Improving Concepts of E-Learning by Using ERP Systems for an Interactive Knowledge Diffusion

David Heim(✉), Marcus Fischer, and Axel Winkelmann

University of Wuerzburg, Wuerzburg, Germany
{david.heim, marcus.fischer,
axel.winkelmann}@uni-wuerzburg.de

Abstract. As digitalization reshapes consumer needs sustainably, enterprises must cope with an increasing complexity of products, processes, and job designs. On the one hand, business operations depend on specialists and their expert knowledge to provide high-quality products and services. On the other hand, customers get more connected and establish new, flexible ways of interacting with organizations throughout the entire product lifecycle. Therefore, interdisciplinary knowledge is the central source of competitiveness and employability. However, as higher education is influenced by technology, digitalization, and decentralization, the teaching paradigm becomes more teacher-centered. Consequently, most online courses focus on the distribution of facts, instead of mediating competencies in a problem-oriented environment. The purpose of this paper is to evaluate the use of enterprise simulations for traditional e-learning concepts. Enabled by cloud-based ERP systems, students participate in a decentralized course design, while cross-departmental interdependencies require communication, coordination, and knowledge diffusion. Thus, we propose that enterprise simulations can positively influence learning success in e-learning scenarios. To test our hypothesis, we conduct a survey from a university course using the cloud-based ERP system SAP Business ByDesign. Results of 32 participants reveal that the proposed course design positively influences process-orientation, communication and teamwork.

Keywords: Knowledge transfer · Computer-supported collaborative learning · Enterprise simulations · Cloud-based enterprise research systems

1 Motivation

In a continuously changing environment, knowledge is the central source of competitiveness for many organizations. As market pressure increases, products and services are continuously innovated and enterprises are forced to further specialize in their core competencies. Simultaneously, technological advancements allow customers to connect with their environment, establishing new ways of interacting with enterprises throughout the entire product lifecycle [1]. Thus, enterprises must provide an integrated customer experience to address new requirements on quality, flexibility, connectivity, and ubiquity. As organizations rely on an enterprise-wide coordination of processes

P. Zaphiris and A. Ioannou (Eds.): LCT 2017, Part I, LNCS 10295, pp. 199–215, 2017.
DOI: 10.1007/978-3-319-58509-3_17

and activities, effective mechanisms of knowledge diffusion among organizational members must be established to enable process-orientation, communication, and coordination [2].

While organizations increasingly focus on cross-functional education efforts for their employees, initial competencies are limited by a teacher-centered paradigm course design in higher education [3]. Thus, courses rather focus on the distribution of facts, instead of mediating competencies in a problem-oriented environment [4, 5]. Consequently, potential employees frequently lack necessary communication and reasoning skills when entering the labor market and require additional educational effort. However, as higher education is increasingly influenced by technology, digitalization, and decentralization, a shift from traditional teaching approaches to e-learning scenarios can be observed. As most online courses only provide little opportunity to interact and collaborate, the prevailing lack of competency mediation tends to intensify [X].

To address those challenges, the present paper suggests integrating enterprise simulations based on cloud enterprise resource planning (ERP) systems into traditional e-learning concepts. Based on a common database, ERP systems are generally implemented to provide organization-wide support for business operations. Consequently, problem solving depends on the interaction and collaboration of organizational members. This research is summarized by the following research questions:

(RQ1) Do traditional teaching concepts facilitate the perceived competiveness of students when entering the labor market?

(RQ2) Do cloud-based enterprise simulations increase the likelihood of learning success in the context of online course designs?

This contribution is organized as follows: Sect. 2 provides background on ERP systems. In Sect. 3, a theoretical framework is introduced, describing the process of knowledge diffusion within an enterprise simulation. The methodology underlying this research endeavor is presented in Sect. 4. Subsequently, a comprehensive survey is conducted to draw implications on the effect of the proposed course design on the participants' learning success. Concluding this contribution, Sect. 6 summarizes the main findings and gives an overview of limitations and future research potentials.

2 Enterprise Resource Planning Systems

ERP systems can be defined as a special type of information system that enterprises use to collect, store, manage and interpret data gathered from executing their business operations [6]. In general, systems support the entire process organization and track business resources such as cash, raw materials, and production capacity as well as the status of transactional objects, such as customer orders, purchase orders, and payroll [7]. Based on an integrated, and centrally managed database, ERP systems share and provide data across functions and departments. Thus, employees access relevant data in real time, without the need for switching systems. Implementing ERP systems, enterprises aim to optimize business processes, support management decision making, increase data security, and to improve overall customer satisfaction [8].

The functions covered range from financial accounting to human resources and supply chain management [9]. However, as systems consist of multiple modules, functions can be parametrized and customized to align with enterprise-specific needs. A recently conducted survey revealed that more than 90% of small and medium enterprises (SME) in Germany use ERP systems to support their business operations [10].

As the market for enterprise software has been continuously growing during the last decades, a large variety of vendors and systems emerged [11]. Due to varying requirements across different industries, the market can be further distinguished into software solutions for large companies and SMEs. Though in the past, implementing and ERP system was linked to significant IT investments, today cloud-based technologies provide access without on-site hosting or maintaining IT infrastructures [12].

