Tampere University

KAROLIINA NISULA

Holistic Business Learning Environment

Bringing practice and integration to business education

Tampere University Dissertations 53

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Bringing practice and integration to business education

ACADEMIC DISSERTATION
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Learning is a fascinating subject. During this dissertation process, I have studied it as a research topic and also experienced it firsthand. At times, my learning process has been struggling and surviving but for the most part, it has been inspiring and rewarding.

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Karoliina Nisula

ABSTRACT

For decades, business education has been criticized for being too theoretical and distant from the realities of actual business. The business school curricula are poorly aligned with the competencies and knowledge needed to succeed in today's business world. In addition to disciplinary knowledge and soft skills, graduates need the capabilities to be able to integrate these skills and implement them in practical settings. Learning practical, integrative skills in an environment that emphasizes theoretical orientation and academic research is challenging.

Experiential learning has been widely used to bring the practical element into business studies. In particular, technology-driven learning environments such as simulations, games, business information systems, virtual worlds, and social media have offered great possibilities for experiential exercises.

And yet the criticism continues. Despite the technological developments, education still continues to be theoretical and academic. Experiential business education has not become mainstream. Different types of experiential learning solutions have been presented but they tend to solve specific areas of business management. They often focus on the technology rather than on a holistic, pedagogical model. Business education research is yet to present an experiential learning environment that combines people and information technology in a holistic way.

This dissertation investigates how an experiential business learning environment should be constructed to provide a holistic business perspective and a practical training ground to enhance the competencies required of future business graduates. First, the theoretical foundations of learning and learning environments are examined. Second, the relevant research on business learning environments and curricula is presented. These lead on to the refined research questions. A design science approach is chosen as a method to construct and study a business learning environment artifact consisting of an enterprise resource planning (ERP) system, a business simulation, and learning communities of students and teachers. It is structured around a supply chain network, and the business transactions utilize

automated information flows in an information system structure that is based on the principles of ERP II.

The artifact alone does not solve the challenge of integrated business learning. It needs to be attached to the whole learning process. This dissertation presents an integrated business learning model that combines the artifact with a business curriculum based on the dynamic capabilities' framework. This brings the intellectual coherence that indicates how disciplines, courses, and the business learning environment influence each other. It is the concrete combining factor between the people and the disciplinary topics on the curriculum plans and documents.

There are positive indications of learning on all of Bloom's domains. In particular, the artifact appears to improve the poor and average students' long-term lower-level cognitive learning. The dissertation offers an explanation for such improvement: The artifact acts as a boundary infrastructure where different stakeholders carry out their own roles and tasks and interrelate with each other. It provides a common ground to join the theoretical perspective to the practical processes and tasks of business management. It is flexible and can be used from many different perspectives and for many different purposes at the same time.

TIIVISTELMÄ

Vuosikymmenten ajan liiketoiminnan opetusta on kritisoitu liiasta teoreettisuudesta. Opetussuunnitelmat eivät tuota työelämässä menestymiseen tarvittavaa osaamista ja tietoa. Oppiaineisiin liittyvän tiedon ja pehmeiden taitojen lisäksi tarvitaan kykyä yhdistellä ja käyttää niitä käytännön toiminnassa.

Liiketoiminnan opintoihin on tuotu käytännön näkökulmaa kokemuksellisen oppimisen avulla. Tietotekniikka hyödynnetään monipuolisesti kokemuksellisissa oppimisympäristöissä, jotka perustuvat simulaatioihin, peleihin, liiketoimintajärjestelmiin, virtuaalimaailmaan ja sosiaaliseen mediaan. Kokemuksellisen oppimisen ratkaisut ovat kuitenkin kohdistuneet yksittäisten liiketoiminnan osa-alueiden opetukseen ja teknologisiin ratkaisuihin ennemmin kuin kokonaisvaltaisin pedagogisiin malleihin.

Tämä väitöskirja tutkii sitä, miten kokemuksellinen oppimisympäristö pitäisi rakentaa, jotta se antaa kokonaisvaltaisen liiketoimintanäkökulman ja käytännön harjoituspaikan tulevaisuuden liiketoimintataitojen hankkimiseksi. Väitöskirjassa rakennetaan suunnittelututkimuksen keinoin liiketoiminnan oppimisympäristö, joka muodostuu toiminnanohjausjärjestelmästä, liiketoimintasimulaatiosta ja oppimisyhteisöistä.

Oppimisympäristö yhdistetään opetussuunnitelmaan dynaamisten kyvykkyyksien mallin avulla. Näin muodostuu kokonaisvaltainen liiketoiminnan oppimisen malli. Oppimisympäristön ja mallin toimivuutta tutkitaan Bloomin taksonomian viitekehyksessä ja osoituksia lisääntyneestä oppimisesta havaitaan taksonomian kaikilla osa-alueilla. Erityisesti oppimisympäristö vaikuttaa parantavan heikkojen ja keskiverto-opiskelijoiden pitkäkestoista, kognitiivista osaamista. Parannusten havaitaan johtuvan siitä, että oppimisympäristö toimii yhdistävänä elementtinä eli rajakohteena (boundary object), jota eri opiskeluyhteisöt voivat hyödyntää omasta näkökulmastaan: opettajat tuottavat sinne käytännön esimerkkejä ja opiskelijatiimit harjoittelevat liiketoimintaa vuorovaikutuksessa toistensa kanssa. Se tarjoaa yhteisen maaperän jossa voidaan liittää teoreettinen näkökulma käytännön prosesseihin ja liiketoiminta-aktiviteetteihin.

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ABBREVIATIONS

BBA	Bachelor of business administration
CSCL	Computer supporter collaborative learning
EDI	Electronic data interchange
ELT	Experiential learning theory
ERP	Enterprise resource planning system
ERPII	An extended enterprise system that includes supply chain management (SCM) applications, customer relationship management (CRM) applications, and e-commerce applications
LAMP	An open source development platform consisting of Linux operating system, Apache server, MySQL database and PHP scripting language
MySQL	An open source relational database management system
PE	Practice enterprise
PHP	An open source scripting language
PLC	Professional learning community
REAL	Rich environment for active learning
SLC	Student learning community
SME	Small or medium size enterprise
UAS	University of applied sciences
XML	Extensible markup language

ORIGINAL PUBLICATIONS

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I	The author conducted the literature review, collected the data, conducted the study, coordinated the writing process, and wrote the paper with the co-author.
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1 INTRODUCTION

Business education research is looking for ways to reduce the distance between education and business. The most-cited management education articles in recent decades focus on four streams (Arbaugh & Hwang, 2015): One stream criticizes business schools and their curricula for poorly preparing students for their employing organizations. Another concentrates on entrepreneurship education, which overlaps to a certain extent with the business management domain (Ireland, Hitt, & Sirmon, 2003). The other two streams focus on experiential learning and the role of information technology (Arbaugh & Hwang, 2015).

These research streams criticize business education for being too theoretical and distant from the realities of actual business. The business school curricula are poorly aligned with the competencies and knowledge needed to succeed in business (e.g. Bennis & O'Toole, 2005; Datar, Garvin, & Cullen, 2011; Holden, Jameson, & Walmsley, 2007; Jackson, 2009; Mintzberg, 2004; Pfeffer & Fong, 2002; Weber & Englehart, 2011). The same concern is shared in the entrepreneur education research stream (Kuratko, 2005).

Universities are not doing enough to provide students with small and medium-size enterprise (SME) employment skills (Martin & Chapman, 2006). Unlike large companies, SMEs have a limited ability to train their employees. They need the higher education graduates to be equipped with applicable competencies and knowledge to be productive immediately upon employment (Woods & Dennis, 2009). The challenges are similar in undergraduate and graduate studies (Colby, Ehrlich, Sullivan, & Dolle, 2011) as well as in the vocational field. For example, in Finland, a vocational education reform is restructuring education toward practice-oriented learning and tighter cooperation with workplaces (Finnish Ministry of Education and Culture, 2018a).

What is it that the businesses want? Hard skills of disciplinary expertise and knowledge are not enough in today's workplace (McMillian & Overall, 2016; Pettigrew & Starkey, 2016). There is an increasing emphasis on soft skills such as business acumen, communication, teamwork, ethics, and social responsibility

(Andrews & Higson, 2014; Azevedo, Apfelthaler, & Hurst, 2012; Benjamin & O'Reilly, 2011; Jackson, 2009; Robles, 2012; Rubin & Dierdorff, 2013).

In addition to soft skills and disciplinary expertise, the business graduates need abilities to enable them to integrate the skills and knowledge and exploit them in practical settings (Brown & Rubin, 2017; McMillian & Overall, 2016). Learning business management is much more complex than merely acquiring a set of theories on individual learning topics (Chia, 2014). Business management is "*the task of becoming aware, attending to, sorting out, and prioritizing an inherently messy, fluxing and chaotic world of competing demands that are placed on a manager's attention*" (Chia, 2005, p. 1092). This is particularly relevant in SME businesses. Large enterprises are more likely to make decisions in an organized, linear, and structured manner in comparison with SMEs, where decision-making tends to focus on the issues and concerns of the everyday business (Gilmore & Carson, 2000; Martin & Chapman, 2006). SMEs emphasize the applicants' experience over their formal qualifications (Martin & Chapman, 2006). Entrepreneurship education covers the entire scope of business administration (Kuratko, 2005) whereas business education is fragmented into narrow specializations and individual disciplines (Weber & Englehart, 2011; Teece, 2011).

Business management should not be viewed as a fragmented collection of separate disciplines. Nor is it an academic discipline such as physics or chemistry (Bennis & O'Toole, 2005). It is a profession, like medicine or law. When business management is viewed as a positivist, normative science, it tends to produce causal and functional theories and models that ignore the complex phenomena of human behavior such as ethics or morals (Ghoshal, 2005; Hühn, 2014). When students are taught such representational structures, they subsequently apply these representations to their own practice (Chia & Holt, 2008).

The academic-discipline orientation also presents another challenge: Business education focuses too heavily on academic research at the expense of practice and pedagogy (Bennis & O'Toole, 2005; Ghoshal, 2005; Sandberg & Tsoukas, 2011; Thomas & Wilson, 2011). Academic institutions emphasize and reward discipline-based research rather than research on pedagogy and applications (Hambrick, 2005). Bringing the interests of pedagogy, synthesis, and practice into business education in equal measure to the academic focus would improve both business education as well as the conducting of the business itself (Benjamin & O'Reilly, 2011; Bennis & O'Toole, 2005; Ghoshal, 2005; Pfeffer & Fong, 2002; Statler, 2014). Rather than replacing one with the other, business education needs to blend experience with theory (Mintzberg & Gosling, 2002; Sandberg & Tsoukas, 2011).

Mintzberg (2004) goes even further and presents a widely accepted view (Rubin & Dierdorff, 2009): Rather than it being a science or a profession, business management is a practice that needs to be learned in practical settings. Good teaching does not equal more learning (Pfeffer & Fong, 2002). Instead of focusing on making things "user friendly" for the students, the responsibility for the learning should mainly lie with the student, and the mode of instruction should be practice-oriented.

The mode of instruction in business education is overly preoccupied with knowledge by representation (Chia, 2014; Chia & Holt, 2008). This stems from the emphasis on analysis and theory, and the assumption that the realities of business management can accurately and thoroughly be represented by management theories, concepts, and designs (Paglis, 2012). Concentrating on the structure of the knowledge that is being represented makes us overlook the persuasive power of the method of instruction. What is equally important to what is being relayed is the way in which it is being relayed (Hühn, 2014). There is a need for an alternative, accompanying form: knowledge by exemplification (Chia & Holt, 2008; Statler, 2014). The manner of the representation affects both learning as well as whether the knowledge learned is deemed as beneficial and useful. Subjectively experiencing the outcomes of actions and decisions, both errors and achievements, is vital to the mastery of those practical skills required in business management. Also, acquiring and passing on tacit knowledge takes place with examples and experimentation (Statler, 2014).

Experimentation, or experiential learning, has been widely used in the different areas of business education such as management learning (Arbaugh & Hwang, 2015) marketing (Gray, Peltier, & Schibrowsky, 2012), accounting (Apostolou, Dorminey, Hassell, & Watson, 2013), entrepreneurship education (Kuratko, 2005), and information systems (Lee, 2012). The experiential learning theory presents learning as a process of knowledge creation through experience (Kolb, 2014). Learning happens in transactions between the learner and the environment (Kolb & Kolb, 2005). Experiential learning activities have been tested and used in business education in a variety of ways, for example, as capstone courses, laboratory exercises, teamwork projects, case studies, integrative activities on different courses, service-learning activities, cooperative education placements, student business start-ups, as well as practitioner mentorships (Govekar & Rishi, 2007; Kuratko, 2005; McCarthy & McCarthy, 2006). The learning environments have varied from classrooms and laboratories to technology-driven learning environments.

The most authentic experience is acquired in the workplace. Work-integrated learning combines academic studies with exposure to working life, increasing the learner´s appreciation of working life and employability skills (Jackson, 2015). There are various methods for work-integrated learning such as internships, job shadowing, cooperative education, and work placements (Jackson, 2015; McCarthy & McCarthy, 2006). In vocational education, apprenticeships are complete degrees where studies are organized as part of work tasks in the workplace where the student has an employment contract. These studies are supplemented with theoretical studies (Finnish Ministry of Education and Culture, 2018b). Work-integrated learning aims at authentic workplace activities that are as complex as real practices are and that are aligned with other learning activities and assessments (Smith, 2012).

In business management, it may be difficult to find realistic and yet complex learning activities in workplaces. Providing inexperienced students with challenging and complicated practical activities may be risky to both the student and the company. The development of information technology offers great possibilities for risk-free experiential learning environments: e-learning (Arbaugh et al., 2009), business simulations and games (Anderson & Lawton, 2009; Faria, Hutchinson, Wellington, & Gold, 2009), enterprise resource planning (ERP) systems (Angolia & Pagliari, 2016; Jewer & Evermann, 2015), virtual worlds (Dickey, 2005; Halvorson, Ewing, & Windisch, 2011), collaborative Web 2.0 tools (Weyant & Gardner, 2011), and social media (Galan & Khodabandehloo, 2016; Granitz & Koernig, 2011; Neier & Zayer, 2015; Rinaldo, Tapp, & Laverie, 2011).

Despite the technological advances, the debate and criticism over the relevance of business education continue (Alajoutsijärvi, Juusola, & Siltaoja, 2015; McMillian & Overall, 2016; Pettigrew & Starkey, 2016). Enhancements in experiential learning have not become widespread (Pettigrew & Starkey, 2016). Different learning environments solve different challenges: e-learning enables learning and collaboration from a distance (Weyant & Gardner, 2011). Simulations and virtual worlds provide dynamic, realistic learning situations where students can experiment and solve problems (Clarke, 2009). Real-life applications such as business systems and social media bring with them the authenticity of hands-on tools (Hepner & Dickson, 2013; Neier & Zayer, 2015). However, the experiential learning exercises, even when implemented successfully, have remained individual, isolated activities. There is a need for a holistic, integrative approach (Caza, Brower, & Wayne, 2015; Waddock & Lozano, 2013).

Information technology alone does not improve learning (Alavi & Leidner, 2001). A combination of information technology and human-to-human interaction between students appears to result in learning more effectively than with technology or the face-to-face environment alone (Al-Shammari, 2005; Belias, Labros, Kakkos, Koutiva, & Koustelios, 2013; Bryant, Campbell, & Kerr, 2003; Cao, Crews, Lin, Burgoon, & Nunnamaker, 2008; Clouse & Evans, 2003).

Business education also continues to be criticized for being distant from the realities of actual business. The theory and academic focus are still emphasized at the expense of practice and pedagogy. And yet the world is in continuous and increasing change, where future graduates need to understand the bigger picture. They will manage in complex and uncertain situations with increasing emphasis on practical and soft areas of business management such as business acumen, problem-solving, communication, teamwork, and ethics. In addition to understanding, these things need to be internalized. Awareness needs to become competencies.

Competencies are created through subjective experiences where the outcomes of actions become visible. The experiences should take place in meaningful environments that provide concrete practice and the ability to reflect upon the learning. The learning environments should increase the learner's ability to see the bigger picture and enable him or her to combine different pieces of knowledge to solve complex problems. It should also provide a training ground for internalizing soft issues of interaction, social responsibility, and ethics. Therefore, the learning environments should be holistic entities rather than sub-optimized, stand-alone solutions.

Different types of experiential learning solutions implemented in manually-oriented as well as information technology-oriented learning environments have been presented but they tend to solve specific areas of business management. The focus is often on the technology rather than on the holistic, pedagogical model. The business education research is yet to present an experiential learning environment that combines people and information technology in a holistic way. It appears that partial solutions do exist, but the key question is how an experiential business learning environment should be constructed to provide a holistic business perspective and a practical training ground to enhance the competencies required of future business graduates.

This dissertation aims to find an answer to this research question. First, the theoretical foundations of learning and learning environments are examined. Second, the relevant research on business learning environments and curricula is presented. These lead on to the refined research questions, as well as on to the design and the schedule of the research. Next, the research process and the results of the research are then described in more detail. The dissertation concludes with a discussion and conclusions.

2 THEORETICAL FOUNDATIONS

2.1 Pragmatist paradigm

Scientific research is built on general philosophical assumptions made by the researcher. Ontological assumptions refer to the nature of reality (Cohen, Manion, & Morrison, 2013). For example, the world can be seen as an objective entity or from a subjective perspective where the phenomena depend on the actors involved (Cunliffe, 2011). These perspectives guide the epistemological assumptions of how knowledge is acquired and constructed, which in turn direct the choice of research strategy and methods (Cohen et al., 2013). For example, the positivist philosophy sees reality as an entity that can be objectively studied (Cunliffe, 2011; Remenyi, Williams, Money, & Swartz, 1998). Knowledge is based on natural phenomena, which are identified through sensory experience, measured and interpreted through reason and logic. In the social sciences, this philosophy is criticized for being inappropriate as human beings are complex creatures that view the world from a subjective and relativist perspective (Cohen et al., 2013). The anti-positivist (or interpretivist) perspective opposes the idea of universal, objective truth, and claims that reality is a subjective interpretation by individuals (Cohen et al., 2013).

A paradigm is a way of looking at the research phenomena through shared principles, concepts, theories, and postulates (Cohen et al., 2013). The pragmatist paradigm shares the concerns of both positivism and anti-positivism (Goldkuhl, 2004). It sees the reality as the practical effect of ideas. All human conceptions are determined by their consequences: *"Consider what effects, that might conceivably have practical bearings, we conceive the object of our conception to have. Then, our conception of these effects is the whole of our conception of the object"* (Peirce, 1878, p. 292). Rational cognition and rational purpose are inseparable (Baskerville & Myers, 2004). If something works, it is true (James, 1909).

The early pragmatists—Charles Peirce, William James, and John Dewey—have greatly influenced the development of contemporary learning theories. James saw experience as the starting point for examining thought. He thought that instead of being passive copies of environmental inputs, simple ideas are created by abstract thoughts and study (Schunk, 2014). Charles Peirce opposed the idea that all knowledge is gained passively (Gingell & Winch, 2002). He also argued that the process of learning has its physiological basis in the nervous system and that the mind is not separate from the feelings and interests of the body. Learning, believing, and knowing are an important part of doing and feeling (Garrison & Neiman, 2003).

Dewey (1938) introduced the concept of controlled scientific inquiry that involves a problem definition, the determination of possible solutions and reflecting on those solutions and testing the adequacy of a solution by trying it out in practice. He also emphasized that immediate experience is always relational and never exists in isolation from other people and concrete realities. It is creative rather than just passive data registration, and it is always personal and particular, affected by historical and cultural values rather than being universal (Kloppenberg, 1996). He stressed the role of democracy in education (Dewey, 2004). He felt that learning should revolve around the learner instead of the teacher. It should be carried out in active groups where the teacher is the facilitator and an equal member of the group. He introduced the idea of the interdisciplinary curriculum and believed that education and society should be interconnected.

2.2 Views on learning

There are various definitions of learning. This dissertation uses the generic definition by Schunk (2014, p. 3): "*Learning is an enduring change in behaviour, or in the capacity to behave in a given fashion, which results from practice or other forms of experience.*"

This definition includes three important criteria: 1) Learning happens when people become capable of changing the way in which they act. 2) Learning happens over time. Temporary changes in behavior are not considered learning. 3) Learning occurs through experience, for example, by observing others or practicing.

There are different perceptions regarding how learning takes place. In behaviorism, learning is seen as a process where associations are formed between external stimuli and responses (Skinner, 1974). Internal mental states or consciousness are not considered (Schunk, 2014). It is based on a positivist view of the world: There is a universal reality that can be represented and transferred from the teacher to the learner (Bredo, 1997). All learners use the same process for understanding the world (Schunk, 2014). Observed behavior determines whether learning has occurred. Lectures are a typical mode of instruction.

Social cognitive theory, on the other hand, emphasizes the idea that much of human learning occurs in a social environment (Bandura, 2001; Schunk, 2014). People absorb knowledge, skills, and attitudes when they observe other people. Learning happens either by actual doing or observing models or representations of the behavior. Correct behavior is rewarded in a social context, whereas incorrect behavior is punished (Bredo, 1997).

Constructivism is present whenever learning theories are discussed. However, rather than a theory, it is an epistemology or a philosophical explanation of the nature of learning (Schunk, 2014). According to constructivists, there is no absolute reality. Instead, people can mentally construct their own worlds (Bringuier & Piaget, 1989). Constructivism contradicts the behavioristic assumption that learning is a product of the external environment. Instead, people build their own knowledge as active learners (Geary, 1995). On the other hand, constructivism shares the view of social cognitive theory in that people, behaviors, and environments interact with each other in the learning process (Schunk, 2014). Constructivism promotes an integrated curriculum where topics are studied from multiple perspectives through social interaction.

2.3 Experiential learning theory

The experiential learning theory (ELT) has been researched extensively in business (Swailes & Senior, 2001), education (Cassidy, 2004; Jones, Reichard, & Mokhtari, 2003; Loo, 2004), psychology (Desmedt & Valcke, 2004), medicine (Grace, 2001), as well as other disciplines (Kolb & Kolb, 2005). It is rooted in pragmatism and constructivism (Kolb, 2014). The ELT originally defines learning as: "*the process whereby knowledge is created through transformation of experience. Knowledge results from the combination of grasping experience and transforming it*" (Kolb, 2014, p. 67). The key point for learning is the personal, immediate experience. The theory is built on six propositions (Kolb, 2014): 1) Rather than outcomes, learning should be viewed as a process. 2) All learning is relearning and best promoted when the learner can examine, test, and transfer his or her ideas to new and improved ideas. 3) The learning process is driven by conflicts, disagreements, and differences. 4) Learning is a holistic process where the learner adapts to the world. 5) Learning is a result of the transactions between the learner and the environment. Finally, 6) learning is the process of creating knowledge.

The ELT has been widely used in recent business and management education research (Armstrong & Mahmud, 2008; Hawk & Shah, 2007; Hedberg, 2009; Mainemalis, Boyatzis, & Kolb, 2002). Kolb and Kolb's (2005) study about experiential learning styles and spaces is the second on the list of the most-cited articles in management education research (Arbaugh & Hwang, 2015). Kolb and Kolb (2018a, 2018b, 2018c, 2018d, 2018e, 2018f) have collected extensive bibliographies on experiential learning research between 1971 and 2018. These bibliographies containing 4259 citations on experiential learning that were used to search for literature on ELT, methods, and learning environments.

2.3.1 Learning cycle

The experiential learning model in Figure 1 presents the learning process as a cycle of four phases or modes (Kolb, 2014). The concrete experiences act as the foundation for observations and reflections. They are further assimilated into abstract concepts that in turn breed new ideas to be actively tested. Learning involves two dimensions of knowledge that depend on each other: acquisition and transformation. In the knowledge-acquisition dimension, there is a tension between apprehension through a concrete experience and comprehension through an abstract conceptualization. Apprehension takes place when a person has to accept new knowledge through his concrete experiences. Comprehension happens when the person takes the experience and breaks it into meaningful events to be placed within a culture and societal system. The transformation dimension contains the tension between the intention and the extension. Through a reflective observation, the learner moves inward to consider the experience, whereas in active experimentation, the person moves beyond the self to interact with the environment.

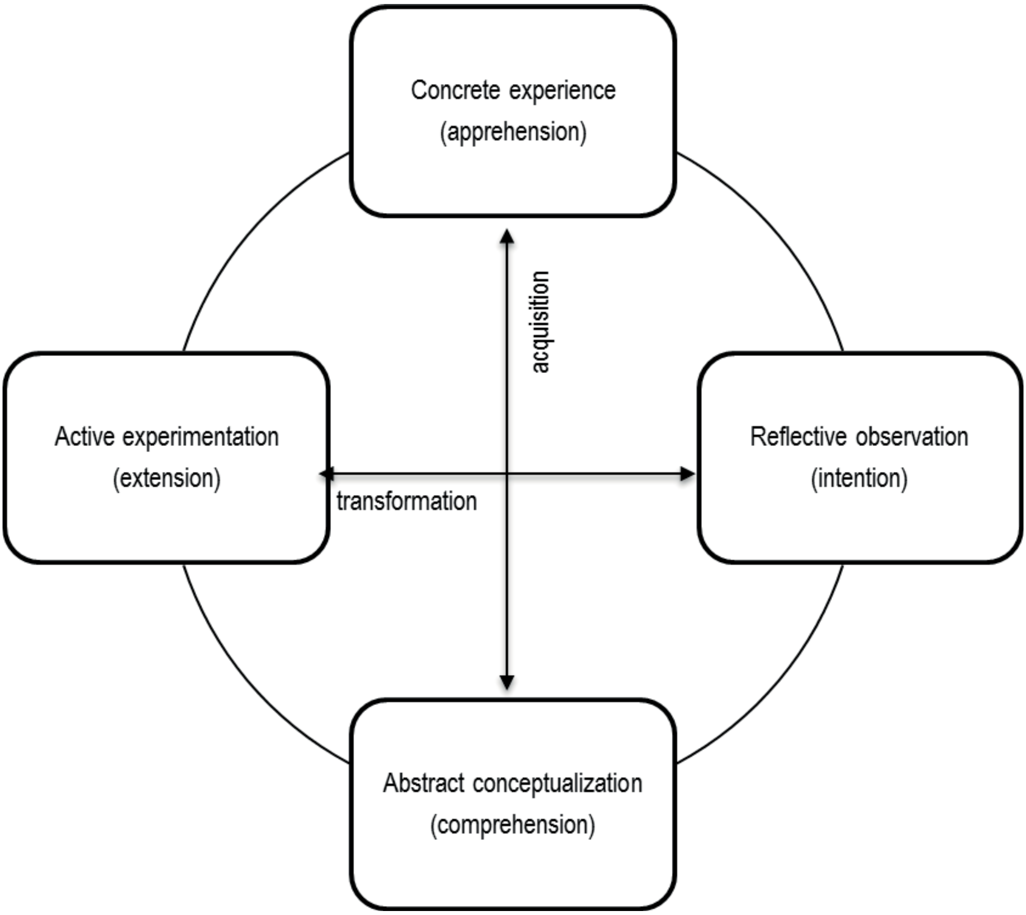

Figure 1. Kolb's cycle (Kolb, 2014).

Kolb's cycle portrays learning as an individual activity, which has led to criticism of the model (Vince, 1998). As a response to the criticism, Kayes (2002) presents a K-model that combines the individual and the social cycle, as presented in Figure 2. It is based on Kolb's idea that there are two kinds of knowledge (Kolb, 2014): Personal knowledge combines the apprehensions arising from an experience with socially-acquired comprehension to explain the experience. Social knowledge, on the other hand, is the structure of words, images, and symbols based entirely on comprehension and transmitted socially and culturally (Kolb, 1984). Kayes (2002) combines this division within the experiential learning cycle so that the experience and reflections are activities of tacit, personal knowledge, and abstraction and action are part of social, implicit knowledge. The process of learning is a balance between social and personal activity, and experience is based on existing social knowledge.

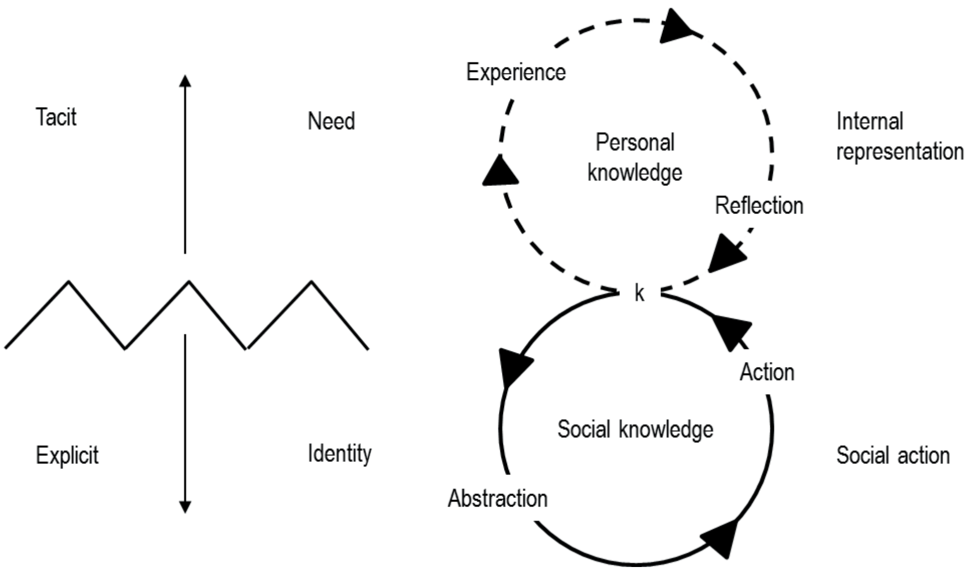

Figure 2. The K schema (Kayes, 2002).

The K schema resembles Argyris' double-loop learning (2002). The first loop entails learning to follow the given rules or goals and the second loop refers to questioning the rules to solve the potential source of the problem. The second loop of learning enables the modification of rules based on experience. Even if both entail learning through experience, they view the experience from different perspectives, as double-loop learning does not consider the personal or the social aspect of knowledge.

