Knowledge Transfer in Teaching Business Process Management Supported by a Layered Model

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Abstract: Learning and teaching requires the transfer of knowledge from one person to another. Due to the relevance of knowledge many models have been developed for knowledge transfer. However, the process of knowledge transfer has not yet been described completely and the approaches are too vague to facilitate its implementation. This paper contributes to a better understanding of knowledge transfer to support knowledge transfer in teaching. To address this challenge, we depict a layered model for knowledge transfer. The model structures the transfer in several steps and thus identifies major influencing factors. The paper describes the knowledge transfer from one person to another step by step. An example in the area of teaching business process management illuminates the process. The main contribution of this paper is the development of a layered model and its application in teaching.

Keywords: knowledge transfer; teaching; business process management.

1. Introduction

In this paper the authors will discuss the transfer of knowledge and the challenges that accompany this process. Due to the complicated transfer of knowledge from one person to another, transmission, misunderstanding, misinterpretation or no result at all are possible consequences. To avoid errors during the knowledge transfer a good understanding of the process is crucial. Due to the relevance of knowledge many models have been developed to explain the knowledge transfer from one person to another. However, the process of knowledge transfer and influential factors are still not fully understood (Maier, Hädrich, & Peinl, 2009). Powell and Ambrosini (2012) argue that knowledge transfer is of great importance for the competitiveness of organisations. Because of the importance of knowledge transfer, both for organisations and for individuals, it is essential to improve the understanding of knowledge transfer. Nonaka and Takeuchi (1995) presented the Socialization, Externalization, Combination, and Internalization (SECI) Model as an approach to describe knowledge conversions. However, even this model leaves open questions. Spannagel (2007) points out that knowledge has a context and that the transfer from one person to another is not directly possible. Rather, the recipient must actively construct the knowledge.

This also applies for its application in teaching. It is the goal of this paper to make a contribution to provide a better understanding of this process. The approach used in this paper is based on “A Layered Model for Knowledge Transfer” (Schiele, Laux, & Connolly, 2013). The focus of this paper is on the utilisation in the area of teaching and learning. Business informatics is an interdisciplinary science, where the students acquire knowledge in the field of informatics as well as in business administration. An interesting subject is business process management (BPM), since the knowledge of business administration in combination with the knowledge about informatics is a great advantage.

When CEOs argue for BPM and support its application, it represents an important management strategy. All operations of the company, in every location, can be managed by BPM. Schmelzer and Sesselmann (2013) specify BPM as a management approach that helps a company to handle challenges such as globalisation, rapid technological development and increasingly shorter product life cycles. This is achieved by modelling, optimising and monitoring of all business processes of the organisation. As defined by Scheer and Nüttgens (2000) a business process is a description of activities in a sequence with the goal of value creation. The business process includes the complete sequence of activities from the start to the end.

In teaching the way the knowledge is transferred plays an important role. For example, Spannagel (2007) points out that the exercises used in teaching programming are often not suitable to support learning. He indicates a lack of relation to reality and excessive simplification of the task as the main cause.

This paper is structured as follows: Section II discusses and provides working definitions of data, information and knowledge. Furthermore, concepts such as communication, knowledge conversion, knowledge transfer and learning are presented. Section III reflects critically on existing communications models. Section IV proposes a model for knowledge transfer that structures the transfer in several steps. Section V illustrates knowledge transfer in the field of teaching. For this purpose the explanation of the basics of business processes are used as an example. Section VI draws conclusions and discusses future directions.

2. Foundation for Knowledge Transfer

This section intends to set the foundation for the model described in Section IV. The terms data, information and knowledge are discussed and distinguished from one another. The process of communication is explained and different types of knowledge conversions are covered, as well as challenges in knowledge transfer and knowledge sharing. Moreover, learning and interacting factors are considered.

2.1 Data, Information and Knowledge

Colloquially the terms data, information and knowledge are often used without a clear demarcation and therefore it is of great importance to start with a definition (Nonaka, 1994). To obtain a common understanding of the terms data, information and knowledge, this section presents definitions used in the layered model for knowledge transfer. The importance of a common understanding of these terms is also highlighted by Rowley (2007).

