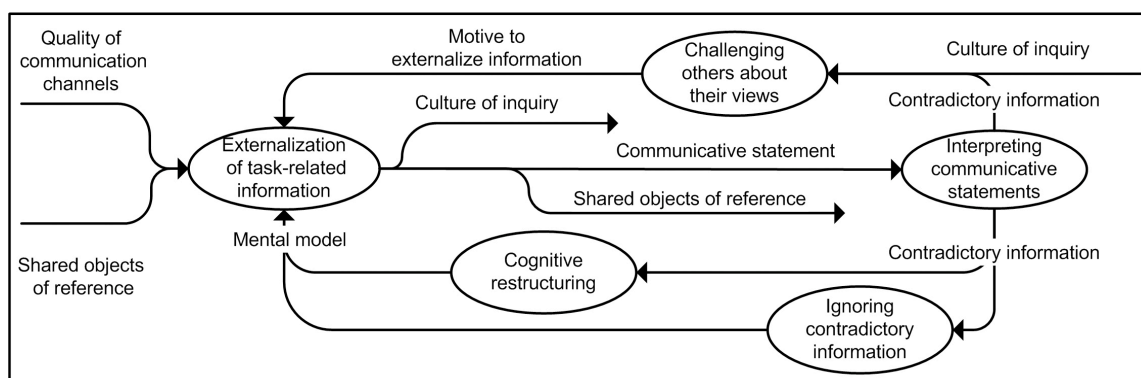

Figure 1. Hypothetical and simplified network of mechanisms (the mechanisms are depicted as ellipses, and conditions and outcomes as arrows).

Up to now the model only delineates the mechanisms and some conditions resp. outcomes, especially those that relate the mechanisms to each other. Thus it is incomplete as each generative pattern usually comprises a set of conditions that trigger the mechanism, and a range of outcomes it generates. One of the generative mechanisms in this example is the externalisation of task-related information. While, as proposed above, a question addressed to a learner, can represent 'a motive for externalizing information' to the learner – but the question itself is neither a necessary nor sufficient condition for triggering the mechanism. It is just one possible incidence that might satisfy the necessary condition of the presence of a motive, others might be rooted in the task itself, e.g.. Additionally figure 1 indicates that there is a range of further conditions that have to be fulfilled in order to trigger the mechanism of externalizing information, which include the availability of task-related information, the quality of communication channels and shared objects of reference. On the other hand the externalization of information does not exclusively produce a communicative statement but also results in a new shared object, that can be referenced, and also contributes to the culture of inquiry. All these conditions that are supposed to trigger the generative mechanism as well as the specific outcomes it produces make up the generative pattern that is put under scrutiny in the inquiry. Every generative pattern deemed to be important in an educational situation at hand, outlines a hypothesis to be tested. As these generative patterns usually include conditions that depend on individual characteristics of the actors involved or features of the social and cultural context, the pattern-oriented research strategy does not aim to reveal the effects of a certain intervention per se but its dependence on specific situational factors.

Identification of Hypothetical Generative Patterns

While the previous paragraph focussed on the characteristics of generative patterns and the models they form, the question of how to identify these patterns based on available theories has not been addressed. The process of identifying relevant theories and relevant generative patterns is the first step in the cycle of inquiry. This process includes two complementary tasks: (a) the identification of a set of potentially relevant generative mechanisms and (b) the detection of potential conditions and outcomes of a specific mechanism.

Given the complexity of real learning environments the identification of potentially relevant mechanisms is a nontrivial but crucial task. Instead of postulating a set of mechanisms purely based on the researcher's intuition and experience it is also possible to exploit the fact, that an educational setting as well as any other social intervention is designed according to a so called program-theory. According to Weiss (1998, p. 55) a program theory

is *"an explanation of the causal links that tie program inputs to expected program outputs."* Referring to the example introduced above the program inputs into the educational situation might include the task assigned to the students, means to foster a culture of inquiry and - in the case of a virtual setting - tools for communication and collaboration. These inputs are introduced in the educational situation in order to foster the discourse among the students which in turn is assumed to contribute to the improvement of students' skills. The program-theory delineates a more or less linear chain of inputs and effects in order to reach the intended goals. Methods to guide the construction or reconstruction of program-theories are well documented and the interested reader is referred to the existing literature (e.g. Weiss, 1998; Leeuw, 2003). While program-theories are a helpful tool for the purpose of program management they also are a good starting-point to identify relevant mechanisms, as there have to be mechanisms which link the inputs to the effects. Thinking about which mechanisms are affected by an element of the program and which outcomes are assumed to be produced by such these mechanisms, leads to a first set of mechanisms. When elaborating on a specific mechanism probably additional mechanisms, which complement the model, may come to ones mind.