2.3.2 Learning styles

Individual learners are different from each other (Hawk & Shah, 2007). They do not necessarily start their learning cycle in the same way from concrete experience, nor do they go through the other modes in the same way (Joy & Kolb, 2009). Their learning style depends on their genes, life experiences, the demands of the present environment (Kolb, 2014), and cultural influences (Yamazaki & Kayes, 2004). Based on the learner's approach to the dimensions of knowledge transformation and knowledge acquisition, the learning styles can be divided into four main categories: diverging, assimilating, converging, and accommodating, as described in Figure 3 (Kayes, 2005; Kolb, 2014). The divergers prefer concrete experience and observation (Sugarman, 1985) having strengths in creativity and interaction with others (Turesky & Gallagher, 2011). The assimilators utilize abstract conceptualizing and reflective observation (Sugarman, 1985) and their strengths lie in systematic planning, organizing, and analyzing (Manolis, Burns, Assudani, & Chinta, 2013; Turesky & Gallagher, 2011). They prefer reading and lectures (Kolb & Kolb, 2005). The convergers use abstract conceptualization and active experimentation (Manolis et al., 2013). Their strengths lie in goal-setting, problem-solving, and decision-making (Turesky & Gallagher, 2011). The accommodators process information through hands-on experience and experimentation (DiMuro & Terry, 2007). They are good at implementing plans and starting new activities (Turesky & Gallagher, 2011).

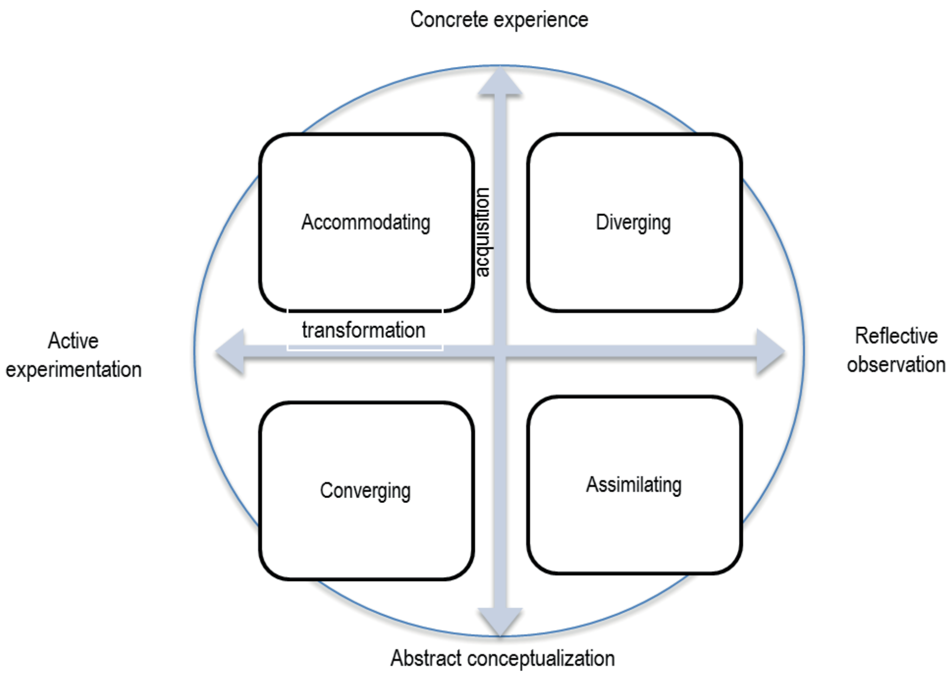

Figure 3. Kolb's learning-style inventory of four dimensions (Kolb, 2014).

The individual's learning consists of a unique combination of these modes. The ability to move from one learning mode to another throughout the learning cycle enables effective learning (Passarelli & Kolb, 2012). Teaching around the experiential learning cycle ensures all learning styles are addressed, and therefore individual student learning-style preferences do not need to be assessed (Felder & Brent, 2005).

Students' learning-style preferences vary across disciplines. Jones and colleagues (2003) found that students preferred an assimilating style in math, science, and social studies, whereas in English studies the preferred style was the diverger. The students were able to adjust their learning style to the specific discipline requirements. The learning styles may also evolve over the course of the studies (Fleming, McKee, & Huntley-More, 2011). Ventura and Moscoloni (2015) found that in the early years of the university, the students from different disciplines had little difference in their learning styles. But as they proceeded, their learning styles became more discipline-specific.

Learners achieve higher learning outcomes when they engage in environments that complement their learning styles (Armstrong & Mahmud, 2008). An optimal learning environment should accommodate different learning styles simultaneously (Untener, Mott, & Jones, 2015). It should blend together theoretical and practical learning so that the learner can absorb information and put it into practical use in a way that is most fitting to him or her. In addition, it should include a social aspect where the learner can interact to make the learned content explicit for him or herself and others.

2.4 Learning spaces and environments

Learning spaces typically refer to physical settings (Beyes & Michels, 2011; Oblinger, 2006). Kolb (2014) expands the concept of a learning space to include institutional, cultural, social, and psychological aspects. It is an aggregate formed by the experience of the learner and therefore the social and psychological dimensions have the most influence on learning (Kersh, 2015; Passarelli & Kolb, 2012).

When the learning space is expanded from being student-centered to a relational space where ideas and people move in relation to each other (Tomkins & Ulus, 2016), it resembles the concept of a learning environment. A learning environment can be defined as a combination of physical surroundings, psychological or emotional conditions, and social or cultural influences affecting the student in an educational enterprise (Hiemstra, 1991). A constructivist perspective of a learning environment emphasizes the collaborative element of learning as "*a place where learners may work together and support each other as they use a* *variety of tools and information resources in their guided pursuit of learning goals and problem-solving activities*" (Wilson, 1996, p. 5).

Learning effort can be maximized when the learner can fully engage in the learning cycle in learning spaces that promote growth-producing experiences (Kolb, 2014; Kolb & Kolb, 2009): Such a space needs to combine challenges and support and leave room for conversational learning. The learners and their experience have to be respected. There has to be room for the development of expertise, acting, and reflecting.

Emotions, both positive and negative, have an important role in experiential learning (Finch, Peacock, Lazdowski, & Hwang, 2015). Positive emotions expand a person's thought–action repertoire and foster openness to new relationships, experiences, and information (Abe, 2011). Negative emotions such as frustration, humiliation, and distress may block learning (Tyson, Linnenbrink-Garcia, & Hill, 2009).

A feeling of safety can reduce negative emotions. The students need a safe space in which they can experiment and increase their confidence and independence (Kisfalvi & Oliver, 2015). The instructors can construct this by providing them with boundaries and limits and by helping them to avoid chaotic disintegration in an emotional and unmanaged situation. Learning spaces should be challenging and supportive, also enabling different opinions in a hospitable way (Kisfalvi & Oliver, 2015).

A good learning space provides a balance of thinking and feeling and allows time for expressing and testing the learning instead of concentrating only on thinking (Kolb & Kolb, 2009; Tomkins & Ulus, 2016). In addition, it provides a safe place for students to experiment without the fear of making mistakes, losing control, or being humiliated (Kisfalvi & Oliver, 2015). The learning space needs to link the experiences to the learner's interests and experiences and encourage the learners to take responsibility for their own learning. Such as space can combine a physical environment with appropriate timing, the suspension of judgment, mutual trust, respect, and reflexivity (Kisfalvi and Oliver, 2015)

2.4.1 Student-centered learning environments

Rather than being passive recipients, students are active constructors of knowledge (Schunk, 2014). Student-centered learning environments are an alternative to the traditional, transmissive instruction where information is transmitted from teachers or technology to learners (Land, Hannafin, & Oliver, 2012). Despite the various different ways in which to design a student-centered learning environment, there are common core values and key principles (Land et al., 2012): First, the learner constructs his or her own meaning. External learning objectives may exist, but the learner determines how to approach learning based on individual preferences and questions. The learners take responsibility for their own learning. Second, prior and everyday experiences are important contributors to constructing the meaning. Third, learning is done as scaffolded participation in authentic tasks and socio-cultural practices. Scaffolding refers to providing aid to students through human or technological instructors when needed and withdrawing the aid when competence increases (Azevedo & Hadwin, 2005). Fourth, student-centered learning environments aim at enriching and extending learning through multiple perspectives, resources, and representation. Varied perspectives from teachers, experts, and peers are provided in suitable contexts and by appropriate tools. Student-centered learning environments prefer authentic, student-oriented learning contexts that promote skills over isolated knowledge acquisition in externally directed instruction (Land et al., 2012).

Grabinger and Dunlap (1995) present a concept of rich environments for active learning (REALs) that

- provide learning experiences in complex and authentic contexts;
- encourage students to be responsible, take initiative, and make decisions;
- use dynamic and cross-disciplinary learning exercises that enhance high-level thinking processes where students can integrate acquired knowledge with previous knowledge and experiences;
- evaluate student progress in content through realistic activities and performance; and
- foster an attitude of knowledge-building learning communities where students and teachers learn collaboratively.

Simulations are examples of REALs (Ferry et al., 2005). Flipped classrooms are REAL activities where class time is spent on solving actual problems that have traditionally been homework and the instructional content such as lectures is delivered, for example, online (Bishop & Verleger, 2013). An IT-programming project carried out like a problem-based exercise for a real customer in a student team can be a REAL (Bennett, Harper, & Hedberg, 2002; Grabinger, Dunlap, & Duffield, 1997). Another example is using prediction markets to build management decision scenarios that are associated with real-world events (Buckley, Garvey, &

McGrath, 2011). A more advanced example is a digital forensics laboratory for educational purposes (Vidas, Branch, & Nicoll, 2008).

There are several potential benefits to authentic learning environments (Edelson & Reisener, 2006): Authentic practices can be found outside of the educational settings in personally consequential ways, which increase their relevance. Increased motivation may result from applying knowledge to meaningful contexts. In addition, the structure of knowledge or a discipline may become more apparent as a result of engaging in practical activities.

Students do not only learn from teachers and instructors, nor do they construct their knowledge in isolation from other learners. They also learn from each other (Land et al., 2012). An experiential learning environment can involve an individual or a group. Kolb's original cycle does not involve other learners. A student can carry out a simulation exercise with a computer or do practical training and gain experience without other students, teachers, or instructors. However, collaboration and interaction in a social context provide an important part of the learning process. Experiential learning that triggers interdependency, gives students possibilities to learn to share positive emotions and regulate negative emotions that are caused by the interaction as well as the experiential activities, thus highlighting the meaning of other students in an individual student's learning experience (Finch et al., 2015).

2.4.2 Learning communities

Student-centered learning emphasizes the importance of scaffolded participation in socio-cultural practices (Land et al., 2012). The K schema of experiential learning states that experience needs to involve social engagement to combine tacit, personal knowledge with the structures of implicit, social knowledge (Kayes, 2002). The social dimension consists of other learners and the teachers. A learning community is

> *an intentionally developed community that exists to promote and maximize the individual and shared learning of its members. There is ongoing interaction, interplay, and collaboration among the community's members as they strive for specified common learning goals.* (Lenning, Hill, Saunders, Solan, & Stokes, 2013, p. 7)

It acts as the psychological learning environment. A professional learning community (PLC) contains specialists from one or several fields working together to learn and create solutions to perceived problems (Lenning et al., 2013).

The aim of learning communities in education is to organize students and teachers into groups to enhance curriculum integration. Learning communities can act as academic and social support networks for students and as peer-support groups for faculty (Shapiro & Levine, 1999). Group learning activities result in positive learning outcomes (Engstrom, 2008).

Student learning communities (SLCs) are small groups that are organized for interactions between students, faculty, and the curriculum. The integration varies from clustering two courses around an interdisciplinary theme to a complete program of study. Faculty and staff, on the other hand, can form PLCs by organizing into collaborative groups to plan and execute strategies to optimize student learning (Lenning et al., 2013). These educational PLCs can develop a culture of collaboration in the institution. They can shift the focus from teaching to ensuring that the students learn (DuFour, 2004).

2.4.3 Computer-supported collaborative learning

Computer-supported collaborative learning (CSCL) is interested in how group and individual learning can be supported by information technology (Jeong, Hmelo-Silver, & Yu, 2014). CSCL environments vary from generic collaborations to domain-specific knowledge tools. CSCL has emerged to provide support for learning contemporary skills that are not acquired when taught through memorizing and via traditional teaching methods (Ludvigsen & Mørch, 2010). Typical CSCL environments enable learners and instructors to be geographically dispersed and allow learners to participate at a time that suits them (Kreijns, Kirschner, & Jochems, 2003).

There are two overarching concepts: scaffolding and mediating (Ludvigsen & Mørch, 2010). In scaffolding, the teacher models the learning exercise and then gradually moves away and transfers the responsibility of the learning to the students. Technological artifacts can carry out the same role. The technology can also be used as an enhancing and mediating artifact. Scaffolding comes from many sources: the software, the teacher, the other students, and the learning material. When there is an effective overall strategy, synergies can be developed between these scaffolds (Dillenbourg, Jarvela, & Fischer, 2009).

Several studies demonstrate that CSCL tools affect the learning process positively (Arnseth & Ludvigsen, 2006): They promote task orientation and reflective activities, collaborative knowledge-building, rationale and argumentation, problem-solving, developing a deeper understanding, as well as enabling the student's meta-cognitive understanding. Students that have been provided with CSCL tools have been shown to have a better performance than students without them (Brown, Ellery, & Campione, 1998; Lamon et al., 1996). CSCLs have also been reported to have disadvantages and challenges such as poor levels of discussion and argumentation and idea challenging (Arnseth & Ludvigsen, 2006).

Even if the CSCL has developed through the development of technology, it should not be viewed as the solution for organizing learning and teaching (Dillenbourg et al., 2009). The educational functionality needs to be supported by social interaction, which does not happen automatically without planning and facilitation (Kreijns & Kirschner, 2004). Also, technology-supported learning groups with relevant instructional guidance succeed better than groups without such guidance do (Dillenbourg et al., 2009). However, interaction needs to be analyzed to understand how collaboration and guidance should be undertaken (Arnseth & Ludvigsen, 2006). Also, collaboration is not necessarily better than individual learning. The best mixture of artifacts, collaboration, and individual activities depends on the situation (Ludvigsen & Mørch, 2010). Self-regulation, individual motivation, and social processes should also be considered in the CSCL planning process (Dillenbourg et al., 2009).

2.4.4 Summary of learning environments

To reduce the distance between business education and the realities of business enterprises, there is a need to bring experiential elements into business learning in a novel way, as enhancements in experiential learning are yet to become widespread (Pettigrew & Starkey, 2016). Experiential learning is still often teacher-centered, promoting the behavioristic learning perspective (Estes, 2004). Student-centered learning environments put the learner in the middle (Land et al., 2012). The responsibility for the learning and constructing the meaning reside with the student. Business students consist of very different individuals with different learning styles. In an ideal student-centered learning environment, students with different learning styles are able to move through the learning cycle from concrete experiences through to reflections and abstract conceptualizations, to new ideas in spaces that best accommodate their learning styles.

The students do not learn in isolation by themselves. They need support and guidance or scaffolding for their learning process (Azevedo & Hadwin, 2005).

Teachers, peers, technology, and their combinations can provide these scaffolding structures in suitable contexts and through the use of appropriate tools.

REALs promote studying in realistic, authentic, and complex contexts with interdisciplinary learning activities. Information technology is utilized for providing such learning environments.

However, technology alone is not an optimal environment. Learning is optimized when technology is used in cooperation with other people. CSCL brings together people and information technology. It can combine the internal ideas with social interaction according to the K schema of Kolb's cycle that Kayes (2002) calls for. Such a combination can also foster an attitude of knowledge-building learning communities where students and teachers learn collaboratively (Grabinger & Dunlap, 1995).

The experiential learning literature has studied learning environments from physical classrooms and workplaces, to computer-supported, distributed, simulated, and virtual learning environments (Kolb & Kolb, 2018a, 2018b, 2018c, 2018d, 2018e, 2018f). There are numerous articles on e-learning environments as well as some examples of simulations and virtual learning environments, but there are few examples of holistic learning environments that would combine several tools and methods into one.

We need to create a learning environment that accommodates multiple learning styles and combines the internal ideas of individual students with larger learning communities. Learning is an interplay between the actors participating in the learning process.

3 RELATED RESEARCH ON BUSINESS LEARNING ENVIRONMENTS

In business education, experiential learning has taken multiple forms such as case exercises (Brunel & Hibbard, 2006; Walker & Ainsworth, 2001), problem-based learning (Anderson & Lawton, 2009; Van den Bossche, Segers, Gijbels, & Dochy, 2004), internships and job shadowing (McCarthy & McCarthy, 2006), business projects (Lidon, Rebollar, & Møller, 2011), as well as service-learning projects (Godfrey, Illes, & Berry, 2005; Steiner & Watson, 2006).

Different experiential learning environments bring different elements of the REALs to the learning situation. The human interaction in learning communities is done face to face in the classroom or in virtual worlds (Halvorson et al., 2011). Real-life tools such as ERP systems (Angolia & Pagliari, 2016; Jewer & Evermann, 2015) and social media (Galan & Khodabandehloo, 2016; Granitz & Koernig, 2011; Rinaldo et al., 2011) bring the authenticity to the learning process. Business simulations and games (Anderson & Lawton, 2009; Faria et al., 2009; Lainema & Lainema, 2007) enable dynamic situations and interdisciplinary activities.

According to the principles of student-centered learning environments, we need to support the student's internal meaning construction by combining the scaffolding structures of human instruction, technology, and socio-cultural interaction (Land et al., 2012). These different elements could be brought together by a CSCL that utilizes technology, human collaboration, and interaction for improved business learning. This chapter studies previous research on the relevant learning environments and their integration.

3.1 Literature review

To expand the view of experiential learning and learning environments to cover business learning, a literature review was conducted. Simulations were identified as a learning environment in the experiential learning literature: The bibliography (Kolb & Kolb, 2018a, 2018b, 2018c, 2018d, 2018e, 2018f) contained several citations for *Simulation & Gaming*, alongside simulation-related articles from other sources, so business simulation was chosen as a search term. The case university in this dissertation was using a manual simulation referred to as the practice enterprise (PE) model (also known as a training firm, practice firm, and virtual enterprise) and therefore those terms were also used as search terms.

ERP systems are the practical computer tool used in the everyday life of business management. They are also used as authentic tools in business learning and so the ERP system was another search term. The original literature review was conducted on materials published prior to 2012 and the results are presented in article I. An additional literature review was conducted for this dissertation. The review was carried out on business education and information management education literature, as identified in Table 1. The journal selection was based on Currie and Pandher's (2013) review of top-ranking business education journals and Arbaugh and Hwang's (2015) review of the most-cited business education articles. Altogether, 158 potential articles were identified in the business education literature, out of which 65 were published in *Simulation & Gaming*. The majority of the articles focused on simulations. There were only fourteen articles that mentioned ERP systems in relation to business education.

In the information systems literature, 46 potential articles were identified. In the information management literature, the focus was on ERP systems rather than on simulations: 25 of the articles that were located dealt with ERP systems in educational use.

The reviewed literature did not contain anything about the PE model. This presents an obvious research gap to start with. Additional searches with the same search words were conducted in Google Scholar and in academic databases including Ebsco, Science Direct, and Sage to find more research on experiential business learning environments.

In addition, a systematic literature review (Kitchenham, 2004) was conducted to get an understanding of the status of business curriculum integration. Several databases were searched for all articles published between 2013–2017. The details of that literature review are presented in article III.

The next chapters present the findings of the literature reviews amended with more recent studies of the subject.

Table 1. Selection of literature.

Business education journals
Academy of Management Learning and Education
Journal of Education for Business
Management Learning
Business Communication Quarterly
International Journal of Management Education
Journal of Management Education
Decision Sciences
Decision Sciences Journal of Innovative Education
Education & Training
Journal of Economic Education
Issues in Accounting Education
Journal of Marketing Education
Journal of Business Ethics
Journal of Leadership & Organizational Studies
Simulation & Gaming
Information management education journals
Management Information Systems Quarterly
Information Systems Research
Journal of Management Information Systems
Journal of Information Systems Education
Communications of the ACM
Communications of the AIS
European Journal of Information Systems
Journal of the Association for Information Systems
Scandinavian Journal of Information Systems
Journal of Information Technology
Information Systems Journal

3.2 Business skills laboratory

Blaylock, McDaniel, Falk, Hollandsworth, and Kopf (2009) present a conceptual model of a business skills laboratory (BSL) that combines features of simulations with the human interactions of student teams and day-to-day work. They borrow the idea from the nursing school laboratories of medical education.

With the BSL concept, students hold positions in fictitious companies that have physical offices. They make business decisions under the supervision and support of the faculty. The business activities are structured around a commercial business simulation or customized software. By incorporating role playing and injecting "experiments", the BSL creates an environment where students not only make strategic decisions; in addition, they engage in face-to-face interactions and gain practical knowledge in managing staff, negotiating deals, and dealing with crises. (Blaylock et al., 2009).

One type of BSL is the PE model. A PE is a virtual company that is organized like a real company, but it does not trade money, actual services, or physical products (Europen-pen International, 2017). In this non-computer-assisted simulation, the student-run PEs trade with others and manage their internal activities and processes (Borgese, 2011; Collan & Kallio-Gerlander, 2007; Isokangas, 2009; Tampieri, 2014).

The PE model strives for business and entrepreneurship learning (Costea, 2010; Gramlinger, 2004; Riebenbauer & Stock, 2015; Santos, 2008) through interactions between real people. It appears to have positive effects on learning teamwork, communication, and motivation (Krauskopf & Frei, 2012; Neuweg & Pfatschbacher, 2013). There are indications that low-performing students benefit the most from the PE activity (Borgese, 2001; Graziano, 2003).

The PE model provides a training ground for multiple disciplines, but it also has deficiencies. It lacks action and credibility (Greimel-Fuhrmann, 2006; Miettinen & Peisa, 2002; Neuweg, 2014; Santos, 2008). It does not contain pre-designed scenarios or any competitive elements (Santos, 2008). Consumer and raw-material markets are missing (Miettinen & Peisa, 2002; Tramm & Gramlinger, 2002). The amount of trading is highly dependent on the participants' motivation and competencies (Gramlinger, 2004; Santos, 2008). The PE model needs to be developed to better utilize information technology (Gramlinger, 2005) and increase the level of activities (Greimel-Fuhrmann, 2006).

The majority of the literature on the PE model was in German, written mainly in Austria. The review identified a clear gap in the English-speaking literature for research on the PE model or other types of business skill laboratory experiments.

3.3 Computer-supported business learning environments

3.3.1 Business simulations

A computer simulation is an activity that combines realistic functions with an artificial environment (Thavikulwat, 2004) where the basic dimensions of a business environment are represented by a computer model (Anderson & Lawton, 2009). Business simulations consist of open-ended, changing situations with many dependent variables (Thavikulwat, 2012). All the participants need to play a role and respond to the events that take place. The first business simulations were introduced in the 1950s (Faria et al., 2009). They are often used in capstone courses and strategic management courses (Faria et al., 2009).

Business simulations focus on different types of learning (Clarke, 2009): Micro-world simulations serve the purpose of understanding the company's internal operations whereas macro-world simulations offer a horizontal, industry-wide perspective on business problems. The interpersonal skill and business acumen simulations focus on the personal skills of decision-making, managing, creating strategies, and solving individual situations. The review only revealed examples of these separate, differentiated simulations. There were no integrated simulations that combined the micro- and macro-perspectives with personal decision-making and problem-solving.

Participating in a simulation exercise has resulted in increased motivation, improved problem-solving and analytical skills, the transfer of knowledge to real business situations, improved decision-making and cross-functional skills, and the increased retention of knowledge and learning ability (Clarke, 2009). Several studies have indicated an improvement in behavior from the beginning to the end of the simulations (e.g. Davidovitch, Parush, & Shtub, 2008; Langley & Morecroft, 2004; Olhager & Persson, 2006; Thavikulwat, 2012).

On the other hand, business simulations often oversimplify real-life situations (Goosen, Jensen, & Wells, 2001; Hofstede, De Caluwé, & Peters, 2010). The concept of time is unrealistic as simulations are typically operated in "business episodes" instead of involving a continuous flow of events (Lainema & Makkonen, 2003). They emphasize management decision-making and strategy formulation (Faria et al., 2009).

Business simulations are not an efficient pedagogy for learning terminology, concepts, factual knowledge, or basic principles (Anderson & Lawton, 2009). Other pedagogies such as lectures are quicker and more efficient. Simulations should be combined with other pedagogical tools to enable optimal learning. In addition, for a simulation to be a real learning experience, all participants need to have some degree of commonality in understanding the simulated environment (Teach & Murff, 2009).

3.3.2 ERP systems

ERP systems are business management systems where companies run their business operations as well as manage, collect, and store the data for their business operations. ERP systems became part of business learning in the late 1990s (Becerra-Fernandez, Murphy, & Simon, 2000; Bradford, Vijayaraman, & Chandra, 2003; Ruhi, 2016). They are used in teaching business processes, business information technology, marketing, logistics, accounting, and human resource management (David, Maccracken, & Reckers, 2003; Hawking, Foster, & Bassett, 2002; Johansson, Zimmerman, & Rehnström, 2014; Pridmore, Deng, Turner, & Prince, 2014; Rienzo & Han, 2011; Seethamraju, 2012; Schwade & Schubert, 2016; Strong, Fedorowicz, Sager, Stewart, & Watson, 2006; Wimmer & Hall, 2016). ERP systems emphasize cross-functional business processes, decision-making, cooperation, and coordination within organizations (Boykin & Martz, 2004; Hepner & Dickson, 2013; Kanthawongs, Wongkaewpotong, & Daneshgar, 2010; Schwade & Schubert, 2016).

ERP system learning environments focus on practical work. Students improve their IT skills and business process orientation (Davis & Comeau, 2004; Hawking, McCarthy, & Stein, 2004; Hawking, Ramp, & Schackleton, 2001; Hepner & Dickson, 2013; Jensen, Fink, Møller, Rikhardsson, & Kræmmergaard, 2005; Monk & Lycett, 2016; Schwade & Schubert, 2016; Targowski, 2006; Watson, Noguera, Maurizio, & Holmes, 2015). The learner is put in the center and given hands-on experience (Angolia & Pagliari, 2016; Nelson, 2002; Noguera & Watson, 2004), which increases motivation, attendance, and engagement (Alshare & Lane, 2011; Davis & Comeau, 2004; Jewer & Evermann, 2015; Scholtz, Cilliers, & Calitz, 2012). Students that have taken ERP system courses have been offered better employment opportunities and higher starting salaries than students without ERP experience (Holsing, 2007).

Hands-on learning experiences have limited value if they focus on executing tasks and learning ERP technical skills (Wang & El-Masry, 2009). Especially in the large, complex ERP systems, the students struggle to understand the connection between business processes, information, and management decisions (Monk & Lycett, 2016; Seethamraju, 2007). When learning is conducted with pre-designed cases (Bradford et al., 2003) or point-and-click exercises (Angolia & Pagliari, 2016), learning situations have a tendency to be predictable and static. Sometimes the ERP exercises focus on system implementation rather than on the successful use of ERP systems (Hepner & Dickson, 2013).

ERP-based simulations combine the ERP systems with the simulations. Managerial decision-making situations are solved in an ERP system (Cronan, Léger, Robert, Babin, & Charland, 2012; Draijer & Schenk, 2004; Hajnal & Riordan, 2004; Léger, 2006; Léger et al., 2011; Pittarese, 2009; Seethamraju, 2011).

The most widely used and researched ERP simulation is the ERPSim game (Chen, Keys, & Gaber, 2015; Cronan et al., 2012; Dunaway, 2018). It illustrates the supply chain by combining automated business functions with simulated market data utilizing the real SAP system as the user interface (Léger et al., 2012). Teams of 2–6 students operate a cereal company and run full business cycles from forecasting through to production, and sales to finance. The students go through several expedited business cycles during one game day. In between the cycles, they analyze and discuss the process. The ERPSim has been used, for example, in studying business processes and enterprise integration (Léger et al., 2012; Seethamraju, 2011) on management information systems courses (Hayen & Holmes, 2014) as well as in integrative capstone courses (Legner et al., 2013).

3.4 Curriculum integration

The term "curriculum" is not easy to define. There are over 120 definitions, ranging from wide, philosophical orientations, to narrow, technical definitions (Portelli, 1987). We use Walker's (2003, p. 5) definition of a curriculum as "*a particular way of ordering content and purposes for teaching and learning in schools*." Content is a list of topics, themes, and concepts, or works to be covered. Purposes are the intellectual, social, or personal reasons for covering the content. The content and purposes are ordered, or organized by scope and sequence, for example, to be presented as curriculum documents. That documentation enables the faculty to coordinate the learning and teaching based on the big picture of what and why, to the details of planning the scheduling for individual learning situations.

Curriculum integration, on the other hand, can be seen as

> *a philosophy of education and set of practices through which content is drawn from several subject areas or disciplines to focus on a particular topic or theme with the aim of seeing the connections between the subject area content and the wider context* (McBrien & Brandt, 1997, p. 5).

There have been various efforts undertaken to construct the ideal, integrated business curriculum. Capstone courses are typically taken at the end of the studies to integrate previous learning by using a business project or a case study (Desai, Tippins, & Arbaugh, 2014; French, Bailey, van Acker, & Wood, 2015; Karagozoglu, 2017; Misra, Ravinder, & Peterson, 2016; Schwering, 2015; Weber & Englehart, 2011). Service-learning programs are real community projects offering benefits both to the students' learning and the community (Godfrey et al., 2005; Niehm, Fiore, Hurst, Lee, & Sadachar, 2015; Steiner & Watson, 2006; Wozniak, Bellah, & Riley, 2016). Students can integrate knowledge from different disciplines and acquire concrete experiences, as well as get to reflect the experiences onto their earlier learning (Gallagher & McGorry, 2015; Govekar & Rishi, 2007; Tyran, 2017). Team teaching provides a cross-functional setting where students can concurrently learn different areas of expertise (Lafond, Aleer, & Wentzel, 2016). With more than one teacher on a course, each teacher brings a different perspective to the covered issues (Usry, White, & Olivo, 2009). There are also other integration methods such as problem-based learning activities, business process-oriented curriculum structures, strategy courses, guest lecturers, work-integrated learning, cross-disciplinary discussions, and cooperation with local businesses such as multi-disciplinary projects or internships (Alstete, 2013; Athavale, Davis, & Myring, 2008; Smith & Worsfold, 2015; Sroufe & Ramos, 2015; Waddock & Lozano, 2013).

Strempek, Husted, and Gray (2010) studied sixteen curriculum-integration activities and found three distinctive approaches. In the most basic approach, the students took separate disciplinary courses and the integration took place in a specific laboratory or a project course. The second approach involved the students in highly integrated courses that served the purpose of a central business project or a case. The most ambitious approach took an entrepreneurial focus and students worked in teams to create real or simulated businesses. One integration model followed the business start-up process where the student teams created start-up companies and presented their business plans to actual financiers. All the integrated programs delivered core business content equally well or more effectively than normal programs. Several integrated programs showed improvements in the student learning results.

Bajada and Rowan (2013) argue that integration of the whole degree program is the most efficient learning method. Jaiswal (2015) presents just such a reform: The whole core curriculum was integrated with holistic modules, team teaching, cross-disciplinary cases, an international experience, and a student team mentorship program. Brunel and Hibbard (2006) introduce a core business course integrating information systems, operations, marketing, and finance. The integration is done with a semester-long project with student teams. Ramesh and Gerth (2015) describe an information systems core curriculum that combines clustered modules with student groups working on integrative projects and cases.