The terms data, information and knowledge are often described as a hierarchy (Maier et al., 2009; Rowley, 2007; Frické, 2009). The authors present the working definitions for data, information and knowledge. Further explanation and considerations can be found in "A Layered Model for Knowledge Transfer" (Schiele et al., 2013).

1) *Data*: Data consist of symbols that are combined into words by using syntax. Data are produced by humans or machines. They can be the result of observations of the real world, descriptions of abstract things, or the result of processing existing data. Data cannot be true or false since this decision is beyond the scope of data.

2) *Information*: Data becomes information when a person receives data, decodes them, recognises the meaning and considers them relevant. If the data does not contain anything new for the receiver, the data does not become information. However, they may result in meta-information, such as confirmation of the known.

3) *Knowledge*: Information becomes knowledge if a thinking process occurs in which the information is linked to the existing knowledge and is stored persistently. The quality of information being relevant and new, insofar as there is a difference to the existing knowledge, encourages the permanent memorisation of information. Based on the input by the information, the knowledge base of the person may be extended or restructured.

2.2 Communication

The protagonist of systems theory, Luhmann (1987), explained communication as a process consisting of three steps of selection. In the first step, the sender decides which information he wants to pass on. In the second step, he selects a single message from many possible messages. In the last step, the recipient selects the information out of the message thereby completing the communication. Based on Luhmann's work, Berghaus (2011) describes several results that can occur if a sender is forwarding a message to a receiver.

- Case 1: The receiver picks up the message and interprets it in the desired way.
- Case 2: The receiver picks up the message but interprets it differently.
- Case 3: The receiver does not recognise the message as a message.

Only one of the three cases achieves the desired result. In this paper the second case and the various reasons for the error in communication will be considered in more detail. The third case plays a minor role as it is assumed that the message is detected as a message because only the messages presented as data are considered.

2.3 Knowledge Conversion

Nonaka and Takeuchi (1995) described the conversation of knowledge in their SECI Model. For this work externalization and internalization of knowledge are of particular importance. Nonaka and Takeuchi describe the internalisation as conversion from explicit to tacit knowledge and the externalisation as conversion from tacit to explicit knowledge. The authors use the concepts of externalisation and internalisation with respect to the conversion of data to knowledge and vice versa. Externalisation enables a person to converse parts of the personal knowledge base, making them accessible to others. For example, if someone writes down what he knows, everyone except him will refer to this as data. Internalisation will happen when a reader receives new knowledge by reading and learning from it.

Transfer and persistent storage require an externalisation of knowledge in a recognised and structured language. The various levels of messages are related to levels of semiotics, which are syntactic, semantic and pragmatic. Krcmar (2010) states that syntax declares the rules according to which characters can be combined to words and these can be combined to sentences. The relation between words and objects represented by the words as the relationship between characters is denoted by

semantics. The intention of a person sending words as a message is explained as pragmatic. Boisot and Canals (2004) state that a message must be interpreted on various levels. They point out that the understanding of the sentence used in the message is not the same as interpreting the message as intended by the sender.

2.4 Knowledge sharing and knowledge transfer

In organisations, employees must be motivated to share the knowledge necessary for daily work. The motivation is necessary because the employees reduce their own knowledge advantage by sharing it with others. Jasimuddin, Connell, and Klein (2012) point out, that the biggest challenge of knowledge transfer is not a technical but a social challenge. This is also the opinion of Douglas (2002) who sees knowledge sharing mainly as a social and cultural action. While in industry employees need a motivation to share their knowledge it is much easier in schools and universities. The lecturers are paid by the state to share their knowledge. While the profit-oriented organisations use their knowledge to increase capital gains, non-profit organisations practise knowledge transfers to fulfil their public contract (Hasler Roumois, 2010). A social dimension of knowledge transfer that is a challenge, both in industry and public sector are cultural differences. They may affect the knowledge transfer; however, these challenges are beyond the scope of this paper.

2.5 Learning

In order to obtain a better understanding of learning it is helpful to consider learning from different views.

1) *Learning - From the perspective of neuroscience*: Wittrock (1992) notes the influence of brain research on models for learning and teaching. Within the brain the hippocampus is very important for learning facts, for example, location information. Spitzer (2007) claims that the hippocampus enables the learning of particular events. In experiments he shows that it is possible to measure whether a proband has learned new facts or not. Therefore the proband has to learn new vocabulary. Using measurements the activity of neurons in the hippocampus can be examined, whereby it can be recognised whether he has learned the new words. The hippocampus is highly self-referencing and complements incomplete information. However, learning skills and rules by repetition is possible without the hippocampus (Spitzer, 2007).