The paper at hand uses the cloud-based ERP system SAP Business ByDesign, which was especially developed for SMEs. The system was parametrized to cover the functions specified in Table 1. Activated modules were simultaneously used as departments to organize the enterprise simulation.

Table 1. Covered functions within the enterprise simulation [9]

SAP business by design		
Department	Abbreviation	Function
Customer relationship management	CRM	To manage the enterprise's current and future customer interactions
Material management	MM	To manage movement of materials, logistics, and the supply chain
Production planning	PP	To plan futureproductionbydeterminingandarrangingwhichfacilitiesareneeded
After sales	AS	To perform activities and services that tie customers to the enterprise
Finance and controlling	FICO	To manage financial flows and monitor the enterprise's performance
Human resource management	HRM	To maximize employee performance in the service of an employer´s strategic objectives

3 Knowledge Transfer in Enterprise Simulations

Using ERP systems to support interactive course designs has become increasingly popular in recent years [5, 13, 14]. ERP-related teaching concepts have proven to enable process-oriented competency mediation with positive impacts on teaching quality and experience [15]. However, the suitability of traditional on-premise software is limited when transferred to an e-learning environment. Nevertheless, emerging technologies, such as Cloud Computing, allow ubiquitous accessibility and location independency [16].

Due to the definition of learning as an active process of constructing knowledge in the receiver's mind, knowledge cannot be exchanged like tangible goods [17–19]. In fact, aspects like social interaction, personal understanding, and sense making influence knowledge creation significantly [20, 21]. Following Wilkesmann et al., knowledge

transfer can be described as a multi-level phenomenon that is realized on the individual, intra-organizational, and inter-organizational levels [22]. Inkpen and Tsang further define the process of organizational knowledge transfer as a change in knowledge or performance of the receiving unit [23]. While at the individual level, units are defined as organizational members, they represent departments on the intra-organizational level and entire organizations at the inter-organizational level. However, as the course design is naturally limited to the simulation of a single enterprise, aspects of inter-organizational knowledge transfer are not accounted for in this research.

In alignment with Wilkesmann and Wilkesmann, knowledge creation always includes the individual level, although mutual learning effects can be generated on the intra-organizational and inter-organizational level [24]. Thus, this study defines knowledge transfer as a process of knowledge exchange between experts and novices that are connected through an ERP system. A conceptual overview of the knowledge exchange process is illustrated in Fig. 1.

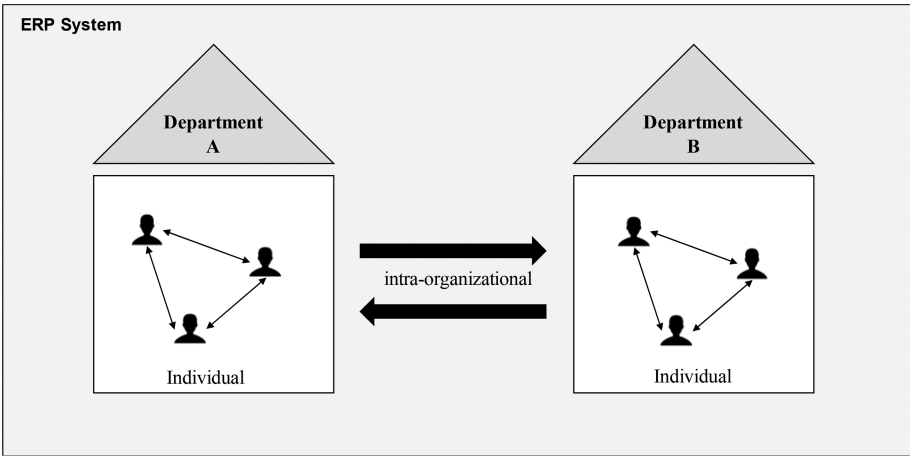

Fig. 1. Knowledge transfer in enterprise simulations [24]

To describe knowledge transfer on the individual level, we utilize the model of skill levels by Dreyfus and Dreyfus, who distinguish stages of knowledge acquisition as follows: novice, advanced beginner, competent, proficient, and expert [25]. The first three stages can be summarized as a person's knowledge that solution guidelines for a certain problem exist. The stages 'proficient' and 'expert' are characterized by knowing how to act in certain situations and how to use the acquired theoretical knowledge [24]. In fact, novices conform to rules, with no or little linkage of theory and its practical application. In contrast, experts use intuitive reasoning based on vast experiences in their field of expertise [25].

These differences mostly result from information asymmetries between both cohorts [24]. However, as individuals only absorb information that is relevant in certain situations, it facilitates knowledge diffusion. Table 2 illustrates the five stages of skill acquisition as well as their main characteristics.

