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UNDERSTANDING INTEGRATED BUSINESS SOFTWARE: A PREREQUISITE FOR TODAY'S DIGITAL FIRMS

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Abstract:
Today's companies are supporting their business processes with the help of integrated software packages such as Enterprise Resource Planning (ERP) systems. Employees are more than ever empowered to take and execute decisions thanks to information technology. This also includes some challenges: due to the integrated character of ERP systems, business tasks are highly interdependent. Therefore, a profound conceptual understanding of integrated business software is a prerequisite for successful company-wide system usage.
As this has not been researched on before, a large qualitative study was conducted in order to analyse how individuals build up their knowledge on ERP systems. Based on the conceptual change theory as well as phenomenography a comprehensive research design was developed. 34 expert and 30 learner interviews were conducted and resulted in five phases of building up an understanding of ERP systems. The main findings are three threshold concepts. In a first stage an ERP system is regarded as a database (database concept). In further stages there is an understanding of ERP software as an electronic reproduction of a company (reproduction concept). In addition, an awareness of the technical interfaces provided in the system's background emerges (interface concept).
The model makes a contribution to both companies and higher education institutions. New insights into understandings of ERP systems help to increase the quality of existing and new teaching programmes. Qualified employees are in the end a prerequisite for the successful management of today's digital firms.

Keywords: enterprise resource planning, integrated business software, threshold concepts, phenomenography, conceptual understanding, higher education, professional training

1. INTRODUCTION

1.1. Decision-making in today's digital firms

In today's knowledge-based society it is getting more and more important that the employees have a profound understanding of their work tasks. It is not sufficient to execute only a sequence of clearly predefined steps that have no meaning to the individual. More than ever it is relevant that employees are able to judge the scope and effects of their business activities (Laudon & Laudon, 2016, pp. 87-88). This also includes the tasks that need to be performed in the company's software systems. The majority of big corporations and an increasing number of medium and small enterprises use integrated business software, like ERP systems. ERP is the short code for enterprise resource planning and terms a modular application package that supports the main business processes and helps to centralize a company's key master and transactional data. These systems provide a large functional scope for different business areas such as logistics, financials and human resources (Monk & Wagner, 2013, p. 1; Ganesh, Mohapatra, Anbuudayasankar & Sivakumar, 2014, p. 7).
The integration of data, functions and processes is both an opportunity and a challenge for organizations working with ERP packages. For example, a simple booking like a customer order entry can lead to several background and subsequent process steps in the financial accounting, materials management and manufacturing. A mind-set that only focuses on the single departmental scope is not appropriate, because the integration of underlying IT systems results in task interdependencies. Instead of having a linear control structure which grants decision-making sovereignty to some selected people, information technology and especially ERP products empower employees at various levels of the hierarchy. The top-down command line is replaced by a networked structure, where decisions are taken and executed remotley driven by information available through comprehensive company databases. (Laudon & Laudon, 2016, pp. 122-124).
To leverage the successful company-wide usage of IT applications, like ERP systems, a profound conceptual understanding is a prerequisite. Nevertheless, becoming a skilled person in the area of integrated business software is a challenging learning process that can take several years' time. The business and the technical perspective need to be coordinated (Al-Mudimigh, Zairi & Al-Mashari, 2002, p. 217). The relevance of learning and teaching has also been widely discussed in publications dealing with ERP software. Making sure that employees are trained effectively before they operate in the productive system environment is regarded as a critical success factor (Norton, Coulson-Thomas, Coulson-Thomas & Ashurst, 2012, pp. 647-648; Kositanurit, Ngwenyama & Osei-Bryson, 2006, p. 556).

1.2. Research on learning and teaching ERP systems

The question how to learn, train and teach ERP systems has been a topic of interest in research. The following paragraphs will show that there was some effort made, but that so far there is no insight as to how individuals form their conceptual understanding of this phenomenon.
Many suggestions for the usage of ERP software in higher education are available. Some recent investigations were published by Léger and her colleagues (Léger, 2006; Léger, Charland, Feldstein, Robert, Babin & Lyle, 2011). Together with the software vendor of SAP they developed a game-based environment guided by a didactical concept. Measuring the learning progress is one aim of this research group however a quantitative test approach is used in order to check whether the students reach a desired knowledge level. The single phases of learning and critical stages are not studied.
Cope is a researcher, who deals with information systems in general and who investigates understandings. He conducted a study on how learners perceive information systems and make sense of it (Cope, 2002; Cope & Prosser, 2005). His investigation results in five different categories. Nevertheless, an information system is a very broad expression, and does not mandatorily focus on such complex and integrated software packages like an ERP system. In addition, the current state of understanding of the students is captured, but the study does not give an insight as to how people with more experience perceive the phenomenon of an information system. The focus is kept on the learners who have not yet reached an expert level. In order to develop a target understanding of an information system, Cope has to refer to the literature.

