Complex Learning in Multimedia Environments – Which Kind of Learning and How to do Research on it?

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Abstract

Based on an extensive analysis of a course in process automation engineering we explore the current state of research on complex learning by means of a request analysis. The analysis compared the type of research on complex learning which is needed with the actual state of the art of learning and the current relevant approaches we find today. Research on complex learning has to answer at least three questions: (1) What is a useful definition of learning? (2) What changes – how to describe what is learnt? (3) How does it change – how to describe the process of learning? We try to answer these three questions by seven theses, which describe important features of future research on complex learning.

Introduction

Learning is currently discussed with regard to many up-to-date topics like multimedia learning, lifelong learning or the PISA study on school learning. Against this background what is the state-of-the-art of learning research? The motto of the 5th Workshop of the Special Interest Group "Instructional Design" in the European Association for Research on Learning and Instruction (EARLI) is "Instructional Design for Multimedia Learning". Instructional Design is a large field concerning the planning, construction, implementation and evaluation of learning settings (cf. Schott 2001; Tennyson & Schott 1997). Learning plays an essential role in the context of instructional design. Our title "Complex learning in multimedia environments – which kind of learning and how to do research on it?" refers to a descriptive, a basic learning research. Although we are skeptical that basic learning research can be applied directly to the instructional design for multimedia learning, we think insights in basic learning processes can help to improve "multimedia learning". Learning is a large field of research. We will focus on those learning processes, which are necessary in complex (multimedia) instructional settings and require partly self-directed learning. This is called "complex learning".

How to Conduct Research on Complex Learning? Why Questioning the Current State-of-the-Art Research on Learning

The reason for our questions on learning lies in a cooperation with the Institute of Automation at the Faculty for Electrical Engineering of the Technical University in Dresden (Germany). This faculty offers the course "Process Automation Engineering" as an integrated approach for university education. "Integrated" here means that at the end of their studies the students are to design and construct an automation system as a model of an industrial plant by integrating all their knowledge learnt at university. The course is described elsewhere in more details (Janschek & Hofmann, 1997). We got the opportunity to conduct a psychological analysis of this course. From our point of view such an investigation should start with a very careful task analysis in order to get to know what one goes into. After the task analysis we carried out a participatory observation of two courses. Finally we tried to decompose the learning process concerning a subtask of the analyzed course. We tried to apply the well-known theories of learning to analyze this complex learning setting and got the impression that this does not work very well. Therefore we started two related projects. In the first project we try to construct an approach to describe complex learning, and in the second project we carry out a task analysis of the research on complex learning. This paper refers to the second project. We are not left alone with our problems on understanding complex learning for instruction. Franz Weinert, the unfortunately recently deceased director of the Max Planck Institute of Psychological Research in Munich, Germany, summarized the state of the art in research on complex learning from an instructional psychology's point of view (Weinert, 1996, p. 41). He diagnosed an unsatisfactory situation of research on complex learning: This unsatisfactory situation "also will hardly change in future on the basis of the currently preferred research strategy. Presumably, instruction continues to be the use of principles, which are only applicable by means of common sense, practical reason, and plausible generalizations of experience, but which are, although underpinned scientifically, in its true nature no principles." (Own translation). Is the situation of research on complex learning really so unsatisfactory from an instructional point of view and if so, how to overcome it? Are the current preferred research strategies inefficient? One can get the impression that the current basic research theories of learning provide not a solid basis for an analysis and improvement of instruction like in house building the physic supplies rules to develop static calculations. Weinert pinned his hopes at the development of an Educational Learning Theory (ELT). The approach of an ELT (cf. Bereiter, 1990; Steiner 1997) reflected the dissatisfaction of instructional psychologists with the current basic learning research. Despite a lot of interesting aspects, which are discussed in ELT to

improve instruction, you do not hear much about ELT anymore. It is also our impression that research on complex learning indeed has at present essential deficits. The ELT approaches started with the dissatisfaction about the relevance of current learning theories for instruction and asked the question which requirements a learning theory should meet from an instructional point of view. Our analysis of complex multimedia learning settings also led to a big disappointment about learning theories. Our reaction is more radical. We got the impression, that basic learning research has in some fields serious mistakes independent of the requirements of instructional design. Nevertheless we think, that to rectify these mistakes will also help basic learning research to be more useful for instructional design. Some of these deficits we have tried to put in a nutshell: a short task analysis of research on learning and seven theses. The task analysis is reduced to three basis questions research on complex learning should answer. For the purpose of discussion the answers focus only on seven theses. We think these seven theses form a short but coherent view of research on complex learning.