However, there are not many concrete examples of holistically integrated curricula. There are theoretical models (e.g. Allen, Miguel, & Martin, 2014; Fenton & Gallant, 2016), but not many concrete examples, implementations, or their evaluations (Jaiswal, 2015). For example, a 2008 survey of 143 American business schools reported that only 22% of schools had planned to integrate the core undergraduate business curriculum (Athavale et al., 2008). Strempek et al.'s (2010) research on sixteen integrated curricula reported that only ten had remained intact and the rest had been discarded or considerably altered.

The biggest challenges identified in curriculum integration involve people. Learning communities have been used as a curriculum integrator in several ways (Lenning et al., 2013; Levine & Shapiro, 2000): In its simplest form, learning cohorts of small student groups take several large courses together. They are given integrative seminars to help them make connections between the knowledge content of the courses. In paired or clustered courses, the courses are presented as an integrated cluster where the students complete shared exercises across the courses and collaborate on their learning endeavors. In the coordinated studies or team-taught programs, the faculty and the students form a learning community that actively collaborates in a complete program or study.

ERP systems and simulations have been used as the integrating medium in the curriculum (Grandzol & Ochs, 2010). Successful implementations have varied from a single integrative course (Alshare & Lane, 2011; Kanthawongs et al., 2010; Rienzo & Han, 2011; Seethamraju, 2007) or a paired course (Payne & Whittaker, 2005), to an information systems-focused integration throughout the lifecycle of the studies (Mandal & Flosi, 2012), and even to extensive integration throughout the whole curriculum (Boykin & Martz, 2004; Sager, Mensching, Corbitt, & Connoly, 2006).

Courses have also been clustered around an ERP system. Hejazi, Halpin, and Biggs (2003) provide an example where different course contents were presented through SAP in lectures, demonstrations, or hands-on exercises throughout the whole curriculum. This effort integrated many disciplinary courses, but the integration remained rather superficial and concentrated on demonstrating rather than on producing in-depth understanding. Johnson, Lorents, Morgan, and Ozmun (2003) describe a SAP implementation of a simulated manufacturing company that was used for all hands-on exercises in two parallel courses. The integration had more depth, but it only contained two business functions: management information systems and production.

The examples described above are single or clustered course-type curriculum integrations where the integration remains fractional. Using an ERP system for a wider interdisciplinary integration across business disciplines requires extensive planning, coordination, and modification to curricula (Holsing, 2007). The core curriculum needs an overarching structure that builds an integration foundation for the different disciplines (Teece, 2011).

3.5 Summary of the related research and the research gap

Blaylock et al. (2009) present a conceptual model of a student-centered business learning environment: A BSL that would resemble a real work environment by combining face-to-face interaction with a business simulation. The student is in the center and forms his/her own mental structures by participating in the business activities and learning exercises. He/she is supported by the scaffolding structures of teacher guidance, the contexts and tools of the business environment, as well as interactions with other students working in the laboratory.

Blaylock et al. (2009) suggest that the conceptual model needs to be concretized. Parts of the model exist already. The PE model is a manual simulation that provides the socio-cultural interaction of a student-centered learning environment: role-play, teamwork, and negotiations. It revolves around a learning community of student teams. From the perspective of a REAL, it aims at authenticity and realism, but there are challenges: There are only a limited number of companies and business areas presented—the ones that are run by the fellow students (Neuweg, 2014; Santos, 2008). There are no consumer or raw-material markets (Miettinen & Peisa, 2002; Tramm & Gramlinger, 2002). The learning environment lacks the contemporary tools that modern business enterprises use (Gramlinger, 2005). It provides the context, but the tools are not good enough for the student-centered learning environment.

CSCLs combine people with technology. They can act as scaffolds to learning and mediators between the students and their learning process. Business simulations provide tools for interplay with a (fabricated) outside world, but there are not many socio-cultural interactions or actions relating to day-to-day business operations (Lainema & Makkonen, 2003). A business simulation could increase the feeling of authenticity and complexity of a PE model by simulating the consumer and raw-material markets. It should combine the micro-world and macro-world approaches to offer both the internal and the external perspectives on business problems. Building the simulation onto an existing ERP system would bring additional scaffolding structures to concretize the integrative business perspective that has been identified as a gap in the graduates' skills and knowledge.

Combining the PE model with an ERP-supported simulation could provide a BSL that has been called for by Blaylock et al. (2009). The literature review did not reveal any examples of such holistic business learning environments. This experiential learning environment would provide the practical training ground for business learning. But the practical training tools and artifacts cannot operate in isolation. The different scaffolds need to be part of an overall strategy (Dillenbourg et al., 2009). They need to be combined with learning objectives, learning methods, and the content of the studies.

The overall strategy would be based on the curriculum. To provide a holistic understanding of business, the learning needs to be structured through an integrated business curriculum. In recent years, there have been multiple efforts to also build the integrated curriculum in combination with experiential learning environments. However, the integrations have remained isolated experiments that solve some of the challenges but do not create overall solutions. Few concrete examples of extensive, holistic core curriculum implementations have been proposed (Jaiswal, 2015).

There is a pragmatic research gap: The theoretical BSL concept needs to be implemented in practice. Concrete examples and research on holistic business curriculum integrations are called for in order to develop business learning that fulfills the needs of the contemporary business.

4 RESEARCH DESIGN

4.1 Research objective and research questions

The initial research question was: How should an experiential business learning environment be constructed to provide a holistic business perspective and a practical training ground to enhance the competencies required of future business graduates?

Previous related approaches provide several examples of how experiential learning environments bring different types of practical elements into business learning. Each of them approaches business learning from a different perspective. Each approach has benefits but also challenges. An appropriate combination could bring the benefits from each environment. The benefits also need to be concretized in improved business learning.

On the other hand, the earlier research also indicated that the learning environments tend to be isolated activities within a course or simulation exercises that are detached from the rest of the studies. The learning environment should be integrated into the rest of the studies. All learning inside and outside the experiential learning environment should be tied together. The integration perspective needs to be elevated from the learning environment to the level of the whole curriculum.

Therefore, the initial research question is further refined into four separate questions:

- RQ1 How should the holistic business learning environment be constructed?
- RQ2: How should the holistic business learning environment be combined with the curriculum?
- RQ3: When the holistic business learning environment is constructed, does it improve learning?
- RQ3: If the holistic business learning environment improves learning, why is that?

Table 2. Research questions and their relation to the articles.

	Research question	Article	Perspective
RQ1	How should the holistic business learning environment be constructed?	I	Literature review, background, needs assessment
		II	Technical description of the learning environment
RQ2	How should the holistic business learning environment be combined with the curriculum?	III	The holistic business learning model
RQ3	When the holistic business learning environment is constructed, does it improve learning?	IV	Learning results
		V	Using ERP system log files in assessing learning
RQ4	If the holistic business learning environment improves learning, why is that?	IV	Boundary object

4.2 Research approach

4.2.1 Design science

> *The world we live in today is much more a man-made, or artificial, world than it is a natural world. Almost every element in our environment shows evidence of human artifice.* (Simon, 1996, p. 2)

Design science is based on pragmatic philosophy where truth and utility are connected (Hevner, March, Park, & Ram, 2004), information is extracted from experience, and knowledge is collaboratively shaped by researchers and practitioners (De Villiers, 2012). The roots of design research are found in the sciences of the artificial by Herbert Simon (Hevner et al., 2004). In the present world, the natural sciences are complemented with human-constructed, artificial sciences such as engineering, medicine, law, or business (Simon, 1996). Where the natural sciences focus on how things are, artificial or design science looks at how things ought to be. The key differences between the natural and the artificial, or the design sciences, are the artifacts. Simon (1996) defined four criteria for the artifacts: they are synthesized by human beings; they imitate the appearance of natural things while lacking the reality; they can be characterized by functions, goals, and adaptation; and they are often discussed, especially in the design phase, by imperatives as well as descriptives. Design science consists of problem-solving, invention, and the building and evaluation of the artifacts and interventions (De Villiers, 2012).

Design science research shares features with practical product development (Hevner et al., 2004). Both are based on business needs and require relevant solutions to actual, concrete problems. Research, however, requires a solid theoretical knowledge base as well as rigorous testing and evaluation of the artifact to increase understanding of the artifact's functionality. In addition, design science aims at contributing new information and understanding to the existing knowledge base.

Design science research comprises of activities that aim at constructing and evaluating technology artifacts to solve practical problems (Hevner et al., 2004). Another equally important goal is to develop theories associated with them (Purao, Rossi, & Sein, 2010). The term "design" refers to both the outcome (a design) as well as the process (to design) (Hevner et al., 2004). Both the end result and the process are relevant.

The core of design science research is to build a construct or an artifact to solve a practical problem that has not been solved before. Artifacts come in many various forms. Hevner et al. (2004) divide IT artifacts into constructs, models, methods, and instantiations. Constructs offer the language through which the problems and solutions can be defined and communicated. Models, in turn, represent real-world situations through constructs. Models aid the problem and solution, and understanding, and provide the connection between the problem and solution components (Hevner et al., 2004). Methods define processes. They provide guidance for problem-solving and for searching for the solution space. Methods can be anything from formal, mathematical algorithms, to informal, textual descriptions of best practices. Instantiations present a working system that implements the constructs, models, or methods. They are used to demonstrate feasibility and to assess the artifact's suitability for its purpose.

The two main activities in design research are building and evaluation (Hevner et al., 2004). Artifacts are built to fulfill the needs of the users. This requires knowledge from earlier research. Evaluation defines how well the artifact works in its environment and gives input to the iteration of the artifact. Criteria and metrics are generated to evaluate performance in context.

4.2.2 Case study

IT artifacts can be evaluated by analyzing their technical features or by observing them in a business environment (Hevner et al., 2004). If the artifact is not ready yet, there can be black- or white-box testing or simulation. The focus of this dissertation is on exploring the learning opportunities in a complex learning environment in actual use. Observation via a case study (Henver et al., 2004) was chosen as the research method. A case study is suitable for qualitative IS research because the information system can be studied in a natural setting with all the complexities of the day-to-day processes. The researcher is able to answer "how" and "why" questions and theories can be generated from practice (Benbasat, Goldstein, & Mead, 1987).

A case study typically uses several different data-collection methods and evidence from several sources such as documentation, interviews, archives, direct and participant observation, and physical artifacts (Yin, 2013). Using multiple methods for data collection increases the accuracy of the data.

4.2.3 Research schedule

After problem identification, the project started up in 2009. A literature review was conducted to get an idea of the existing solutions. A needs assessment was produced based on the discussions and input from the coaches and the students. That gave the inputs for the design process of the ERP simulation. Concurrently with the design process, learning data from the existing PE model was collected during the study year 2009–2010 to act as the comparison point for the learning results. In fall 2010, the new holistic business learning environment was implemented. Throughout the study year 2010–2011, a learning data-collection phase resembling the previous year was undertaken.

The first articles were published in 2012. They presented the background and needs assessment as well the technical design of the learning environment. From 2013–2015, the research process was on hold due to a change in profession away from education and into another line of business. In 2016, the article introducing the use of log files in an ERP environment was published. In 2017, the work continued through writing the remaining articles as well as the summary, which were finalized in 2019.

The schedule for the research is illustrated in Figure 4. It follows the model introduced by Peffers, Tuunanen, Rothenberger, and Chatterjee (2007) with six practical activities:

- identification and motivation of the problem to introduce and justify the research problem;
- definition of the objectives for a solution derived rationally from the problem specification;
- design and development where the artifact is created;
- demonstration by experimentation, case study, simulation, or other proof;
- evaluation by observing and measuring how well the artifact solves the problem; and
- communication of the problem and its relevance, the artifact, its usefulness and originality, the rigor of its design, and its effectiveness.

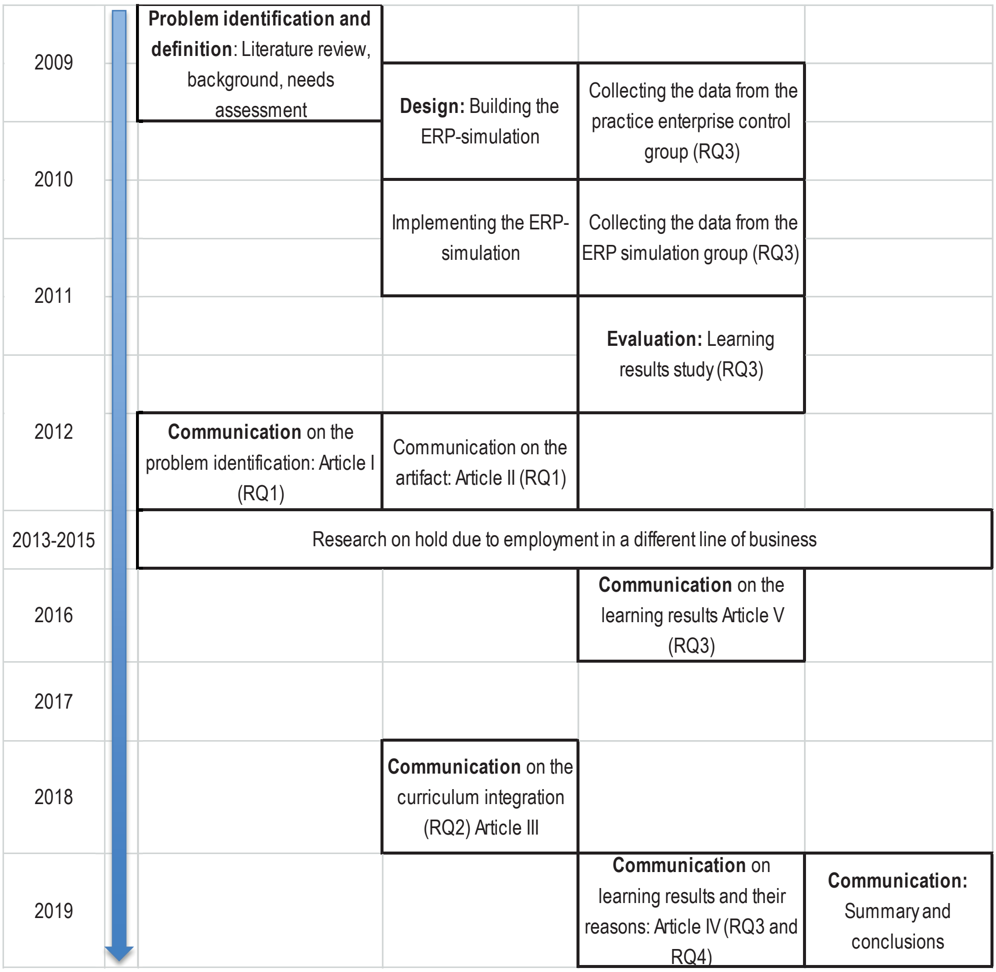

Figure 4. The schedule for the research.

5 RESEARCH PROCESS

5.1 Problem identification

In Finland, university education has a dual structure (Finnish National Agency for Education, 2018). Higher education is provided by universities and universities of the applied sciences (UASs). Both offer bachelor's- and master's-level degrees, but the universities focus on the master's level and the UASs focus on the bachelor's level. Universities emphasize scientific research and instruction, whereas the UASs adopt a more practical approach and engage in applied research and development.

The starting point for the dissertation project was the need to develop a better learning environment for learning business skills. The business need arose from the practical day-to-day educational work at Tampere University of Applied Sciences, School of Business and Services (later the TAMK business school) that specializes in SME business management. Its intake is approximately 120 students in the Finnish-speaking degree program of Business Administration (BBA) studies.

This study focuses on the curriculum and learning environment development that had started in 2005 when the TAMK business school had changed its curriculum toward a more experiential learning approach and implemented the PE model as the learning environment for the first year of BBA studies.

In the PE model, student teams founded virtual companies that they operated throughout the year. Each team had a physical space or a "company office", computers, and a mobile phone. The first-year curriculum was organized as four consecutive modules so that the courses in different disciplines were integrated into the life cycle of the simulated companies. The curriculum structure shows how the disciplines and courses related to each other (Figure 5).

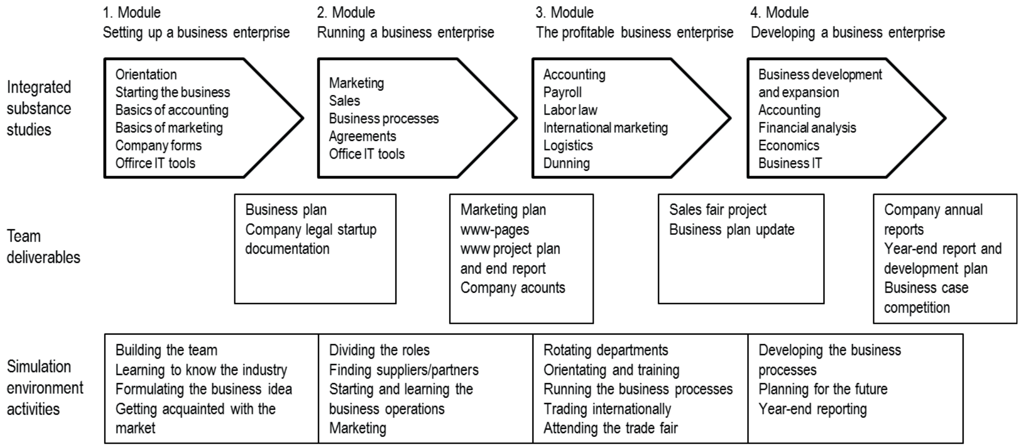

Figure 5. The first-year business curriculum structure.

Each team had a supervising teacher who coached and mentored the students in the learning environment. The researcher of this dissertation was a part of the curriculum development team and became one of the coaches who started the PE model. The team of six coaches formed the team that implemented the learning environment and the integrated curriculum. They also acted as consultants to all the teams, according to their personal areas of expertise: business law, marketing, accounting, finance, logistics, and management. They planned the implementation of each module in cooperation with the substance lecturers. They held weekly meetings to update each other as well as to plan the upcoming week's activities.

5.2 Article I: Motivation and definition of objectives

Nisula, K., & Pekkola, S. (2012). ERP-based simulation as a learning environment for SME business. *The International Journal of Management Education, 10*(1), 39–49.

The PE model was found useful, but it also had challenges. It lacked momentum, as identified in the literature review. The student teams mainly conducted business with each other. The national PE center administrator managed the bank and acted as an occasional external customer or supplier. The communication was done by e-mail. The students were frustrated by the lack of momentum and the artificiality of the business transactions. Also, the students operated their businesses manually or by utilizing office automation tools such as Excel. The coaches had no direct visibility in terms of the students' activities. They had to rely on information provided by the students. There was an obvious need for an improvement in the environment.

As a result of the improvement need, a literature review was conducted on business learning environments for experiential learning; namely, ERP systems, business simulations, and the PE model. Business simulations were identified in the literature review as experiential business learning environments. ERP systems, on the other hand, have an important role in managing any kind of business. The literature review showed that using ERP systems both as a learning topic and a learning environment for business process integration has increased dramatically in the past few years. The researcher had previous experience of ERP systems both from corporate use as an IT manager, as well as from teaching about them in the business school. All three of these learning environments approached business learning from different angles. It was felt that the combination of these three would have the potential to achieve more learning than any individual learning environment on its own could.

Article I motivates the research by addressing the gap between the higher education graduate skills and knowledge, and the needs of the SME companies. Many of those needs are similar to those of large companies, but the practical understanding and experience of the disciplinary areas are emphasized. In addition, small companies need to have their employees ready to contribute as soon as they enter the company. The article presents a review of the business needs and studies earlier research on the three experiential learning environments: the PE model, ERP systems, and business simulation games. Their ability to provide the knowledge and skills that companies presently need is evaluated. The analysis reveals that the learning environments' benefits and challenges complemented each other, thus resulting in the conclusion that the three learning environments should be integrated to create an optimal learning environment. In addition, the article presents the combined learning environment solution and some preliminary results from the learning results study.

5.3 Design and development of the artifact

Next, the key principles behind the conceptual model are introduced, followed by a description of the design process. This section answers RQ1: How should the holistic business learning environment be constructed?

5.3.1 The design principles

5.3.1.1 The business environment: Supply chain network

The previous business game and simulation solutions have usually focused on one team working in one company. In this research, the target was to build a network of companies where the PE model could be implemented. On the other hand, the PE model was challenged because it lacked the consumer and raw-material markets (Miettinen & Peisa, 2002; Tramm & Gramlinger, 2002). To overcome these challenges, the supply chain network was taken as the core construction principle.

A supply chain is a two-directional flow of products, information, and money between the raw-material suppliers and the end customers through different parties, and "*strictly speaking, the supply chain is not a chain of businesses with one-to-one, business-to-business relationships, but a network of multiple businesses and relationships*" (Lambert, Cooper, & Pagh, 1998, p. 1). Figure 6 presents the supply chain network from the focal company's perspective. Business communities consist of these kinds of networks that operate side by side. Occasionally they interact and overlap with each other.

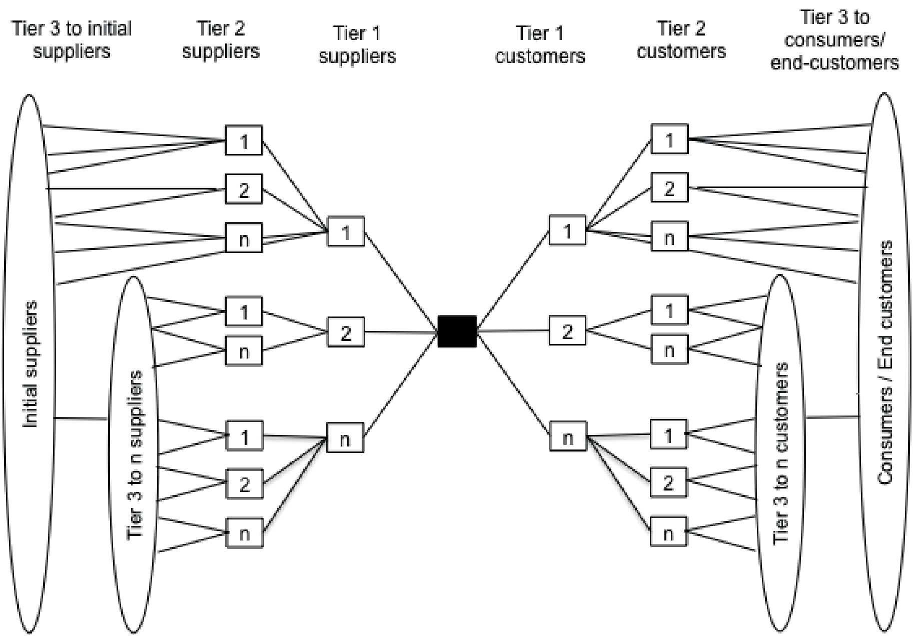

Figure 6. Supply chain network (Lambert et al., 1998).

A supply chain management framework contains three elements, as illustrated in Figure 7 (Cooper, Lambert, & Pagh, 1997). First is the supply chain structure that consists of the network and the links between the members of the supply chain. Second are the supply chain business processes, or the activities that create value for the customer. Third, the supply chain management components are the variables that integrate and manage these business processes.

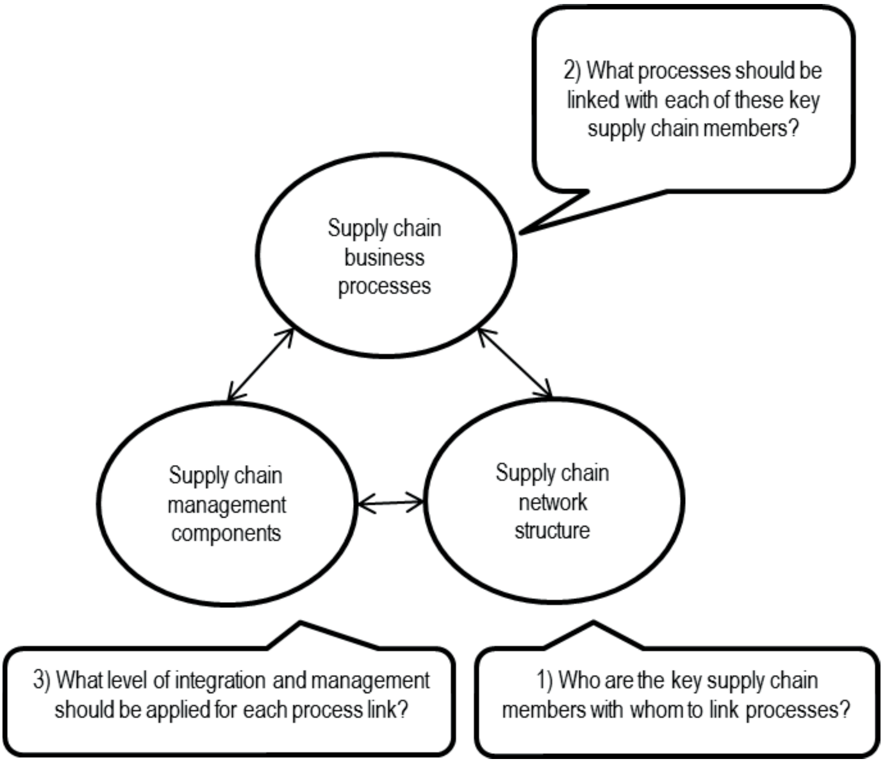

Figure 7. Supply chain management framework (Cooper et al., 1997).

5.3.1.2 Automated information flows in the supply chain

Another challenge in the PE model was the lack of credibility and action (Greimel-Fuhrmann, 2006; Miettinen & Peisa, 2002; Neuweg, 2014; Santos, 2008). All the activities from the PE administrator were created manually and transmitted through e-mails. This was time consuming and prone to errors. The amount of trading was highly dependent on the participants' skills and activity levels (Gramlinger, 2004; Santos, 2008). If the students did not trade with each other, there was little activity. That is why automating information flows was taken as another core design principle. Automation was needed both in the student-to-student processes as well as in the administrative, simulated processes such as operating the banks and the tax authorities.

There are three ways to automate information flows in intra-company processes (Nurmilaakso, 2008): In manual business interactions, human intervention is necessary at both ends. Information is shared through meetings, mail, phone calls, or e-mails. In semi-automated business interactions, the information systems conduct information sharing at one end and human intervention is necessary at the other end. An example is an e-commerce site where the information flow is automated to the ERP system, but the customers place their orders manually. In fully automated business interactions, information sharing takes place directly between information systems. No human intervention is needed.

Fully automated business interactions require the partners' information systems to be compatible. Interfaces can be customized or operated with standardized messaging such as Electronic Data Interchange (EDI) or the extensible markup language (XML) (Nurmilaakso, 2008). Electronic invoicing, or e-Invoicing, is an electronic transfer of structured invoicing data (billing and payment) that can be automatically processed by the sender and the receiver (Salmony & Harald, 2010). The format of the e-Invoice can be EDI, XML, or another standard.

5.3.1.3 ERP II

The previous research has identified multiple benefits in using the ERP system in business learning such as improved IT skills and business process orientation (Davis & Comeau, 2004; Hawking et al., 2001, 2004; Hepner & Dickson, 2013; Jensen et al., 2005; Monk & Lycett, 2016; Schwade & Schubert, 2016; Targowski, 2006; Watson et al., 2015). The challenge, however, has been the focus on a single company and its internal processes. We wanted to expand the perspective to include the whole supply network and include the inter-company processes in the learning environment.

ERP II expands the concept of an ERP system into "*a business strategy and a set of industry-domain-specific applications that build customer and shareholder value by enabling and optimizing enterprise and inter-enterprise, collaborative-operational and financial processes*" (Bond et al., 2000). It provided an appropriate design principle to build the actual hands-on tools for the simulation.

The conceptual framework of ERP II is illustrated in Table 3. It consists of four layers (Møller, 2005). The foundation gives a base for the operative business processes, or the traditional functionalities of the ERP system. On top of that there are analytical functions that support and extend business operations such as customer and supplier relationship management. The final layer contains the collaboration with external partners.

Table 3. ERP II conceptual framework (Møller, 2005).

Layer	Components	
Foundation	Core	Integrated database (DB) Application framework (AF)
Process	Central	Enterprise resource planning (ERP) Business process management (BPM)
Analytical	Corporate	Supply chain management (SCM) Customer relationship management (CRM) Supplier relationship management (SRM) Product lifecycle management (PLM) Employee lifecycle management (ELM) Corporate performance management (CPM)
Portal	Collaborative	Business-to-consumer (B2C) Business-to-business (B2B) Business-to-employee (B2E) Enterprise application integration (EAI)

This conceptual framework was used as the design principle to modify the ERP system that formed the core of the new learning environment.

5.3.1.4 Summary of the design principles

The artifact was planned to be a combination of the PE model, a business simulation, and an ERP system. In order to avoid the earlier challenges of each of these separate learning environments, as well as to combine their best features in a constructive way, the following design principles were used:

- A supply chain network forms the structure of the business environment.
- The business interactions utilize automated information flows.
- The information system structure is based on ERP II.
- With these principles, we proceeded to design the artifact.

5.3.2 The development process

The researcher contacted an open-source software supplier, Pupesoft, who was interested in providing the ERP platform. A development team was formed (Figure 8), consisting of a teacher, five students, and the researcher acting as the project manager. Both the researcher and the teacher had participated in implementing the original PE model and had acted as coaches since 2005. The other teacher was an expert in the integrated curriculum and its scheduling. Two student team members studied information systems, one focusing on infrastructure and the other on graphical design. The three business students had previous experience of the curriculum as they had studied in the PE model learning environment. After the implementation, one of the business students became the administrator of the learning environment. Both the information management students and the business student who became the administrator did their five-month internship in the project.

The researcher and the other teacher designed the pedagogical manuscript and the learning methods. The researcher was the main architect of the simulation and designed the initial structure. She created the ERP system customization specifications. The information systems students installed the ERP system and started programming the required changes. One of them took the main responsibility for the server infrastructure and the ERP system's PHP programming. The other, with her graphical design background, took responsibility for the web pages and other visual elements.

Faculty	
Project manager (the researcher) - ERP expert - Coach - Disciplinary expertise on project management, logistics, IT systems	Teacher - Curriculum expert - Coach - Disciplinary expertise on business law

Students	
Information management - Student 1: Infrastructure (LAMP), ERP expert - Student 2: Web page expert, graphical design	Business - Student 1: Project assistant - Student 2: Web-publication content - Student 3: Insurance expert

Figure 8. The development team.