As a last example, Peslak and Boyle intend to give some guidance when setting a learning target for an ERP system course. They conducted a quantitative study in which IT professionals are asked which competences they expect from graduated students that aim to work in an ERP related job (Peslak & Boyle, 2010). The data analysis unfolds four demand categories. The understanding of business and applications is of high relevance. According to the authors this is linked to soft skills like being willing to familiarize oneself with new business areas or to learn new technologies. Next, team skills as well as project management competences are desired. Finally, a graduate student should be able to analyse and integrate systems. The investigations of Peslak and Boyle contribute to the companies' demand for practice-oriented education. However, the study results in rather generic claims that could be valid for the broad area of information systems. Also, the process of learning is not in scope.
The study presented in the next chapters explores the stages of understanding the concept of an ERP system starting out as a novice up to the level of an expert. It is a study published in the dissertation of Schneider 2017.

2. EMPIRICAL STUDY DESIGN

2.1. Theoretical Background

The comprehensive research design of the following study is mainly driven by two learning theories. On the one hand this is the phenomenography and on the other hand the conceptual change.

Phenomenography was originally introduced by Ference Marton, who intended to find the reasons why some students are more successful in learning than others (Marton, 1994, p. 4424). Based on his research experiences he developed a theory that aims to collect and analyze the different ways how single persons perceive a phenomenon. Not the phenomenon itself is of interest, but how individuals conceptualize it. The main element is the perception which is defined as the relationship between the subject and the learner (Marton & Pang, 2008, p. 535).
Phenomenography is a qualitative research approach that aims to improve a teacher's lessons. Learners are the main target group for the sampling. The most popular method for data acquisition is the individual interview (Marton, 1994, p. 4427). The transcriptions are analyzed by applying a large, iterative process. Equivalences and dissimilarities are evaluated step by step, so that a set of concepts develop. The set should be sparse and the single elements should be easy to differentiate. At the same time, the result should be showing the variety of views. Each concept, called a category of description, is defined in detail focusing on the referential and structural aspects (Marton, 1994, p. 4428). Finally, the phenomenographic approach acts on the assumption that instead of having a loose amount of perceptions there is a relation between the single description categories themselves. They can be combined into a coherent model, the so-called outcome space. A hierarchical model where certain concepts are more advanced than others is common but not mandatory (Åkerlind, 2005, pp. 323-324).

The second research methodology, the conceptual change, investigates how the act of learning takes place. Strongly linked to constructivism, learning is defined as a process where the sub-level concepts and their relationships are modified (Vosniadou, 2013, p. 1). One of the initiators of the early phases of this theory is Posner who compared learning to a revolutionary procedure. As a teacher it is important to influence and support the conditions for making a progress. A learner has to become aware of the inadequacy of the existing knowledge and a new, appealing concept needs to be available as a prerequisite (Posner, Strike, Hewson & Gertzog, 1982). The conceptual change approach has branched out into different areas. One famous author is Stella Vosniadou, who supports the framework theory. According to this a learner's understanding forms a relatively coherent conceptual system (Vosniadou, Vamvakoussi, Skopeliti, 2008).
As an enhancement to the conceptual change approach, the theory of the threshold concept evolved. Meyer and Land consider it „ […] as akin to a portal, opening up a new and previously inaccessible way of thinking about something. It represents a transformed way of understanding, or interpreting, or viewing something without which the learner cannot progress." (Meyer & Land, 2003, p. 412). A threshold marks the critical concepts in a learning path. In contrast to phenomenography the threshold concepts refer to the subject discipline. They are central to the mastery of a topic (Meyer & Land, 2005, p. 374).