Table 2. Stages of skill acquisition [25]

Skill level	Characteristics
1. Novice	Conformance to rules
	No discretionary judgment
2. Advanced beginner	Attribute-based action guidelines
3. Competent	Action planning based on long-term goals
4. Proficient	Holistic perspective on problems
5. Expert	No rule-based actions
	Intuitive, reflexive, and evaluative acting

Due to the variety of requirements, tasks, and activities, each person can be novice and expert in different fields simultaneously. According to Argyris and Schön, organizational learning works best in a problem-oriented environment in which actions lead to a mismatch of expected and accomplished results [26]. Thus, individuals aim to identify a problem's solution by performing a process of thought and further action. In general, the learning process starts with individuals perceiving a problem and acting on behalf of the organization. In line with that, Wilkesmann et al. suggest that a linkage of individual and organizational learning can be facilitated by performing routine and innovation games [27]. While routine games focus on recurring tasks, such as producing goods or services, innovation games aim to modify and optimize the current status quo of activities and processes. Participating in routine games, a novice′s learning process is initiated by the acquisition of basic knowledge about social and functional interdependencies and requirements of an adequate problem solution. However, as routine games are repetitive, a steep learning curve is provided and the novice eventually becomes an expert. Thus, a former novice can advise and teach another novice solving unknown problems. Knowledge transfer is facilitated by the occurrence of complex problems, which are generally characterized by their innovativeness. Thus, the problem cannot be solved with the information of a single individual, since no established procedure to approach the problem exists [28]. In dealing with those situations, an individual must transfer his or her knowledge within a collaborative learning process, in which all participating members exchange opinions and integrate their perspectives into a single solution [24].

Organizational knowledge transfer can be facilitated by technologies providing direct channels for an immediate exchange of information [29]. Following Wilkesmann and Wilkesmann, direct interactions can be adequately supported by e-learning or knowledge management systems [24]. While e-learning aims to qualify persons in a certain direction, knowledge management supports the process of knowledge creation. As ERP systems provide a central source of information, the present paper defines them as a special type of knowledge management system. Following Wilkesmann and Wilkesmann, an ideal type of knowledge transfer from experts to novices can be modeled as illustrated in Fig. 2.

According to Wilkesmann and Wilkesmann, novices are less experienced and require broad and more elaborative presented information [24]. Thus, they can start their individual learning and qualification process by using e-learning tools, such as

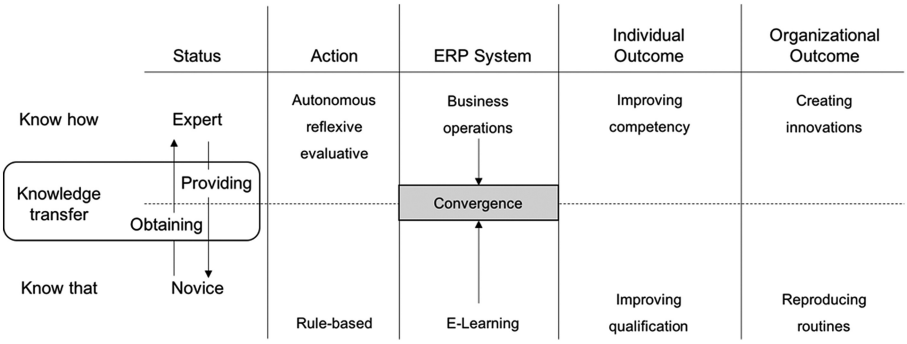

Fig. 2. Knowledge transfer as an interaction between experts and novices [24]

videos or online documentations. However, as experts know how to accomplish their predefined goals, they can search for specific pieces of information or data within an ERP system. Consequently, knowledge transfer is enabled by the integrated environment in which experts and novices collaborate. Compared to traditional knowledge management systems ERP systems further exhibit the advantage, that supported business processes connect every individual within an organization. Thus, information diffusion is facilitated and more complex problems can be solved.

4 Research Design

To evaluate our hypothesis and to answer the predefined research questions, we apply a quantitative research methodology. Thus, results can be analyzed using statistical methods, and the survey can be conducted anonymously.

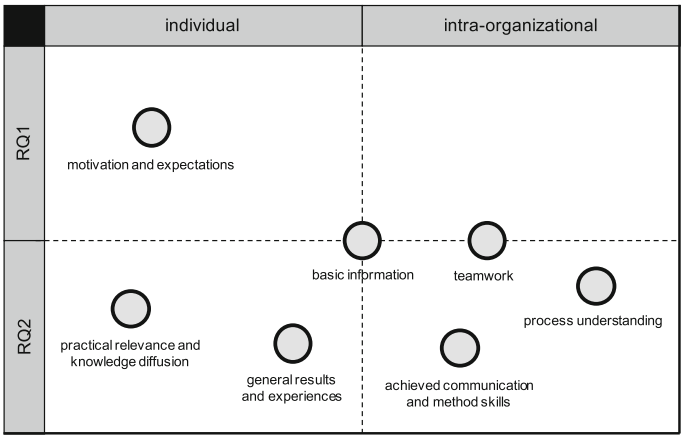

Fig. 3. Survey design based on research questions and theoretical framework

Constructing the survey, we aimed to cover multiple aspects of knowledge exchange, including previous knowledge, perceived skills, competencies, and expectations. Figure 3 summarizes the survey´s scope and links the proposed research questions to the predefined theoretical framework. As the survey was conducted twice, impacts of the simulation can be analyzed from a longitudinal perspective. Table 3 gives an overview of sections covered at the courses beginning and end.