It is impossible to put this topic for discussion in a short paper and to take into account all relevant specialist literature. We are trying to develop an approach on research on complex learning, which will hopefully live up to our expectations. Because we have great respect for the previous extensive learning research of more than hundred years, we try to open a discussion of our approach. To make a complete inventory of research on complex learning is impossible, because the amount of respective publications is gigantic. What is possible is to ask, which answers we need from research on complex learning and to discuss with experts the benefit of current scientific results. Therefore we will carry out a task analysis of research on complex learning. We try to limit our arguments to the most essential points. In the following we present a very short task analysis of research on complex learning. Research on complex learning has the task to try to give answers to at least three questions:

1. What is a useful definition of complex learning?
2. What changes – how to describe what is learnt?
3. How does it change – how to describe the process of complex learning?

We try to answer these three questions by stating seven theses, which describe important features of future research on complex learning.

How to Conduct Research on Complex Learning? – Our Task Analyses on Learning Research

***Question 1*: What is a useful definition of complex learning?**

Thesis 1: It is useful to conceive of complex learning as the acquisition of world knowledge. A traditional definition of learning we find in one of the well-known books on learning in the last century (Bower & Hilgard, 1981, p. 11): "Learning refers to the change in a subject's behavior or behavior potential to a given

situation brought about by the subject's repeated experiences in that situation, provided that the behavior change cannot be explained on the basis of the subject's native response tendencies, maturation, or temporary states (such as fatigue, drunkenness, drives, and so on)." This definition probably is influenced by the Anglo-American empiricism, because it separates strictly the experience from native response tendencies and maturation. But a careful analysis of the evolution of intelligent behavior shows clearly, that learning is connected with innate aspects of behavior. Organisms have an innate system for perception, information processing, and behavior tendencies, which defines the possibilities and constraints of learning. For example, a human being perceives and learns sexual aspects in a different way before and after puberty. Puberty is not a result of subject's repeated experiences and influences contents of learning. Repeated experience, as it is mentioned in the definition above, is not necessary in any case to acquire knowledge. In the case of complex learning it is not possible to differentiate between learning and thinking. World knowledge can be acquired to some extent within the lifespan of one organism and across many life stories of organisms of a certain species. (cf. Klix, 1996). A child will hardly learn to calculate, if there is no possibility to build on a thousands years old tradition how to use numbers. Here, a definition of learning, which is up to date (International Encyclopaedia of Developmental and Instructional Psychology, 1996; p. 37): "Learning: ... is a constructive, cumulative, self-regulated, goal-directed, situated, collaborative, and individually different process of meaning construction and knowledge building." In this definition of learning, which obviously is influenced by the current constructivistic view of the teaching-learning process in educational settings, we find all modern aspects of good instruction. But there are neither research findings predicting that learning, which is constructive, and goal-directed, situated and collaborative is the most efficient one in any case nor is clear how the process of meaning construction and knowledge building is going on.

Consequences: Here our proposal of a definition of complex learning, which takes into account the above considerations: *Learning is the acquisition of world knowledge*. We try to avoid unnecessary or wrong preconditions. The world knowledge of an organism (or a machine) denotes all possibilities to react in a certain way to external or internal stimuli. It is not possible to always separate complex learning from thinking or what is innate from what is acquired from the environment. World knowledge can be innate and/or acquired and comprises not only we can realize in our consciousness, not only factual knowledge, not only declarative or procedural knowledge, but also all possibilities to react included motivations, volitions and emotions. World knowledge develops in the evolution of species (e.g. the tendency to explore the environment), in the changes of civilization (e.g. the use of numbers) and in the individual life (e.g. to know a lot of one's own). Therefore, it is necessary to take into account all kinds of previous knowledge in the wide sense as described above. That means e.g. to

pay attention to innate constraints and cultural prerequisites. Complex learning refers – as any kind of learning – to the acquisition of world knowledge. Our proposed definition of complex learning follows arguments of Klix (1996) and has in comparison to the traditional and the up to date definitions of learning the advantage to not take unnecessary or wrong preconditions for granted. Additionally, our proposed definition takes into account the previous knowledge of organisms and species no matter whether this previous knowledge is innate or acquired by experience, whether it is assembled by ontogenesis, phylogenesis or cultural development.