2) *Learning - Conscious and Unconscious Knowledge*: Spitzer (2007) argues that we have learned much more than we realise. This was recognised already by Polanyi (1966, p. 4) who stated: “I shall reconsider human knowledge by starting from the fact that we can know more than we can tell”. This tacit part of our knowledge is hard to express. The knowledge of which we are aware is called explicit knowledge and can be externalised to share it with others (Nonaka, Byosiere, Borucki, & Konno, 1994). For this paper the focus is on explicit knowledge, whereby the tacit knowledge also has an influence on the knowledge transfer described in the model. Explicit knowledge is reflected in what the lecturer is talking about and what he is offering the learners in his teaching materials and presentations.

3) *Learning - rote or meaningful*: Mayer (2002) points out that education has the goal to support retention and transfer. Retention relates to memorising and remembering, while transfer describes the ability to apply the learned. Mayer differentiates between rote learning and meaningful learning. Rote learning is learning facts without obtaining understanding. Mayer mentions that in rote learning gained knowledge is often fragmented and without a context. Meaningful learning occurs when the learner does not only memorise facts, but also gains understanding. Meaningful learning is facilitated when the knowledge is integrated in a context.

4) *Learning - Influencing Factors*: Attention is of great importance for learning. There are two different types of attention. First, vigilance or alertness describes the condition of a person and can be in the range between high awareness and comatose. Second, orienting happens when the attention is focused on a special object while other things can be masked. Both types are independent of each other (Spitzer, 2007).

As described by Luhmann (1987), a successful communication requires that the receiver recognises the message as a message, which requires attention of the receiver. He must be both focused on the sender to pick up the message and sufficiently alert to process the message. Spannagel (2007) points out that mental activity is a good indicator for successful learning. Constructivist learning takes place when the cognitive activity of a person is high and mental construction processes help to create new knowledge. This includes a person just listening to someone else.

Spannagel (2007) remarks that knowledge that is learned in a practical context is considered important, while abstract information is considered less import. This is also the view of Spitzer (2007), who points out that a good teacher should tell a story instead of enumerating facts. This is due to the fact that the hippocampus is a “novelty detector” searching for new facts and classifying them according to the relevance. Relevant facts will receive priority and can therefore be better memorised. These characteristics are consistent with those of information defined in Section II. This means a message that contains information for the receiver has a greater chance to lead to new knowledge.

3. Related Work: Communication Models

3.1 Schema of Social Communication

Figure 1 shows Aufermann's (1971) model for social communication in which two parties are involved. The sender encodes the statement he intends to submit in a message. Therefore, he uses his own character set to encode the message. The message is sent via a medium to the recipient whereby spatial and temporal distance is overcome. When receiving the message the recipient will use his own character set for the decoding of the message.

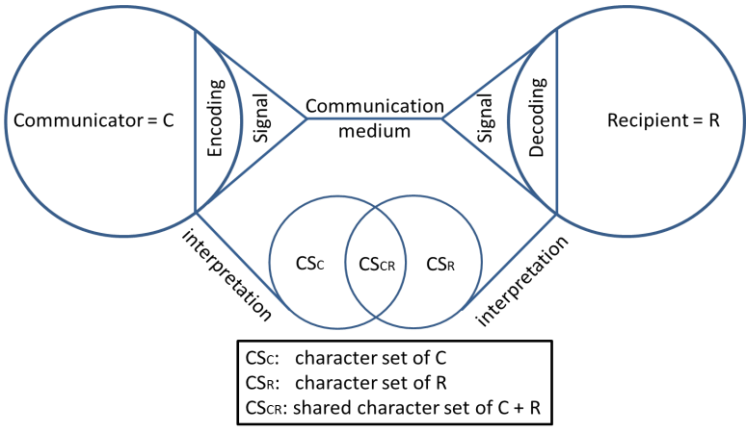

Figure 1: Schema of Social Communication (Aufermann, 1971) (German)

The model illustrates the important point of the character sets used by sender and recipient and the need to use only those characters that are within the shared character set.