The business students participated in designing the "story" for the learning environment; the facts of the imaginary city, as well as the stories of the wholesalers and the infrastructure providers. Each was given a particular look and feel with a logo, a specific product offering, and a history. One business student was the project assistant participating actively in the generic development work. The other business student researched the various types of insurance needed by SME companies and created a product portfolio and instruction sheets for the insurance operations in the learning environment. The third student created the business structure for the web publication, which the information systems student then implemented on a web-publication platform.

As a whole, the development project lasted approximately eight months and was carried out in an agile way. The artifact specifications developed as the team learned more about the Pupesoft system and innovated new ideas for the simulated learning environment. The needed features were listed in one big product backlog. There was constant development and testing. As the instruction material of the Pupesoft system was virtually non-existent, most development was done through trial and error.

At the same time as the development was done, the documentation and instruction materials were being created. As a result, there were instruction manuals for all three roles in the learning environment: the administrator, the teacher, and the student. The researcher had the main responsibility for the ERP system and simulation feature specifications, creating the basic data for the simulation features, testing, documenting, and creating instructions.

The coaches who were going to start using the learning environment were given an initial introduction and training in spring 2010. In fall 2010, they were given other, more detailed training.

5.4 Article II: Demonstration of the artifact

Nisula, K. (2012). ERP-based business learning environment. *Proceedings of the 4th international Conference on Computer Supported Education (Vol 2),* (pp. 233-238), Setúbal, Portugal: SciTePress.

The second article presents the artifact. It provides a concrete answer to RQ1: How should the holistic business learning environment be constructed?

The new business environment needed to be as concrete as possible. The students had criticized the PE model for being vague and difficult to grasp. They had not known what kinds of companies existed because the PE center set up companies and authorities whenever they were needed. Everything was based on e-mail correspondence between the student companies and the national PE center administrator. There was nothing visible or concrete. The model lacked a story and credibility.

The new learning environment consisted of a fictitious market area with a number of basic infrastructure providers, an online bank, local online media, and an electronic tax account. All of the actors in the network had web pages with a company story, product offering, and other details. An imaginary business area map was drafted to contain all the addresses for the companies.

A lack of real-life tools had been one of the challenges in the PE model (Gramlinger, 2005). Now the ERP system became the core of all operations. All the student companies ran their business operations in the ERP system. Almost everything that they did in their company was recorded as transactions in the ERP system. The administrator-run companies were also operated in the ERP system, just like normal companies. This helped the administrator to play her part, as she was able to keep track and monitor all the activities of the different student companies.

There were minor modifications to the ERP core to accommodate the learning environment. Additional features included some automated business simulation functionality to ease the administration and produce momentum in the student companies, and teacher reporting to keep track of the business and learning processes. The bank operations and the tax account for reporting value added taxes were added as customized modules into the ERP system.

The modified ERP system had three user roles: student, teacher, and administrator. The profiles assigned to these roles defined which activities were available to each user. The student only had access to the simulated company he/she worked in. The students managed transactions in the ERP system and utilized its documents to communicate with other companies. The teacher had access to all the student companies that he/she facilitated. To monitor the learning process in the environment, the teacher used reporting tools that were based on the ERP system log files. The administrator had full access to all companies in the database. He/she set up the companies and the user accounts, set the ERP parameters, and acted as a help desk for technical problems. The administrator also acted as the banker and managed the support companies. The administrator communicated through several e-mail aliases to give the students the feeling that they were communicating with several companies.

A business simulation element created momentum in the learning environment by sending automated purchase orders to the student companies. There was an administrator who managed the business simulation element through a set of parameters that adjusted the frequency, size, value, and content of the purchase orders to simulate the market fluctuations in the consumer market.

The next chapters describe the artifact in more detail, reflecting the design principles presented earlier.

5.4.1 The business framework

The artifact was based on the SCM framework (Lambert et al., 1998). The framework was expanded to a business network that included all the actors in the business network, not just the ones that operated in a specific supply chain. The framework is illustrated in Figure 9.

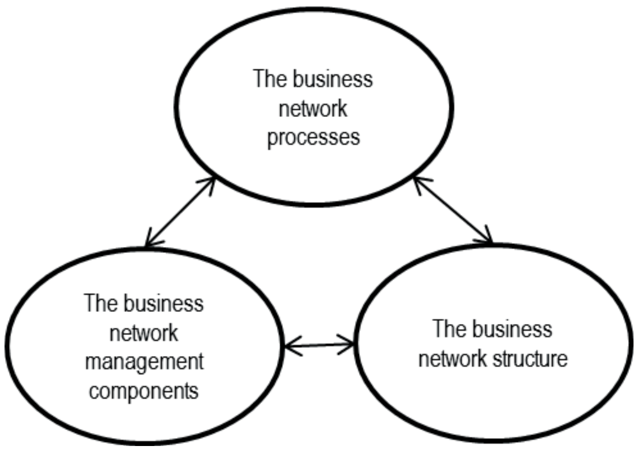

Figure 9. The framework of the ERP-supported business learning environment.

The supply network structure and the actors are presented in Figure 10. In addition to the student companies, the network contained the wholesale suppliers, customers (or the "consumer market"), and service providers. There were also government agencies providing the services of a trade register and tax services; namely, the value added tax declarations. The bank acted as the mediator of all financial transactions as well as the provider of the initial investments. All the actors, apart from the student companies, were either manually operated by the administrator or automated in the simulation.

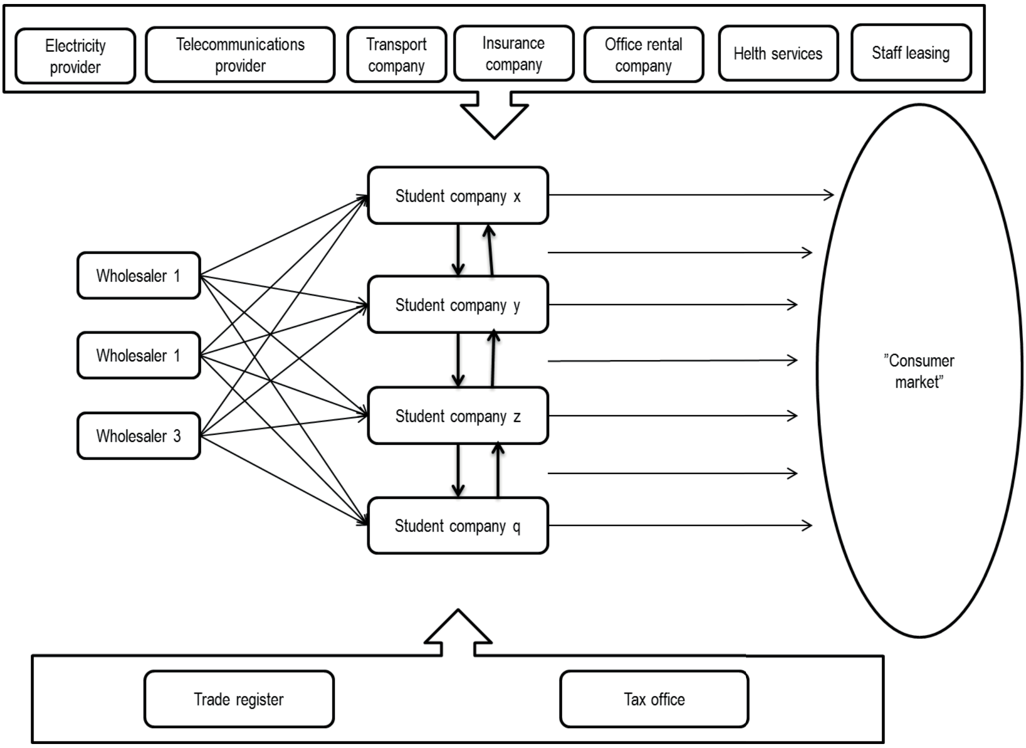

Figure 10. The network structure and the actors.

5.4.2 The simulated city

The city was the conceptual platform for the business network. It was represented through web pages that formed the "plot" of the business environment. The city web pages (Figure 11) contained general information about the area, a map, and a "yellow pages" section that was linked to all the other actors' web pages in the business network.

Figure 11. The conceptual platform: The simulated city web pages.

5.4.3 The student companies

In the earlier PE model, the students had been able to decide on their own business area. That led to situations where some had no customers and others were in monopoly situations (Neuweg, 2014) as the logistic chains or networks had not been pre-planned. Now the student companies were founded as pre-defined business areas such as computer retail, office supplies, printing, decoration and design, business gifts, catering, or recreation services. The business areas and their potential connection points are illustrated in Figure 12. Even if some companies were service-oriented, all companies also bought and sold goods. Each student company represents a different business area.

When the students started to operate in the business learning environment, they were first randomly assigned to one of the business areas in Figure 12.

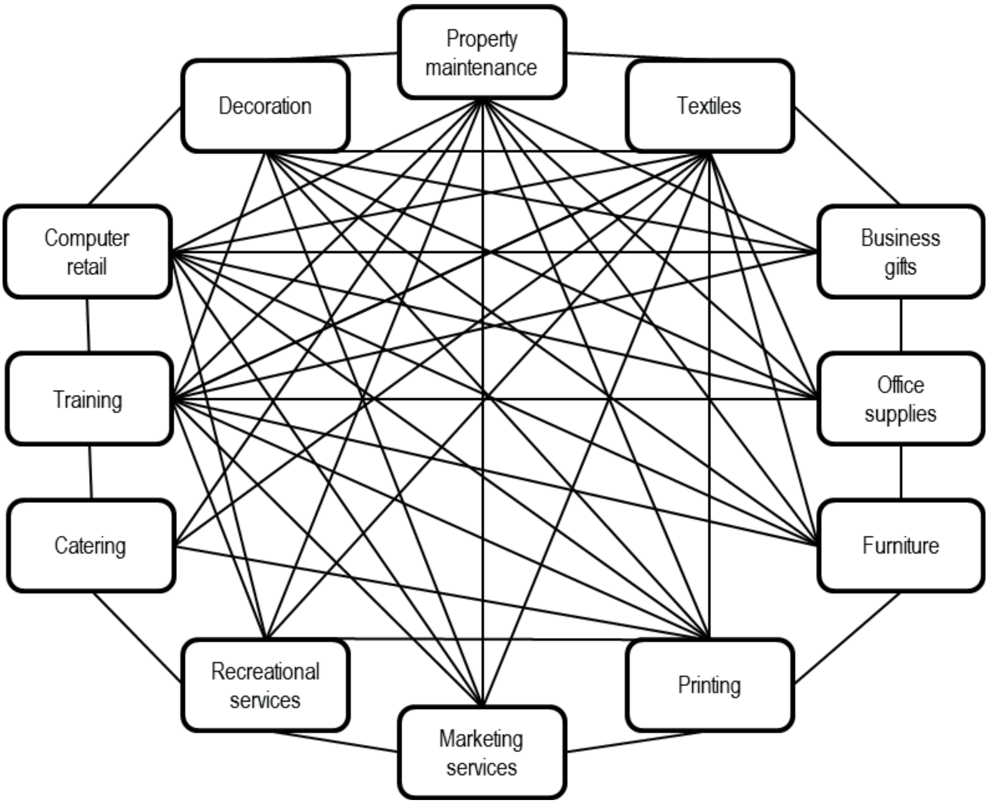

Figure 12. The business areas and their connection points.

The business network processes contained virtual material flows:

- Buying or renting services from the service providers
- Office space, electricity, and telecommunication services
- Insurance
- Transportation services
- Additional staff
- Buying goods from the wholesale companies
- Selling goods and services to the consumer market
- Buying from and selling to the other student companies

In addition, there were money flows in each process. They were handled through the bank. The business processes also included a number of information flows, from requests for quotes, to orders and invoices. The information flows to the government agencies involved registering the company when it is founded and declaring the monthly value added tax and salaries.

The business network management components, in this case, referred to the ways in which the network was administered, and the simulation was run for:

- The government agencies
- The bank
- The wholesalers
- The consumer market or the "business simulation element"

5.4.4 The government agencies

The students started their company in the assigned business area by creating a business plan as a part of their disciplinary studies. In addition, they had to fill the company start-up forms in that are required by the Finnish trade register and send them via e-mail to the "local trade register" managed by the learning environment administrator. The "local trade register" returned a VAT code and user IDs and passwords for the ERP system so that they could initiate their businesses. A similar process had been in use in the PE model.

Another governmental service was a new innovation that was not present in the previous learning environment—the online tax account (Figure 13)—, where the student companies had to declare their value added tax and employer contributions every month. It was designed as a replica of the Finnish online tax system. The reporting was identical to the real tax declaration process. In addition, they paid the reported taxes and the employer contributions through the online bank.

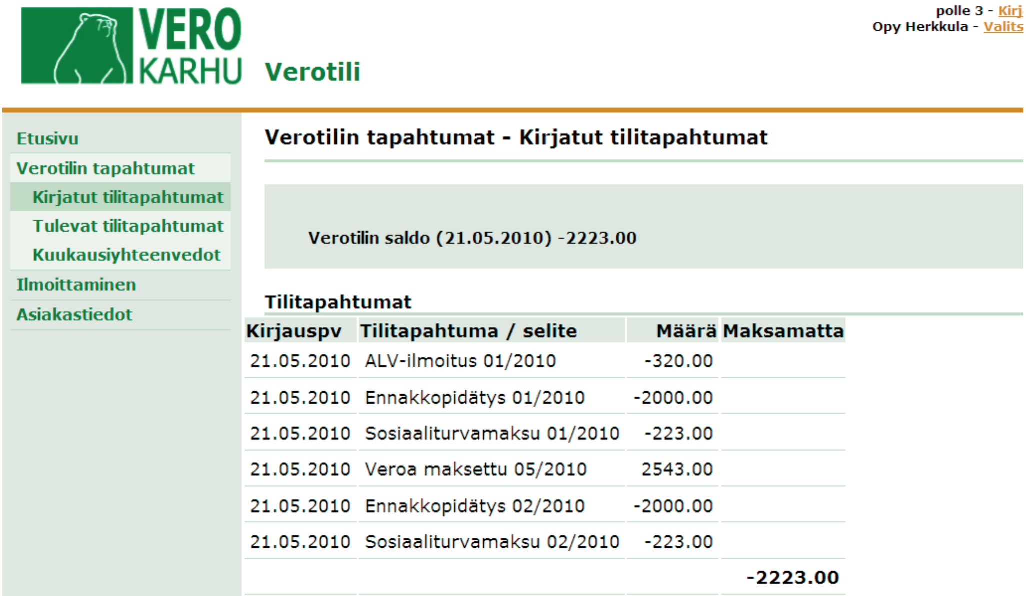

Figure 13. Tax account online.

5.4.5 The bank

The next contact for the companies was the bank where they had to apply for a loan to fund their business. They could choose from three different repayment methods. The school cooperated with actual bank managers who listened to the student teams' business plan presentations. Based on their feedback, the students' companies were provided with a loan and user IDs for the online bank (Figure 14). The repayments were automatically charged from their account according to the repayment method that they had selected.

The student companies managed their cash flow in the bank. All the actors of the system paid their invoices through the bank. The students paid their invoices, wages, loans, and taxes in the online bank. The administrator managed the payments from the simulated consumers to the student companies monthly.

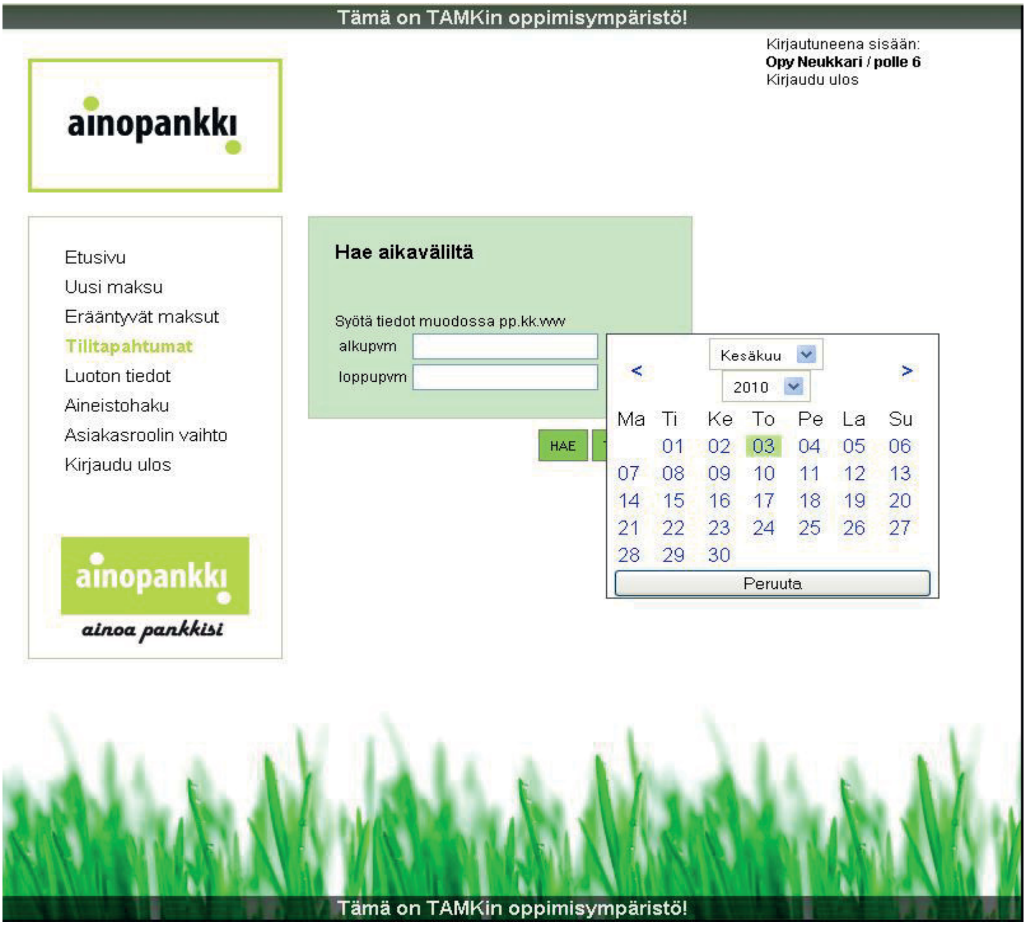

Figure 14. The online bank.

The specifications for the online bank were developed through benchmarking different Finnish online banks. The key functionalities were put together in a simplified form. The online bank contained

- Manual creation and approval of new payments
- Bank statements
    - viewing
    - exporting statements in a file
- Loan functionality
    - calculating loan options
    - applying for a new loan
    - managing existing loans

The online bank had also existed in the previous PE model. However, the new online bank contained more functionalities than the old one did such as the loan operations. The user interface was more user friendly and bore a close resemblance to real online banks.

5.4.6 The service companies

Once the student companies had received funding, they were able to acquire facilities for their business. From the city "yellow pages" they found links to service provider company web pages (Figure 15). They searched for an appropriate office space from the rental company offering. The prices per square meter depended on the area. They chose a location and facility size that fitted their business plans. Once they had signed a contract through an online form, they received an address and monthly charges. A similar process was carried out with an electricity company that billed according to the estimated electricity usage based on the size of the facility. The student teams also had physical office spaces or "home rooms" in the TAMK business school.

In addition, they acquired telephones, cell phone plans, computers, and data services from the telecommunications provider who started billing them accordingly. In their physical offices, each student company had two computers and a cell phone with which to run their operations.

They had to acquire insurance from the insurance company who also started billing monthly. The company's web pages contained accurate descriptions of both mandatory and voluntary business insurance. The student companies assessed their insurance needs as assignments in conjunction with lectures.

There was also a healthcare company providing employer health services, a transportation company for delivering goods, and a staff leasing company where a temporary workforce could be hired. All of their invoicing was based on contracts.

Figure 15. The service company web pages.

All the service companies were operated by the administrator. Each service company had its own e-mail address, and all the correspondence was managed by the administrator through different aliases to create the illusion of working with a real network of people. In the same way as with the student companies, each service company had an ERP system where the administrator created billing plans. The ERP automation sent invoices accordingly via e-mail and the student companies paid them in the online bank. The bank statements were automatically imported from the bank into the service companies' ERP system where they were matched to enable the administrator to monitor the payments. The administrator managed the service companies in very much the same way as any SME company would be managed: with a standard ERP system and an online bank.

5.4.7 The wholesalers

The wholesalers were the initial source of goods. There were three wholesalers that represented different levels of price and quality: Hanki Oy was the most reliable with the highest prices and best product offerings. Hasselhoff was an average price-quality operator, and Oriental Express had the lowest prices, lower reliability, and narrower product offerings. In total, the wholesalers' product offerings contained approximately 5000 different items. Their web pages reflected their brand (Figure 16). To get started, each student company needed to sign contracts with the wholesalers to get user IDs for the web stores. This was done via e-mail aliases by the administrator in the same way as the contracts with the service providers were handled.

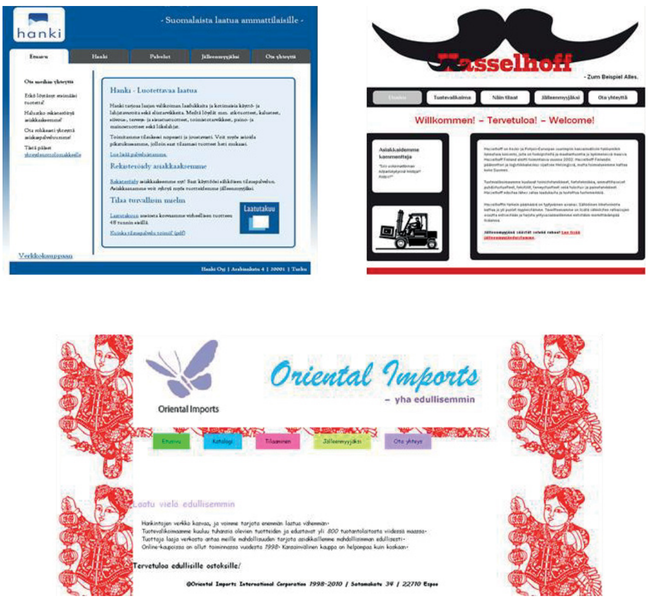

Figure 16. The three wholesalers.

Once the student companies got their user IDs, they were able to place orders through the wholesaler's web store (Figure 17). The wholesalers had a similar ERP system setup as the service companies did. The main difference was that the wholesalers had products to sell. Their web stores were directly connected to their ERP system product offerings with an endless supply of the products. When the student company ordered goods, an invoice was automatically sent from the wholesaler's ERP system to the student company's e-mail. That was also an indication that the goods had been delivered and the students could receive them in their inventory in the ERP system.

The wholesalers' product offerings were created by benchmarking real companies in the student company business areas of computer retail, office supplies, printing, decoration and design, business gifts, catering, and recreation services. A collection of items that could be bought and sold by such companies was created and loaded into the different wholesalers' ERP systems. Some of the product offerings were the same and some were different, and the pricing varied. If the student company required a product that was not available, they could contact the wholesaler (i.e. via the administrator's e-mail alias) and request it to be added into the offering.

Figure 17. Wholesaler Hanki Oy's webstore.

5.4.8 The consumer market

The consumer-market simulator generated demand in the form of purchase orders. The purchase orders were either created manually for a specific pedagogical situation or generated automatically. The "consumer market" was set up as one company—a large trading concern with subsidiaries. The subsidiaries were named in a general fashion so that one could not draw conclusions about their business sector, and they could order anything without appearing incoherent. The trading company setup in the ERP system contained:

- approximately 50 subsidiaries with an identity—a VAT code, a name, an address, and a logo (set up as different delivery addresses in one company's ERP system);
- a product database resembling the wholesalers' product offerings;
- information about which products could be ordered from which student company;
- automation that generated purchase orders for randomly selected customers and products; and
- algorithms that defined the financial value of the purchase orders.

There were two types of automatic orders: random and routine orders. The random orders were created regardless of the student company's business performance. The orders could contain any products, not only the ones within their business line. All companies were given equal amount of work and they all received equal amounts of additional sales.

The routine orders were related to how professionally the student company was running its business operations. A well-performing student company received financially more valuable orders than another company with a lower performance. The performance was checked through a set of indicators in the learning environment. The majority of the indicators were produced by the standard ERP system: the amount of sales to other student companies indicated active selling. The costs of the lease, electricity, cleaning, and decorating gave an indication of the size, the location, and the appearance of the facilities. HR-related costs such as wages, health services, and voluntary HR activities indicated how satisfied the personnel were. Marketing was checked through the marketing costs as well as the level of CRM activities. Another indicator of the marketing communication effort was the level of visibility in the web publication. Both the advertisement clicks and appearances in local news stories increased the performance measurement of the student company.

These criteria were constructed as an algorithm where the administrator managed the parameters that adjusted the frequency and intensity of the purchase orders to emulate the market fluctuations in the consumer market. The administrator also created the manual activities in the learning environment as per requests from the coaches or disciplinary teachers.

When the students received a purchase order, they checked their inventory. If they did not have any stock, they placed an order with a wholesaler. The simplest supply chains contained only three members: the wholesaler (tier-1 supplier), the student company and the consumer (tier-1 customer). However, there were situations where the students could do business with each other. In that case, they formed each other's first-tier suppliers or customers and the secondary-tier companies were administrator-managed. There could be even longer chains. For example, a "consumer company" could buy T-shirts from an event coordinator who would buy them from a printing company (tier 2) who would buy them from a textile company (tier 3) who would buy them from the wholesaler (tier 4).

When the student company was ready to ship the goods, they created a shipment from their ERP system and generated an invoice to the "consumer company." The administrator managed the consumer payments through the ERP system and online bank interface, thus resembling normal SME operations.

5.4.9 The web publication

The web publication (Figure 18) provided the news and the advertisement slots in the learning environment. The dissertation researcher initiated the idea and designed the structure, the business student created the concept plan, and the information management student created website design and implementation in the Joomla open-source content management system. It contained both "local news" from the simulated business environment and real business and other news embedded with an rss-feed to increase the sense of authenticity.

Figure 18. The web publication.

The students were able to get free publicity by sending press releases to the publication. This was utilized as an exercise in an external communications class. Again, they would send the press releases to the publication e-mail—an alias of the learning environment administrator. In addition, they were able to buy advertisements of different sizes as top and side banners. The advertisement cost depended on the location and the duration of the advertisement. A big banner on the top of the page was the most expensive whereas the smaller banners on the right were cheaper. The students created the advertisements themselves and sent them to the web publication. All publicity increased the financial value in terms of the demand from the consumer market.

The coaches and the disciplinary teachers were able to utilize the local news to create learning situations in the simulation. For example, when there was a need to learn about risk management and insurance, there was news about break-ins and other risk-related events.

5.4.10 The information system structure

The information system structure followed the conceptual framework of ERP II (Møller, 2005). The environment consisted of four layers, as described in Table 4.

Table 4. The information system structure.

Layer	Components	
External	Web pages and e-commerce sites	The business area web pages The service providers' web pages with agreement forms for the wholesalers' web store The online bank The tax office online system The web publication
Internal	Pupesoft ERP	Student company business activities Wholesaler business activities Banking activities Consumer-market activities Tax management activities
Analytical	ERP log data reports	Teacher reporting
System	System integration	Banking standard data transfer

The development platform was LAMP: Linux operating system, Apache web server, MySQL database, and PHP programming language. The core applications—the Pupesoft ERP system and the Joomla content management system—both utilize this platform. Figure 19 presents the different elements developed with Joomla and Pupesoft, and it shows the areas of responsibility for each role in the learning environment.

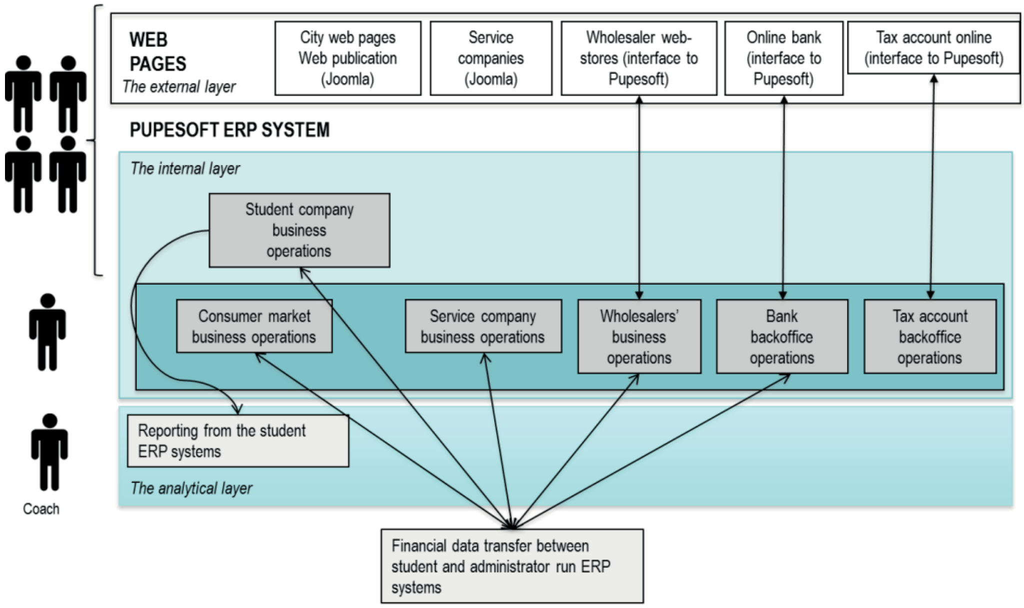

Figure 19. The artifact's structure.

The external layer resembled the e-business layer in the ERP II framework. It contained a visual representation of the market area city's web pages, the web publication, and the web pages of the different service and wholesale companies.

The internal layer was built into the Pupesoft ERP system. The student companies, the administrator-run service companies, and wholesalers utilized the standard functionality of Pupesoft with a web-browser user interface. The students operated the order-to-delivery flow (Figure 20) and invoicing, as well as managing their supplier, customer, and product data, inventories, and work hours in the ERP system.

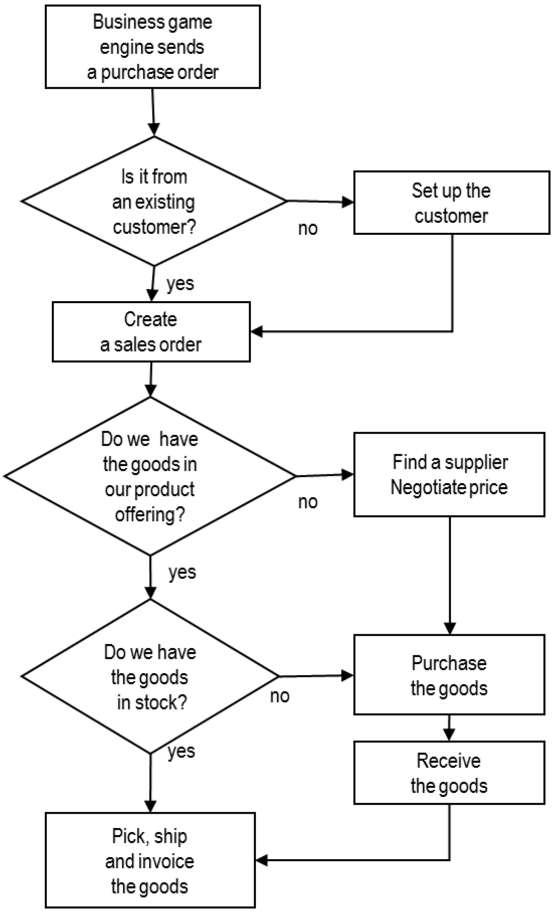

Figure 20. Order-to-delivery flow in the business learning environment.