***Question 2*: What changes – how to describe what is learnt?**

Thesis 2: What is learnt should be described and classified as precisely as possible or necessary. At the moment, we have no sufficient insight into the physiological processes, which are the physical basis of complex learning. But even if we would, it is indispensable to analyze the observable experiences during complex learning. Otherwise there is no way to assign certain observable and experienced learning activities to certain physiological processes. This statement should not be considered as a relapse to behaviorism, because it may be fruitful in some cases, to formulate hypotheses what is going on in the mind of the learner. Nevertheless the description what and how is observably learnt is the only relative reliable basis for research on complex learning. Therefore – concerning what is learnt – an appropriate task analyses is necessary. We often miss such task analysis in publications of research on complex learning. By "observable" we mean, what we can directly detect in a learning setting. For example, we see, what the learner is doing, we hear his verbal reports about his or her thoughts during learning. When a learner draws with the method of mind mapping a certain structure of concepts on a sheet of paper, that may give us a useful impression, how he or she structures certain concepts, but that is not the cognitive knowledge structure in the mind of this learner but at best a figure with some relationship to the assumed cognitive structure. Some readers may think, we are narrow-minded at this point. Our concern here is, that in research on complex learning often too quick cognitive structure is mentioned and too seldom there is a careful description, what can be observed. Our demand of an appropriate task analysis may provoke the objection, that every task analysis is a more or less theory-driven description – therefore why not start with a description using concepts of cognitive structure and cognitive processes at the very beginning? Our answer is again: We are not against the assumption of cognitive structures and processes in principle, but we think that a careful description of the objects to learn and the behavior of the learner is a much easier and more reliable starting point for the research of complex learning. You need a relative stable crystallization point to relate different results of research on complex learning at the beginning. At the beginning? We think, we are only of the first stretch of road. Because not any single object to be learnt can be

researched on, it is advisable to define appropriate (and as far as possible, empirically tested) classes of objects to learn. Results in research on complex learning can lead to change such a classification. But you can only change something that exists. Therefore the classification of learning objects is a prerequisite of research on complex learning.

Consequences: Methods to analyze and describe behavior and behavior change as precisely as necessary should be used in research on complex learning. Procedures of task analysis should be based on a theoretical foundation (cf. Schott, 1992). We proposed such a method of task analysis, which is able to clearly separate content and behavior of a task or an instructional goal, to describe the structure of the task, to quantify content and behavior and can be used to classify objects of complex learning (Schott, 1992, Schott & Seidl, 1997). The description of learning objects has to differentiate between the gross learning object and the net learning object (cf. Schott, Grzondziel & Hillebrandt, 2001). The former refers to the learning outcome, the latter to what is to be learnt by a certain individual with a certain prior knowledge. Furthermore it is useful to take the structure of the objects to be learnt into account. We will come back to this aspect in more details in thesis 5. One relevant structural aspect of task analysis in learning research seems to us the differentiation between the surface structure and deep structure of objects to be learnt. The concepts of surface structure and deep structure are used differently in disciplines like linguistics. Here we mean by surface structure the structure of the material or the mental objects, which are perceived and manipulated by the learner directly. For example the learner operates with numbers and relationships of numbers on a sheet of paper or in her head when adding 15 and 37. May be she first adds 15 and the 7 of 37 with the result of 22 and put back 30. Then she added this 30 and 22 with the result of 52. When doing this she operates with objects – here numbers – directly. It is possible, that she did not well understand the rationale behind her addition and nevertheless comes to the correct result. Probably she never will experience, that our decimal system facilitates her addition in contrast to using roman numbers. The deep structure means references of the object to be learnt or to operate on, which may not perceived directly by the learner but can lead to a better understanding and remembering (e.g. the understanding of the procedure of adding in our decimal system). These references can be at the same level of abstraction and/or of different levels of abstraction. The former is the case in the well-known restaurant script. When at the surface level a visit of a restaurant is mentioned, it is not necessary to deal explicitly with all detailed features. The latter we find e.g. when a child learns to add. Not all aspects of adding must be realized when adding like described above. One a "deeper" level of this operation the decimal system is of relevance. Furthermore the child profits from thousands of years experience in using numbers. In other problems it will not be able to operate on such a level of abstraction. To summarize: different relations between surface structure and deep structure of learning

