A Concept for Model Driven Design and Evaluation of Knowledge Transfer

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Abstract
How to design the process of transferring knowledge is a fundamental challenge in business processes and in education. This contribution reviews conceptual and operational models of knowledge transfer regarding their explanatory and descriptive power, leading to the conclusion that a closed concept to design knowledge transfer, its operational fulfillment and evaluation is missing. Addressing this in a first step, a conceptual model of factors influencing knowledge transfers was elaborated and a pre-study to measure the impact of the factors on the success of knowledge transfer in an educational setting conducted. Finally, the predictive suitability of operational knowledge transfer descriptions has been evaluated.

1. Introduction

Initializing knowledge transfers is one of the most important tasks of knowledge management. However, no integrated concept or model for the design and optimization toward efficiency or quality exists. This contribution aims to close this gap. The goal is to evaluate the influence of varieties in action, behavior, motivation and other influential factors that contribute towards knowledge transfer success. In order to achieve the goal, a preliminary experiment in which a specific knowledge transfer in an educational setting occurs is conducted.

The long term goal is to develop an empirical model of influential factors determining knowledge transfer success. The model could be used to evaluate existing knowledge transfers and serve as a design guideline for to-be knowledge transfers, e.g. within knowledge intensive business processes. Ultimately, this approach contributes to an increased process quality.

This work evaluates existing theoretical concepts for knowledge transfer in the second section. The evaluation is extended towards a review of current approaches of modeling knowledge intensive business processes, which are expected to reflect a more on activities and therefore provide an operational point of view on knowledge transfer.

Based on this, a first version of a model of variables that influence knowledge transfer success is drawn in section three. Additionally, it is outlined how the general knowledge transfer concepts allow different variants of knowledge transfer. An already established modeling technique was used to create models of these variants for illustration and conceptional purposes.

Selected variants are evaluated in a pre-study with an experimental design applied to 89 students in section four. This pre-study verifies influential factors and evaluates practical measurement settings. Therefore, multiple teaching situations based on the theoretical background of knowledge transfer and teaching methods are outlined and standardized tests to prove knowledge transfer success were set up.

The last section contains an outlook on further research.

2. Theory of Knowledge Transfer

The identification, design and professionalization of knowledge flows are typical goals of common knowledge management approaches in general [1-4]. The term knowledge flow or knowledge transfer can be criticized as knowledge is always related to context and a human mind [5]. However, the constructivist view on knowledge sees its continuous (re)creation based on communication and information. Following this approach, both knowledge flow as well as transfer can be used but refer to knowledge externalization and internalization or recreation of similar knowledge [5, 6]. First conceptual models for knowledge transfer are
presented followed by an evaluation of approaches to describe operative knowledge transfer.

2.1 Conceptual Models of Knowledge Transfer

General models describing knowledge transfer are developed by [6-8]. Krogh / Köhne [7] split the knowledge transfer in different phases: In the Initiation phase, an assessment regarding kind and scale of the knowledge transfer is being carried out by the sender. Following is the phase, the actual knowledge transfer (here called “knowledge-flow”), which is known as critical, because it is influenced by most of the factors takes place. Among others, the kind of knowledge which has to be transferred (tacit, explicit), the kind of transfer and its intensity, the involved persons (motivation, attitude etc.) and the organisational culture have an impact on this phase [9]. The knowledge transfer occurs by interaction and communication and takes place consciously as well as unconsciously. The transfer of implicit knowledge is more difficult and it can occur by direct interaction between people, e.g. in a situation of instruction [10].

After the end of the knowledge transfer, the integration phase starts. In this phase the receiver integrates the newly learned knowledge to his own knowledge basis, respectively in its actions and helps to institutionalize it in the organization. Knowledge Transfer can also be interpreted as a communication process: The information source selects a required message from a set of possible messages. This message is being coded by the transmitter/encoder and translated by the channel, which can be affected by disruptive elements. It is therefore necessary for the receiver to separate the actual signal from the accompanying disturbing noise. Afterwards, the message is being decoded by the receiver/decoder. Errors can occur in every component of the model [8].

To illustrate this, we examine a communication process between two persons via spoken language. The information source is here the speech center of person A’s brain, who talks to person B. Using the vocal cord (transmitter/encoder), the person converts the sentences (which should be communicated) from digital signals into sound waves. These are transmitted by air (which is the channel). In this scenario Person B symbolizes, both the receiver and decoder and the destination. At first, the sound waves are being received by the ear and again decoded into digital signals. These are being translated to the speech centre of person B.