3.2 A Mathematical Theory of Communication

In Shannon's description of the operation of a communication system, the sender is named "information source" and the receiver is called "destination" (Shannon, 1948/2001). Shannon has investigated the frequency of characters contained in a message, and compared the expected and the actual occurrences of a character. Using the 'entropy' Shannon invented a key figure to measure the information contained in a message. Due to the technical use of the model, specifically the control of missiles, the emphasis is on the transmission of the signal (Roch, 2009). In addition to Aufermann's schema of social communication, Shannon's model describes the influence of the transmission of a signal by a noise source.

3.3 Four Forms of Knowledge Conversion

The SECI Model, developed by Nonaka and Takeuchi (1995), is focused on the knowledge conversions during knowledge transfer. The description of four conversions takes place at an abstract level showing the particularities of each conversion. However, a detailed description of the individual conversions is missing. Nonaka and Takeuchi describe socialisation as a direct knowledge transfer from the tacit knowledge of one person to the tacit knowledge of another person, enabled by action and observation. However, this abstract view does not show exactly how knowledge is transferred in this case. A situation in which socialisation happens may arise when master and apprentice work together. Even though the master does not express his knowledge intentionally he externalises it through his action. Based on the perceived action and the results of action, the apprentice will unconsciously obtain knowledge by internalisation.

3.4 A Hierarchical Modelling Approach to Intellectual Capital Development

Ammann (2010) describes knowledge conversions from one person to another, in which the different types of knowledge are taken into account. In addition to the knowledge conversions described in the SECI Model the conversion from latent or conscious knowledge to explicit knowledge is described. Even though Ammann's approach represents knowledge transfer in greater detail, this approach does not give a precise description of how the transmission works.

3.5 Generative Learning and Teaching

A model with focus on knowledge transfer in teaching is presented by Wittrock (1992). The model consists of four phases; attention, motivation, knowledge and preconceptions, and generation. First, attention specifies the process of learning, where attention is actively directed to an event. Second, motivation is concerned with attribution and interests. Third, knowledge and preconceptions addresses the effect of prior knowledge on the learning process. Fourth generation describes the process of constructing relationships to existing knowledge. This includes the establishment of analogies and

metaphors as well as the concentration on the quintessence. Wittrock's model of generative learning and teaching describes the knowledge transfer in the area of teaching. The model addresses important aspects of teaching. However, it contains no precise description that could facilitate technical support.

4. Model of Knowledge Transfer

In communication knowledge is passed on in the form of a message. The success of the knowledge transfer depends on the transmission of the message. This transmission can be affected by external circumstances. Important causes are inferences, which can affect the transmission of a message from sender to receiver. Those inferences have been described by Shannon and are caused by noise sources. The noise sources can cause a physical inference on the medium used for the transmission of the message. The impact on the transmission depends on the severity of the inference and the redundancy within the message. Weak disturbances may be compensated by redundancy. Significant interference may lead to a distortion of the message or result in a complete abort of the transmission. Beside the disturbances on the transmission there are other circumstances that are of great importance for the knowledge transfer.

Beside the external noises that influence the knowledge transfer, the internal knowledge bases of sender and receiver are essential for the successful knowledge transfer. During the knowledge transfer the message passes four different layers within the personal knowledge bases of sender and receiver, where each of the layers influences the knowledge transfer. The interpretation of the message transfer depends on the elements used for the message and whether they are part of the knowledge base of the receiver and equivalent to the elements of the sender's knowledge base.

4.1 Layers that Influence the Transfer

The four layers that influence the transfer of a message from one person to another are code, syntactic, semantic and pragmatic layer. The concept of a knowledge transfer through different layers was influenced by the OSI Reference Model (Zimmermann, 1980). Figure 2 illustrates the transfer of a message from the sender to the receiver passing through the four layers.