Figure 21 shows the sales order entry screen with customer data in the order header and product data on the order lines.

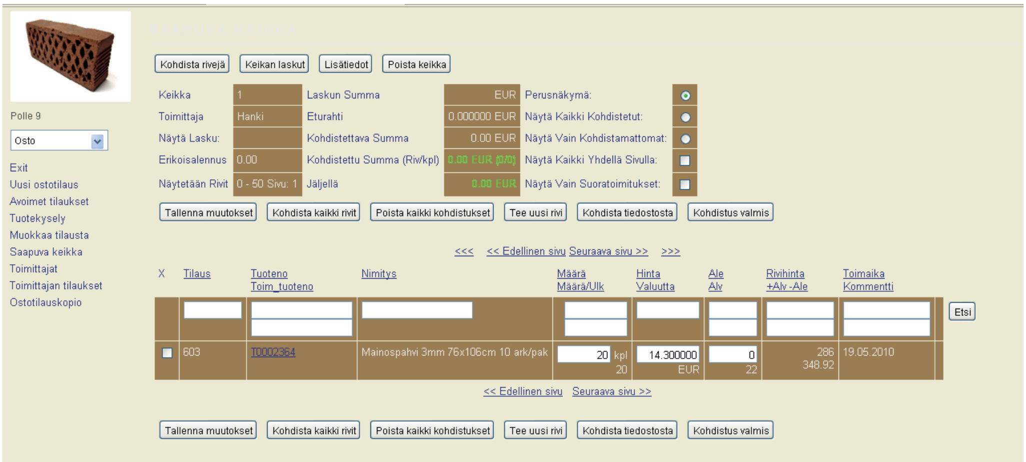

Figure 21. Sales order entry screen in the ERP system.

Minor changes were made to accommodate the learning perspective. Configuring the Pupesoft standard webstore functionality enabled creating the wholesalers' web stores with a reasonable amount of work. The wholesalers' database was populated with the appropriate product data with the student companies as customers. The service company ERP systems also had the student companies as customers. Their databases did not contain products. Instead, by using the Pupesoft standard functionality, the administrator created service agreements that automatically generated invoices via e-mail to the student companies.

All the different companies resided in the same database. The user rights defined what information was available and for whom. The administrator had the user rights to all the different companies whereas the students only had access to their own company. The coaches had access to their own teams' data.

Customization was needed to create the bank, the tax account, and the consumer-market simulator. The bank and the tax account were separate modules inside the Pupesoft database. They had specific functionalities that reflected their real-life counterparts. The functionalities were specified in cooperation with the researcher, the business law teacher, and the ERP expert student. These functionalities—the bank and tax back-office management—had little in common with the standard ERP operations. The Pupesoft application, however, offered suitable tools with which to construct these functionalities and it was logical to add these functionalities to the same interface that was also used to manage the other parts of the simulation.

The consumer market was constructed as one trading-concern company in the ERP system. The 50 consumer companies were set up as subsidiary delivery addresses with a VAT code, a name, an address, and a logo. The trading concern had all 5000 simulation products set up in its product database. The student companies were set up as the suppliers. The administrator was able to manually create purchase orders and directly e-mail them to the student companies from the ERP system.

The simulated demand was programmed as an automated purchase-order generator. The administrator had an interface where she could define parameters that affected the automated demand. The order generator could be set to generate the demand on specific days of the week. On the defined days, the purchase-order generator picked products from the product database and random customers from the trading concern's delivery addresses. It checked the algorithm for the financial value of the total demand for each student company. It then generated the required number of orders and order lines (the same for all the companies) but adjusted the ordered quantities so the financial value was met. As a result, a required number of purchase orders were generated as pdf files and e-mailed automatically to the student companies. The simulator's functionality was specified in cooperation with the researcher and the ERP expert student.

The analytical layer in the ERP system contained the teacher reporting. It comprised of customized reports that drew from the ERP log data. The report illustrated in Figure 22 shows student activity and student company activity as master data and transaction entries in the ERP, and bank activities. This report had to be customized, as user activities are not a typical reporting target in a business ERP system. In addition, the teachers had access to the standard reporting in the ERP system where they could monitor the business activities of the student companies.

Figure 22. The teacher reporting on master data and transactions.

The system layer was created to automatically transfer data between the different elements for two purposes: 1) to automate the wholesaler, service company, and consumer-demand company operations; and 2) to create cost and revenue data for the student companies' ERP accounting to be utilized by the consumer-demand generator algorithm.

The automatic data transfers consisted of invoice and payment data between the bank and the ERP companies. The transfers were carried out via the electronic account statement and by using the recurrent payment standards such as the Finvoice standard (Federation of Finnish Financial Services, 2010). Figure 23 illustrates how the data were transferred between the different elements. Whenever a company created an invoice in the ERP system for another company, the invoice data were transferred to the recipient's ERP system with the standardized Finvoice message. When these data were added to the other accounting data produced by the transactions created in the ERP system (sales, purchases, warehouse management), the ERP accounting module received a comprehensive picture of the company's income and costs. Those accounting data, in turn, were the basis for the consumer-demand generation.

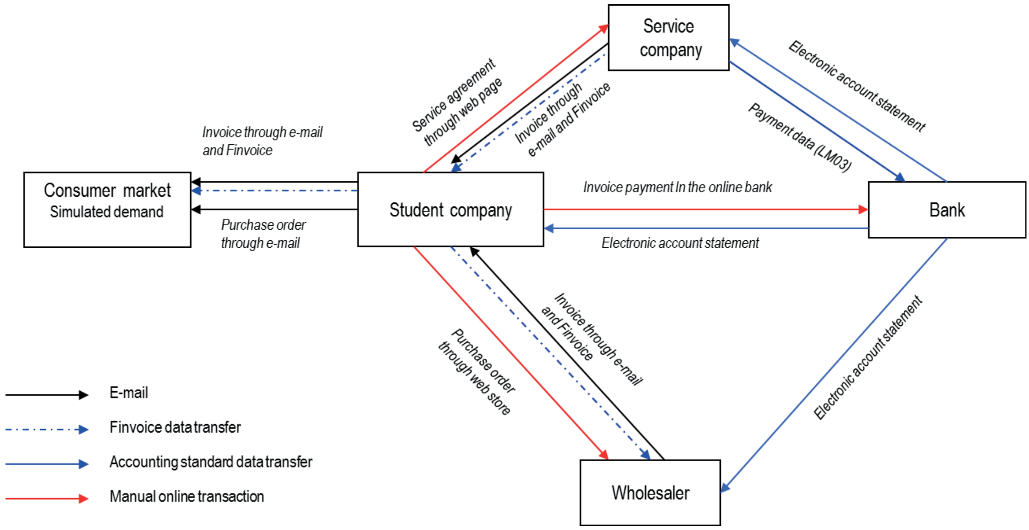

Figure 23. Data transfers between different elements in the environment.

The students did not manage nor have access to the accounting module of the ERP system. Instead, they practiced managing the company accounts in a separate accounting system. Finvoice standard messaging was used to give the teachers and coaches an accurate picture of the student companies' business situation.

The administrator-operated companies' financial transactions were automated with the help of the electronic account statements, the Finvoice standard messages, and the standardized payment data transfers.

5.5 Article III: The holistic business curriculum model

Nisula, K., & Pekkola, S. (2017). How to move away from the silos of business management education? *Journal of Education for Business, 93*(3), 97–111.

During the research it became evident that the physical learning environment solved only some of the challenges of practical and integrated business learning. Article III expanded the perspective to include the structure of the studies, or the curriculum, and the people involved in the learning process. Article III answers RQ2: How should the holistic business learning environment be combined with the curriculum?

The paper presents a holistic business curriculum model that consists of an overall curriculum structure, a combination of student and teacher learning communities, and an experiential learning environment (Figure 24). It validates the model with the TAMK business school case study.

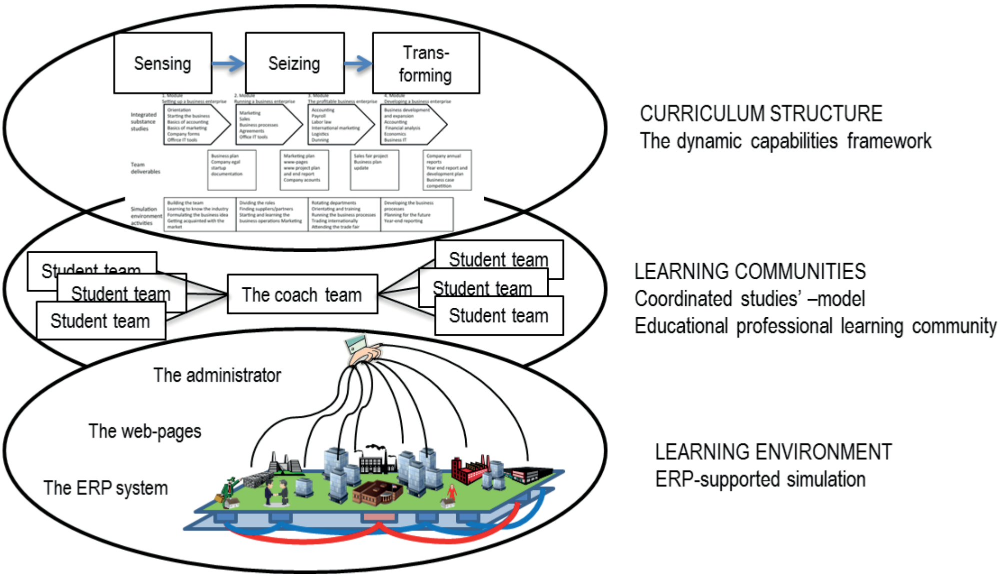

Figure 24. The holistic business curriculum model.

Business studies require intellectual coherence to demonstrate how disciplines, courses, and cases influence each other (Teece, 2011). A coherent, overall framework offers an explanation regarding how and why things interrelate. The business theory of dynamic capabilities (Teece, 2007) provides a structure to interconnect and associate the different functions of a business enterprise. It can be used for the same purpose in the business curriculum. In the TAMK case, the curriculum structure for the first-year studies was mapped to the dynamic capabilities model, which turned out to be an appropriate framework for a start-up company's life cycle.

Experiential learning combines the internal processes of experience and reflection with the social processes that require interaction with the other people involved in the learning process (Kayes, 2002). Learning communities can be used to organize the faculty and students around integrated studies. An educational PLC consisting of the key members of the faculty supports their personal development and work in planning holistic business studies. It also transforms the organization toward collaborative ways of working. The SLCs dissolve the traditional boundaries between students and faculty. In the TAMK case, the coach team constituted the PLC and the student companies led by a coach formed the SLCs.

The experiential learning environment refers to the ERP-supported business learning environment. It was the practical training ground that tied together the conceptual ideas of the curriculum structure and connected the learning communities around the same concrete settings.

The article evaluated the holistic business curriculum model through the student and coach feedback. It was found that the PLC of the coaches played a key role in the success of the model. With a clear mandate and adequate resources, the coach team took responsibility and the ownership of the model. Planning and managing the integrated curriculum model required clear working processes and constant monitoring and checking with disciplinary lecturers and student teams. Communication between the different learning communities was critical. Student motivation was a challenge. The student perceptions varied from extremely critical to highly motivated depending on the student and the learning situation. The students adapted to the new learning technology with more ease than the coaches did.

5.6 Evaluation of the artifact

The artifact and its impacts need to be evaluated (Hevner et al., 2004). Hevner & Chatterjee (2010) define evaluation as "*the systematic determination of merit, worth, and significance of something*" (p. 109). The artifact evaluation criteria can include validity, utility, quality, and efficacy (Gregor & Hevner, 2013). Validity suggests that the artifact works and carries out the tasks that it was intended to carry out. It needs to be operationally dependable in achieving its goals. The artifact should contain improvements when compared to the earlier solutions. Pragmatic validity (Krippendorff, 2006; Worren, Moore, & Elliott, 2002) is evaluated by the artifact's usage in practice. The utility criteria evaluate the value in achieving the goals outside of the development environment.

Observational, analytical, experimental, testing, and descriptive methods are potential options for evaluating the artifact (Hevner et al., 2004). A case study is an observational method where the artifact is studied in its operative environment. Analytical methods include examining its static, dynamic, architectural, and optimal properties. Experimental methods can be controlled experiments or simulations. Testing can be functional black-box testing or structural white-box testing of the artifact. Descriptive methods refer to argumentation for the artifact's utility and scenarios to demonstrate its utility.

Gregor and Hevner (2013) suggest providing any evidence that shows the worth of the artifact such as summative tests in case studies, usage data statistics, expert reviews, and evidence of its impact in the field. They note that when an artifact is very novel, even a proof-of-concept may be sufficient.

> *When a researcher has expended significant effort in developing an artifact in a project, often with much formative testing, the summative (final) testing should not necessarily be expected to be as full or as in-depth as evaluation in a behavioral research project where the artifact was developed by someone else* (Gregor & Hevner, 2013, p. 351).

To evaluate the artifact's validity using a descriptive method, it was compared with earlier solutions to the same problem. To evaluate its quality and efficacy, the TAMK case was studied for indications of learning results and user experiences. To evaluate the artifact's utility, the continued and expanded use of the learning environment as well as the infrastructure model were assessed.

5.6.1 Evaluation of quality and efficacy

The quality and the efficacy of the artifact were evaluated by assessing learning results and analyzing feedback from the students and the coaches.

5.6.1.1 Article IV: Learning results

Nisula, K., & Pekkola, S. (2018). ERP-based business learning environment as a boundary infrastructure in business learning. *Education and Information Technologies,* 1–20. doi:10.1007/s10639-019-09889-0

Article IV reports the learning evaluation from the cognitive, affective, and psychomotor perspectives. It answers RQ3: When the holistic business learning environment is constructed, does it improve learning?

The earlier research on the experiential learning environment's learning results, particularly in the information systems field, has been criticized for a lack of rigor (Anderson & Lawton, 2009; Monk & Lycett, 2016). The research has been based on subjective measures such as self-assessments or questionnaires, or it has studied learning from a restricted perspective, focusing only on some areas of learning (Anderson & Lawton, 2009). Another source of criticism has been a lack of control groups or of comparing groups that learn via different modes of learning. When information technology is evaluated for improvements in learning, the comparisons must be made within the same learning model instead of comparing one model of learning with technology to another model of learning without technology (Leidner & Jarvenpaa, 1995). The modes of learning refer to the mindset such as the objectivist/behavioral, constructive, or collaborative models that are each based on different philosophies and approaches. One cannot evaluate the effect of the learning environment or the tools if there are also variables present in the learning model. Also, there have been criticisms that the learning has been evaluated after or during a short period of time (Monk & Lycett, 2016).

Knowledge and capabilities cannot be measured directly but need to be measured as the actions and performances that result from learning (Wan, Fang, & Neufeld, 2007). Assessment can be divided into direct and indirect measures. Indirect measures are based on the students' or the teachers' opinions about how well the students have achieved their learning objectives. Indirect measures include surveys, questionnaires, focus groups, self- or peer-assessments, learning diaries and other self-reflective assignments, and the observations of student performance (Ingols & Shapiro, 2014; Kemery & Stickney, 2014; Martell, 2007; Michlitsch & Sidle, 2002).

Direct measures, on the other hand, require demonstration of knowledge or skills (Pringle & Michel, 2007). Direct assessment methods include individual or group assignments and projects, written reports, oral presentations, case studies, portfolios, normed or locally-developed exams with multiple-choice or open-answer questions, assessment centers, commercial assessment instruments used by recruiting companies, business simulation exercises, job-related exercises, business plans, and capstone courses (Dudley & Marlow, 2005; Martell, 2007; Monk & Lycett, 2016; Michlitsch & Sidle, 2002; Pederson, Benson, & Dresdow 2013; Weldy & Turnipseed, 2010). Several assessment modes and methods (i.e. triangulation) should be used to evaluate learning objectives to avoid the bias of any single method (Cronan et al., 2012).

Schumann, Anderson, Scott, and Lawton (2001) suggest the following approach for evaluating learning associated with a business simulation exercise: The learning objectives are first developed using Bloom's taxonomy. A test of attitudes, knowledge, and skills for those objectives is developed. Two equivalent sections of the course are chosen: The experimental group uses the business simulation and the control group does not. The test is given at the beginning of the course to both groups. The same test is given again at the end of the course. The pre-test measures of both groups are compared to check that the groups are starting from similar levels. Then the post-test gains are compared. If the experimental group shows larger gains in their knowledge and skills than the control group does, then the simulation experience accounts for the difference, since the only difference between the groups is the use of the simulation.

Bloom's taxonomy is a widely used generic classification for learning objectives (Krathwohl, 2002). The learning objectives are classified into three domains: cognitive, affective, and psychomotor. Since 1956, when the original taxonomy was developed, it has been expanded and revised several times (e.g., Anderson et al., 2001; Anderson & Lawton, 2009; Krathwohl, 2002; Krathwohl, Bloom, & Masia, 1964). This dissertation uses a cognitive domain description from 2001 (Anderson et al., 2001), an original affective domain description (Anderson & Lawton, 2009; Krathwohl et al., 1964), and a later psychomotor domain taxonomy supplement not published by the original authors but by several others (e.g. Harrow, 1972; Simpson, 1966).

The cognitive domain addresses knowledge and comprehension, the affective domain describes attitudes, emotions, and feelings, and the psychomotor domain indicates mechanical skills. These domains are further divided into different levels of learning. The domains, as described in Table 5, combine the original and revised taxonomies from the literature. The levels of learning range from low-level, superficial learning to profound learning.

Table 5. Bloom's taxonomy of learning combined from Anderson et al. (2001), Krathwohl, Bloom, and Masia (1964), and Simpson (1966).

Cognitive/Knowledge domain	Affective/Attitude domain	Psychomotor/Skill domain
Creating	Internalizing Values	Origination
Evaluating	Analyzing	Valuing
Understanding	Receiving Phenomena	Guided Response
Remembering		Readiness to Act

The basic level of the cognitive domain is remembering, while the higher levels, evaluating and creating, are related to a deeper understanding of the topic. The affective domain extends from receiving phenomena to internalizing values. Similarly, the psychomotor domain comprises of the skills of physical manipulation. In that domain, learning objectives include the change or development of behaviors, or capabilities such as efficiency and effectiveness (Wan et al., 2007). Readiness to act implicates motivation and the recognition of one's abilities and limitations. The deeper levels suggest mechanisms that form habits and the ability to use skills in new situations.

The business undergraduate curriculum focused on the basic disciplinary understanding of business management: marketing, sales, logistics, finance, economics, and law. The affective learning objectives included teamwork, responsibility, commitment, critical thinking, creativity, ability to tolerate changes, cooperation skills, and acting in the organizational environment. The earlier research suggestions (Anderson & Lawton, 2009) were followed to assess cognitive learning with objective methods and affective learning with self-reported measures. Psychomotor learning outcomes were measured in terms of efficiency, or the time to complete a task (Sharda et al., 2004).

5.6.1.2 Lower-level cognitive learning

The evaluation attempted to follow Schumann et al.'s (2001) setup of experimental and control groups with pre- and post-tests. The PE was used as the control group. As the PE model was used as a design principle in both environments, the model and the setup were very similar. The curriculum structure was the same and approximately 70% of the teachers were the same in both years. The main differences related to the ERP simulation and the processes and improvements to implement it.

The evaluation was done by comparing the PE model to the ERP-supported business learning environment. The same data collections were carried out with the class of 2009 using the PE model (the PE group) and with the class of 2010 in the ERP-supported business learning environment (the ERP group). Both classes had 117 students. The students' cognitive learning was evaluated by a three-phase learning results study (before school started, mid-term, end of the year). All the tests were answered anonymously, and the students were told that the learning tests would not affect their grades.

The first test evaluated the students' pre-understanding. As the students had no previous business training, open-ended questions were considered as more suitable than multiple-choice questions to evaluate their general understanding. In cooperation with the coaches, seven questions were created on different business situations, ranging from starting a company, to marketing-, production-, and accounting-related issues. The questions were formulated using common language, avoiding any professional business-related terms or expressions. The answers were scored based on an *a priori* set of ideal responses. The answers were graded with a scale from 0–3 (0 = no understanding, 3 = very good understanding).

The mid-year test contained 44 multiple-choice questions on the disciplinary topics taught during the first two modules: marketing, sales, logistics, finance, economics, and law. The respective disciplinary teachers created the questions on their area of responsibility based on the learning objectives of the modules. The online test was carried out in a classroom simultaneously with all the students to avoid information passing between the students. The students had not got prior information about the test, so they had not been able to prepare for it. Even if the scores did not affect their grades, the students were encouraged to use it as a self-test as they were able to see their score immediately after completing it.

The year-end test was created in a similar manner. Again, it was a web-test containing 44 multiple-choice questions covering the contents of the third and fourth modules. It was not given immediately after the school year, but at the beginning of the next semester in August to measure the long-term learning effects rather than short-term memorizing. The number of respondents decreased from the original 117 students to 73 (PE group) and 60 (ERP group) because of transfers to other universities.

A *t*-test analysis was performed on the score comparisons to check whether the differences in the results were significant. The results for both groups are presented in Table 6. In the pre-test and for the mid-term results, the p values were significantly over 0.05, indicating that there were no significant differences in the groups' prior knowledge nor learning at the mid-term stage. The p value for the year-end test was 0.005, indicating a significant difference in the results in favor of the ERP group.

Table 6. Results of the learning tests.

	PE group	ERP group		PE group	ERP group	PE group	ERP group	PE group	ERP group
	mean		P value	std deviation		median		mean deviation	
Pre-test	62.4	61.6	0.29	0.11	0.10	61.9	61.9	0.09	0.08
Mid-term	70.8	69.8	0.16	0.07	0.08	71.0	70.2	0.06	0.06
Year-end	57.8	61.8	0.005	0.10	0.07	59.2	62.2	0.08	0.06

In the pre-test and the mid-term test, the groups had almost equivalent normal distribution curves (as presented in article IV), but the year-end test showed different distributions for the groups (Figure 25). The standard deviation for the ERP group was smaller and the peak of the scores had shifted to the right.

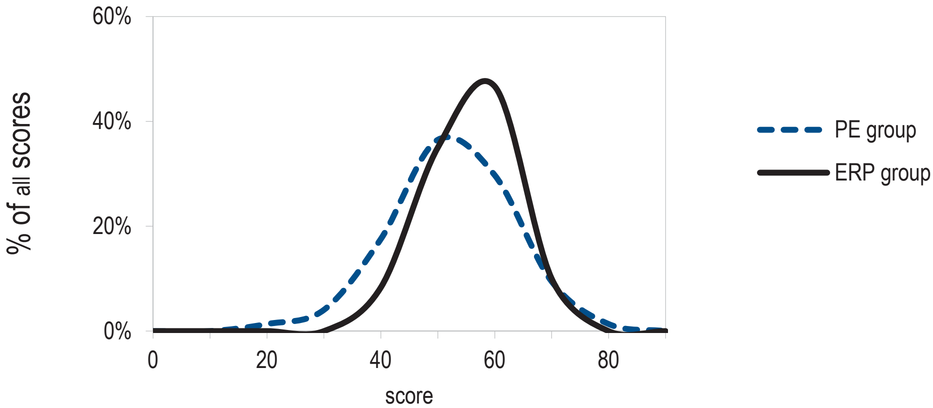

Figure 25. Normal distribution for the year-end tests.

This pattern indicates that better students perform well regardless of the learning environment, whereas lower and average performers seem to benefit from the ERP-supported business learning environment. This also suggests some improvements in their long-term learning. This concurs with earlier research indicating that the ERP systems and simulations benefit lower performers (Monk & Lycett, 2016; Pasin & Giroux, 2011).

Generating student commitment was a challenge. As the tests were not graded, the student motivation varied. Even the time taken to complete the mid-year and year-end tests ranged from 11 to 45 minutes. Some students clearly just browsed through them, while others were engaged in the exam and answered the questions as best they could. However, student behavior was similar for both groups; therefore, neither commitment nor a lack of commitment explains the differences between the groups. Additionally, because the tests were not graded or announced, the students were unprepared. We consider this a benefit because the answers reflected the students' real knowledge acquired during the learning process, not their preparation for a particular test situation.

The students' pre-understanding was measured with a different approach (open-ended questions) to their mid-term and year-end learning. As the students had just begun business education, they were not expected to know business terminology or details, even though they might possess some knowledge and understanding. Hence, open-ended questions were used. However, the subsequent use of the same set of questions was not employed for two reasons; the students would learn the terms and concepts in their studies, and the students would be able to prepare for the test. A basic test would therefore be too easy. Most importantly, learning the concepts and terminology created possibilities for more advanced testing of the deeper levels of cognitive competency.

5.6.1.3 Higher-level cognitive learning

Following Anderson and Lawton's (2009) suggestion to measure deeper cognitive levels of learning in situations that require analysis, synthesis, and evaluation, a large case exam was utilized. As a part of their studies, the first-year BBA students take a large, case-based final exam that includes all disciplinary areas that have been taught during the first year in May, at the end of the academic year. The students are given large amounts of data about a case company. They are asked to analyze the situation, find potential problems, and make suggestions within three hours. The students are informed well in advance and are allowed to bring notes and materials with them. The final exam is graded on a scale ranging from 0 to 5 and contributes to their grade and credit points. The exam is considered to be demanding and stressful—an effective learning situation for the higher business competencies and deeper cognitive and affective domains. It was also considered to be an appropriate measurement for more complex learning goals.

Figure 26 displays the results of the final exam for the PE group (n = 111) and the ERP group (n = 112). The grades for the ERP group were slightly higher, but no significant differences were found. The students seem to acquire the same level of higher-level cognitive learning in both learning environments.

The research setting challenges the reliability of this single result for comparing the groups. The original intention and design of the exams was to grade and compare students within both groups rather than objectively compare two separate groups. Exam grades have a tendency to result in a Gaussian curve (Wiggins, 1989) and these results evidently follow the bell-shaped curve. The suitability of final exams for comparing the groups was identified only after the exams had been taken. This limitation does not affect this measurement's potential to evaluate learning in general and this learning environment in particular. However, for exams to function as a rigorous measurement tool for comparing the groups, this issue of comparability must be considered early in the investigation.

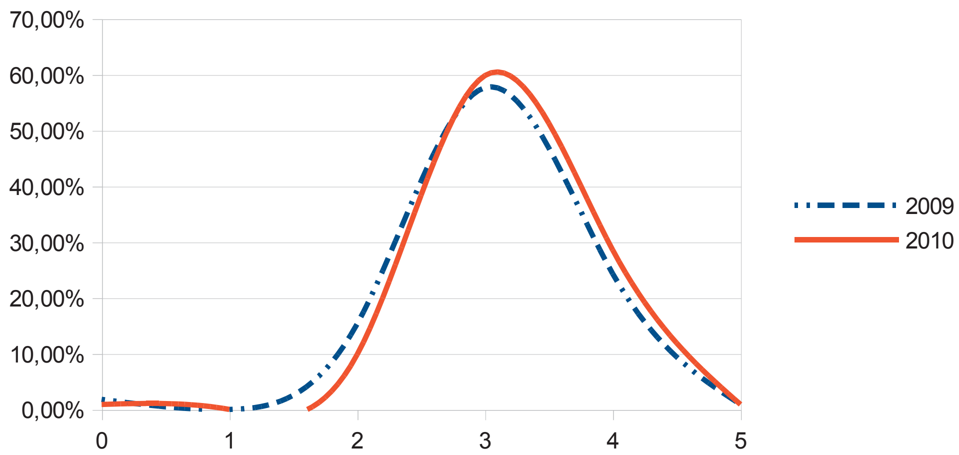

Figure 26. Final exam results.

5.6.1.4 Affective learning

Affective learning was evaluated via a web questionnaire in conjunction with the mid-term learning test. The students were presented with arguments about the learning environment and their own effort in it and were asked to evaluate these aspects on a Likert-type scale ranging from 1–5 (1 = strongly disagree, 5 = strongly agree). The average scores are presented in Table 7.

Table 7. Student feedback questionnaire scores.

	Average score (1–5)	
Argument	PE group (n = 100)	ERP group (n = 101)
The simulation/practice enterprise environment makes studying versatile.	4.2	4.1
The simulation/practice enterprise environment enables applying theory to practice.	4.1	4.0
The simulation/practice enterprise environment is well integrated into the rest of the curriculum.	3.9	3.8
The simulation/practice enterprise helps in understanding the big picture.	3.8	3.8
It is motivating to run the student company.	3.6	3.2
Work is distributed evenly between the student team members.	2.5	2.8

The results in both groups were quite similar. The best scores were on applying theory to practice (PE group 4.1/ERP group 4.0) and making studying versatile (4.2/4.1). This provides encouraging evidence for the practical nature of both learning environments. Integration between the ERP simulation/PE environment and the curriculum also scored well (3.9/3.8). Moreover, the students appreciated the learning environment in terms of it creating the big picture of the business processes (3.8). The workload division within the teams scored the lowest (2.5/2.8).

In the questionnaire, the students were also asked to answer open-ended questions on the positive and negative sides of the learning environment. All the responses were first reviewed to look for recurring topics. This resulted in five positive topics and seven negative topics (Table 8). Once the topics were identified, the answers were once again reviewed to count the number of recurrences.

Table 8 presents the most frequently mentioned issues and the number of responses. The results are surprisingly similar for the most part. In both learning environments, the students liked teamwork but disliked the uneven workload and free riders. They appreciated combining theory and practice but had challenges in separating which parts of the business operations reflected reality and where they could use their imagination. The biggest difference between the groups was with the practical hands-on work. It was mentioned twice as often by the ERP group than by the PE group. This indicates that the practical tools provided by the ERP system and the business game functionality increase the sense of hands-on real work. In the ERP simulation environment, on the other hand, the students were critical toward the teachers' support and communication. Some of these challenges could be solved by improving the curriculum integration through the ERP simulation.

Table 8. Frequently mentioned issues in the questionnaire.