Maier [6] extends this general model to include knowledge transfer between two individuals. His concept is depicted in Figure 1. Consequently, the component called „knowledge“ is the knowledge contained by the brain, which initially has to be explicated and then transferred by sensors and activity systems (here e.g. by communication tools such as eyes, ears, mouth and nose). The signals which have been received during a communication, can be reconstructed to knowledge and can be integrated in the own mental model.

In conclusion, all concepts reflect the three phases introduced in [7]. The initiation phase concerns itself with the preparation of knowledge transfer and the integration phase with its post-processing. This

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**Figure 1: Model of Knowledge Transfer**
contribution focuses on the actual knowledge transfer, which takes place in phase two (knowledge-flow). According to [7], all important influence factors are settled in phase two like for example the kind of knowledge which has to be transferred, the kind of transfer and its intensity, the involved persons and the organisational culture. In this contribution, phase one and three are not of primary interest.

In summary, these models provide general factors that influence knowledge transfer, such as communication channel(s), the selection of the message (sender) and the integration of the message through the receiver. Easily multiple variants how to perform an actual knowledge transfer can be derived. However, none of these conceptual models allow a description of knowledge transfer on an operational level, e.g. by illustrating the course of actions or variants as described above.

2.2 Operational Models of Knowledge Transfer

The previously introduced conceptual models are explanatory and not suitable to be applied as personal strategies and methods towards actual knowledge transfer (such as teaching methods). Therefore it is necessary to have a descriptive modeling approach which integrates more details on the operational perspective. We refer to this as micro perspective.

Business process modeling is a well known and widely accepted method to describe work procedures and order(s) of activities eg. for business process management / reengineering or during the design of information systems [11, 12]. The model itself represents an artifact of process knowledge and can be used for communicating on the process. However, classic business process models usually do not describe knowledge required to perform the tasks and do not reflect detailed knowledge related activities [13]. The idea of using a (process) model to analyze current knowledge activities and to develop a to-be concept of knowledge management led to the development of various modeling languages (e.g. [14-17]), which extend classic business process models by knowledge objects and include knowledge activities.

An advantage of process oriented knowledge management is the ability to tie knowledge flows towards the actual tasks within business processes. Knowledge transfers are often described using predefined phases between knowledge creation and application [13, 18]. However, these knowledge activities such knowledge creation, knowledge storage, knowledge distribution and knowledge use do not reflect the influential factors identified above. In general these processes are suitable to define knowledge transfers on a macro perspective paying more attention towards their actual identification and manifestation. The micro perspective however, which includes individual methods of transfer is overlooked.

Also, process descriptions are on a type level and therefore cannot reflect individual attributes of the participating actors, which are human individuals. This results in an incomplete reflection of the organizational knowledge base, as tacit knowledge is tied to individual persons.

2.3 Knowledge Transfer modeling with KMDL

As opposed to other languages for business processes modeling and knowledge related activities, the knowledge modeling and description language (KMDL) [17, 19, 20] facilitates the visualization of tacit knowledge through integrating individuals and allows to describe variants and instances of knowledge related activities through its conversion based view. Therefore in this contribution the modeling approach KMDL is used. It is only briefly introduced in here due to space limitations (please refer to [17, 19, 20] or http://www.kmdl.de for a full introduction). Figure 2 contains selected objects included in KMDL.

The recent version 2.2 of KMDL uses three layers which are also called modeling views: The process-based-view, the activity-based-view and the communication-based-view.

The process view describes the operational course of the business process from the perspective of the process steps. This layer shows which task should be completed before the next task begins and which alternatives exist. The assignment of tasks to each resource also takes place in this layer. These tasks describe the logical sequence of the business process and are executed by roles.

The activity view provides a more detailed description of the knowledge conversions performed to complete tasks in the process. It is commonly used only for the knowledge intensive tasks identified in the process view. These tasks are analyzed closer and decomposed into knowledge conversions. These conversions are derived from the knowledge generation concept introduced by [10]. Four conversion types can be differentiated:

- From tacit to tacit knowledge: Socialization means the exchange of experiences, where shared mental
models and technical skills can be created. This can happen for example during a personal dialogue or through imitation. Tacit knowledge is gained through experiences.

- From tacit to explicit knowledge: Externalization means the articulation of tacit knowledge into explicit concepts. Tacit knowledge can be expressed in a way that it will be understood by third parties using for example metaphors, analogies or models.

- From explicit to explicit knowledge: Combination: Existing explicit knowledge is put together by combination, resulting in new explicit knowledge. Different forms of explicit knowledge can be added to the existing knowledge through the use of media like for example telephone calls, e-mails or reconfiguration and categorizing.