2.2. Sampling and study design

In order to capture the stages of an ERP understanding from the beginning up to the final level, a broad range of study participants was required. Learners that have little knowledge as well as more experienced ones were taken into account. In contrast to the phenomenographic theory, experts were also included in order to reveal the conceptual understanding that marks the target of the learning process. When selecting the study sample, the variation of the participants' professional background was ensured. The experts had different job profiles ranging from business users and IT project managers up to software programmers and server administrators.

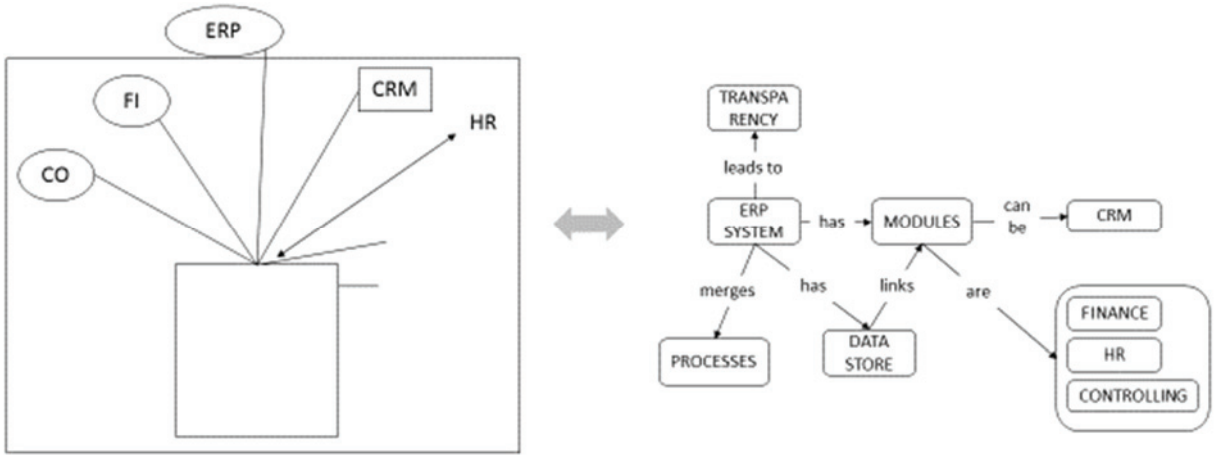
Table 1: Overview of the study sample

Interview round	Description	No. of Interviews
Learners	Students in the area of business administration and business informatics before and after a university course	30
Experts SAP	Experts in the area of SAP ERP or Microsoft Dynamics AX working for companies and universities	34

Source: own data (see also Schneider 2017)

Data gathering was conducted with the help of individual interviews that included two parts: On the one hand the participants were asked to express their current conceptions. As a specific add-on, the learners and experts had to draw their ideas on a piece of paper (see left part of Figure 1). On the other hand, the interviewees were requested to recall their experiences with ERP systems. Their biographic descriptions should start at the moment of their first contact with ERP software and should go on by pointing out the critical events of learning. In total, 64 interviews took place (see Table 1).
In a first step, the material was prepared so that the participants' propositions were transcribed. Following that, the texts were transformed into concept maps. This method specializes on the visualization of knowledge structures and belongs to the conceptual change approach. The single sub-concepts mentioned by the interviewee have to be drawn as rectangles and their relations are represented using arrows labelled with a short description (see right part of Figure 1). A network structure is built, reflecting the theory-like understanding of the individual (Cañas, 2005, pp. 205-208). The drawings were processed by applying the documental method of Bohnsack. This approach is separated in two phases. In the beginning the focus is on describing what can be seen in the drawing. In a second step, the evaluation as to how the drawing is shaped takes place, and interpretations are allowed (Bohnsack, 2013, 348-350).

Figure 1: Replica of a participant's drawing and extract of the corresponding concept map



Source: own study data

This comprehensive research design has made available a large set of data which appears in two formats − textual and graphical. In accordance with phenomenography an iterative analysis was

conducted. With the help of coding as well as with several cycles of searching for similar characteristics and contrasting the differences a coherent classification was shaped.

3. RESULTS OF THE EMPIRICAL STUDY

3.1. Description of understandings

The study resulted in five categories of description that reflect the advancing ERP conceptions (Schneider 2017). Each level of understanding will be described separately before linking the stages to each other in an overall model that will be the base for discussion.