Discussed topics	Number of times mentioned	
	PE group (n = 100)	ERP group (n = 101)
1. What works well?		
practical hands-on approach	27	55
team work	42	49
combining theory with practice	34	31
connections to real work life	20	20
versatility, variation, and change to traditional studying methods	12	16
2. What does not work well?		
uneven distribution of work load, free riders	28	30
technical problems	29	23
difficulty in drawing the line between the simulation and real life	16	20
scheduling challenges between the simulation and substance teaching	14	17
problem-based learning orientation	15	16
lack of instructions from teachers		10
poor communication by the teachers		9

5.6.1.5 Psychomotor learning

A comparable measurement for psychomotor learning in both environments was a challenge. The idea about using the ERP-system log files emerged during the research process. It offered the possibility of being able to evaluate the processing times in the ERP-supported simulation, so the comparison data are missing.

Efficiency, accuracy, and response magnitude are psychomotor learning outcomes (Sharda et al., 2004). Efficiency is measured in terms of the time to complete a task. Effectiveness can be assessed by counting the number of errors committed during task completion.

The efficiency of the order-to-delivery process, the purchase-order process, and inventory management process were analyzed. Psychomotor learning within the ERP-supported business learning environment was measured by the development in processing times. The sales order processing time declined from fifteen minutes to three minutes, on average, during the course of the simulation. The other processes and their analysis showed a similar decline. The average order processing times declined significantly over the course of the academic year, indicating improvements in psychomotor learning. The psychomotor learning results are discussed in further detail in article V.

5.6.2 User perceptions and feedback

5.6.2.1 Student feedback

In addition to the mid-term questionnaire, student feedback in the university's general course feedback system was analyzed for the year 2010. The students filled in a survey after each module in the general course feedback. The module feedback had an average response rate of 73 out of 117 students. The students evaluated their own input and the module implementation with a Likert-scale ranging from 1–5. In addition, they gave open-ended feedback.

The numeric module feedback reflected the scores of the whole university, receiving scores between 3 and 4 in all areas. On a generic level, some students highly appreciated the integration whereas others were frustrated with the integrated approach and the practical learning environment. Some of this may be explained by the fact that the majority of the students come directly from high school where they are used to the distinct, disciplinary-oriented curriculum and the traditional, individual learning methods: lectures, reading books, and exams. Some students had a culture shock with the integrated curriculum as they cannot always clearly make a distinction between the disciplinary topics. Such students felt uneasy with the problem-oriented approach where the disciplinary topics were taught at the same time or even after the issues had arisen in the simulated companies. They would have preferred the "learn first, try then" approach. The generic feedback reflected the responses of the mid-term questionnaire presented earlier.

The greatest dissatisfaction was with the uneven workload between the different modules. In the first and second modules, the amount of student company work was balanced, and it was new and interesting. In the third module, the combination of other learning exercises and student company work was too much. And then in the last module, the company operations became boring routines and the motivation died down. The students would have wanted more challenges and new perspectives on running a business, or to have stopped the simulation after the third module.

5.6.2.2 Coach feedback

The coaches' perceptions of the ERP-supported learning environment were collected in the weekly meetings and via a small survey at the end of the second module, after the ERP-supported learning environment had been implemented. The meetings were recorded in 29 meeting memos. Also, the coaches held a meeting at the end of the 2010–2011 academic year to review the lessons learned from the ERP simulation.

The meeting memos and the feedback survey responses were analyzed. As a summary, the coaches felt that the students adapted to the learning environment relatively easily. The novelty value and the challenges seemed bigger for the coaches, who felt that the new environment required a lot of general knowledge as well as an understanding of business IT. Teachers are typically experts in their own specific domain. The coaches would have wanted more time and resources to properly familiarize themselves with the new environment. The appreciated the monitoring capabilities provided by the ERP log files and reports but regretted that they had not possessed or taken the time to properly learn to use them. A more detailed analysis of the coaches' perceptions is found in article III.

5.6.3 Evaluation of validity: Comparison to earlier solutions

In design science, the developed artifact needs to enable solutions to problems that have not been solved before by extending the knowledge base or applying existing knowledge in new and innovative ways (Hevner et al., 2004). The artifact is next compared to the earlier experiential learning environments.

5.6.3.1 Comparison to the practice enterprise model

The starting point for the dissertation was the dissatisfaction with the existing PE model that was in use in TAMK. Reflecting the earlier research, it was considered artificial and static (Greimel-Fuhrmann, 2006; Miettinen & Peisa, 2002; Neuweg, 2014; Santos, 2008). It lacked a story or the content of the business environment.

Rather, the interactions between the student companies and the surrounding business environment were structured through occasional e-mails between the students and the national PE center. Student companies received purchase orders when the coaches requested them from the national PE center. In the artifact, the artificiality and the lack of context (Greimel-Fuhrmann, 2006; Santos, 2008) were tackled by creating a fictional market environment with simulated service providers, supplier web stores, and tax officials that resembled their real counterparts. These were presented through concrete web pages, online stores, and applications.

Students decide themselves what kind of a PE they want to set up. The majority of the PEs are typically retail companies and they do not always have customer companies to sell to, or some may possess a monopoly, which distorts the market situation (Neuweg, 2014). To avoid this, the artifact was designed to be a supply network. The business areas for the supply network were chosen to maximize the potential for interaction and still keep their context simple enough for the first-year undergraduate students.

The PE model is static partly because it is highly dependent on the participants' skills and activity levels (Gramlinger, 2004; Santos, 2008). The purchases and sales are occasional and require the teacher to initiate them either by requesting the administrator or the students themselves to place orders. It is heavily dependent on the students' activity levels. In the artifact this challenge was tackled with the simulation component automatically creating consumer demand.

In the PE model, a better utilization of IT was seen as a point of development (Gramlinger, 2005). In the artifact, the ERP system is the main tool that the student companies use to run their operations. In addition, the students use the online bank and the online tax system, both resembling their real-life counterparts. This enables the students to learn modern business IT as well as increasing the sense of reality when using the same systems as real companies use.

In the PE model, there are no monitoring tools. The teachers rely on the information provided by the students on what kinds of activities have been done and by whom. In the artifact, the ERP system log files are utilized to report student activity. Even though there is no clear correlation between simulation success and learning (Gosen & Washbush, 2004), the student company business reports provide information about the learning process and help the coach in guiding the team. Monitoring learning is a challenge in all learning environments. The artifact provides a potential solution as the ERP system log files can be used for monitoring purposes as described later in this chapter as well as in article V.

Earlier research on the PE model has indicated positive effects on the affective learning relating to teamwork, communication, and motivation (Deissinger, 2007; Deissinger & Ruf, 2007; Glombitza, 2012; Graziano, 2003; Greimel-Fuhrmann, 2006; Isokangas, 2009; Santos, 2008). Cognitive, disciplinary-oriented learning about business domains and their integration has been identified as an area that needs development (Krauskopf & Frei, 2012; Neuweg & Pfatschbacher, 2013).

This dissertation compared the artifact to the PE model. From the affective learning perspective, both were seen as motivating learning environments. The artifact was particularly appreciated for its hands-on approach. This indicates that real-life tools increase the sense of learning by doing, which has been a challenge in the PE model (Greimel-Fuhrmann, 2006; Santos, 2008).

In terms of cognitive learning, it was detected that the artifact improved the long-term learning of the poorer students on the lower levels of Bloom's cognitive domain. This supports earlier research suggesting that ERP systems and simulations benefit the weaker performers (Monk & Lycett, 2016; Pasin & Giroux, 2011). A combination of the PE model and an ERP simulation appears particularly beneficial, as the poor performers also seem to benefit from the PE model (Graziano, 2003).

5.6.3.2 Comparison to educational ERP systems

ERP systems can provide a hands-on learning experience and business process perspective for business learning. On the other hand, the students need business process knowledge to be able to utilize the ERP systems for learning (Monk & Lycett, 2016). In addition, ERP systems typically concentrate on the processes of one company. There is rarely an inter-organizational context involving several companies (Jaeger et al., 2011). Providing a network of student teams with an ERP system without any supporting knowledge or connecting structures is little more than a case exercise carried out with individual, yet realistic tools. There is no control over interrelated activities.

In the artifact, the information system structure was based on the conceptual framework of ERP II (Møller, 2005). All the data for the different student companies resided in the foundation of an integrated database. The ERP system, the bank application, and the tax system formed the process layer where the students operated. The analytical layer was a combination of standard ERP reports and customized student activity reports, providing the coaches with information to support the students' learning process. The e-business layer enabled the student companies to interact and the business simulation element created momentum for the ERP tool and the student network.

This type of setup was possible because the artifact was implemented in an open-source environment. The main body of educational ERP research has been done on large proprietary ERP systems; namely, SAP (e.g. Léger, 2006; Léger et al., 2011; Cronan et al., 2012). There is relatively little research on the educational use of ERP solutions for SME companies. Recently, open-source ERP systems have also been introduced in educational research (Ayyagari, 2011; Huynh & Chu, 2011; Jewer & Evermann, 2015). Large proprietary ERP systems are complex to learn (Seethamraju, 2007) and inflexible, if not impossible to change or customize.

Earlier research on ERP systems has identified positive learning outcomes in the cognitive domain (Cronan et al., 2012; Monk & Lycett, 2016; Noguera & Watson, 2004). Noguera and Watson (2004) found a significant difference between two groups; one using an ERP system and the control group not using it. Similarly, this dissertation found indications that the learning environment with the ERP system yielded improvements in the learning results. Monk and Lycett (2016) found indications that the poorer students benefited from the ERP exercises, which is also supported by the findings of this study.

5.6.3.3 Comparison to business simulations

The artifact can be considered a business simulation that combines a manual simulation of the PE model with the ERP system tools. In addition, it adds automated and simulated features to the combination.

Business simulations typically represent a specific business perspective such as a set of macro-world problems and decisions of an entire organization, a functional business area within a company, or a set of interpersonal skills (Clarke, 2009). This artifact combines the different perspectives of the macro-world of the supply chain network, the micro-world of the company's internal business, and the interpersonal skills into one learning environment. The students make organizational decisions in the PE context and practice functional day-to-day activities in the ERP system. Their organizational decisions are based on reporting that stems from their day-to-day business activities.

Business simulations typically contain business scenarios based on simplified models of reality that follow a specific business theory (Goosen et al., 2001). This artifact replaces the pre-planned scenarios based on specific theories with a flexible set of rules that can be adjusted to the situation. The business scenarios can be created and implemented without having to customize any systems.

A custom-made simulation that emulates the real-life tools is cumbersome to build and difficult to maintain. There are benefits to following the building principles of this artifact and in building the simulation as an attachment to an ERP system:

- **Reality**: The tools for the students are the same as real businesses use.
- **Constant development**: The artifact can keep up with the development of the ERP system without having to customize its interface when new business developments roll into ERP functionalities.

These benefits have already been realized in the simulations that are attached to proprietary ERP systems such as the ERPSim game, which operates with the SAP system (e.g. Cronan et al., 2012). Attaching the simulation to an open-source ERP system, as has been done for the artifact, provides additional benefits:

- **Transferability**: The learning environment framework and the structure can be transferred from one ERP system to another. Even though this is no easy task, it is possible.
- **Compatibility**: When using the standard data-transfer protocols of e-Invoicing, the elements of the simulation can also interact with other ERP platforms, enabling educational cooperation with other similar simulations.
- **Flexibility and scale**: The learning environment simulation setup can be expanded from the present business-to-business goods and services retail sector to other types of operations such as manufacturing.

Earlier research has indicated that simulations improve learning on the lower cognitive levels (Anderson & Lawton 2009; Fowler, 2006; Gosen & Washbush, 2004) and on the affective domain (Anderson & Lawton, 2009; Clarke, 2009). There have also been indications of increased retention of knowledge (Clarke, 2009). All these results concur with the findings of this dissertation.

In terms of the psychomotor domain, several studies indicate an improvement between the beginning and the end of the simulations (e.g. Davidovitch et al., 2008; Langley & Morecroft, 2004; Olhager & Persson, 2006; Pasin & Giroux, 2011; Thavikulwat, 2012). This is also in line with the findings of this dissertation.

5.6.4 Article V: Using log files to assess and monitor learning

Nisula, K., & Pekkola, S. (2016). Assessing business learning by analysing ERP simulation log files. *Proceedings of the AIS SIGED 2016 Conference on IS Education and Research, 4*, https://aisel.aisnet.org/siged2016/4.

All learning environments struggle with assessing performance instead of results, as well as with monitoring and supporting the learning process. Business simulations focus on measures of business success (Dickinson, 2003; Teach & Patel, 2007) or statistics that can be compared to other teams (Markulis, Nugent, & Strang, 2015). Business success in a simulation is not necessarily an appropriate measure of learning (Gosen & Wasbush, 2004) as it can give biased learning results.

The research on simulation learning results focuses on the usability of the simulation rather than on learning assessments for an individual student (Anderson & Lawton, 2009). This article brings forth the assessment perspective. When evaluating the learning environment's impacts, the idea was to utilize the ERP system log files for embedded assessments. The fifth article discusses how the assessment of business learning could be expanded from cognitive outputs and self-assessments, to objective, concrete performance measurements. The use of log files is presented for all Bloom's domains: the cognitive, affective, and psychomotor domains.

Research on psychomotor learning during the simulation has been limited (Anderson & Lawton, 2009). The article suggests using ERP system processing times to indicate the individual's learning curve. Cognitive learning has typically been measured by self-evaluations, teacher perceptions, or external tests (Anderson & Lawton, 2009). The article suggests that the ERP system's order-to-delivery process time measured from the log files can be used as a supplementary learning assessment. It is a complex process that combines several people, business processes, and transactions, and requires both psychomotor and cognitive processing.

Affective learning has mostly been assessed by self-reports or teacher perception (Anderson & Lawton, 2009). The article demonstrates a practical example of how log data can be used to assess affective learning. In the ERP-supported business learning environment, the coaches were able to access the log file reports on individual student activity. They were able to compare the students' self- and peer-assessments to the actual work performed in the ERP system.

The assessments typically focus on summative measures at the end of the learning process rather than on formative activities during the learning process (Anderson & Lawton, 2009). In this case, the log data was available for reflective discussions and immediate improvement. In addition, the coaches were able to use the standard ERP reports, for example, on sales, financial statements, and inventory to guide the student teams in their learning process. Without the log data, the coach would have relied solely on the students' perceptions of the situation.

The log file analysis holds potential particularly for formative assessments to guide the student's learning process during the simulation. Affective learning can be assessed from how active the students are in the simulation. Cognitive and psychomotor learning can be detected from how well the students perform.

The article also emphasizes the importance of the assessment strategies in business simulations. They need to be part of the learning environment design from the very beginning to make assessments a natural part of the simulation infrastructure. This article provides an additional perspective on RQ3: When the holistic business learning environment is constructed, does it improve learning?

5.6.5 Evaluation of utility

Utility refers to the artifact's ability to achieve its goals outside of the development environment (Gregor & Hevner, 2013). Kasanen, Lukka, and Siitonen (1993) suggest a market-based validation to indicate such usefulness. A weak market test is passed if the artifact is applied in practice. A semi-strong market test is passed if the artifact is adopted by other actors than the original user organization. A strong market test is passed if the organizations using the artifact are producing better results than those organizations not using it.

5.6.5.1 Continued and expanded use of the artifact

The prototype was taken into permanent use and continues to be the core of the first-year business studies in TAMK, eight years after the initial implementation. In 2017 it was expanded from business undergraduate studies to also include students of international business. Between 2010 and 2018, approximately 1600 TAMK students have used the ERP business learning environment for their first study year.

The TAMK learning network has grown, with three similar learning environments in other educational institutions. Savonia University of Applied Sciences and Rovaniemi University of Applied Sciences have utilized the TAMK ERP business learning environment infrastructure with their own conceptual content since 2014.

The network has also grown internationally: Brno University of Technology in the Czech Republic joined the ERP business learning environment in 2016. In total, the learning environment has been used by 2690 students to date (A. Kallionpää, personal interview, October 4, 2018).

Based on these results, it can be concluded that the artifact has passed the semi-strong market test.

5.6.5.2 Implementation of the design principles in another infrastructure

The pragmatic validity of design theories or principles is tested by their usage in practice (Worren et al., 2002). The design principles were applied in the Tampere University of Technology in the years 2013 and 2014. A learning environment was constructed around the Open-ERP system using the same ERP II and logistics network structure. The researcher acted as the project manager and main architect in the learning environment construction.

The learning environment was used in the introductory course at the beginning of the studies. The course, Business and Technology in Context, lasted for two semesters and contained a total of ten credit units. It had the following learning objectives:

- Basic understanding of the business processes
- Basic understanding of ERP systems
- Entrepreneurial attitude and appreciation of entrepreneurship
- Ability to work independently and do teamwork

The group was a combination business and information management students who were organized into teams that learned entrepreneurship and basic business skills by operating fictional companies. The instructions for the activities in the simulation environment were provided with wiki-pages. The course was divided into ten weeks. Each week, a new assignment was provided in the wiki-pages. In addition, the wiki-pages contained generic business information, business tips, and detailed instructions on how to use the ERP system and the other tools in the learning environment.

In 2013, there were 78 students that were divided into ten teams. Their learning outcomes and perceptions of the learning environment were analyzed through learning diaries and student company final reports: 75 out of the 78 students turned in a learning diary. The students had been instructed to write down the following notes about the entrepreneurship exercise: their expectations and learning goals; notes on the training sessions and the team meetings; a summary of the final report presentations; feedback and lessons learned from the exercise; as well as how much time they had spent on the exercise. The company's end report contained an introduction to the company—past, present and future—as well as findings on teamwork, lessons learned, and feedback on the learning environment.

The verbal feedback in the learning diaries was converted into numerical form on a scale ranging from one to five. One represented very negative feedback, three was neutral, and five was very positive feedback. Between the groups, the satisfaction varied from 2.55 to 3.75, averaging out to 3.1. Interestingly enough, the dissatisfied students also felt they had learned from the exercise. Some of the dissatisfaction was caused by the learning results not matching their own expectations. Most students had had high expectations of learning entrepreneurship, business management, decision-making, and other business-related issues. Instead, many thought that the learning environment was too IT-system-oriented and lacked momentum. Part of this was due to a deficiency in the simulation design. On the other hand, the students were expected to take the initiative and be active in marketing and seeking additional business rather than wait for the teacher to give out the tasks and obvious triggers for action. The teams that organized themselves quickly, marketed their companies actively, and participated in all of the training were satisfied and got good learning results. The more passive groups lost the motivation to carry out even the simplest of tasks. Another reason for the loss of motivation was that the groups were too big to have enough work for everyone. Even though some students had originally feared the big work load in the exercise, many ended up dissatisfied with the lack of work inside the simulation.

The learning diaries were analyzed for notifications for reaching the learning objectives. Understanding the basic business processes was an objective with high expectations. The students themselves were most dissatisfied with this objective, even if learning did occur. Particularly, if a student had previous business experience, he/she felt he/she had learned few new things. On the other hand, others that came directly from high school felt that they had gained a good basic understanding of the business, particularly when they combined the simulation experiences with other learning activities such as the company excursion. Some notes clearly identified learning, such as:

> *I started understanding internal and external logistic flows.*
>
> *Different business departments (sales, purchasing, and finance) are heavily dependent on each other—everything someone does or does not do affects someone else's work in the company.*
>
> *In the beginning the profitability calculation was just numbers. In the end we would have been able to do it in a rational way.*
>
> *In the end we understood a whole lot more about what business requires, how much personnel, what kind of cash flow, etc.*

The students felt that they gained a good basic understanding of ERP systems. Some were frustrated because they only got to scratch the surface and would have wanted more insight into the ERP, whereas others were either content or even felt that there was too much ERP orientation. Some of the comments in the learning diaries were as follows:

> *I have used an ERP system in my trainee job, but only from a minor perspective. This was easier and I saw a bigger picture regarding what can be done with it.*
>
> *I think I will even be able to do sales and purchases in another ERP system.*
>
> *In the beginning it was so complicated and confusing. But after a few times, it became routine.*

All teams reported learning taking place regarding entrepreneurial attitude and the appreciation of entrepreneurship. At the end of the exercise, they reviewed the initial business profitability calculations they had created with very little information. They analyzed what they would then do differently. There were several learning points noted, such as:

> *The business needs to start small, there are major financial risks involved.*
>
> *There is a lack of cash and sales at the beginning of the business. There are expenses even before any money is coming in.*
>
> *Lack of clear company direction causes poor results and inefficient processes.*
>
> *In a company, all employees should be kind of entrepreneurs themselves.*

The ability to work independently and do teamwork was the area where the most learning had occurred. Quite a few students commented that they had expected to learn about entrepreneurship but instead they learned about teamwork, interpersonal and organizational leadership, and most of all, communication. For all the students, this team was the biggest they had done teamwork with. Many were out of their comfort zone:

> *We learned how to operate in large teams. Leadership and hierarchies are needed, democracy doesn't work.*
>
> *In a big group people assume that someone else will do the work. Roles and team rules need to be discussed and agreed upon and taken into practical use.*
>
> *If responsibilities are not spelled out, tasks will not get done or several people do the same.*

This was learning the hard way through mistakes, conflicts, and challenges. And it seemed particularly beneficial to do an activity incorrectly the first time, see the problems that were caused, correct them, and do the activity again correctly. Fortunately, not all learning experiences were through problems. Particularly, the successful teams had many positive learning situations:

> *Having to teach someone else about the department routines forced you to learn them properly yourself first.*
>
> *Mistakes were a learning opportunity for the whole group. Halfway through the exercise, the learning environment did not seem valuable. But in the final discussions, we noticed that a lot of learning had occurred.*
>
> *Good time management and planning forward is important both in the company operations as well as for individual studying tasks.*

There were also several suggestions for improvements: The team sizes were too big and there was a lack of leadership. The instructions in the beginning were not clear enough to start planning the business. There should have been more face-to-face teaching and coaching on the big business picture. The students had only been trained in their first departmental role. When they changed roles, they had to teach each other. Some teams managed the transition better than others did. The exercise lost momentum—ten weeks was too long and there were not enough new activities to keep the motivation up. The routines became boring when only interacting with simulated companies. Even though the students could have done business with each other, they chose the easier route and conducted their business with simulated companies. There should have been an element of competition. If the best business had received some sort of reward, it would have motivated them to perform better.

In 2014, as a result of the feedback, there were changes made to the ERP simulation and to the exercise. There were 69 students and the team sizes were reduced to approximately 6 people. Each team was appointed a senior business management student to act as a CEO. The exercise was shortened from ten to eight weeks. The teams were given clearer instructions and restrictions on the number of employees, the selection of sales products, raw materials, and the costs. This enabled them to create more accurate business plans.

The teams were forced to do business with each other; half of the teams sourced their materials from the other half. This created a logistic chain: The simulation-operated end customers placed orders with the student-retailers who in turn purchased from the student-assemblers. The student-assemblers then bought their raw materials from the simulation-run wholesaler, assembled the computers, and sold them to the student-retailers. As there were several student companies in the same business line, this added the element of market competition and the need to utilize negotiation skills. Momentum was added after a month by reversing the direction of the logistic flow. The previous student-assemblers started getting consumer demand for sports electronics products that were available only through their earlier student-retailers.

The learning diary was removed from the course, as it was regarded as involving too much work for the students. The feedback and learning points were analyzed from the company end reports of 69 students.

The learning points noted were quite similar to the previous year: day-to-day business operations, the start-up activities, the basics of an ERP system, teamwork and communications skills, among other things. The implemented changes appeared to be successful. Based on the reports, the students had engaged themselves in the exercise more than the previous year's students had and had taken the make-believe exercise more seriously. Some end reports sounded like real-life companies with detailed present situation reports and future plans. The reports contained analyses, graphs, and calculations on the business's success. They were more logically organized and seemed more professional than the previous year's outputs did. The reports also utilized content knowledge from the other courses that had been running parallel to the simulation.

The learning outcomes seemed to match the students' expectations better. In all the company end reports, it was noted that those goals were met, although some were met better than others. The team size seemed optimal. The competitive situation taught about the importance of networks and relationships, as one team noted:

The teams that had created good relationships were the most successful.

Another team made a discovery that it was not always the lowest price that won the deals. One student team organized a coffee-serving to the other teams during a lecture break. This enabled them to turn prospects into customers, even if they were only working in a simulation. The more active teams sent out requests for quotes to all potential suppliers every time they got a bigger order from the simulation. The less active teams only bought from whoever they happened to find.

The results indicate that the design principles can be implemented in another infrastructure and in a different educational setting. The Tampere University of Technology represents the other branch of the dual structure of higher education: the academic university. Even if the educational orientation, the curriculum, and the duration of the course were very different from the initial TAMK case, the implementation was successful: In 2014, that solution was one of the finalists in the annual competition for the best e-learning solution in Finland. The jury stated that it

> *is an excellent learning environment that brings the PEs to today's world. It would require more motivating, guiding and game-like elements, but a clear strength of the learning environment is the concrete attachment to the real world and actual business processes and tools. This artifact has international potential and wide applicability* (Vesterbacka & Vainio, 2014).

6 DISCUSSION

This dissertation set out to investigate if an appropriate combination of different experiential learning environments with a people-orientation could create a student-centered learning environment (Land et al., 2012) providing realistic and authentic learning experiences to offer a solution to some of the challenges of current business education.

To conduct the research, a design science framework was set up to construct a business learning environment that would combine key features of the earlier business learning environments to follow the concept of a BSL (Blaylock et al., 2009). The earlier learning environments chosen for further analysis and development were the PE model, ERP systems, and business simulations.

6.1 How should the holistic business learning environment be constructed? (RQ1)

One of the main deliverables of the dissertation is the artifact that offers an answer to the first research question. Article I suggests that the holistic business learning environment can be constructed by combining features of the PE model, a business simulation, and an ERP system. Following the principles of CSCL (Ludvigsen & Mørch, 2010), it acts as a learning scaffold, enhancing and supporting the student's learning experiences, as well as being the mediating artifact between the students and the teachers.

Article II presents the technical structure of the artifact that uses the following design principles:

- A supply chain network forms the structure of the business environment
- The business interactions utilize automated information flows
- The information system structure is based on ERP II

IT artifacts contain five specific core elements: hardware, operating and system software, application software, data content, and additional artifacts (Zhang, Scialdone, & Ku, 2011). Our artifact illustrated in Figure 27 was constructed on standard hardware and open-source system software. The application software was developed from the standard open-source ERP system by adding simulation and reporting functionality. It was expanded to a supply network using the framework where student- and administrator-operated companies were linked to each other with automatic data exchange. The students and the simulation elements produced the application content that was collected, organized, stored, and manipulated in the ERP system. The web pages and the physical offices were the auxiliary artifacts that extended the ERP simulation and gave it meaning, characteristics, and a concrete façade.

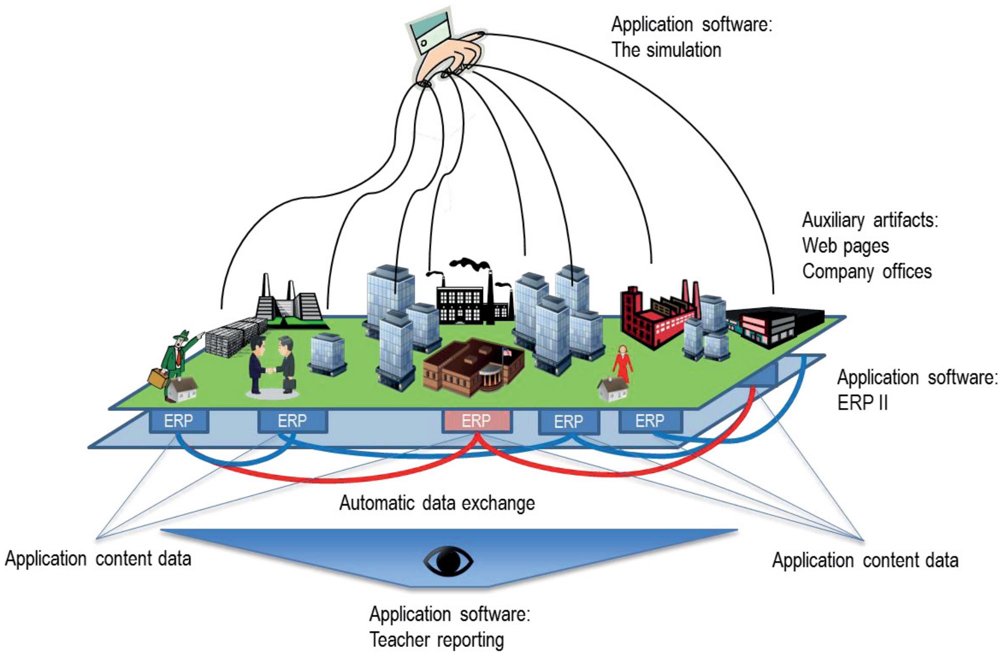

Figure 27. The core elements of the artifact.

The artifact supports the learner, who is the key constructor of his/her internal meaning making (Land et al., 2012). It does not contain clearly dictated ways of learning, but rather accommodates different learning styles (Joy & Kolb, 2009) and allows the experiential learning process to start from different phases of Kolb's cycle.

6.2 How should the holistic business learning environment be combined with the curriculum? (RQ2)

At the beginning of the research, the focus was predominately on the technical implementation of the information systems' oriented, concrete learning environment. In the course of the research, however, it became evident that the challenge was much larger. Following the views of constructivism and the social cognitive theory that people, behaviors, and environments interact with each other in the learning process (Schunk, 2014), it was detected that the curriculum structure and the people involved with the process play a major role in reaching the desired learning objectives successfully, following Bajada and Rowan's (2013) suggestion that the most efficient learning method is the whole degree program's integration.

Article III offered an answer to this research question by presenting a holistic business curriculum model consisting of a curriculum structure, learning communities of students and teachers, and the ERP-supported learning environment. It follows the principles of the student-centered learning environment (Land et al., 2012) by providing structural scaffolds through the curriculum, and the ERP simulation and socio-cultural interaction through the learning communities. It also ties together different learning methods and strategies and ensures that all parts of Kolb's learning cycle are addressed, accommodating all the different learning styles (Felder & Brent, 2005).

When we want to move away from the disciplinary silos of business education, it requires a major change of mindset in the faculty, the administration, and the students. To enable that mindset, several elements have to be in place.

People involved in the learning process need to be organized in a way that differs from the behavioristic setup where the teacher is the author providing information to the passive recipients. The students need to be put in the position where they have to take responsibility for their own learning (Land et al., 2012; Pfeffer & Fong, 2002). Learning communities provide organizational structures for this (Lenning et al., 2013): SLCs organize the students and the teachers around the learning process. PLCs of teachers, on the other hand, act as development communities for the teachers and the faculty and offer peer-support in implementing the changes in the curriculum and pedagogy.