- From explicit to tacit knowledge: Internalization: Internalization means the conversion of explicit to tacit knowledge. It is very closely related to learning-by-doing. Experiences gained through socialization, externalization or combination can be integrated into the existing individual knowledge basis. This way, it becomes part of the individual know-how or a mental model.

Conversions are used to describe intermediate steps that eventually lead to the desired knowledge, which then is used to perform a task. By studying the origin of knowledge and information objects, their use as well as knowledge flows, statements about the creation of knowledge and information and their use within the process can be made. Each conversion uses information and knowledge objects as input and generates output as information and knowledge objects. Knowledge objects reflect tacit knowledge and are always attached to persons. Attributes are used to describe the qualification of each knowledge object. It is possible to define requirements for every conversion. A differentiation between functional, methodical, social and technical requirements is made. The technical requirements can be covered by functions of information systems. The coverage of the remaining requirements is ensured by - also differentiated - knowledge objects of persons / teams. Start- and end-objects of conversions can be both information objects and knowledge objects. Knowledge objects can be related to persons, teams or undefined persons. A task at the process-based-view can consist of multiple conversions and means an abstraction of the application area.

The communication-based-view provides the basis to model the communication within an organization.

KMDL includes a procedural model in order to identify, visualize and improve knowledge intensive business processes. It facilitates an integral visibility of knowledge flows within the modeling of business processes.

In this contribution only the modeling language is used. A focus is set on a process describing a knowledge transfer task and on corresponding activity views, which map specific knowledge related conversions of various kinds within this business process.

KMDL activity view models are therefore able to fill the black boxes of the knowledge transfer micro perspectives. In this contribution we utilize KMDL activity view models to describe to describe and communicate the anticipated variants of a knowledge transfer for our experiment.
3. Designing variants of Knowledge Transfer

This section outlines variants for knowledge transfer in an educational setting, which we use for our preliminary tests. The above described KMDL is used to model and describe the actual operational knowledge transfer.

3.1 Teaching methods

Whenever knowledge is being transferred from one person to one or multiple persons, the learning depends on two factors: First, how the knowledge is being transmitted and second how it is being received by the student. Within the knowledge transmission, the educator plays a critical role in the learning process. The teacher’s behaviour in the classroom impacts on many different areas of the learning process. For example his preparation, the classroom presentation, learning activities and approaches to the assessment of learning affect the outcome [21]. The “teacher’s personal behaviours and media used to transmit data to or receive it from the learner” is called teaching style [22], involving the philosophy applied by the teacher about teaching.

The scope and nature of teaching styles have been characterized by identifiable descriptors, such as reactive or proactive [23]; highly people or content centered teaching [24]; learner-centered to teacher-centered [25, 26]; or exposition, guided learning, or inquiry approaches [27]. [28] determined the six most common methods of University education which are: traditional lecture, business games, audio-visual instruction, case study, computer assisted instruction, guided inquiry / activity. [29] presents the following list of college teaching methods: lecture, various lecture-discussion, the discussion group with or without formal leader, combinations, autonomous small groups, independent study with various degrees of supervision, laboratory methods, enquiry learning and project methods. [30] classifies methods into progressive and traditional. Progressive methods focus on student centered teaching, where each student is in the centre of the teaching effort, letting the student participate. Traditional methods do not allow the student to participate. [31] classifies teaching methods into traditional lecture, interactive and group case study based.

3.2 Experimental Setting

We selected a highly people centered guided inquiry teaching setting to evaluate the success of various knowledge transfers variants. As the taught subject is a relatively new method, students were not expected to have any prior knowledge on KMDL.

A human experiment to test the success of variants of knowledge transfer in teaching situations was conducted. The human experiment is commonly used in behavioral and medical science. From a moral point of view it requires knowingly and voluntarily involvement of participants. Therefore, the students were informed about the experiment and the option to leave was given. In all groups knowledge was transferred, however not in all groups the optimum approach was taken. The teaching approach was randomized, hence differed between the groups. To minimize problems from unequal treatment, especially for the final course exam, students were provided with information on the subject after the experiment to close potential gaps. Further, we issued the results of the tests as an additional feedback. We think these experiments led to an overall reflection on the subject both for teachers and students.

Figure 3: Classification of the tutorial held

The study took place in the winter-term of 2009/2010 and was meant to be conducted in a tutorial of the faculty of business administration and social sciences at the University of Potsdam. After checking the course offerings, it was decided to carry out the experiment within the context of the Business process management lecture.