objects can influence the learning process and therefore should be taken into account. The classification of the learning objects is not a mere assignment to cognitive, social-emotional, and motor behavior. We like to divide learning objects in categories like head (cognitive), heart (social-emotional) and hand (psycho-motor), but these do not need to be psychologically useful distinctions. The contrary can be the case: this classification prevents learning psychology to treat cognitions, emotions and motivations in an integrative way (cf. thesis 6). We have the impression, that in many cases of research on complex learning the careful description and classification of learning objects and how the learner treats it, is a much more reliable starting point than too hastily invent internal cognitive processes and just looking for learning objects, which perhaps can indicate in an experiment that this invention has some evidence. In a word: a careful analysis what happens when a person learns a certain matter with a certain structure shows great promise in the research of complex learning.

***Question 3*: How does it change – how to describe the process of complex learning?**

Thesis 3: The great variety of learning theories is an obstacle in the way of fruitful research on complex learning. If we look in textbooks, which deal with learning or educational psychology, we find a more or less large variety of learning theories. At the first glance, this great variety of learning theories seemed to be fruitful for scientific progress: variation is a precondition of selection, like in evolution. But what varies, are not theories of the same species. Therefore there is no efficient selection. Often we find arguments, that this variety is a welcome enrichment, because for every single theory, there are useful applications, and the hope of unifying theories in psychology is unrealistic in a time of great diversification in the field. These are strange arguments. To find possible examples for a certain learning theory is an easy job: as in most of the points of view you can find what you are looking for – you cannot prove any theory this way. To describe all relevant phenomena in one unified theory was very successful in disciplines older than scientific psychology. Probably the intention to establish operant conditioning as unifying learning theory in the past deter scientists to invent new unifying theories on complex learning. The attractiveness of the theory of operant conditioning is based on at least two effective aspects: First, it is a simple and therefore easy-to-use concept. Second, it meets a relatively general principle: variation and selection what is good for a certain organism. As above mentioned, operant conditioning went to far in unifying because it requires to be valid for a wide range of organisms from an earthworm to a human being and a wide range of learning objects from pressing a lever in the Skinner box to acquiring the expertise as a famous pianist. Operant conditioning and other stimulus-response theories of learning are more instructional settings than theoretical descriptions of the learning process. They describe, how to arrange an instructional setting,

e.g. in order to learn to press a lever, but they say nothing about the learning process itself. To look at learning as a sort of information processing in cognitive psychology is another attempt to construct a unifying theory in cognitive science. But the first flowers of promise in cognitive psychology are wilted. In his reflection on the past decades of cognitive psychology Neisser (1994, p. 226) complains: "The concept of information processing in psychology soon led to a vast proliferation of model-making and model-testing, from which we have learned more and more about particular paradigms but less and less about the forms of cognition we really want to understand". One problem of this long-term full of promise approach is the same like of the physiological basis of learning as described in the explanation of thesis 2. To get out of the way of the problem to describe precisely observable learning behavior by taking refuge in the current attractiveness of hypothetical human information processes or in the supposed objectivity of neuronal processes will not lead to a better understanding of complex learning. You never will understand, what you are not able to describe!

Consequences: We think the possibilities to look for basic principles and an integrative approach within learning theories as unified as possible are currently not exhausted. It is necessary to take into account the actions of individuals in their world as systemically and holistically as possible. This leads us to the next thesis.

Thesis 4: Research on complex learning has to hold a subjective, inter-subjective and multi-perspective view. In psychological research it is useful to distinguish two points of view: a subjective view, and an inter-subjective view. In research on complex learning we first have to take into account the subjective view of a learner, e.g. his or her impression of the object to be learnt included the concerning individual feelings and prerequisite knowledge. Second, we intend to collect data of learners and to construct and test hypotheses on complex learning as unbiased as possible. For this reason, we try to test our statements on complex learning by the agreement with other informed subjects – we try to get an "inter-subjectively" shared view of the engaged scientists. We can stop here and be sure to meet sufficient epistemological correctness. But we find it useful in psychological research to add a third view, named "multi-perspective view" of the scientists, which can be treated within the inter-subjective view, but is better mentioned extra. A central object of psychological research is the experience and behavior of human beings. The research on directly produced or elicited experience and behavior can lead to forget those aspects of psychological phenomena, which are not at the current observable surface or which are not up to date in the contemporary theory discussion. In the case of research on complex learning take objects to be learnt as example. For instance, as mentioned, it would be impossible for a child to learn to calculate in its ontogenesis without the background of thousand years mathematical