In addition to organizational silos, the disciplinary silos need to be broken down in the curriculum. There needs to be intellectual coherence to indicate how disciplines, courses, projects, and cases influence each other (Teece, 2011). In article III, the dynamic capabilities framework (Teece, 2011) was mapped to the

TAMK curriculum as the overall structure. It appeared to be suitable for tying together the different areas of business management. The dynamic capabilities framework is definitely not the only possible overall framework and it is debatable whether it is the best. That would require further research. However, this dissertation argues that an intellectual framework is required for successfully implementing an integrated curriculum.

Article III also presented lessons learned in implementing the holistic curriculum model:

- Faculty needs to be committed to do a lot of hard work and concrete actions.
- Integration management requires clearly assigned responsibilities, processes, and tools.
- Constant everyday integration between the disciplinary content and the simulation needs good planning, continual supervision, and the ability to react quickly.
- Explicit, consistent, and well-planned communication between the teachers and with the students is critical for successful curriculum integration (c.f. Ramesh & Gerth, 2015).
- Simulation in the curriculum calls for imagination and creativity—the faculty need to lead by example and to throw themselves into the role-play.
- Student motivation requires constant focus: inspiration, encouragement, rationalizing the learning methods, and the impression that the workload is balanced.
- A system implementation demands much energy; the tools are useless if people do not have the skills or the time.

But what then is the role of the physical, concrete business learning environment that is the artifact of this dissertation? In addition to being the safe practical training ground in which to experiment without the fear of making mistakes (Kisfalvi, 2015), it is the concrete combining factor between the people and the disciplinary topics on the curriculum plans and documents. It is the "flesh on the curriculum skeleton" that makes the learning concrete and real.

6.3 When the holistic business learning environment is constructed, does it improve learning? (RQ3)

IT-supported business learning environments have been studied using Bloom's taxonomy, but the perspective has typically been one of the domains (Anderson & Lawton, 2009). The PE model has not been previously studied from the perspective of Bloom's taxonomy. Article IV brought together all the domains and viewed learning from the perspectives of the cognitive, the affective, and the psychomotor domains.

In article IV, the learning results of the artifact were compared to the previous PE model. The artifact brought about improvements in the poor and average students' long-term lower-level cognitive learning. The results indicated that better students perform well regardless of the learning environment, whereas weaker and average performers seem to benefit from the artifact. This is concurrent with earlier research indicating the benefits to the weaker performers from the experiential learning environments: the PE model (Borgese, 2001; Graziano, 2003), ERP systems (Monk & Lycett, 2016), and simulations (Pasin & Giroux, 2011). The earlier research has studied the learning environments separately. This dissertation brings the different learning environments into the same piece of research.

Our results on the affective domain were concurrent with the previous research on experiential learning environments indicating positive results (e.g. Anderson & Lawton, 2009; Chen et al., 2015; Clarke, 2009; Deissinger & Ruf, 2007; Glombitza, 2012). In particular, in our research, there were improvements in the perceived practical hands-on skills and in terms of learning motivation. The psychomotor learning was only measured within the ERP-supported learning environment, but the improvements in processing times gave clear indications of learning, concurring with earlier findings of experiential learning environments (e.g. Davidovitch et al., 2008; Langley & Morecroft, 2004; Olhager & Persson, 2006; Pasin & Giroux, 2011; Thavikulwat, 2012).

Article IV found positive learning results for all three of Bloom's domains, providing evidence that the artifact supports a solution to the identified problem.

6.4 If the holistic business learning environment improves learning, why is that? (RQ4)

Article IV offers an explanation as to why the holistic learning environment improves learning: It acts as a boundary infrastructure. A boundary infrastructure consists of boundary objects (Bowker & Star, 2000; Star, 2010), which in turn are objects that combine different communities. They are "*plastic enough to adapt to local needs and constraints of the several parties employing them, yet robust enough to maintain a common identity across sites*" (Star & Griesemer, 1989, p. 393). They can mean different things for different groups, but they act as points of interaction and communication (Star & Griesemer, 1989).

The holistic learning environment is a "*complex representation that can be observed and then used across different functional settings*" (Carlile, 2002, p. 451). Each social group can interpret it from their own perspective, and yet the artifact offers a common ground for concrete actions, discussions, and mutual understanding. In multi-disciplinary learning, a boundary object is a central point where disciplines interact (see Figure 28).

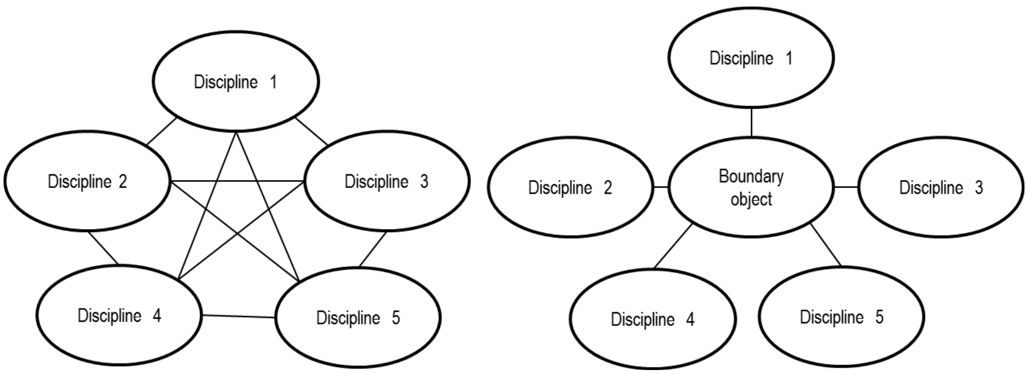

Figure 28. Boundary object in multi-disciplinary teaching.

The PE model presented a common discourse that acted as a boundary object. That discourse, however, remained on a highly abstract level. When the aim is to create common understanding, the boundary objects need to be specific and combined to other boundary objects that reinforce each other (Fujimura, 1992).

The ERP simulation converted the abstract discourse of the PE into a concrete form with a narrative (stories on the web pages and in the online publication) and concrete artifacts (ERP system, online bank, tax system). The students saw make-believe companies in an imaginary city where they worked with real-life tools. The teachers used the environment for knowledge by exemplification (Chia & Holt, 2008; Statler, 2014) and created concrete examples for the students to train with instead of concentrating only on thinking (Kolb & Kolb, 2009; Tomkins & Ulus, 2016). It provided a safe place for students to experiment without the fear of making mistakes (Kisfalvi, 2015). The ERP system was a repository for shared data and knowledge (Abraham, 2013; Pawlowski & Robey, 2004). The ERP system functionalities and processes were standardized methods that formed "*a mutually understood structure and language*" (Carlile, 2002, p. 451). Article V describes how the artifact also enabled the teachers to monitor learning and further support the students' learning efforts. Article III showed how the administration can attach the artifact's business environment to the structures of the curriculum and make the abstract collection of courses into a coherent story formed of concrete experiences. In fact, the curriculum framework itself was a map of a boundary that "*exists between different groups or functions at a more systemic level*" (Carlile, 2002, p. 451). It brings together the different disciplines to form a common ground between the teachers, the faculty, and the students.

This kind of boundary infrastructure supports learning as defined by Schunk (2014), where learning is a permanent change that takes place over time and as a result of experience. It provides a long-term training ground for practicing as well as observing other students' behavior.

Creating and managing boundary objects is vital for developing and keeping coherence between intersecting social worlds (Star & Griesemer, 1989). In undergraduate business studies, we are combining very different social worlds: The students, many fresh out of high school, have little understanding of the business world. Their interest is in acquiring competences for their future careers. The teachers are pedagogical experts, many with business experience. Their interest is in enabling and guiding the students to reach the learning goals. In order to create increased and shared knowledge and understanding, the actors have to have the capacity, ability, and a need to interact, and to have boundary objects to interact with (Rosenkranz, Vraneši, & Holten, 2014).

7 CONCLUSIONS

Design science research contributions can be classified into four types: new inventions, improvements, exaptation, and routine design (Gregor & Hevner, 2013). This dissertation set out to contribute a concrete improvement to the education relevance challenge where existing solutions have not closed the gap between education and business. This dissertation itself is a boundary object, bridging gaps between theory and practice; people and technology; the curriculum and learning environment; as well as different research streams.

The developed artifact along with its design principles can be seen as a boundary infrastructure where different stakeholders carry out their own roles and tasks and interrelate with each other. It provides a common ground to join the theoretical perspective to the practical processes and tasks of business management. It is flexible and can be used from many different perspectives and for many different purposes at the same time. The students can view it as a playground to run their simulated businesses and practice interaction with other students. The coaches use it to illustrate a point in their disciplinary learning. The coaches follow the learning process through the reporting tools of the system.

All learners are individuals and may start their learning cycles from different stages (Kolb & Kolb, 2005). Analytical learners prefer to start with the theory whereas experimental learners try first and conceptualize after that. The learning style varies depending on the interactions between the learner and the environment. When the learning environment is a part of an ongoing learning process, it provides opportunities for repeating and continuous learning cycles, and the students can start at the stage most suitable for their learning style. A good learning environment is like a buffet table where each learner picks the combinations most suitable to fulfill his/her appetite and nutritional needs.

A holistic, experiential learning environment enables vast opportunities for knowledge by exemplification (Chia & Holt, 2008). It does not mean disregarding knowledge gained by representation such as through lectures and exams. Lectures have their place and time. Some things are such that there is a need for the teacher's expertise in formulating, explaining, motivating, inspiring, simplifying, and story-telling, as well as answering. The way the teacher represents the information assigns value to it and increases or decreases the students' motivation toward it (Chia & Holt, 2008). Expertise does not breed on experience alone. Tapping into the expertise and wisdom of the "previous generations" or the lecturers adds value to the learning process.

Experiential learning environments such as the BSL (Blaylock et al., 2009) or the PE model bring the practical world to learning. IT systems add the concrete tools and the simulation creates action. Each of them acts as boundary objects and together they construct a boundary infrastructure. This is demonstrated here in the form of the artifact—the holistic business learning environment.

7.1 The artifact and the design principles

The key contributions of the dissertation are the artifact and its design principles. The practical outcome is the concrete artifact, or the instantiation, which combines the benefits of three earlier learning environments: the PE model, an ERP system, and a business simulation. It adheres to the criteria for a "rich environment for active learning" (Grabinger & Dunlab, 1995) by putting the learners in an authentic context of an SME business. It follows the principles of student-centered learning where a student constructs his/her own meaning supported by scaffolds and socio-cultural structures (Land et al., 2012). Each student can carry out Kolb's experiential learning cycle at his/her own pace as the cycle is repeated constantly and executed simultaneously to the theoretical learning. The participant teams act as knowledge-building learning communities (Lenning et al., 2013) that coach each other in the learning process.

Improvement design science research is evaluated based on how clearly it can represent and communicate the new artifact design (Gregor & Hevner, 2013). The conceptual and the technical design of the artifact are described in the integrative section of the dissertation as well as in articles II and IV. The connection to the learning communities and the curriculum are presented as the holistic business learning model in article III.

The artifact must be evaluated to provide evidence of what improvement it has achieved in comparison to current solutions (Hevner et al., 2004). The artifact was piloted and validated in real-life use. It was evaluated through the three domains of Bloom's taxonomy: cognitive, affective, and psychomotor. When compared to the earlier PE model, it improved the cognitive learning of the poor and average students. On the affective domain, the students were particularly motivated by the hands-on learning approach of the ERP system. The psychomotor learning was only measured within the ERP-supported learning environment, but the improvements in processing times gave clear indications of learning. The presentation needs to show how and explain why the new solution is different from the existing solutions (Henver et al., 2004). This analysis is presented in the discussion chapter of this dissertation.

Continued and expanded use also presents evidence of the artifact's worth. The artifact passed a semi-strong market test (Kasanen et al., 1993) as 2690 students in different UASs have used the learning environment over a period of nine years to date, and the use continues.

In addition to demonstrating the physical artifact, design science research should present other, more abstract artifacts such as the overall method description, the constructs, and the design principles (Kasanen et al., 1993).

This thesis presents a number of abstract artifacts that can be considered models (Hevner et al., 2004). Another main contribution of the dissertation is the learning environment structure and its design principles:

- A supply chain network forms the structure of the business environment
- The business interactions utilize automated information flows
- The information system structure is based on ERP II

The structure is not platform-specific. The design principles can be applied in different surroundings by creating

- integration between the different ERP companies through e-business methods (e-invoice, XML, EDI, etc.);
- reporting on the individual performance;
- simulation functionality such as automatic customer orders based on company performance; and
- the visible part of the business environment on web pages.

The conceptual model based on these design principles also proved its worth as it was used to construct a different learning environment utilizing similar components. Also, that learning environment was tested and used over two consecutive years.

Another abstract artifact is the holistic business curriculum model described in article III. Business curriculum integration has been debated for decades (Fenton & Gallant, 2016; Navarro, 2008; Porter & McGibbin, 1988; Rynes & Bartunek, 2013; Teece, 2011; Weber & Englehart, 2011). Different solutions have been offered ranging from the experiential learning environments to learning communities and curriculum structures. This dissertation brings a new perspective to that discussion by integrating these into one holistic model. The curriculum structure and the learning environment form a boundary infrastructure through which the different learning communities can interact, communicate, and form their own ways of learning. The tools and systems are only a small portion of a well-functioning learning environment. The students and the faculty play a critical role in successful implementation.

Gregor and Hevner (2013) identify four types of design science research contributions: new inventions, exaptations that extend known designs to new problems, improvements that develop new solutions to known problems, and routine designs. In this dissertation, the contribution can be classified as an improvement. A new solution is developed for the existing problem of making business learning more practical. The reasons for making the improvements are based on the ELT as well as on the earlier research on business learning environments and curriculum integration.

7.2 Contribution to business education research

Earlier research provides several examples of experiential business learning environments, often answering the question of what can be done. The questions of how and why are rarer. This dissertation provides answers to all three questions.

The contribution to the "what" question is the experiential learning environment that combines technology and learning communities in a novel way. The earlier examples of business simulations have concentrated on specific, isolated areas of business management such as strategic management, logistics, or sales (Clarke, 2009). There are some examples that have combined real-life tools such as the ERP system into a simulation (Léger et al., 2012; Legner, Estier, Avdiji, & Boillat 2013), but they have been used for short periods of time, for example, as stand-alone business games. The business education literature contains few examples of the extensive use of ERP systems in business education. The majority of the research on ERP systems in education is found in the information systems literature and it focuses on information systems education. In addition, this dissertation expands the scarce research on the PE model (e.g. Costea, 2010; Gramlinger, 2004; Riebenbauer & Stock, 2015; Santos, 2008) by comparing it to a more extensive ERP-oriented learning environment.

The research design of the dissertation provides a contribution to the "how" question. The business education literature review did not reveal any examples of business learning environments presented with a design science approach. Constructing a good learning environment is as much a pedagogical design as it is an IT design. The majority of the design decisions even in IT-oriented learning environments deal with the principles of business management and pedagogical approaches. Design science does not only belong to the information management domain, particularly when it deals with business education constructs. It should also be an area of discussion in business education research. This dissertation contributes to the artifact construction knowledge from a pedagogical and business learning perspective (Hevner et al., 2004) by describing the artifact development process and the lessons learned. The process and the artifact are presented in detail through a business pedagogy lens rather than from an IT perspective.

Another "how" question was how it can support the curriculum. Article III synthesizes Teece's (2011) dynamic capabilities framework, learning communities (Lenning et al., 2013; Levine & Shapiro, 2000), and the ERP-based experiential learning environment into a holistic business curriculum model, answering the call for an overall strategy for learning tools and scaffolds (Dillenbourg et al., 2009). The dissertation also fills the requirement for concrete examples and implementations of an integrated business curriculum (Jaiswal, 2015) and adds a new perspective to the earlier, short-term integrations of business curricula (Saraswat, Anderson, & Chircu, 2014), entrepreneurship curricula (Abbondante, Caple, Ghazzawi, & Schantz, 2014; Addams, Allred, Woodbury, & Jones, 2014), as well as information systems curricula (Ramesh & Gerth, 2015). The earlier research shows that many integration efforts have failed (Strempek et al., 2010). The learning environment constructed in this dissertation has prevailed for nine years, continuing to support the integrated curriculum. The dissertation concurs with earlier research (Caza et al., 2015; Ramesh & Gerth, 2015) in emphasizing the importance of people in a technical change: One of the success points of the implementation was organizing the coaches as a PLC. Their team played a key role in managing, communicating, and motivating the student teams in adapting to the learning environment.

The earlier research concentrates on what learning environments contain and whether learning takes place. There is little research into why they work. The dissertation answers that question by viewing the learning environment as a boundary infrastructure. This expands the business education research stream and brings a business learning perspective to the boundary object research stream (e.g.

Akkerman & Bakker, 2011; Aprea & Cattaneo, 2019; Dillon, 2008; Münster, Kröber, Weller, & Prechtel, 2016).

The dissertation also contributes to developing business education assessments by introducing the idea of formative assessments utilizing log data of the IT-oriented learning environments; namely, simulations and ERP systems. The majority of the assessments in business education are still summative and there is a need for more ways to support the learner, intervene, and give feedback already during the learning process. Learning management systems track and report progress data, but they tend to focus on statistics and visualizations rather than on assessment and feedback (Chatti, Dyckhoff, Schroeder, & Thüs, 2012). Simulations and ERP systems are rarely utilized even for that. And yet the log files provide data about the behavior change in the form of processing time, errors, and other indicators. They do not replace any other existing forms of analysis, assessment, or feedback, but provide yet another angle to them.

Assessment strategies have received little attention even though they are an important part of the learning experience in business simulations (Vos, 2015). This dissertation contributes to that discussion with a lesson learned from the learning environment implementation project: Assessment planning needs to be part of the learning environment design from the very beginning. When learning and assessment strategies are planned together, the assessment becomes a natural part of the simulation and the infrastructure can be built to support the assessment activities.

7.3 Contribution to information systems research

The main contribution to information systems research is the artifact and its design principles, which can be applied in different surroundings. The literature review did not reveal any business learning environment studies undertaken with a design science approach where the construction and the design principles were described in detail. Business simulations and ERP research (e.g. Anderson & Lawton, 2009; Clarke, 2009; Léger et al., 2012; Schwade & Schubert, 2016) have focused on how the learning environments are used and how they improve learning rather than on how they are constructed. Often, the researched simulations are commercial (Clarke, 2009; Faria et al., 2009; Markulis et al., 2015). The dissertation provides a multi-dimensional perspective to the artifact: the theoretical base for the construct, the technical and conceptual construction, the connections to the pedagogical and curricular processes, and the evaluation. All these perspectives bring new insights into developing educational information systems. The design principles are generalizable.

The earlier research on the educational use of ERP systems has focused on information systems education. This dissertation contributes to the knowledge of using ERP systems in business education. Also, research on educational ERP system usage concentrates heavily on large, proprietary ERP systems such as SAP (Ayyagari, 2011). Previous research on educational open-source system usage is scarce (Jewer & Evermann, 2015).

This dissertation contributes to the information systems research stream by presenting a simulation that is built onto an existing open-source ERP system. It provides the design principles and the theoretical reasoning for them. The simulation functionalities are built into the ERP system in a novel and creative way. There is little additional programming required for the simulation logic or algorithms. The majority of the simulation consists of normal ERP business logic used in a creative way. For example, the simulated consumer market is actually one business corporation in the ERP system consisting of hundreds of sub-companies. The administrator runs the simulation with standard ERP system tools. The simulation utilizes the electronic data-transfer functionalities used by real companies in their e-invoice and bank transactions. The ERP system's standard reporting is utilized for assessment purposes. The profit and loss reports indicate business activity and success.

ERP-system and business simulation research has not previously contained web stores, bank transactions, or tax management. This dissertation expands the information systems research to include simulation functionalities that involve practical transactions in the external business environment.

New evaluation methods are considered as contributions to the design evaluation knowledge (Hevner et al., 2004). Bloom's taxonomy is a widely used theory to assess learning objectives in experiential business learning environments. The main focus in the previous research has been on the perceived cognitive learning or attitudes toward the learning environment (Anderson & Lawton, 2009). Anderson and Lawton (1998) have presented a set of methods to assess different levels of cognitive learning in business simulations. Article V expands that view by synthesizing the earlier research and providing a set of methods for assessing learning in the affective and psychomotor domains. The previous studies have usually evaluated business learning environments through one of Bloom's domains (Anderson & Lawton, 2009). Providing an example to assess the learning environment from all the perspectives of Bloom's taxonomy offers another contribution to the design evaluation knowledge.

Article V also contributes by suggesting a new evaluation method: The use of ERP system log files as a basis for the learning environment evaluation. In addition, the earlier simulation and educational ERP research (Anderson & Lawton, 2009; Clarke, 2009) has focused on evaluating the systems rather than on assessing the student's learning. Article V makes a contribution by suggesting the use of log files for assessment purposes, particularly for formative assessment.

Another contribution of the dissertation is the description of the development process, which has also been rarely presented in earlier literature. With its structure and lessons learned, it provides a practical benchmark and an example, encouraging other researchers and developers to proceed with open-source alternatives (Ayyagari, 2011; Huynh & Chu, 2011; Jewer & Evermann, 2015). It describes the benefits of an open-source ERP system platform, which was flexible and allowed for very creative solutions. It also describes the challenges of minimal support and documentation. The open-source environment enabled the customization of the ERP system, as well as enabling embedding versatile functionalities and additional features. It did not require heavy investments in the licenses nor in the infrastructure. On one hand, it required much effort, trial, and error from the development team. The open-source solution was found to be practical, as it allowed agile development with little investment or heavy decision-making. On the other hand, the development was highly dependent on the development team's enthusiasm. The development was run by a small number of individuals in the development team. The documentation and the technical support for the open-source platform were virtually non-existent. The team developed the critical technical and pedagogical know-how behind the system both for the core open-source ERP system as well as for the additional functionalities of the simulation.

This dissertation also contributes by bringing forth the lessons learned from the project. One big lesson was that the assessment, the curriculum, and the learning environment should be designed concurrently. When assessment is built into the system afterwards, the results are not as good as if it had been considered early in the design process. There were also many lessons learned from the implementation. Similarly to an ERP-implementation project, the big challenges are not technical. They involve commitment, processes, and people. Good, clear communication and clearly assigned roles are important success factors in a learning environment implementation. Motivation to utilize the learning environment calls for constant attention as well as a fair share of imagination and creativity.

7.4 Practical implications

The prototype was taken into permanent use and continues to be the core of the first-year business studies in TAMK, nine years after the initial implementation. It has been expanded from business undergraduate studies to cover the international business curriculum of TAMK. Similar learning environments have been set up in different educational institutions in cooperation with TAMK. Some utilize the same infrastructure as the ERP simulation but present the learning environment from their own perspective through their own websites and cooperate on business activities and learning exercises. Others have their own infrastructure on the same platform.

The design principles have also been successfully applied in another university by constructing the learning environment around a different open-source ERP system using the same ERP II and logistics network structure. That business learning environment integrated the first-year business and information management students into learning communities that learned entrepreneurship and basic business skills by operating fictional companies.

When the different learning environments follow the overall structure of the supply network, define the integration points, and agree on the communication methods, they can create a network of simulated companies that goes beyond one educational unit. It would be possible to create a limitless world of interacting business environments.

The artifact holds potential for an international application, if it is implemented on an ERP system that has multi-language and multi-country procedure support. TAMK has expanded their learning environment to Brno in the Czech Republic. The environment itself can be translated into any language. The restricting factors on the operability of the environment are associated with taxation, labor laws, and other country-specific features.

7.5 Validity of the research

Unlike in quantitative research, threats to validity are difficult to eliminate beforehand in qualitative research. Therefore, they should be ruled out by a more rigorous examination and supportive evidence. Maxwell (1992) offers five aspects of validity for qualitative research: descriptive validity, interpretive validity, theoretical validity, generalizability, and evaluative validity. He considers the first three as the most central to qualitative research.

Descriptive validity indicates the factual accuracy of the data (Maxwell, 1992). The researcher may not misinterpret the data he/she has received. The data have to be presented in the form that they were gathered from the source. All the data that were used to evaluate learning were collected in written format directly from the students, rather than seen or heard, so there was no room for misinterpretation. The first cognitive learning test was carried out with pen and paper and the latter two tests were done on a Moodle learning platform. The affective learning material was collected with a web questionnaire. The data for the psychomotor learning was collected directly from the ERP system log files. In addition, the generic university feedback system was analyzed for feedback on the learning environment.

The coach perspective was gathered with a web questionnaire. In addition, there were 29 weekly meeting memos that were taken by an administrative assistant and reviewed in the consecutive week by all the attendees of the meeting.

Maxwell (1992) defines interpretive validity as the meanings that the research setting, including people, events, and behaviors, have to the participants of the study. This type of validity has no equivalence in quantitative research. These meanings are constructed from the data and other evidence by the researcher. One challenge of interpretive validity is that the researcher interprets the data to get the desired results. This is a valid concern, as the researcher of the dissertation was also the developer as well as one of the coaches, and, as such, a part of the phenomenon being studied. This was addressed by relying on the data for the learning results. When the data needed to be assessed and evaluated, such as in the first cognitive learning test where open-ended questions were graded manually, the grading was based on an *a priori* set of ideal responses and graded by two different people in both years. The second- and third-year learning tests were multiple-choice tests that were graded automatically by the Moodle learning system tools. The learning test questions were validated with an item analysis (Livingston, 2006).

Affective learning was assessed by a Likert-scale survey and open-ended responses. The open-ended responses were analyzed for frequently repeated concepts.

Theoretical validity refers to the appropriateness of the outputs such as constructs, or theories drawn. The earlier research on experiential learning environments, particularly on the information systems field, has been criticized for a lack of rigor. The research has been based on subjective measures such as self-assessments or questionnaires, or it has studied learning from a restricted perspective, focusing only on some areas of learning (Anderson & Lawton, 2009). This dissertation used learning tests as objective measures to assess cognitive learning and evaluated learning on all Bloom's domains.

Another source of criticism has been a lack of control groups or comparing groups that learn via different modes of learning (Anderson & Lawton, 2009; Monk & Lycett, 2016). When IT is evaluated for improvements in learning, the comparisons must be made within the same learning model instead of comparing one model of learning with technology to another model of learning without technology (Leidner & Jarvenpaa, 1995). The models of learning refer to the mindset, such as the objectivist/behavioral, constructive, or collaborative models that are each based on different philosophies and approaches. One cannot evaluate the effect of the learning environment or the tools if there are also variables in the learning model. Also, there have been criticisms that the learning has been evaluated after or during a short period of time (Monk & Lycett, 2016).

To address Leidner and Jarvenpaa's (1995) concern about the different models of learning, the evaluation was done by comparing the ERP-supported business learning environment to the earlier PE model. The target of the study was the total population of first-year students. The model and the setup were very similar. The curriculum structure was the same and approximately 70% of the teachers were the same in both years. The main differences were ERP simulation and the processes and improvements to implement that. It can be argued that the research settings still varied. However, constructing a large-scale research setting where the circumstances remain exactly the same is challenging in concrete day-to-day university studies.

Generalizability indicates the extent to which the findings of the research setup can be generalized to a larger population. Qualitative studies are not usually designed for systematic generalizations and transferability may be a more appropriate term (Guba, 1981). It refers to the extent to which the findings can be applied in other situations (Merriam, 2002). Rather than trying to find generalizations, what should be considered is what can be learned from the analysis of a specific situation and how that knowledge can be transferred to another situation (Merriam, 2002). The aim of the study was to create an example of how an experiential learning environment could be constructed. The experiences from the design principles, the construction process, the artifact, and the increased understanding about curriculum integration, and the use of log files in assessing learning can be transferred to other educational contexts. The results of this dissertation, the artifact and the design principles, have been proven to be transferrable to other situations and organizations.

The original aim of the dissertation was not to measure if and how experiential learning environments improve learning. Instead, the aim was to find out how a learning environment could be constructed to support the needs of contemporary business learning. The earlier research was synthesized to construct a new learning environment. The learning results study focused on evaluating whether the new artifact actually did cause improvements to the existing situation. As such, the research setup was not designed for generalization and the learning results are not generalizable to a wider population. However, during the course of the research, the dissertation developed a generic model of the business learning environment based on the ERP II and supply network principles. This can be reconstructed and studied in other contexts. Another abstract artifact that can be transferred to different surroundings is the holistic business curriculum model.

Evaluative validity refers to applying an evaluative framework to the objects of study (Maxwell, 1992). In this dissertation the artifact was evaluated through the learning results study. There are, however, limitations to this perspective: The cognitive learning assessment focused on the lower levels. The final exam was only identified afterwards as a potential assessment for higher cognitive levels. As the exam was intended for grading purposes rather than learning environment evaluation, it has limited validity as an evaluation tool. Further research on higher levels of cognitive learning as well as other Bloom domains would be needed. The measurements should be designed and constructed simultaneously to developing the learning environment.

In the artifact, the log files were used to evaluate psychomotor learning. Their validity is limited due to the challenges in the research setting. The log files were only identified as a potential learning measurement afterwards. As the measurements were not considered in the design process, the research had to utilize the data that were available from the ERP system's standard log files. They only provided a basis for indications of learning rather than material for deep analysis.

As the learning results provide for a limited perspective, the artifact and the design principles were also evaluated from the perspective of validity and utility (Gregor & Hevner, 2013). The pragmatic validity (Krippendorff, 2006; Worren et al., 2002) was evaluated with a semi-strong market test (Kasanen et al., 1993).

7.6 Suggestions for further research

This dissertation indicated some suggestions to study psychomotor learning through the ERP system's log files. There are many potential research areas in the log file analysis. Students' logs could be compared to the average time spent on tasks and potential learning challenges could be detected. Error logs could provide information about where the students need assistance. The processing times of more complicated processes that involve many students could provide interesting insights into team behavior and learning. The activity in the simulation does not necessarily result in learning (Gosen & Washbush, 2004). This could be further studied by comparing the student's log file performance to the learning outcomes measured with traditional, external assessments.

The evaluation of learning outcomes lacks rigor if the tools do not provide adequate amounts of reliable data. The measurements should be designed simultaneously with the learning environment to enable reliable data collection. Development on how to build assessment methods for both the evaluation of the learning environment as well as the summative and formative assessment of the learning process and outcomes would benefit from additional research in this area.

The holistic curriculum model can be implemented in different disciplinary learning contexts. The combination of the curriculum structure, learning communities, and a physical learning environment is an idea that would be worth studying in other disciplines as well.

The coaches and their PLC are critical for the success of this type of learning environment. Further research on their role and influence as the learning facilitators would be interesting. Another interesting topic would be the transition from a teacher to a coach, and more widely, the transformation of the educational organization to support such a transition.

The operability of the learning environment relies heavily on the functionality of the SLCs. The team functionality, workload division, and other teamwork elements would be another interesting research topic.