We used a tutorial design with two phases: during the beginning of the tutorial, presentations were held by the students regarding various business process management concepts like for example Event Driven process Chains (EPC). Afterwards, the students were asked to model and explain business processes based on an exercise. This resulted in a two-phased tutorial where the first part was more like a lecture and the second part consisted of independent student work.
Following [32], the tutorial held during the experiment can be classified as depicted in Figure 3.

The tutorial took place in a computer lab of the faculty and the students worked for the practical part with the computer. However, no technical instruments or e-Learning environments were used.

In the practical (second) part of the tutorial the tutors function was mostly explaining and care taking, meanwhile the students tried to cope with the asked exercises. 89 students were distributed among five separate sessions. Even though, the division into the different exercise-groups was random, there were some characteristics which had to be taken into consideration in the evaluation. Because there were five groups of students a manipulation of the level of didactic care was possible.

The experiment took place on two consecutive days. On the first day were three surveys and on the second day two surveys. No measures were taken to prevent students that students transfer the solution or hints inbetween test groups.

A standardized multiple choice test was used to measure the success of knowledge transfer.

### 3.3 Variants of knowledge transfer

As discussed, the KMDL modelling approach is used to plan knowledge transfers. Once concept could be a classical lecture or a tutorial. This is very close towards the general concepts for knowledge transfer discussed in section 2.

However, the anticipated teaching situation involves two phases of knowledge transfer and cannot be described with a simple monodirectional knowledge transfer. By using KMDL activity view it is possible to describe even the complex knowledge transfer situations anticipated. Figure 4 depicts such a knowledge transfer reflecting personal interaction by questioning the tutor through students.

Five variants of knowledge transfer were set up to determine the influence of factors on its success as shown. It was planned to modify only the level of didactic care during the two phases by using variants of the operative knowledge transfer. This results in the level of didactic care being the controlled variable. The level of didactic care is described in more detail for each experiment in table 1.

<table>
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<tr>
<th>Group</th>
<th>Variant of knowledge transfer</th>
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<tr>
<td>1</td>
<td>- low didactic care</td>
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<tr>
<td></td>
<td>- mid-level of autonomy of test persons</td>
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<td></td>
<td>- peripheral, indirect walkthrough of test exercises</td>
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<td>- unsure appearance of the tutor</td>
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Table 1: Variants of knowledge transfer in the experimental teaching situation

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| 2 | - mid-level of didactic care  
- low level of autonomy of test persons  
- peripheral, indirect dealing with test exercises  
- competent appearance of the tutor |
| 3 | - intense didactic care  
- very low level of autonomy of test persons  
- very competent appearance of the tutor  
- peripheral, indirect walkthrough of test exercises  
- Erasmus Students, some are facing language barriers |
| 4 | - very low didactic care  
- tutor leaves room during autonomous work of students  
- high level of autonomy of test persons  
- very competent appearance of the tutor |
| 5 | - mid level of didactic care  
- Tutor stands in front of class during autonomous work of students and only answers questions  
- middle level of autonomous work of students  
- very competent appearance of the tutor |

4. Prestudy

The next section describes the identified influential factors and hypotheses. Afterwards results from our prestudy are presented.

4.1 Influential Factors and Hypotheses

Based on the defined variants of knowledge transfer the following influential factors have been identified:

Technical influence factors (non controlled):
- Projector: KMDL was introduced using projected slides.
- Screen sharing of student solution: A randomized group of students elaborated the solution of an exercise. The content of their screen was shared with their peers. The quality of the solution was manipulated in one group, to prove its effect on the result.

Didactic influence factors (controlled):
- Didactic care / Autonomic exercise solving: The level of didactic care during the independent work phase can vary. The manipulation of this influence factor took place through actively creating a discussion (high didactic care, simple answering questions or leaving the students work unattended. With lower level of didactic care, a higher degree of autonomous work by the students was required. Each tutorial was split in two sections: an introduction and an independent work phase. In the first phase, the test persons were briefed in the basics of a modelling tool and afterwards a first knowledge-conversion was modelled together. In the second phase, the test persons tried to work on an exercise autonomously.
- Tutor preparation (uncontrolled): The confidence in the intercourse with the knowledge which has to be transferred is defined by the knowledge-carrier. His intercourse has an impact on the success of the knowledge-transfer.