development in the phylogeny of human beings. That is why, other tasks with a comparable degree of abstraction are certainly much more difficult to learn for that child. Another example: social learning is influenced by behavior tendencies we share with some highly developed mammals living in groups (cf. Bischof, 1989). This world knowledge (in the broad sense as defined in thesis 1) progressed during phylogeny or cultural development was also reason for the above proposed definition of complex learning. Research on psychology in general and on learning especially has the problem, that humans are the research objects of humans. We are prejudiced against us and adapted to us and mostly do not realize this like a sweating man does not smell his sweat (cf. Bischof, 1985). A lot of findings in learning research are regarded as a matter of course and therefore not of scientific value. Other problems are not perceived because of our incompetence to take a view on us outside of us. To take multi-perspective views can help us to reduce these problems. Perhaps the word "multi-perspective view" can be misunderstood. We are not able to view beyond our possibilities to perceive our world at the first glance. Nevertheless we can reconstruct aspects of the "real world" beyond our direct perception. If we say: "this piece of wood and this piece of plastic contain both carbon", we speak of this "real world" in a way, which can be useful. The multi-perspective view, as understood in this way helps to look for understanding of the "real world" of psychological phenomena, of some transcendence beyond our direct possibilities to detect the world. This understanding is easier in physics or chemistry. After hundreds of years of research it is normal in these disciplines to think about objects and phenomena beyond our direct possibilities to detect the world. If we stand in the woods of our psychological world it is natural to be not able to see the forest for the trees.

Consequences: To get a better multi-perspective view (as defined above), it is useful to analyze the same complex learning process from different perspectives as they are offered by different disciplines of human behavior like cultural history, sociology, behavioral research of animals, philosophy. How to reach more understanding here perhaps should be a matter of a theoretical psychology, which takes into account the epistemological problems of research on complex learning.

Thesis 5: The interaction between the structure of the objects to be learnt and the process of complex learning should be taken more into account. It is useful to take into account the structure of the objects to be learnt. This requirement sounds to be taken for granted for persons with common sense outside psychology are engaged in teaching or training. In psychology, a lot of learning theories ignore the relevance of the structure of the objects to be learnt. The interaction between the structure of the objects to be learnt and the process of complex learning was neglected in S-R learning theories. In the theory of operant conditioning e.g. the immediate consequence of a reaction controls the

frequency of this behavior independent of its content. Proponents of this theory like Skinner (1977) tried to apply this approach to all phenomena of behavior, e.g. in teaching (programmed instruction) and in therapy (behavior therapy). Using this theory in instructional design in the 1960ies, Gagné was disappointed of the promises of operant conditioning and developed an approach, which took into account all at that time well-known learning theories. He assigned different types of objects to be learnt to different learning theories. After the turn to cognitive psychology in the USA he changed the learning procedures in accordance with the new development (Gagné, 1985). He replenished his approach by steps relevant to any instruction, the so-called "nine events of instruction", like gaining attention, giving feedback. On the one hand Gagné's approach liberated instructional design from the one-sidedness of operant conditioning and was for some decades an important method to develop teaching and training. On the other hand today Gagné's differentiating approach seemed to be replaced by simpler approaches like "cognitive apprenticeship" (Collins, Brown & Newman, 1989) or "situated learning", which are unspecific concerning the structures of the objects to be learnt. In our experience (Schott, Grzondziel & Hillebrandt, 2001), the nine events of instruction provide also today a solid ground for prescriptive applications in instructional design, whereas available theories on complex learning are not able to do the job better. One of the reasons for this deficiency is in our opinion the lack of systematic research on the interaction between the structure of the objects to be learnt and the structure of the learning process, which is very important for the instructional design of multimedia learning environments – despite the fact of the extensive research on complex learning objects in the last decades cognitive psychology. At first glance, modern cognitive psychology seemed to be interested in the interaction between the structure of the objects to be learnt and the learning process. We find rough differentiations like between declarative and procedural knowledge with different expected consequences for the learning process. We also find a correspondence between the content structure of the object to be learnt and its expected internal representation, for example as semantic network. What we miss is more research on the possible assignment of different structures of the objects to be learnt to different learning processes. For example: what is the difference in the learning process to acquire the factual knowledge of the concept of negative feedback in system dynamics and to acquire the ability to construct examples for negative feedback in different fields of applications. In thesis 2 we demand that what is learnt should be described and classified as precisely as possible or necessary. Additionally, a systematic analysis of learning objects concerning their influence on the learning process should be an important objective of future research on complex learning. Both should be theory-driven, the systematic analysis of learning objects by a task analysis and the description of the learning process. How to combine these two sets of theories? That will be an iterative process to improve the relationship between