Phase 1: Personality Concept

Digging into the topic of ERP systems, learners understand quite soon that there are different departments or functional business areas that are all working with the same business software. At this stage the realization dawns that ERP packages are large and complex. Nevertheless, there is no clear insight into the functionality and logic of the system. Because there is no explanation for how ERP works and how it all belongs together, the system is regarded as a personality of its own, which has a human-like intelligence. Also, the software is regarded as some external unit that exists separately from the software modules like Sales, Financials and so on.

ERP is described as the center of power for controlling the business activities. The learner is not aware of his or her impact at this stage. However, the participants explicitly state that they feel uncomfortable with the situation, because it is obvious to them that the current knowledge level is not professional. The personality concept is a precursor to the subject-based understanding of ERP systems.

Phase 2: Database Concept

This stage is mainly concerned with the database part that centralizes the master and transactional data of a company. The learner gets a first insight into how the software works. It is understood that data is inserted, updated and extracted by different organizational units and that there are dependencies. The usage of the same data in several places in the enterprise is a critical finding for the learners at the database concept level. Also, it becomes obvious that system authorizations are needed in order to restrict data access. However, the understanding has some shortcomings. There is for example no awareness of the broad application functionalities. In addition, the connection between the business data and the overarching processes is not established.

Phase 3: Segment Concept

With the understanding of the segment concept, the learner now shifts the focus towards the application functionality of the ERP system. As there is a broad variety reaching from business tasks like order entry or master data administration to technical tasks like programming or authorization handling, only small pieces can be adopted. The learner starts to build up some detail knowledge in one specific area. The understanding of an ERP system is making progress but it is obvious that it is still fragmented. This concept is a transition phase that prepares for the expert levels.

Phase 4a: Reproduction Concept

This stage is part of the expert understanding and marks the point when the big picture is realized. The fragmentation from the segment concept has been overcome and the knowledge is pulled together in a context. The processes that span several business areas, and which combine the functionality of the various software modules come to the fore. The learner understands that the ERP system is the electronic reproduction of an existing company. The organizational structure, the resources and the processes of the real world are simulated with the help of data structures and application logic. However, it is important to point out that the reproduction concept does not imply that the ERP software and the company are put on the same level. It is understood that both are conceptually overlapping but not equal.

Phase 4b: Interface Concept

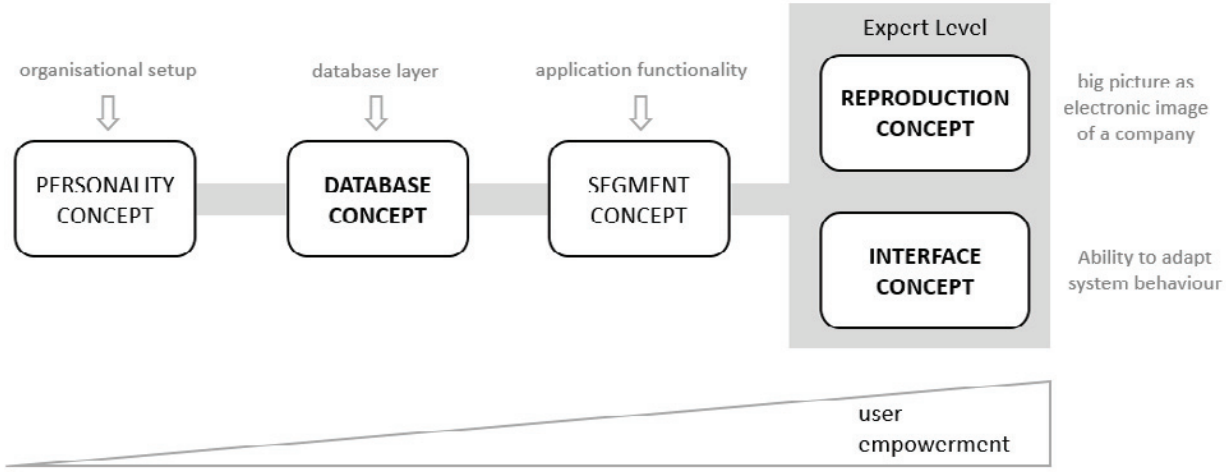
The second part of the expert understanding is the interface concept. The main point is the awareness of the background interfaces, that are required for combining the system's components into one coherent system. So, the focus is set on what is not obvious. It is understood that the ERP components are highly interdependent and that there are external connections to the surrounding environment. The boarders of the system have been realized which makes it possible to distinguish the system from other application types. It is not only understood that there are interfaces, but also how they work and – this

is highly relevant – that they can be adapted in order to use the system as a tool for the flexible support of a company's business tasks.