The second task deals with finding potential conditions and outcomes of a specific mechanism. A program-theory already comprises some of the relevant conditions and outcomes. But these have to be supplemented by further variables. While a program-theory usually focuses on those variables that are either a direct input or an intended effect it is necessary to complement the generative patterns by looking for variables that e.g. characterize the context, the addressee, or that are side effects or important intermediate outcomes. Existing scientific theories and results from empirical studies are evident resources that should inform this process. Beside this, an informal exploration of important conditions and expected outcomes including those that are usually taken for granted might reveal additional insights. In this process it is also important to check, whether the generative mechanism really is the agent which is supposed to generate an outcome or whether it is another mediating variable (2).

Testing Generative Patterns

Testing generative patterns basically means to compare the theoretical patterns with empirical patterns observed in a given learning environment. In this sense we refer to research as pattern-matching (cp. Campbell, 1975; Trochim, 1989). Pattern-matching basically draws on two main analytic strategies: (a) it tests whether the observed data fits the postulated pattern and (b) it tries to rule out alternative explanations (cp. Yin, 2003). Both strategies are inherently intertwined: the more complex the predictions derived from a theoretical pattern, which fits the data, the lower the probability for the validity of a rival explanation. Conversely, an observation that contradicts the postulated pattern inevitably calls for a rival explanation. Pattern-matching entails the testing and refinement of already stated patterns as well as the conceptualization of new ones in the case of missing fit. In a concrete study this means to check, whether in those cases in which the hypothesized set of conditions was fulfilled the likelihood for the correspondent outcomes is also increased, or if there is reason to assume that other mechanisms produced the outcomes observed. For example, do the data support the hypothesis that the likelihood of asking challenging questions is increased in cases in which contradictions appear in the course of the discussion and the students believe that inquiry will be appreciated by the group, or is there reason to assume that the challenging questions arise from the wish to impress the teacher and get a good mark. The insights gained by testing the hypothetical against the empirical patterns is twofold: On the one hand it helps to gain a deeper understanding of the processes actually going on in an educational situation and on the other hand to figure out if the educational intervention had the impact it was intended to have. Therefore, the strategy proposed here contributes to the creation of knowledge about generative mechanisms in the field of education and at the same time provides useful information for the practitioner as it allows to decide if the intervention worked out as intended and where unforeseen processes or variables became important and might guide further improvements.

While the concept of pattern-matching as sketched above is a fundamental part of the pattern-oriented research strategy the choice of methods of data collection and analysis substantially depends on the specific requirements of a concrete study. The concept of pattern-matching can be applied to case studies, multiple case studies and studies that involve systematically derived samples of cases. The advantage of drawing on a larger set of cases basically is the increased variability either due to different treatments, diverse contexts or diverse actors. Furthermore, qualitative as well as quantitative methods of data analysis can be used. For example, generative mechanisms, the conditions they depend on, and the outcomes they produce might directly form the categories used to organize the qualitative data. Even though quantitative methods for pattern-matching are currently less developed, Kazi (2003) recently described the use of the binary logistic regression technique in the context of realistic evaluation. Also canonical correlation analysis might be another useful technique. More practical advice regarding

causal-pattern matching can be obtained from approaches described by Yin (2003), Pawson and Tilley (1997), or Mark (2001).

According to the logic of inquiry mentioned above the results obtained by testing the generative patterns are used to revise and specify the theories from which the tested patterns where derived. This holds for the scientific theories used to specify a certain generative pattern as well as for the program theory underlying the intervention.

Discussion

Actually neither the motivation nor the basic ideas underlying the pattern-oriented research strategy are novel. They are rooted in theories and practices in the field of educational research and the social sciences. Throughout this paper we aimed to depict the origins of the idea to match hypothetical generative patterns with empirical ones. Furthermore, the call for a shift from focussing on universal regularities to more context dependent insights is not a new one in this field. Among others Michael Scriven (1974, p. 74) wrote: „*I think the time has come to change our orientation in the development of social science away from the goal of abstract, quantitative, predictive theories toward specific, qualitative, explanatory checklists and trouble-shooting charts.*" The concept of a pattern-oriented research strategy as outlined here is insofar innovative as it replaces models of linear chains of causality with the notion of a network of interrelated generative mechanisms. Furthermore, this strategy proposes an alternative understanding of a program and its context which allows to bridge the gap between what we call activity- and system-centred views. Advantages of the pattern-oriented research strategy are: a more explicit relation between the theoretical understanding and practical experience as well as findings that lend themselves more directly to practical guidance.