these two sets of theories, but, as mentioned above, we prefer to stress at the more solid ground of description of learning objects and observable learning behavior. Sometimes there is even an interaction between the way a task is presented and the way, how to act on it. When the task is to count coins, it is easier to arrange them in a representation of groups with five pieces.

Consequences: For a systematic analysis of learning objects concerning their influence on the learning process it is not sufficient to look at different realms of meaning or didactic of different subjects like mathematic, physics or whatever. These different historically matured subjects do not need to reflect different types of complex learning. What is useful is to classify learning objects in their function for human actions. Second it is a parsimonious hypothesis that humans have a set of cognitive operations like knowing, comparing, analyzing, categorizing, and so on, in order to act in a certain environment in a certain way. But this is a hypothesis, which needs to be verified by further research in which we are currently engaged.

Thesis 6: *Often demanded, seldom realized: emotions and motivations should be treated in research on complex learning as a potential integrative part of the learning process.* If you read a text, you have a feeling about whether you understand it or not. You will not develop carefully all questions you should answer correctly to examine if you really have understood the text. According to our research experiences feelings, emotions and motivations not only influence the learning process as a whole as an individual trait, but also control the sequence of this process to some degree as changing states from one moment to the next. As far as we could see in most of the studies analyzing the influence of emotions and motivation on the learning process, these feelings and tendencies are only added to cognitive processes, they are not treated as an integral part of the cognitive process. For the most part only means of experimental and control groups are compared and the influence on the sequence of the individual learning process is "meaned out" statistically.

Consequences: The interaction between the change of emotions and motivations during the individual learning process and the sequence of learning actions should be analyzed more intensively in future (but see Kort, Reilly & Picard, 2001, for a corresponding approach). Currently we do research on this topic. This research brought us to the last thesis.

Thesis 7: *Research on complex learning should pay more attention to the external learning process controlled by action regulation.* In current cognitive learning research often a hypothetical internal process is assumed and an appropriate experiment to confirm this process is looked for. This research procedure is a possible but not the only one. The risk of this procedure is twice. First, the internal processes are currently very hypothetical. Second, looking for appropriate experiments for this very hypothetical processes may lead to results

far from any ecological validity. Analyzing the external learning process, that is, what the learner observably does and reports, combined with learning objects described and classified as precisely as necessary (cf. thesis 2) should be more reliable in most of the cases. In complex (multimedia) learning environments or e.g. when the learner prepared himself for a final exam, the regulation of different actions is necessary to acquire the demanded expertise. To regard the learning process as a kind of action regulation may be a contribution to a multi-perspective learning theory, because action regulation on different levels is a universal feature of organisms and intelligent machines.

Consequences: We need methods, which more or less generally describe how the individual observable actions of complex learning are regulated – including the verbal reports of the learner concerning thoughts, motivations, and emotions. We can call this temporary proposal to construct a model how the interesting behavior is controlled, a cognitive process model. Calling it a temporary functional model would be more honest. If, for example, there is mentioned "the cognitive representation of this or that kind of knowledge", often we cannot find information about the form of representation and how it works. Then the word "cognitive" is nothing but a trendy hollow word, which sells the addressees false promises of the scientific nature of the concept concerned. Not to be misunderstood: we are not against hypotheses about internal processes of learning! The only thing we want to stress is, that in many cases of research on complex learning it may be more useful to spend more research energy on analyzing what we can observe and analyze more reliable than suspected vague isolated internal processes, especially when we take into account the aspects of the seven theses in this paper. Instead of proceeding in often fruitless average-value-psychology and hypothetical-internal-process-driven experiments, research on complex learning should stress more the analysis of external learning processes (including verbal reports of the learner), their interactions with the structure of carefully described and classified learning objects and the individual action control of the learning process – shortly: Research on complex learning should be phenomenon-driven if we shall overcome the current unsatisfactory situation as cited according to Weinert at the beginning of this paper. The presented seven theses can serve as guidelines for further research into phenomena regarding complex learning.

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