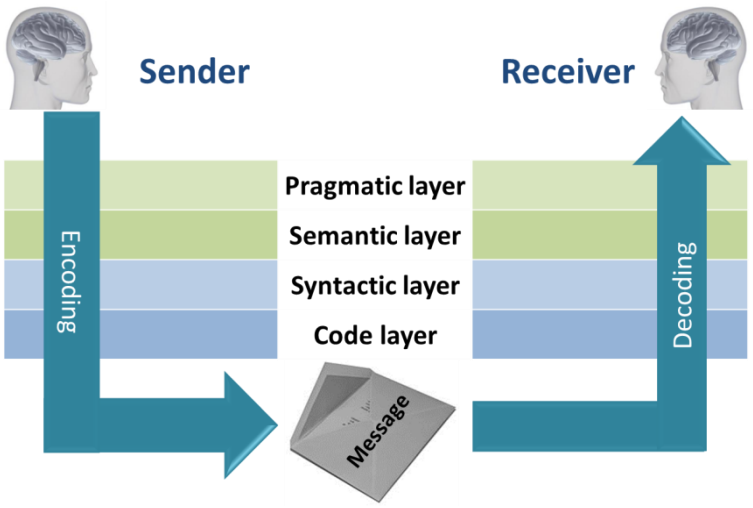

Figure 2: Knowledge Transfer through four layers

1) *Code Layer*: At the lowest level of the layer for transfer is the code. The code consists of symbols or signs that represent the smallest units, which form the basis of the higher layers. In the case of written language, which is the focus here, the smallest elements are the characters, σ, taken from an alphabet Σ. In the case of spoken language it would be phonemes, or in sign language gestures.

2) *Syntactic Layer*: The second layer is constituted by the syntax that contains rules for the combination of signs or symbols. In written language, L, the characters σ are combined to form words ω by the use of production rules P.

3) *Semantic Layer*: The third layer contains the semantics that establish the relation between words ω and meaning m. This relation, called semantics s(ω, m), connects the word to its meaning, which can be a real world entity or an abstract thing.

4) *Pragmatic Layer*: The top layer is the pragmatic layer. Pragmatics p(s, c) connects the semantic term s with a concept c. The concept contains the course of action and the aims and moral concepts that are represented in the human brain. They influence the thinking and acting of sender and receiver.

4.2 Process of a Knowledge Transfer via Messages

The aim of the following example is the desire of a person, called the sender, to communicate something to another person, called the receiver. Even if the model is general, the focus is on the written notification.

1) Sender - Pragmatic Layer: The core of the message is represented in the pragmatic layer. The aims and moral concepts of the sender do not only affect the externalisation of the message, but also the assumptions he makes about the receiver.

2) Sender - Semantic Layer: This layer contains all words ω and their relation to the objects. The sender must choose appropriate words that are available in his personal knowledge base. Appropriate means not only the term that fits best, but also refers to the knowledge of the recipient.

3) Sender - Syntactic Layer: This layer contains the rules P according to which the sentences and terms are made. The words ω chosen to carry the meaning are wrapped in sentences. Again, the sender must choose the words in compliance with the words known by the recipient.

4) Sender - Code Layer: To transfer the message as written communication the sender has to write the words ω by using characters σ that are part of an alphabet Σ of a language.

5) Transfer - Message: The communication medium (e.g., letter, email) transmits the data from the sender to the receiver.

6) Receiver - Code Layer: The receiver will view the message and read the characters, σ, if he knows them. In the case where the message contains characters from an alphabet unknown to the receiver, the transfer might be disrupted. With only small deviations of the used characters a reconstruction might be possible, otherwise it can lead to misinterpretation or stop the decryption.

7) Receiver - Syntactic Layer: The receiver will compose the characters σ to words ω and sentences if they are part of a language L he knows. As in the decoding of the code small differences can be compensated under favourable circumstances, otherwise misinterpretation or stopping the decryption are the consequences.

8) Receiver - Semantic Layer: Almost simultaneously with the combination of words and sentences the receiver will put the terms in relation to the things for which they stand. The more the receiver knows the context and the sender of the message, the easier it is to capture the meaning of the text.

9) Receiver - Pragmatic Layer: In a final step the receiver will interpret the message in relation to his own aims and values. The things the receiver knows about the sender as well as the assumptions regarding the receiver that are influenced by the sender's own values and aims, play an important role in the decoding of the message.

4.3 Influence of Overlapping Knowledge

Knowledge about the receiver is an important requirement for a successful and lossless transfer of a message. The better the sender knows the receiver, the easier he can encode the message. A proper encoding of the message can be done by using elements that exist identically in the personal knowledge base of the sender as well as in the personal knowledge base of the receiver. Due to the nature of knowledge and the way of learning the knowledge base of sender and receiver is never the same.