A potential disadvantage regarding the approach is the huge amount of background knowledge necessary to formulate sound theoretical patterns. Given the predominance of high level theories much is due to the creativity of the researcher to overcome this gap. We state that each stakeholder involved in a program holds his theory of the program. These program-theories, whether scientifically founded or not, are a valuable resource to identify potential patterns. The same is true for pattern-matching techniques. While there are already some rough descriptions of pattern-matching techniques available, there is still need to refine and extend these approaches.

So far we talked about the pattern-oriented research strategy in isolation to other research strategies. In fact pattern-oriented research strategy might be a reasonable completion to other research strategies. As the explanatory power of experimental and quasi-experimental research designs is limited to the question whether a treatment lead to a certain effect, but cannot reveal the underlying mechanisms (cp. Bortz & Döring, 2002) these approaches might benefit from an explicit outline and test of the generative mechanisms which link the independent and dependent variables. This also might shed new light on the results even when no significant differences where found (cp. Scriven, 1974). Furthermore, in real and complex learning situations there is no chance to control all possible confounding contextual conditions. The formulation of generative mechanisms might help to identify the particularities of the situation and the individual actors, that contributed to a certain outcome. At the same time the pattern-oriented research design has much in common with design-research (e.g. Brown, 1992; Collins, Joseph, & Bielaczyc, in press) as both stress the importance of contextual conditions and highlight theories that relate both to the process of learning as well as to the means intended to foster this processes (cp. Cobb, et. al., 2003). But while in design-research the hypothesis to be tested are mainly incorporated in the intervention itself and the analysis often draws on retrospective techniques the pattern-oriented research design calls for an explicit statement of the hypothetical generative patterns prior to the intervention. The pattern-oriented research strategy might complement design-research as it allows to structure the field of investigation and the data without being forced to fall back on very simplified causal models.

Endnotes

This definition focuses on dynamic relations while Trochim (1989) uses the term pattern for structural related objects.
(2) In contrast to the linear program-theory the resulting set of generative pattern usually forms a network.

References

Bortz, J., & Döring, N. (2002). *Forschungsmethoden und Evaluation – für Human- und Sozialwissenschaftler* (3rd ed.). Berlin, Germany: Springer.
Brown, A.L. (1992). Design Experiments: Theoretical and Methodological Challenges in Creating Complex Interventions in Classroom Settings. *The Journal of the Learning Sciences*, *2*(2), 141-178.

Campbell, D.T. (1975). "Degrees of Freedom" and the Case Study. *Comparative Political Studies*, *8*(2), 178-193.

Checkland, P., & Holwell, S. (1998). *Information, systems and information systems: making sense of the field.* Chichester: Wiley.

Cobb, P., Confrey, J., diSessa, A., Lehrer, R., & Schauble, L. (2003). Design Experiments in Educational Research. *Educational Researcher*, *32*(1), 9-13.

Collins, A., Joseph, D., & Bielaczyc, K. (in press). Design research: Theoretical and methodological issues. To appear in J. Campione (Ed.) *Volume in honor of Ann Brown*. Retrieved November 12, 2003, from http://www.extension.harvard.edu/2003-04/ext03drt.pdf.

Davidson, E.J. (2000). Ascertaining causality in theory-based evaluation. In P.J. Rogers, A.J. Petrosino, T.A. Huebner, & T. Hasci (Eds.), *New Directions for Evaluation: Program Theory in Evaluation Challenges and Opportunities*, *87*, pp. 17-26. San Francisco: Jossey-Bass.

Dent, E.B. (2003). The Interactional Mode: An Alternative to the Direct Cause and Effect Construct for Mutually Causal Organizational Phenomena. *Foundations of Science*, *8*, 295-314.

Dillenbourg, P. (1999). What do you mean by collaborative learning? In P. Dillenbourg (Ed.), *Collaborative learning: Cognitive and computational approaches* (pp. 1-19). Amsterdam. Retrieved November 12, 2003, from http://tecfa.unige.ch/tecfa/publicat/dil-papers-2/Dil.7.1.14.pdf.