Table 3. Sections of the survey

Sections at the course's beginning (t = 0)	Sections at the course's end (t = 1)
1. Basic information	1. Basic information
2. Motivation and expectations	2. Achieved method skills
3. Teamwork	3. Teamwork
4. Cooperation and communication	4. Cooperation and communication
5. Practical relevance and knowledge diffusion	5. Practical relevance and knowledge diffusion
	6. General results and experiences
	7. Process understanding
	8. Achieved communication skills

Basic Information (t = 0, 1). Basic information includes the participants' age and gender. We further prompt for students' majors and alma maters, as this provides valuable insights into existing knowledge and fields of expertise. In fact, participants with a bachelor's degree from a university of applied sciences can exhibit a stronger linkage of theoretical knowledge and its practical application.

Table 4. Questions regarding motivation and expectations

Abbr.	Question
Mot&Exp.1	I am satisfied with the amount of practical references in existing course designs
Mot&Exp.2	I feel well prepared for entering the labor market
Mot&Exp.3	Existing teaching concepts enable interdisciplinary knowledge exchange
Mot&Exp.4	Existing curricula enable interdisciplinary knowledge transfer
Mot&Exp.5	I am willing to try new teaching concepts
Mot&Exp.6	I would appreciate more innovative teaching concepts at the university
Mot&Exp.7	I prefer innovative teaching concepts over traditional course designs
Mot&Exp.8	I am interested in applying theoretical knowledge in real-world scenarios
Mot&Exp.9	It is exciting to be a member of an organization
Mot&Exp.10	I look forward to be working in an interdisciplinary team during the course
Mot&Exp.11	Working in a team can be fun
Mot&Exp.12	I can yield knowledge from previous courses for this class
Mot&Exp.13	Working as a group has a positive influence on the quality of results
Mot&Exp.14	I can learn from working with students from other fields of expertise

Motivation and Expectations (t = 0). This section aims to shed light on the motivations and expectations of the participating students. Questions aim to reveal the students' motivation for signing up for the course and their general satisfaction with previously experienced teaching concepts at the university. The section further requests perceived labor market competitiveness within the participant's fields of specialization (Table 4).

Teamwork (t = 0, 1). The teamwork section aims to reveal participants' general willingness to share existing knowledge in a social group, their openness to actively assist other participants and their past teamwork experiences (Table 5).

Table 5. Questions regarding teamwork

Abbr.	Question
TW.1	I am interested in sharing my expertise with other participants
TW.2	I am excited to get in touch with other members of the team
TW.3	I can use my knowledge to facilitate accomplishing team objectives
TW.4	Teamwork helps to analyze theoretical concepts from various perspectives
TW.5	I feel uncomfortable working in team
TW.6	I do not like explaining something to others
TW.7	I do not know how to solve complex problems in a team
TW.8	Results from teamwork exhibit a higher quality
TW.9	When working in a team, it feels like a waste of time
TW.10	Working on your own is better when solving complex problems

Cooperation and Communication (t = 0, 1). This section aims to provide insights into the willingness of participants to cooperate with other students to accomplish overall objectives (Table 6).

Table 6. Questions Regarding Cooperation and Communication

Abbr.	Question
C&C.1	Our team can integrate different perspectives into a single solution
C&C.2	We draw innovative conclusions from discussing different ideas
C&C.3	We constantly develop new ideas and try to integrate them into a satisfactory solution
C&C.4	We ask questions if something is not clear
C&C.5	If a team member expresses his opinion, he is also interested in other opinions
C&C.6	When mistakes happen, the team is willing to find the causes together
C&C.7	If things go wrong, the team takes time to find a solution
C&C.8	If things go wrong, the team takes time to analyze and learn why
C&C.9	Our team shares mistakes to prevent other team members from experiencing similar one
C&C.10	We discuss mistakes as a team because they provide valuable information
C&C.11	Within our team, mistakes are analyzed in a productive way

Practical Relevance and Knowledge Diffusion (t = 0, 1). In this section, students are asked to estimate their ability to transfer knowledge from theory to practical applications. Furthermore, participants are requested to assess the importance of this knowledge for future job applications (Table 7).

Table 7. Questions regarding practical relevance and knowledge diffusion

Abbr.	Question
PrRe&KnDi.1	I can transfer knowledge to practical applications
PrRe&KnDi.2	During my previous school experiences I acquired adequate social skills
PrRe&KnDi.3	I can link interdisciplinary knowledge from different fields
PrRe&KnDi.4	I can analyze logical dependencies in a business context easily
PrRe&KnDi.5	I can structure and solve unknown problems
PrRe&KnDi.6	Linking knowledge is crucial for earning my degree
PrRe&KnDi.7	I can solve practical problems easily
PrRe&KnDi.8	I can evaluate knowledge for its practical relevance
PrRe&KnDi.9	I can estimate the impact of my actions on members of other departments

Results and Course Experiences (t = 1). In this section, participants are asked to provide information about their experiences and overall satisfaction with the course. Answers can be compared to Sect. 2 (Mot&Exp). Furthermore, we evaluate the course's effectiveness in improving the practical relevance of university teaching concepts, and reassess the perception of future job opportunities. Consequently, this section includes questions regarding the applicability of existing knowledge and the quality of cooperation with other team members (Table 8).