Cultural influence factors (uncontrolled):
- Language skills: As language skills, the language barrier in group three, with which the Erasmus students had to deal during the experiment, was understood. It was tried to antagonize this barrier with a high level of didactic care and a high level of confidence from the knowledge-carrier but the language skills itself could not be influenced.
In our pre-study the following two hypothesis were tested:

H1: An increased level of didactic care of the tutor leads to a higher knowledge-transfer success.

H2: Collective development of new knowledge by interaction of knowledge-carrier and knowledge-receiver leads to a higher knowledge transfer success than autonomous exercise solving of students.

4.2 Experiment course and results

The content of the first tutorial was released to the tutor only few minutes before the tutorial started. Therefore, the tutor did not have the chance to prepare a valid solution for the exercise. Hence, he developed the solution together with the group of students using the white board. The level of didactic care in group two could be increased, since the solution of the exercise was known. With the second group, the tutor had a mentoring role and therefore could respond with more detail to the students’ queries. In group three the independent work of the test persons was increased and the tutor’s influence was decreased during the autonomous work phase. This resulted in a lower level of didactic care. All tutorials were structured in an identical manner. Following the instructions on using a modeling tool presented by the tutor, was the phase of independent work. Part of the individual work phase was the preparation of a given exercise by the students. Afterwards two students were chosen to present their solution to all others via a projector. While on day one, the quality of the solutions found were about equal, in the last group of the second day a completely correct solution was created (group five). This has an unplanned impact on the learning effect. As shown in table 1, the level of autonomy in group 4 was the highest, as the tutor left the room during the independent work phase and therefore no didactic interaction could happen.

Group five was planned to have a medium level of didactic care with mostly independent work. However, even though the possibility of interaction was given, it was hardly used. Student queries were very rare. In addition purposely a wrong solution of the students exercise was presented.

The level of independent work in these two groups was about the same and even though the level of didactic care in group five was slightly higher, group 4 achieved better test results. This is caused by the display of a correct solution. The amount of correct answers in the test, which is used as indicator for knowledge transfer success, are displayed in Figure 6. As a consequence the level of didactic care obviously does not directly influence the knowledge transfer success or the effects of other influences interfere. As a result H1 can falsified.

![Figure 6: Test results for H1](image)

![Figure 7: Test results for H2](image)

The test results for H2 are depicted in Figure 7 and were linked towards the two phases of the tutorial. The answers to Questions 1, 5 and 6 can be deduced completely from the introductory part presented in the interactive section of the exercise, on which the test persons worked collectively with the tutor. The answers for questions 2, 3 and 4 can be deduced from the independent, autonomous work phase of the exercise.
The collective development of new knowledge for the knowledge-receiver with help of the knowledge-carrier, leads to an increased success of knowledge, in comparison to independent and cared work of knowledge-receivers.

With this deduction, on the basis of the data-analysis, hypothesis 2 can be accepted.

5. Conclusion and Outlook

In this contribution knowledge transfer in an exemplary teaching and educational setting is evaluated. First, theories of knowledge transfer and its describing models, both conceptional and operational, are evaluated. An operational modeling approach was chosen, capable of describing the course of actions of a knowledge transfer. However, no approach for predicting knowledge transfer success is available.

The results prove that the didactic care (here: the course of actions performed to transfer knowledge) is not the only key to knowledge transfer success. During the design and conduction of our experiment, we found, that the course of actions is only one among many influential factors towards knowledge transfer success.

A first draft of dependencies in an empirical model has been developed (see Figure 5). A second problem faced was the degree to which a knowledge transfer can be planned ahead. This is due to the dynamic nature of the course of a tutorial where factors of the sender and receiver influenced themselves reciprocally. In our experiment this is reflected by e.g. by the routinization of the tutor and the correctness of the exercise solution of the students (let alone their motivation). In one case even language barriers could be assumed. None of these factors were taken into account when designing the knowledge transfer in a model. In conclusion, planning the knowledge transfer (in models) only has a limited reach and can be referred to as guidelines only.

Models of knowledge processes currently have no means to design or predict the success of knowledge transfer as they are not reflecting major influential factors of both sender and receiver. Based on these findings the following need was identified:

- A more precise method for description of knowledge transfer with a model reflecting influential attributes of the sender and receiver based influences and success factors of knowledge transfers
- An empirical foundation for the evaluation and design of knowledge transfer success.

To conclude the research, an extension of the dependency model with additional factors is planned. Besides the sender and receiver based factors, influence through methods of the first and third phase of knowledge transfer as indicated by [7] are assumed. These influential factors need to be incorporated into the model of knowledge processes. With these extensions of the model, the design of knowledge transfers should be improved in the future.

References