Dillenbourg, P., Baker, M., Blaye, A., & O'Malley, C. (1996). The Evolution of research on Collaborative Learning. In E. Spada, & P. Reiman (Eds.), *Learning in Humans and Machine: Towards an interdisciplinary learning science*. (pp. 189-221). Oxford: Elsevier. Retrieved September 25, 2003, from http://tecfa.unige.ch/tecfa/publicat/dil-papers-2/Dil.7.1.10.pdf.

Fischer, F., Bouillion, L., Mandl, H., & Gomez, L. (2003). Scientific principles in Pasteur's quadrant: integrating goals of understanding an use in learning environment research. In B. Wasson, S. Ludvigsen, & U. Hoppe (Eds.), *Designing for Change in Networked Environments*. *Proceedings of the International Conference on Computer Support for Collaborative Learning 2003* (pp. 493-502). Dordrecht, Netherlands: Kluwer.

Fitz-Gibbon, C.T., & Morris, L.L. (1996). Theory-Based Evaluation. *Evaluation Practice*, *17*(2), 177-184. (reprint of an article first published in 1975)

Harrè, R. (1985). *The Philosophies of Science* (2nd ed.). Oxford: Oxford University Press.

Kazi, M.A.F. (2003). *Realist Evaluation in Practice - Health and Social Work*. London: Sage.

Krathwohl, D.R. (1998). *Methods of Educational and Social Research – An integrated Approach* (2nd ed.). New York: Longman.

Leeuw, F.L. (2003). Reconstructing Program Theories: Methods Available and Problems to be Solved. *The American Journal of Evaluation*, *24*(1), 5-20.

Luhmann, N. (1995). *Social Systems*. Stanford: Stanford University Press. (Original work published in Germany in 1984)

Mackie, J.L. (1965). Causes and Conditions. *American Philosophical Quarterly*, *2*(4), 245-264.

Mark, M.M. (2001). What works and how can we tell? *Evaluation Seminar Series*, *2*, State Government Victoria: Department of Natural Resources and Environment.

Pawson, R., & Tilley, N. (1997). *Realistic Evaluation*. London: Sage.

Pfister, H.-R., & Wessner, M. (2000). Evaluation von CSCL-Umgebungen. In H. Krahn, & J. Wedekind (Eds.), *Virtueller Campus '99. Heute Experiment - morgen Alltag? Medien in der Wissenschaft* (pp. 139-149). Münster, Germany: Waxmann.

Rogers, P.J. (2000). Program Theory: Not Whether Programs Work, But How They Work. In D.L. Stufflebeam, G.F. Madaus, & T. Kellaghan (Eds.), *Evaluation Models - Viewpoints on Educational and Human Services Evaluation* (2nd ed., pp. 209-232). Boston, MA: Kluwer.

Scriven, M. (1974). Maximizing the power of causal investigations: The modus operandi method. In W.J. Popham (Ed.), *Evaluation in education: Current applications* (pp. 68-84). Berkeley, CA: McCutchan.

Teja, I.d.l., Ganesan, R., Lundgren-Cayrol, K., & Spector, J.M. (2003). An introduction to issues in the evaluation of educational technology: international perspectives. *Evaluation and Program Planning*, *26*(2), 163-168.

Trochim, W.M.K. (1985). Pattern Matching, Validity and Conceptualization in Program Evaluation. *Evaluation Review*. *9*(5), 575-604.

Trochim, W.M.K. (1989). Outcomes Pattern Matching and Program Theory. *Evaluation and Program Planning*, 12, 355-366.

Weiss, C.H. (1998). *Evaluation – Methods for Studying Programs and Policies* (2nd ed.). Upper Saddle River, NJ: Prentice Hall.

Willke, H. (1999). *Systemtheorie – 2. Interventionstheorie: Grundzüge einer Theorie der Intervention in komplexe Systeme* (3rd ed.). Stuttgart, Germany: UTB.

W.K. Kellogg Foundation (1998). *W.K. Kellogg Foundation Evaluation Handbook*. Retrieved November 11, 2003, from http://www.wkkf.org/Pubs/Tools/Evaluation/Pub770.pdf.

Yin, R.K. (2003). *Case Study Research – Design and Methods* (3rd ed.). Thousand Oaks: Sage.