Table 8. Questions regarding results and course experiences

Abbr.	Question
Re&Exp.1	I feel well prepared for entering the labor market
Re&Exp.2	This course helped improved my competiveness when applying for a job
Re&Exp.3	This course is characterized by an extensive interdisciplinary component
Re&Exp.4	I would appreciate being offered similar courses
Re&Exp.5	This course improved my ability to transfer knowledge from theory to practical applications
Re&Exp.6	We connected the expertise of each team member to find the best solution
Re&Exp.7	Knowledge from other classes helped me in this course
Re&Exp.8	I think I learned a lot during this course

Process Understanding (t = 1). This section aims to evaluate the participants' perception of individual process knowledge. Thus, corresponding questions focus on improvements in understanding business operations and business processes. Additionally, participants are asked to provide information about intra-organizational communication issues between different departments (Table 9).

Table 9. Questions regarding process understanding

Abbr.	Question
Pk.1	This course helped me understand business operations
Pk.2	I improved my ability to analyze and optimize business processes
Pk.3	I achieved a better understanding of interfaces and how to manage them
Pk.4	This course helped me understand complex business processes more easily
Pk.5	This course helped me understand and implement complex business processes

Achieved Communication and Method Skills (t = 1). This sections aims to evaluate improvements in terms of communication, cooperation and complementary social skills. Furthermore, it prompts perceived changes in methodical skills, e.g., regarding capabilities for complex problem solving. Results can be compared to the section on cooperation and communication (Table 10).

Table 10. Questions regarding achieved communication and method skills

Abbr.	Question
Cs&Ms.1	I feel more confident expressing my opinion in a group
Cs&Ms.2	I feel more confident questioning things in a group
Cs&Ms.3	I am able to communicate my thoughts more clearly
Cs&Ms.4	I can participate in discussions more effectively
Cs&Ms.5	I appreciated working together with students from different backgrounds
Cs&Ms.6	This course improved my ability to understand and structure problems in a business context
Cs&Ms.7	I can structure my work better than before
Cs&Ms.8	This course helped to improve my overall skills

5 Results

5.1 Experimental Setup

At the start of the course, an application phase offered participants the opportunity to apply for a department within the simulated enterprise. It is assumed that the decision was based on individual skills and preferences. Screening the applications, the research team carefully assembled teams in consideration of individual job experience, grades in relevant courses and other characteristics. As the course was open to students from different majors, a wide range of capabilities and skills was available. In fact, it was our goal to achieve a good composition of novices and experts in each department. Randomly conducted interviews provided evidence that each member felt like an expert in one or two fields within the range of departmental activities, while exhibiting only little knowledge in many other areas. Eventually, participants were assigned to functions as illustrated in Table 11. As departments vary in workload and functionality range, the number of participants was accordingly adjusted to meet the department-specific requirements.

Table 11. Distribution of participants to departments

CRM	HRM	PP	MM	AS	FICO
7	3	7	4	4	7

The simulation was based on the ERP system SAP Business ByDesign. As a cloud-based system, students could participate in the simulation independent of locality and time. Although the corresponding lectures were held twice a week, personal attendance was not mandatory. However, as the research team served as the enterprise´s executive board, lectures provided a platform to discuss problems, track progresses, and define future goals. The course was further supported by a Massive Open Online Course (MOOC), which facilitated communication and cross-departmental problem solving. At the start of the productive phase of the course, participants were initially requested to identify and implement relevant business processes in their department. Due to the cross-functional character of business processes, interdependencies between departments required communication and interaction with other organizational members. At the beginning of the course, participants had to learn how to use the ERP system productively. Thus, qualifying e-learning materials, such as videos or documentations were offered on the MOOC platform. Driven by routine games, representing repetitive tasks, such as providing master data or creating new customers or invoices, participants achieved an understanding of basic tasks, processes and intra-organizational dependencies. They further experienced the advantages and other consequences of an ERP system´s integrated working environment. At times, the research team purposely initiated special incidents, such as the acquisition of another enterprise, unexpected large-scale orders, or a warehouse fire damage. Thus, the organization had to manage innovation games, which required further communication, coordination, and intra-organizational knowledge exchange.

5.2 Meta-analysis

First, a comprehensive meta-analysis provides information about each participant's socio-demographic background and summarizes existing skills, specializations, and interests.

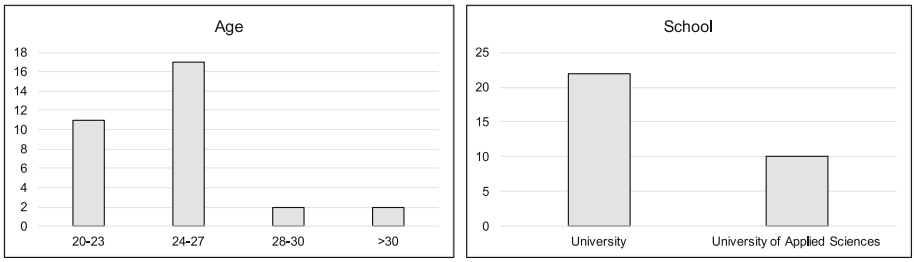

Fig. 4. Socio-demographic information

Figure 4 provides an overview of relevant background information. Since the course is offered in a master´s program, most participants were aged between 20 and 27. However, because of previous job experiences, a small number of students were 28 and above. Due to the German system of higher education, the student´s alma mater can influence their ability to transfer theoretical knowledge to practical applications. Results from our survey reveal that 69% of participants completed their bachelor ‘s degree at a university, while 31% graduated from a university of applied sciences.