If the receiver is unknown, only assumptions can be made to support the selection. The other way around it is easier for the receiver to decode the message if he knows the sender of the message very well. Figure 3 visualises the overlapping of the knowledge in different layers.

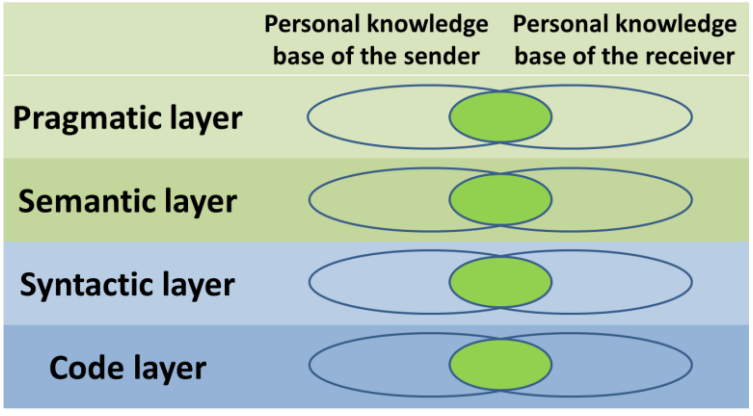

Figure 3: Overlapping Knowledge

5. Application in Teaching

The utilisation of the layered model for knowledge transfer is explained by an example in teaching business processes at university. The section will exemplify the situation of teaching, present the content of the lesson, consider the various knowledge bases, describe the knowledge transfer based on the example of teaching business processes and analyses this approach.

5.1 Situation and Goal of Knowledge Transfer in Teaching

Teaching pursues the goal to transfer knowledge from a lecturer to a learner. It can be assumed that the lecturer has a decent knowledge about the topic he is teaching, while it is new to the learner. Furthermore, it may be that related knowledge is also unknown to the learner. If this is the case the lecturer needs to involve this knowledge in teaching. Some general conditions in teaching are worth mentioning. In consecutive lectures the lecturer has the advantage that he knows which precognition the learners should have. The curriculum of the study is also a good clue about the knowledge the student should have. Specific entry requirements for Higher Education degrees that are required for admission to the programme are to guarantee an appropriate level of basic education. This should help to ensure that the knowledge base of the students contains knowledge that is required to decode the message sent by the lecturer.

If the students do not have sufficient previous knowledge the lecturer can teach the topic and include the necessary context. To interpret the message correctly the context of the described terms is of great importance. Only by including the context, synonyms and homonyms can the message be recognised correctly.

5.2 BPM, Object of teaching

The application of the layered model for knowledge transfer will be demonstrated by the explanation of teaching the concept “business process”. A process describes a flow of activities that are necessary to achieve a defined target state. A business process encapsulates this definition insofar as a business process makes a value creation possible.

Figure 4 shows the concept of a business process along with its important properties. The concept of business process is represented in the pragmatic layer. This is to emphasise the concept of business process with the goals instead of providing an explanation of the term. In contrast the important properties of business process are represented in the semantic layer.

The business process is triggered by a start event. This initiates a sequence of activities that together provide the value added. Additional events can represent temporal happenings that trigger the next activity or represent the results of previous activity. The process terminates with the end event, thus indicating that the process goal is reached. The execution of a business process requires resources such as employees and equipment.