3.2. Summary and discussion of results

Figure 2 combines the five consecutive stages in a coherent model – the phenomenographic outcome space. The learner's understanding evolves from the personality concept on the very left to the expert level on the very right, which is composed of two parts (reproduction and interface concept). In addition to the phases, the main points of each concept are also indicated.

Figure 2: The five phases of building an understanding of ERP systems



Source: own study results according to Schneider 2017

At the bottom of Figure 2 the role of the user is addressed. At the beginning, the learner plays a passive role. The power and intelligence are attributed to the ERP system. It is then understood how the data is stored and maintained in the ERP database. The learner gets a first impression that one's own changes to the business data have an influence on the system and on other organizational units. At the stage of the segment concept, the focus shifts from the data store to the application logic and paves the way for the expert level which fully empowers the users. With the reproduction concept, the learner is able to understand the process flows and can foresee the effects that his or her activities will have on other dependent process steps. The learner is enabled to use a given ERP system in a professional and responsible way. The interface concept enables to move beyond a given condition and yields an understanding that the software can be adapted according to the organization's needs. The power moves away from the software and is assigned to the ERP expert instead.

In order to reach the expert level, both understandings – the reproduction concept and the interface concept – have to be internalized. As mentioned in the introduction, a key challenge of the ERP subject lies in the correlation of the business and the technical perspective. The interface concept approaches the phenomenon from the technical side. ERP is seen as an IT system that can be programmed and customized. Despite the technical focus, the interface concept requires the ability to judge the impact of system changes. Therefore, an expert has to be able to link the data and functions to their business meaning. However, the understanding of an ERP system is incomplete as long as there is no awareness of the full scope and the system's role as a reproduction of a company's structures and procedures. The reproduction concept reveals the original purpose of ERP software. So, this second expert concept approaches the subject from the business perspective. Both understandings are needed, however, in order to become an expert.

One of the main findings of this research are the critical stages of establishing an understanding of ERP systems. Three of the five stages could be identified as threshold concepts. The interviews showed that the database concept was regarded as an important milestone for less experienced learners. The discovery that an ERP system not only acts according to some hidden rules, but that there are explainable mechanisms marks a new level. The reproduction and interface concepts are transformative too and open up an advanced way of understanding the phenomenon as well as one's own position.

4. IMPACT OF FINDINGS AND CONCLUSIONS

The research findings revealed how individuals are learning the subject of ERP, and showed the critical stages during that process. For companies that rely on integrated business software, it is mandatory to make sure that their employees possess a profound understanding of ERP systems. The expert stages of the presented model act as a prerequisite for a professional performance.

The reproduction concept ensures that the employees are able to relate the steps they perform with the software to the business reality, and that the dependencies between the business activities and processes are taken into account. Nevertheless, this threshold concept itself has to be distinguished from the understanding of business processes. It is not only about business processes and sequences of steps, but the key element is the relation of the real and the digital world. An expert is able to connect the scenario on the system's screen to the business case. This includes to understand the limitations of a software emulation and hence avoids unrealistic demands.

An ERP software aims to increase a company's flexibility and should be seen as a tool to support the business operations. The interface concept is helping the employee to consider and make use of system adaptations in order to increase the added value of the implemented business software. This part of the expert understanding fully empowers the employees, and can help to build up their confidence for decision making and put them into action to use the ERP system as a medium. The interface concept is not about being able to program and customize software, but it is a prerequisite to correctly assess the impact of ERP adaptations.

Taking this results into account, an education that focuses on the ERP expert understanding should be a priority for companies. At the same time, the expenses for training should be spent wisely. Training courses should neither focus purely on software handling nor be narrowed down to step-by-step work instructions without any background information. Instead, the mind of the employees should be broadened, and the empowerment should be supported. A teaching programme that aims towards the expert levels – the reproduction and the interface concept – is both effective and efficient. The understanding is not a quick-fix or a short-term solution. More than that it is the establishment of a fundamental conceptual basis that is not bound to a certain ERP software product or a dedicated ERP system version. Therefore, it is sustainable and well-suited to the fast-changing business environment of today's digital firms.

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