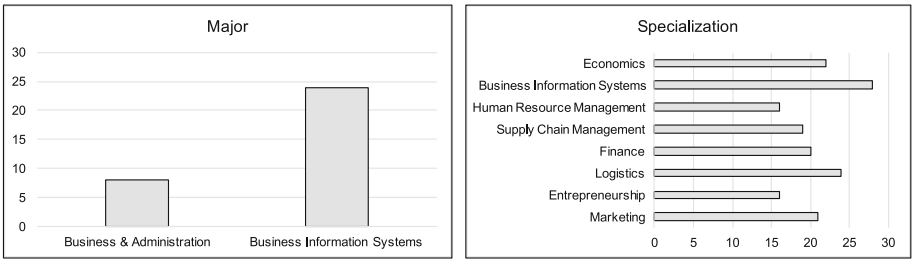

Fig. 5. Skills and interests

Furthermore, Fig. 5 provides information on majors and specializations of the participating students. While the course is open to students of different majors, most participants were enrolled in a degree in Business & Administration (B&A) or Business Information Systems (BIS). However, students with a BIS major were most numerous, since the course description is rather technical. In our investigation of students’ fields of expertise, their skills and interests exhibit a roughly equal distribution on the available specializations. Thus, experts and novices were available in each department of the enterprise simulation and enabled a dynamic process of knowledge exchange.

5.3 Motivations and Expectation

To shed light on expectations and motivations, items of this section aim to reveal the participants’ general satisfaction with existing teaching formats and their perceived labor market competiveness.

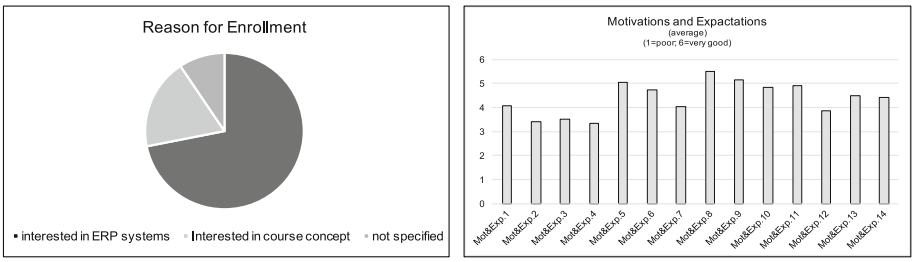

Fig. 6. Motivations and expectations

Results from this section are summarized in Fig. 6. Most students specified, that their main reason for signing up for the course is their interest in working with an ERP system. In addition, a smaller number of students were interested in the interactive course design and based their decision on positive reviews of students, who had previously completed the course. However, most students feel poorly prepared for their labor market entry and estimated their competitiveness as limited. In line with that, linking theoretical knowledge to practical applications is a major motivation for students attending this course (Mot.Exp.8). Most of the students further approve of being part of a simulated enterprise to learn in a problem-oriented environment (Mot.Exp.9). Consequently, they felt comfortable with learning in a group and assume, that they could learn from exchanging knowledge with students with other fields of expertise (Mot.Exp.14).

5.4 Effects on Teamwork, Cooperation and Communication

The sections 'Teamwork' and 'Cooperation and Communication' aim to analyze the willingness of participants to share their existing knowledge in a social group. Additionally, items in these sections address their openness towards interactive and learner-centered course designs. As ERP systems have proven to facilitate teamwork and skills of cooperation and communication, we aim to investigate, if these known advantages can be transferred to e-learning concepts [5].

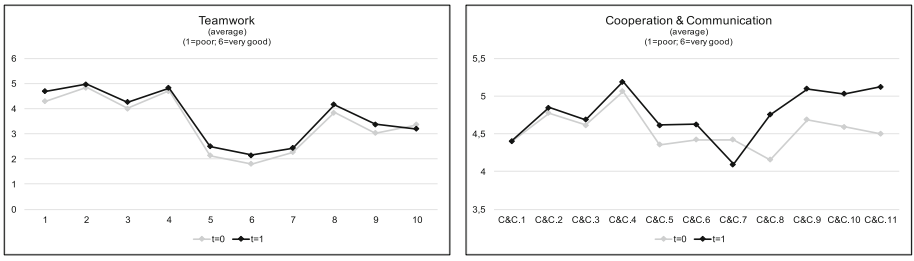

Fig. 7. Motivations and expectations

Figure 7 illustrates the effects on teamwork as well as communication and cooperation. While the course exhibits a positive impact on most teamwork-related items of the survey, most significant effects can be observed in the participants' willingness to share information from their fields of expertise with other group members (TW.1). Positive impacts are mainly due to the intra-organizational compositions of novices and experts. In line with that, participants noticed that linking complementary knowledge within the group resulted in an increased quality of problem solutions. However, most students experienced the necessary efforts on coordination and communication as cumbersome and time-consuming (TW.9). As suggested by the results, the course positively influenced the student's ability in problem solving (TW.10).

To analyze the effect on cooperation and communication, the results from corresponding survey items suggest a positive impact from our course design. While communicating opinions and problems within the group is enabled (C&C.4; C&C.5), it can further be observed that groups often did not take enough time to analyze problems and find an adequate solution (C&C.7). However, participants benefited from communicating mistakes straightforwardly, as the group gained new experiences from individual failures (C&C.9; C&C.10).