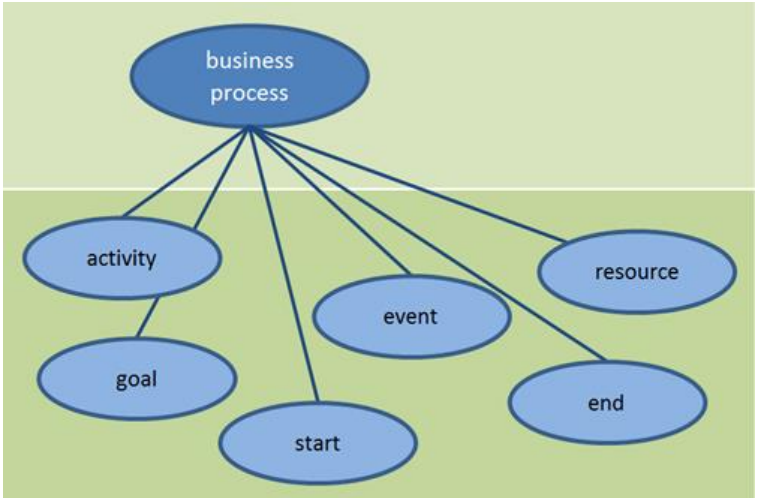

Figure 4: Concept of Business Process

5.3 Awareness of the knowledge bases

To present the procedure of knowledge transfer we introduce the following scenario. A lecturer teaching business process modelling wants to impart knowledge about business process. This topic is completely new to the students. We assume the students already possess basic knowledge of business administration and informatics.

To transfer the knowledge about the concept of business process the lecturer needs to externalise his knowledge. Afterwards he can send the externalised knowledge in a message to the students. His message can contain only data. He can communicate the message verbally to the students, in written form as a hand-out or as a presentation with figures. Until the students receive the message and decode it the message must be considered as data. When the students recognise the message, decode the data and obtain information, the students can process them mentally. Due to this thinking process they can achieve new knowledge by connecting it to their existing knowledge.

A challenge for the lecturer is the differences between his personal knowledge base and the knowledge base of the students. As the students do not know some of the concepts he wants to transfer, he needs to include them in the message. As illustrated in Figure 3, the knowledge transfer becomes more difficult if the message contains content that is not in the area of overlapping knowledge. Due to the fact that normally teaching subjects are novel to the learner, the message has always content outside the overlapping knowledge.

For the preparation of the knowledge transfer the lecturer needs to consider the knowledge base of the students in the different layers. We assume that lecturer and students speak the same language and also understand written language. This implies that overlapping on the code layer, which contains the symbols and signs, is sufficient. This also applies to the syntactic layer, which contains rules for the formation of words. Based on their previous school education and lectures attended the students have a good foundation in their knowledge base and major similarities in the knowledge base. Therefore the overlapping in the semantic layer, which contains the meaning of the words, is good too. Because of the more extensive knowledge in his area of expertise, the knowledge base of the lecturer may comprise more than those of the students. The lecturer might have gained knowledge through working in industry managing production processes. Therefore he has learned new words and their meanings. Assuming that lecturer and students have grown up under similar conditions the basic concepts of aim and moral that are shaped by education, culture, and environment, may be similar for both. However, the lecturer might have a larger knowledge base, particularly on the pragmatic layer. Through his work he might have learned concepts relevant for process management in production.

To convey knowledge about the concept of business process to the students he needs to externalise his explicit knowledge. His goal is to impart knowledge in a way that meaningful learning is supported.

5.4 Example of Knowledge Transfer

The lecturer will look for a descriptive example that he can use. Well known to almost every adult is the process of baking a cake. The lecturer can use the analogy between the two concepts to create an example. Figure 5 shows the concept of the recipe with its main properties. The result of following the recipe will be a delicious cake. To bake, the baker needs equipment and ingredients. The recipe will guide him by the sequence of the instructions. In addition, events, such as the oven must be at 200 degrees, serve to control the sequence.

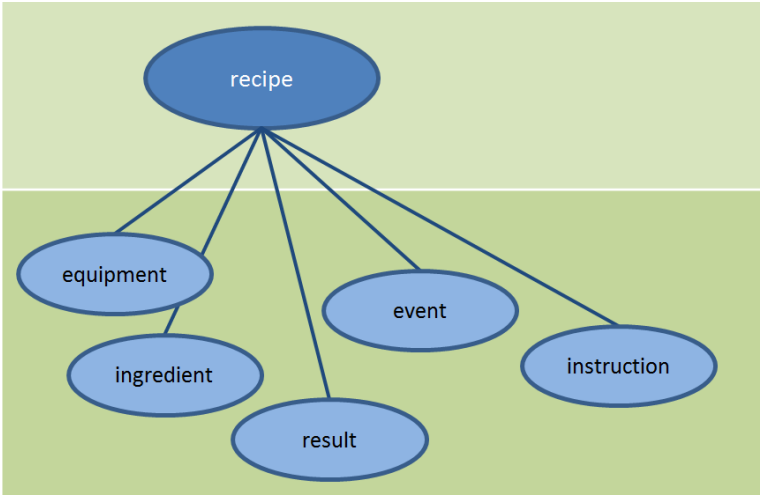

Figure 5: Concept of Recipe

After he has analysed the differences in the personal knowledge bases and realised that the concept of the recipe is similar enough and well known to the students, he can start with the knowledge transfer. Figure 6 shows a schematic representation of the overlapping personal knowledge bases of the lecturer, represented by the outer circle, and the personal knowledge base of the students, represented by the inner circle.