5.5 Effects on Practical Relevance, Knowledge Diffusion and Experiences

The following section investigates if the course design positively influences the perceived practical relevance of university teaching. Additionally, effects on students' ability to transfer knowledge and their overall satisfaction with the course are evaluated. Finally, we control for improvements in perceived competitiveness when entering the labor market (Fig. 8).

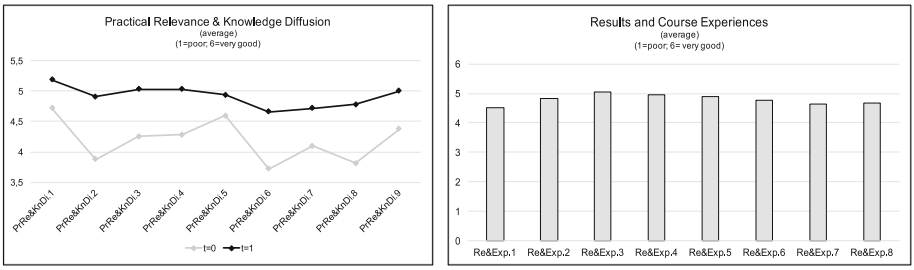

Fig. 8. Practical relevance, knowledge diffusion and results

In our analysis of the perceived practical relevance of teaching concepts, the course exhibits a positive influence on every item of the survey. Results reveal that participants experience improved social competencies, which are crucial for working in a team (PrRe&KnDi.2). It can further be observed that the course supports the linkage of interdisciplinary knowledge and thus, enables participants to work in a more process-oriented manner (PrRe&KnDi.6). Finally, working with the ERP system improves students' ability to transfer theoretical knowledge to practical applications (PrRe&KnDi.7).

Results also show improved perceived competitiveness when entering the labor market (Re&Exp.1). This perception was caused by the process-oriented course structure, and participants acknowledge that solving cross-departmental tasks within the simulation require a high degree of cooperation and communication (Re&Exp.3). In their evaluation of the overall satisfaction, participants gained valuable knowledge and experience (Re&Exp.8).

5.6 Effects on Process Understanding and Skills Improvement

The concluding sections aim to evaluate individual process knowledge and improvements in communication and cooperation skills as well as other social competencies. The results are summarized in Fig. 9.

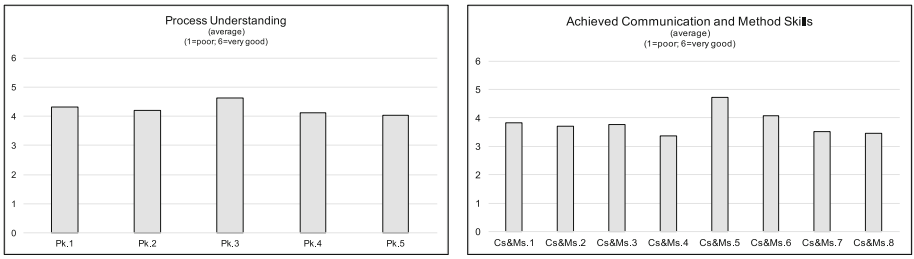

Fig. 9. Process understanding and skill improvements

In our investigation of participants' perceived process knowledge, they exhibit an adequate comprehension of organizational interdependencies. Thus, students achieved competencies in managing cross-departmental interfaces (Pk.3) and felt more confident understanding requirements and implementing them in business operations (Pk.4; Pk.5).

In line with results from previous sections, the course helped students develop and improve social competencies in terms of communication and cooperation. Students especially appreciated the exchange of interdisciplinary knowledge with participants from other fields of expertise (Cs&Ms.5). Results further suggest that the course supports participants in understanding and structuring business problems (Cs&Ms.6).

6 Conclusion and Future Research

The present paper aimed to integrate and evaluate cloud-based ERP systems into e-learning. As most e-learning scenarios focus on the distribution of facts rather than on the mediation of competencies, courses frequently lack appropriate mechanisms for knowledge diffusion. ERP systems proved to have a positive impact on the learning success of students in a higher education environment. This is mostly due to its underlying process structure and the cross-departmental integration of data and activities. However, previous studies have exclusively focused on the use of on-premise software, which is not suitable for e-learning scenarios. As higher education is increasingly influenced by digitalization and decentralization, using cloud-based ERP systems facilitates e-learning success and offers ubiquitous accessibility and location-independency. This research investigated a German course on information systems, using the ERP system SAP Business ByDesign. Our design of the course was built on well-known theories that define knowledge diffusion as an interaction of novices and experts supported by technology. To evaluate our hypotheses, a survey of 32 participants was conducted. It confirmed that ERP systems can be successfully used

in e-learning and positively influence participants' skills regarding teamwork, communication, coordination, and process orientation. However, approaches of this kind are subject to well-known limitations. As data analyses were exclusively based on descriptive methods, large randomised controlled experiments and the application of inferential statistics are essential before drawing generalizable implications.

References

1. Aula, P.: Social media, reputation risk and ambient publicity management. Strateg. Leadersh. **38**, 43–49 (2010)
2. Gold, A.H., Malhotra, A., Segars, A.H.: Knowledge management: an organizational capabilities perspective. J. Manag. Inf. Syst. **18**, 185–214 (2001)
3. Schuh, K.L.: Learner-centered principles in teacher-centered practices? Teach. Teach. Educ. **20**, 833–846 (2004)
4. Saulnier, B.M., Landry, J.P., Longenecker, H.E., Wagner, T.A.: From teaching to learning: learner-centered teaching and assessment in information systems education. J. Inf. Syst. **19**, 169–175 (2008)
5. Leyh, C., Strahringer, S., Winkelmann, A.: Towards diversity in ERP education – the example of an ERP curriculum. In: Møller, C., Chaudhry, S. (eds.) CONFENIS 2011. LNBIP, vol. 105, pp. 182–200. Springer, Heidelberg (2012). doi:10.1007/978-3-642-28827-2_13
6. Shehab, E.M., Sharp, M.W., Supramaniam, L., Spedding, T.A.: Enterprise resource planning: an integrative review. Bus. Process Manag. J. **10**, 359–386 (2004)
7. O'Leary, D.E.: Enterprise Resource Planning Systems: Systems, Life Cycle, Electronic Commerce, and Risk. Cambridge University Press, Cambridge (2000)
8. Becker, J., Kugeler, M., Rosemann, M.: Process Management: A Guide for the Design of Business Processes. Springer, Heidelberg (2011)
9. Hufgard, A., Legner, C., Winkelmann, PA..: B2B-Geschäftsszenarien mit der Cloud-Lösung SAP Business ByDesign. In: Proceedings of the Multi-Konferenz Wirtschaftsinformatik (2012)
10. Konradin, M.: Konradin ERP-Studie 2011: Einsatz von ERP-Lösungen in der Industrie. Anwenderstudie, Leinfelden-Echterdingen (2011)
11. Jacobson, S., Shepard, J., D'Auila, M., Carter, K.: The ERP market sizing report, 2006–2011. AMR Research Inc., Boston, USA (2007)
12. Hufgard, A.: Business Integration mit SAP-Lösungen. In: Hufgard, A., Hecht, H., Walz, W., Hennermann, F., Brosch, G., Mehlich, S., Bätz, C. (eds.) Business Integration mit SAP-Lösungen, pp. 15–34. Springer, Heidelberg (2005)
13. Klima, C., Pfarr, F., Winkelmann, A.: ERP system environments in IS education: design and evaluation of a new course concept. Interact. Technol. Smart Educ. **11**, 112–122 (2014)
14. Seethamraju, R.: Enterprise systems (ES) software in business school curriculum - evaluation of design and delivery. J. Inf. Syst. Educ. **18**, 69–83 (2007)
15. Boyle, T.A., Strong, S.E.: Skill requirements of ERP graduates. J. Inf. Syst. Educ. **17**, 403–413 (2006)
16. Elragal, A., El Kommos, M.: In-house versus in-cloud ERP systems: a comparative study. J. Enterp. Resour. Plan. Stud. 1–13 (2013)
17. Savery, J.R., Duffy, T.M.: Problem based learning: an instructional model and its constructivist framework. Educ. Technol. **35**, 31–38 (1995)

18. Duffy, T.M., Cunningham, D.J.: Constructivism: Implications for the Design and Delivery of Instruction (1996)
19. Oliver, R.: Developing e-learning environments that support knowledge construction in higher education. In: Working for Excellence in the Economy, pp. 407–416 (2001)
20. Aamodt, A., Nygård, M.: Different roles and mutual dependencies of data, information, and knowledge — an AI perspective on their integration. Data Knowl. Eng. **16**, 191–222 (1995)
21. Willke: Systemisches Wissensmanagement. Lucius & Lucius, Stuttgart (1998)
22. Wilkesmann, U., Fischer, H., Wilkesmann, M.: Cultural characteristics of knowledge transfer. J. Knowl. Manag. **13**, 464–477 (2009)
23. Inkpen, A.C., Tsang, E.W.K.: Social capital, networks, and knowledge transfer. Acad. Manag. Rev. **30**, 146–165 (2005)
24. Wilkesmann, M., Wilkesmann, U.: Knowledge transfer as interaction between experts and novices supported by technology. Vine **41**, 96–112 (2011)
25. Dreyfuss, S.E., Dreyfus, H.L.: A five-stage model of the mental activities involved in directed skill acquisition. Oper. Res. Cent. 1–18 (1980)
26. Argyris, C., Schön, D.A.: Organizational Learning. Addison-Wesley Pub. Co., Reading (1996)
27. Wilkesmann, U.: Lernen in Organisationen: die Inszenierung von kollektiven Lernprozessen. Campus-Verl, Frankfurt (1999)
28. Hirokawa, R.Y.: The role of communication in group decision-making efficacy: a task-contingency perspective. Small Gr. Res. **21**, 190–204 (1990)
29. Szulanski, G., Bowman, N., Winter, S., Grant, R., Spender, J.C., Kogut, B., Miner, A., Ghoshal, S., Levinthal, D., Stuart, T., Lane, P., Argote, L.: The process of knowledge transfer: a diachronic analysis of stickiness. Organ. Behav. Hum. Decis. Process. **82**, 9–27 (2000)