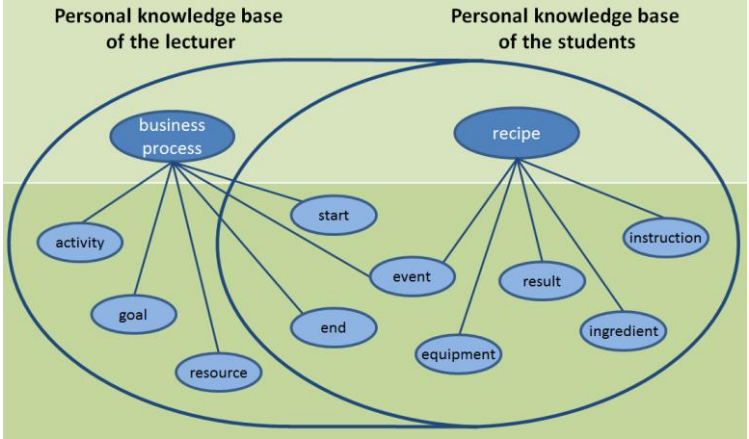

Figure 6: Schematic Representation of Overlapping Knowledge

Based on the knowledge of the student, the lecturer needs to explain not only the concept of business process, but also the connected terms activity, goal and resource. It can be assumed that the students know the words activity, goal and resource but not in the way they are used in the context of business process management. The lecturer will start the introduction to business processes by providing a brief explanation of the concept business process. When introducing unknown terms to the students the lecturer can fall back to the example of the recipe. He can provide analogies, e.g., the resources used for the business process are like the ingredients and the equipment used for the recipe. In addition, resources used in business processes are human resources comparable with the baker producing the cake. Having explained all terms, the lecturer can discuss the differences between the concept of a recipe and a business process.

5.5 Analysis of the application in teaching

This procedure intends to lead to meaningful learning. There are different points that have much to commend it. First, using an appropriate example would help the students to interpret the message in the right way. They would have the chance to understand what the lecturer wants to impart. Furthermore the lecturer is encouraged to wrap his message in a way that is interesting and thereby receives more attention. Second, as pointed out by Spitzer (2007), the lecturer should be a story teller. As mentioned before, this improves attention, but more importantly, it improves long-term learning. Third, the integration of a subject in a context supports meaningful learning. Rote learning of facts is an undesirable type of learning, as it is harder to remember something without a context and the learned knowledge cannot be used to analyse a situation or solve a problem. On the contrary, meaningful learning is useful in long term. It allows the transfer of the knowledge to another area where it can be applied to solve a new problem.

6. Conclusion and Future Directions

The primary goal of this paper was to describe the knowledge transfer in teaching. Definitions important for the layered model and relevant aspects of learning and teaching have been presented. Existing approaches for knowledge transfer have been presented and discussed. The models of Aufermann and Wittrock look at knowledge transfer from the perspective of social science. Shannon's theory has a rather technical perspective while Nonaka and Takeuchi, as well as Ammann, look at it from the perspective of knowledge management. All of the models are helpful to obtain understanding of the knowledge transfer. However, none of the models alone seems to be sufficient for a description of knowledge transfer in the area of teaching.

To provide a solution we propose the application of a layered model for knowledge transfer. The model intends to gain a better understanding of the process of knowledge transfer. It identifies factors that influence knowledge transfer and provides support. We have illustrated this by using an example that shows how the model can be applied.

The application of the layered model for knowledge transfer presented in this paper is a conceptual one. Therefore, the next step is the implementation in a semantic software tool. Once the software is completed it will be used to evaluate the model. Students as well as professionals from industry will be asked to use the software for a task in knowledge transfer. In an experiment with a control group that uses traditional non-semantic software for the same task, the model will be evaluated. This aims to identify differences in the use and benefits generated by the application of the layered model for knowledge transfer in semantic software.

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