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PUBLICATIONS

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ERP-based simulation as a learning environment for SME business

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A B S T R A C T

Small and medium size enterprises (SMEs) lack an adequately skilled workforce and managers, since university education generally focuses on large enterprises and their needs. Complementary skills needed by SMEs have been of lesser interest even though several approaches, methods and environments could be utilized. For example, enterprise resource planning systems, business simulation games and practice enterprise models all support the learning of complementary and practical skills the SMEs desperately need. Yet all these learning environments are problematic as they approach business phenomena from narrow viewpoints. In this paper, we present a learning environment that merges these three environments so that they complement each other, allowing the learning of the daily management of SMEs. In this way future employees are better equipped when they enter the labour market, being ready to contribute to the business of SMEs.

1. Introduction

Small and medium size enterprises (SMEs) are major employers and contributors to the market economy (European Commission, 2010; McGibbon & Moutra, 2009). Small businesses also often drive innovation and change (Kelley, Bosma, & Amóros, 2010). Under these circumstances the SME sector has been seen as "decisive for the future prosperity of the EU" (Commission of the European Communities, 2008; see also Robertson, 2003). Such prosperity is actualized in China and its phenomenal growth led by SMEs (Li, Zhang, & Matlay, 2003).

The expanding SME sector has a need for competent management. Future SME managers and also employees, need to have

> "transversal and generic skills [that] will be increasingly valued on the labour market: problem solving and analytical skills, self-management and communication skills, the ability to work in a team, linguistic skills and digital competences." (European Commission, 2008).

Management educators have also brought up the need for cross-functional integration in the business school curriculum (Crittenden & Wilson, 2006; Seethamraju, 2007). Yet it is argued that higher education institutions are not equipping their graduates with adequate skills that companies, specifically SMEs, require from their managers (Holden, Jameson, & Walmsley, 2007; Martin & Chapman, 2006).

According to Grabinger and Dunlab (1995), effective learning requires rich knowledge structures with many contextual links to help learners address and solve complex problems. They argue that it is not easy to transfer learning between people. Instead, learning is more likely to be transferred in rich, complex learning situations where learners take an active role in forming new understandings. Their learning is a collaborative process into which the learners bring their own needs and experiences. Skills and knowledge are thus best acquired within realistic contexts where the learners can rehearse and learn the outcomes that are expected of them under realistic conditions.

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A learning environment is a combination of physical surroundings, psychological or emotional conditions, and social or cultural influences affecting the learner in an educational enterprise (Hiemstra, 1991). Grabinger and Dunlab (1995) define "rich environments for active learning" as comprehensive instructional systems that promote study and investigation within authentic contexts and cultivate an atmosphere of knowledge building learning communities. Such environments utilize dynamic, interdisciplinary learning activities that promote high level thinking processes through realistic tasks and performances.

In this paper, we will present a learning environment that supports the learning of the practical management skills needed in SMEs. It is based on experiential learning theory, which assumes that knowledge cannot be transferred from teachers to learners. Instead, learning is an active social process where knowledge and meanings are created by the learners and their interpretations and experiences of the world, and by their interactions with other people. Experiential learning further views learning as a continuous cyclical process with four steps: concrete experience, observing and reflecting that experience, forming abstract concepts and generalizations from the observations, and experimentation with new hypotheses (Kolb, 1984).

Several learning environments have been utilized in business education for providing practical skills. Enterprise resource planning (ERP) systems are widely used to support experiential learning (Davis & Comeau, 2004; Hayen & Andera, 2006; Jensen, Fink, Møller, Rikhardsson, & Kræmmergaard, 2005; Johnson, Lorents, Morgan & Ozmun, 2004; Targowski & Tarn, 2006). Business simulation games are used both in conjunction with ERP systems and as separate teaching environments (Faria, Hutchinson, Wellington, & Gold, 2009). Also another experiential learning environment, the practice enterprise model, aims at teaching entrepreneurship skills through a business-to-business network where the learners run simulated SME companies (Kallio-Gerlander & Collan, 2006). In this paper we suggest that these three learning environments should be combined to support the development of practical skills needed for managing SME business processes.

The paper is organized as follows. It starts by describing a profile of industry-relevant business competencies. Next, it gives an overview of the three learning environments and their learning objectives: educational ERP system implementations, business simulation games and the practice enterprise model. The paper continues by introducing the integrated learning environment that combines the three described environments into a single learning environment. Finally, the paper presents an example where the integrated model is used. The paper ends with discussion and limitations.

2. Profile for SME business competences

Jackson (2009) has summarized industry related competence requirements for business graduates. Fernald, Solomon, and Bradley (1999) have identified the skills that SME managers need in their works. Particularly for SME, their requirements underline the importance of hands-on marketing, financial management and procurement, while accounting, international trade and human resource (HR) skills are of lesser importance. A synthesis of Jackson's and Fernald's findings is presented in Table 1.

These requirements are well aligned with the other business skill requirements (European Commission, 2010). However, there is a gap between what is expected by SMEs and what is taught by the universities. This is conceptualized to be the issue that graduates need to be productive immediately after they get their degrees, while in larger companies they can be trained. Small companies do not have the infrastructure to organize training and personal development for prospective employees, but those skills need to be provided by universities (Woods & Dennis, 2009). Hence, as Westhead and Matlay (2005) state, SMEs are reluctant to hire business graduates because of the cost and work suitability, the extensive need for assistance and supervision, and concerns regarding their lack of flexibility and practical skills.

Martin and Chapman (2006) argue for a specialized SME syllabus that would improve skills in business management, marketing, finance, production, IT and HR management. These kinds of multi-management skills would especially be needed in the micro-business sector with very limited resources. In addition to management skills, SME owner-managers emphasize attitude, communications and interpersonal skills, motivation and self-management, the ability to network, and practical experience. According to McLarty (2000), SME managers implied that

> "personal attributes took the graduate to a certain level of acceptability, but business skills made the graduate employable" (p. 621),

thus emphasizing the disciplinary expertise in Table 1.

3. Business learning environments

In this section we will review three different learning environments that address the learning objectives identified earlier.

3.1. ERP systems as a learning environment

The utilization of ERP systems in business learning began in the late 1990's (Becerra-Fernandez, Murphy, & Simon, 2000; Bradford, Vijayaraman, & Chandra, 2003). ERP systems and simulations based on them are often used in teaching supply chain management, marketing, HR, and accounting (David, Maccracken, & Reckers, 2003; Hawking, Foster, & Bassett, 2002;

Table 1
Profile for SME business competencies (adapted from Jackson, 2009 and Fernald et al., 1999).

Requirement	Description
1. Task requirements	
Application and use of technology (IT, etc)	Basic IT skills, the ability to use technology interactively
Problem solving	Using knowledge and facts to solve workplace problems
Decision management	Ability to make decisions in a business context using available information, bringing a multidisciplinary approach to decision making and making decisions under pressure
Operating in organisational environment	Understanding of corporate culture and the employee's role in the organisational environment
Multi-tasking	
Project management	
Meeting management	
Coaching	Instructive feedback, ability to help others learn
2. Core competencies (personal characteristics)	
Ethics and responsibility	Understanding of ethical and professional behaviour, commitment to professional values in practice, maintaining integrity, trust and respect for diversity
Written communication	
Information management	Capacity to access and research information, ability to use knowledge and information interactively
Operating globally	Global awareness of cultures and economics, language skills, international trade knowledge
Intellectual ability	Ability to diagnose problems, find alternative solutions
Numeracy	Ability to use numbers at an appropriate level of accuracy
Lifelong learning	Continuous professional learning, capacity for reflection on practice, willingness to learn from others
3. Disciplinary expertise	
- Marketing	Increasing sales, promoting business, market research
- Financial management	Financial analysis and control, obtaining capital, etc.
- Procurement	Obtaining contracts, inventory management
- Accounting	
- HR	
- Litigation and tax law	
- Risk management	
- Quality management	
- Integration of disciplines	
Business acumen	
Work and life experience	Understanding key drivers for business success
Professionalism, work ethic, accountability	
4. Distinguishing competencies (personal characteristics)	Effective and structured work habits
Oral communication	
Team- and interpersonal skills	
Organisational skills	
Continuous improvement management	Goal-focus, time and priority management, coordination of activities
Meta-cognition	Ability to identify opportunities for improvement and to give effective feedback
Cultural and diversity management	General strategies for learning, thinking and problem solving, self-awareness, reflection
Autonomy, self-efficacy	Ability to learn from and collaboratively work with individuals representing diverse cultures, races, ages, gender, religions, lifestyles, and viewpoints
Critical thinking	Ability to defend and assert one's rights, interests, responsibilities and needs, ability to work without supervision, to accurately understand one's own identity and personal capabilities
Leadership skills	
Adaptability & change management	
Emotional intelligence, political skill, reliability	Openness to new ideas, capacity to learn and change, flexibility
Stress tolerance	Self-awareness, social awareness, self-management and relationship management, the ability to effectively understand others and to influence others' behaviour to enhance one's personal and/or organizational objectives
Attention to detail	
Entrepreneurship	
Creativity	Vision, adaptability, persuasiveness, confidence, competitiveness, risk-taking, honesty, perseverance, discipline, organisation and understanding Demonstration of originality and inventiveness, communicating new ideas to others, integrating knowledge across different disciplines

Hawking, Ramp, & Shackleton, 2001; Seethamraju, Leonard, & Razeed, 2006; Shoemaker, 2003; Springer, Ross, & Humann, 2007; Strong, Fedorowicz, Sager, Stewart, & Watson, 2006). Many ERP system providers, such as SAP, have thus implemented university alliance programs, where they provide software and support, as well as access to materials at reasonable or no cost (Bradford et al., 2003; Nelson, 2002; Rosemann & Maurizio, 2006; Winkelmann & Leyh, 2010).

ERP systems are utilized as an integrating factor for the whole curriculum (Antonucci, Corbitt, Stewart, & Harris, 2004; Cannon, Klein, Koste, & Magal, 2004; Hayen & Andera, 2006; Jensen et al., 2005; Johnson et al., 2004). Joseph and George (2002) suggest ERP systems can be combined with learning communities, where students and faculty are organized into smaller cross-functional groups to work on specific issues. These learning communities form a learning environment that could decrease the redundancies between functional areas and enable the students to obtain a more complete understanding of business processes. Rather than being just tools, ERP systems correspondingly have the potential for more effective pedagogy and new pedagogic innovations.

The main learning objectives in ERP system learning environments are business process orientation, improved understanding of business functions and their integration, increased understanding of enterprise systems and improved IT skills (Davis & Comeau, 2004; Hawking, McCarthy, & Stein, 2004; Targowski & Tarn, 2006). This is often concretized through ERP-based simulation games, which focus on creating situations for managerial decision making (Draijer & Schenk, 2004; Hajnal & Riordan, 2004; Léger, 2006; Pittarese, 2009; Shtub, 2001; Wagner, Najdawi, & Otto, 2000). Seethamraju (2007) describes the key learning objectives of an ERP-based simulation game as the following: to develop business process orientation, to teach ERP skills, and to provide business students with an authentic and exciting student-centred learning experience that is integrative and motivates them to learn. The aim is to offer students an information-rich environment, where the graduates work in groups and make day-to-day managerial decisions.

As noted, ERP systems are found to be useful in learning business processes. For instance, learners learn IT skills that are required in business life and get a feel for the business environment (Jensen et al., 2005). The learning experience puts the learner at the centre and gives hands-on experience (Nelson, 2002; Noguera & Watson, 2004). For example, learning SAP software skills with hands-on work on industry-standard software was considered a better learning experience than a routine theoretical teaching of ERP systems (Hawking et al., 2004). Yet the complexity of large ERP systems makes it hard to understand the links between information, business processes, and managerial decisions, and further to distinguish the differences between the limitations of the software functionality and key managerial requirements (Seethamraju, 2007). This, and the fact that ERP system adaptation in SMEs is low compared to large companies (Buonanno, 2005), also shapes enterprise systems education in universities. For instance, Ask, Juell-Skielse, Magnusson, Olsen, and Päivärinta (2008) suggest that smaller mid-market enterprise systems should be used as learning environments instead of large enterprise-wide systems. This would then also support SMEs with limited resources, as their ERP systems are also smaller, cheaper and less complex than ERP systems used by large companies.

Despite the benefits of ERP systems in education, their focus on companies' internal operations, systems, and processes (Davis & Comeau, 2004) is limiting. They lack the external connections to other companies that are important for SMEs operating with limited resources. Also people skills are not emphasized in ERP system learning environments. Thirdly, learning with ERP systems is usually carried out with pre-planned cases and exercises (Bradford et al., 2003). Learning situations tend thus to be static and predictable, not mirroring the dynamics of real-life business situations.

3.2. *Business simulation games*

Business simulation games are open-ended evolving situations that have many dependable variables. The goal for all participants is to take a role and react to emerging situations. As these are games, their objective is to win (Gredler, 2004).

Business simulation games have built-in rules and roles that support the learning of real-life-like situations without real-life risks (Leemkuil, de Jong, & Ootes, 2000). The learner is a functional component of the game and takes responsibilities in a fluid situation. Business simulation games are simplified mathematical abstractions of business situations or sequential decision making exercises of different business operations, some focussing on top management decision making. They are based on business administration theories (Goosen, Jensen, & Wells, 2001).

Business simulation games can be classified as 'top management' games, functional games and concept simulations (Wolfe, 1993). 'Top management' games approach business operations as management activities. They emphasize strategy formulation and management decision making rather than learning the day-to-day activities on a practical level (Faria et al., 2009). Functional games focus on specific business functions on a tactical and operational level, while concept simulation games cover only a few business operations. Fortmüller (2009) lists the general learning objectives for business games:

1. the ability to use already acquired specialized knowledge in specific problem situations
2. the ability to combine activities acquired separately into a systematic sequence of action
3. the ability to reconstruct basic correlations and processes, and
4. the ability to assess the interactions and consequences of an individual's and others' activities.

These objectives correlate with the competences described in Table 1: problem solving, decision management, operating in an organisational environment, information management, intellectual ability, critical thinking, emotional intelligence, and creativity. Additional objectives are business ethics (Teach, Christensen, & Schwartz, 2005), stress tolerance, and time management (Lainema, 2003).

The main challenge of business simulation games is their complexity. In fact, in order to introduce uncertainties, risks and reality, they need to be complex. On the other hand, when the level of complexity increases, they become difficult to manage and play. Thus, a balance between these has to be found, though the simulations often tend to be overly simplified models of reality (Goosen et al., 2001). Also, business simulation games contain pre-planned scenarios that are based on some business theories. The choice of which theories the simulation game is built on may thus give different learning outcomes (Goosen et al., 2001).

Business simulation games simplify the management of time. Instead of focussing on a continuous flow of events, there are "business episodes" where the decisions are made. Activities may take place "once a month", which does not resemble the ideal of "react to the existing situation" (Lainema & Makkonen, 2003). Also, several years might be compressed into a few months. On the one hand, this kind of fast-tracking puts pressure on the learners. On the other hand, it reduces the feeling of reality. From this perspective, the games should adapt the day-to-day character of continuous processing and decision making.

In many business simulation games, the learners and their businesses are competing instead of having mutual business transactions. Here, the interactions mainly take place with the game engine. Interactions take place within one team but rarely between the teams, thus decreasing the chances for irrational and unexpected events triggered by human behaviours.

3.3. Practice enterprise model

A practice enterprise (also known as a practice firm, training firm, virtual enterprise, virtual business) is a mixture of experiential learning and role-playing. Its central concept is a virtual company that resembles a real one in its form, organization and function, but without monetary transactions or exchange of physical products. The enterprise trades with other enterprises and manages its internal activities and processes (Europen, 2010; Gramlinger, 2004; Miettinen & Peisa, 2002).

Practice enterprises are run by a team of learners and guided by an instructor. The instructor cooperates with the practice enterprise centre that provides the infrastructure (banks, tax office, electricity providers, etc.). The learners and instructors create learning situations dynamically. For example, the instructor can utilize the infrastructure provider to create unexpected situations such as customer reclamations to student companies, expecting appropriate reactions and responses (Collan, 2006; Kallio-Gerlander & Collan, 2006).

The practice enterprise model aims at understanding SMEs and entrepreneurship in general (Costea, 2010; Gramlinger, 2004; Santos, 2006). The model gives the learners an opportunity to apply their knowledge in practice, and take responsibility for finding solutions to emerging problems (Peltonen, 2008). Human interaction within the team and between the teams aims at developing interpersonal skills (Kallio-Gerlander & Collan, 2006). Practical issues such as running the business operations enable learning not only about different disciplines and business processes, but also how they are integrated (Costea, 2010). Emerging unpredictable events illustrate risks and how they are managed as well as practice problem solving and stress tolerance (Kallio-Gerlander & Collan, 2006).

Yet the practice enterprise model also has its challenges. It is highly dependent on the participants and their skills and activity levels. The amount of trading varies both in quality and quantity (Gramlinger, 2004; Santos, 2006). Consumer markets and raw material markets are missing, making most practice enterprises business-to-business companies that trade with each other (Miettinen & Peisa, 2002; Tramm & Gramlinger, 2002). Due to the lack of action, the network starts to lose momentum, reducing the learners' motivation.

The infrastructure lacks credibility. This is because infrastructure providers do not have enough resources to support extensive, realistic business environments. The learners lose the sense of reality and serious engagement with the work. They know that they are playing, being free to make unconstrained solutions.

The practice enterprise model also presents challenges to the instructor. Since the company operations are carried out manually, the instructor has to rely on the information that is reported by the learners. Those reports mirror the learning situation and what has been learnt. They do not necessarily correspond with the reality as they illustrate the learners' stories and their interpretations of the actual situation. Those stories might be genuine or fake, depending on the learners' motivations and intentions. This discrepancy may, for example, lead to a situation where the company sells goods that it does not possess or provides services without an adequate workforce.

4. ERP-based business learning environment

Learning with ERP systems tends to be software-centric, and focuses only on the company's internal processes. Business simulation games interact with an (artificial) outside world, but their interactions are quite limited and the dynamics of day-to-day business operations are missing. The practice enterprise model provides a network of other companies run by real people, but lacks both the momentum of business simulation games and the visibility of learner actions that are provided by ERP systems and business simulation games. Table 2 illustrates the relationship between the learning objectives of these environments and SME business skills.

Consequently, an improved learning environment can be formed by combining the best features from these environments (Nisula, 2012). This aggregate is presented in Fig. 1. The external layer of the learning environment presents a fictitious market area with a bank, wholesalers, infrastructure providers and government authorities operated by a systems administrator. This is represented through the web pages. Teams of learners operate simulated "student companies" in this environment. They trade with each other and with the administrator-run companies. The "student companies" manage their finances in an online bank and their internal operations in a small scale ERP system which forms the internal layer of the environment. The

Table 2
ERP, business game and practice enterprise and their learning objectives compared to the SME skill requirements.

	ERP	Business game	Practice enterprise
Task requirements			
Application and use of technology	Increased understanding of enterprise systems and improved IT-skills (Davis & Comeau, 2004; Jensen et al., 2005)		
Problem solving		Ability to use already acquired specialized knowledge in specific problem situations (Fortmüller, 2009)	Ability to resolve problems (Kallio-Gerlander & Collan, 2006) "[Ability] to supply adequate and coherent solutions for the needs of real companies" (Costea, 2010)
Decision management	Day-to-day decision making (for ERP-simulation game in (Seethamraju, 2007)	Decision making on enterprise or functional level (Goosen et al., 2001)	
Operating in organisational environment	Knowledge and understanding of business processes (Noguera & Watson, 2004)	Understanding company and industry's problems and opportunities (Lainema, 2003)	A more substantial understanding of business processes (Deissinger, 2007)
Multi-tasking			"[Ability] to decide and take on daily responsibilities in the finding of solutions for real day-to-day problems" (Costea, 2010)
Core competencies			
Ethics and responsibility		Sense of moral rectitude (Teach et al., 2005)	
Information management	Understanding how enterprise information is processed (Noguera & Watson, 2004)		
Operating globally	Understanding of the business processes and transactions that are carried out in the global business cycle (Jaeger, Rudra, Aitken, Chang & Helgheim, 2011)	International business (Thorelli, 2001)	
Intellectual ability, numeracy		Ability to combine activities acquired separately to a systematic sequence of action (Fortmüller, 2009)	Ability to resolve problems (Kallio-Gerlander & Collan, 2006)
Disciplinary expertise - Marketing - Financial management - Procurement - Accounting - HR - Litigation and tax law - Risk management - Quality management - Integration of disciplines	Several functional examples presented in the book Enterprise education in the 21st century (Targowski & Tarn, 2006)	A functional simulation's objective is to learn about a specific business function such as marketing, production or finance. (Faria et al. 2009)	Economic, business and technical skills (Gramlinger, 2004). Overview of the various departments, performing the tasks that each job requires (Costea, 2010)
Business acumen			"Understanding the final cohesion between means and ends" (Costea, 2010)
Work experience, life experience		Ability to reconstruct basic correlations and processes (Fortmüller, 2009)	Attitude towards work, job-readiness (Gramlinger, 2004)
Distinguishing competencies			
Team- and interpersonal skills		Ability to assess the interactions and consequences of an individual's and others' activities (Fortmüller, 2009)	Ability to work in groups (Kallio-Gerlander & Collan, 2006). Behavioural skills, whether inside the practice firm, or in dealings with other practice firms (Costea, 2010)
Organisational skills	Capability to see beyond the individual process or problem and view the issue holistically (Jensen et al., 2005)		Arganisational abilities and skills (Gramlinger, 2004). Ability to manage work (Kallio-Gerlander & Collan, 2006)
Cultural and diversity management		International business skills (Thorelli, 2001)	Social skills (Gramlinger, 2004)
Autonomy, Self-efficacy			"Students as groups are responsible for their own success." (Collan, 2006)

Table 2 (*continued*)

	ERP	Business game	Practice enterprise
Critical thinking		Ability to reconstruct basic correlations and processes (Fortmüller, 2009)	
Leadership skills		Social relationships (Lainema, 2003)	Social and organisational abilities and skills (Gramlinger, 2004)
Adaptability & change management		Ability to reconstruct basic correlations and processes (Fortmüller, 2009)	Ability to work under uncertainty (Kallio-Gerlander & Collan, 2006)
Emotional intelligence; Political skill, reliability		Social relationships (Lainema, 2003)	Social and organisational abilities and skills (Gramlinger, 2004)
Stress tolerance		Time management, working in today's dynamic world (Lainema, 2003)	Ability to work under uncertainty (Kallio-Gerlander & Collan, 2006)
Entrepreneurship			Entrepreneurship skills, entrepreneurial attitude (Kallio-Gerlander & Collan, 2006)

instructor may monitor the student companies' activities and business success through the reporting tools in the ERP system. The internal layer also contains a business game element that creates momentum by generating consumer demand. The system layer consists of the data traffic caused by transactions between the companies.

The above-described environment resembles a practice enterprise model which is running on an ERP system. Yet it does not guarantee a sufficient number of activities. The learner dominated business-to-business network thus necessitates a consumer market. This is provided by a business game element that creates automated consumer demand. Optimally, the automated consumer demand launches a sequence of events in the student companies' value chain. For example, a game-generated order of printed T-shirts makes the printing company order T-shirts from a retailer, which in turn needs to buy the shirts from a clothing factory, which buys the material from a textile factory. This kind of chain of routine business operations forces the participants to repeatedly go through a concrete, experiential learning cycle.

Our proposed learning environment differs from a traditional business simulation game, as there are no pre-planned scenarios. The learning situations are built by the instructors and administrators. In addition to the routine operations, they create exceptional or unexpected situations, problems or other decision points. They may start an experiential learning cycle with a practical situation that requires action. Based on the student company's reactions, the instructor can decide on further steps. The instructor facilitates the learning cycle by observing and reflecting and forming abstract concepts and generalizations for students. Finally, he/she has the possibility to create a completely new situation where the learners can test the hypotheses created in the experiential learning cycle. The instructor has the freedom to utilize the learning environment in a way that best fits with the curriculum and the learners' abilities and interests.

5. Practical example: TAMK business curriculum

The learning environment described above is brought into action through the following example. The first version of the learning environment was piloted in Tampere University of Applied Sciences (TAMK) school of business and services in 2010–

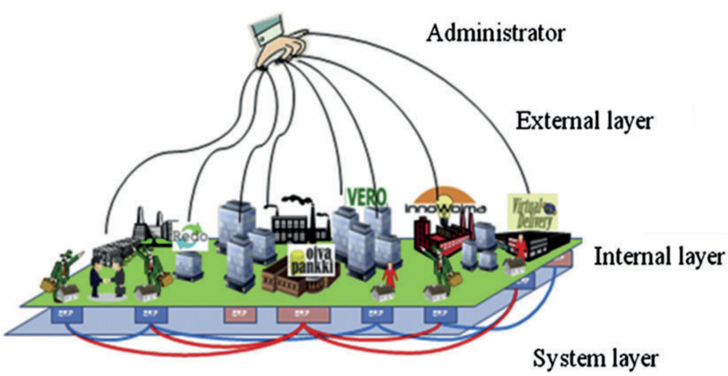

Fig. 1. The combined model.

2011. Before the pilot, the practice enterprise model had been in use since 2005. The pilot was run with 170 business students in 17 simulated companies. Twelve teams were first-year BBA students and five teams second-year BBA students.

The student teams were given a business sector, where they were expected to start their business-to-business company. They created a business plan and negotiated funding for the business with the cooperation of bank credit managers. The students operated their simulated companies for an academic year. In addition to other business courses, they worked 4–8 h a week with their simulated companies. The curriculum was created, scheduled, and synchronized so that the courses in different disciplines were integrated into the life cycle of the simulated companies. Each team had an instructor who coached and mentored them in the learning environment.

The learning process followed Kolb's experiential learning model. The simulated student companies were divided into three departments of 3–4 students: marketing, logistics and accounting. Each student worked in a department for a period of time to gain practical experience. They were guided by their instructor to reflect on their experiences. They also followed lectures, which helped them to conceptualize their experiences and related it to literature. At the end of each period, the department roles were switched. The students had to brief each other on the tasks of their new departments. This made them test their skills in new situations, which, again, completed Kolb's learning cycle. Each student worked in all the departments during the academic year. This gave them a full overview of a company's business processes.

The learning environment was evaluated by measuring the learning outcomes of two groups: the 2009 class used the practice enterprise model while the 2010 class used the SME business learning environment (Nisula, 2012). The groups were given three tests during the academic year: a pre-understanding test to see whether the classes are comparable, a mid-term test and an end test. The end test was given at the beginning of the second school year in order to test the long term learning effects. The tests contained open-end and multiple choice questions that measured declarative knowledge in disciplinary expertise.

Fig. 2 shows the distributions of the scores with the pre-understanding test and the end test. The pre-understanding score distributions are approximately the same for both groups. They are similar also in the mid-term test. However, there is a significant difference in the end test: low and average students performed better in the simulation group than the practice enterprise group. It thus seems that the low and average students benefit from the new learning environment.

Also feedback on the learning environment was collected from both the students and the teachers (Nisula, 2012). The experiences from the pilot were generally considered good. The students appreciated the practical, hands-on approach, combining theory with practice and intensive teamwork. Criticism was directed towards the uneven distribution of work load, challenges in terms of simplification versus reality, technical problems and communication challenges. However, the university decided to continue using the learning environment after the pilot year.

6. Discussion

Our new learning environment answers the criteria for the "rich environment for active learning" (Grabinger & Dunlab, 1995). It puts the learners in an authentic context of a SME business. There, they become active participants of the learning process. They go through Kolb's experiential learning cycle with realistic, practical tasks. The cycle is repeated constantly so the learners may reflect their experiences and lessons learnt the next time the same situation comes up. The participant teams act as knowledge building learning communities that coach each other in the learning process.

In addition to simple task delivery, the learners are faced with unexpected, instructor created problems that do not always have simple solutions. Unlike business simulation games, which apply algorithms that are based on business administration theories (Goosen & Jensen, 2001), the environment facilitates specific learning situations that are derived from the instructor's or teacher's requirements. The learners need to apply what they have learnt in the courses in practical situations. This enhances their critical thinking and creativity. The instructor can train the learners' multi-tasking skills and stress tolerance by creating several simultaneous problems that need to be solved.

These skills meet the skill requirements in general business management and particularly in SME business. The basic business processes are similar. Problem solving, critical thinking, social skills and other competences are required in both SMEs and large companies alike. The learning environment can thus be utilized in learning management skills, regardless of the company size.

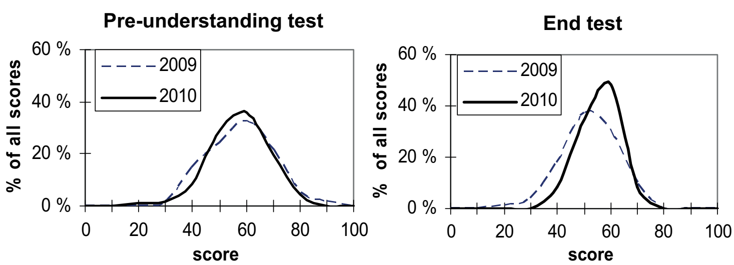

Fig. 2. The distributions of the scores with the pre-understanding test and the end-test.

7. Limitations and further study

The learning environment has not yet been thoroughly evaluated. Yet this challenge is also shared by other learning environments. For example, Anderson and Lawton (2009) argue that there has still been little objective research and information about what the students really learn from business simulation exercises. The same challenges exist with the ERP system learning environments and the practice enterprise model. The evaluation of the learning outcomes is an evident direction for future research.

Implementing this kind of broad learning environment changes the teachers' and instructors' roles and practices. They not only need to learn to use the technical environment but also adapt their didactic methods to it. Even though automation can be used to minimize manual work, the instructors should not be seen as mere operators of the system. Their focus should be in facilitating the learners' experiential learning cycle. In order to succeed, the learning environment relies heavily on the instructors' and teachers' cooperation. Even though the example of TAMK School of business and services had several years of experience of integrated teaching, these changes were still formidable. The new learning environment requires new skills from the whole faculty: in addition to the teachers' functional knowledge and coaching skills, they also need to learn a new mind-set. To study these changes and impacts on the teachers' and instructors' work are obvious topics for further research.

The learning environment has a similar risk of under-utilization as in a typical ERP system (Botta-Genoulaz, 2005). There is a lot of functionality, but the organization needs to have the motivation and the resources to put them to good use. How to do this is still a major question.

8. Summary

The SME business sector lacks an adequately skilled workforce. University education provides knowledge only of large enterprises. Operating a small company requires specific, more generic skills. This kind of practical part of business has been of lesser interest in universities.

Enterprise resource planning systems, business simulation games and the practice enterprise model have all been used as experiential learning environments to address this issue. However, they each have challenges, as they approach business phenomena from a specific, limited perspective. In this paper, we have presented a conceptual learning environment that merges these three environments. They complement each other, giving learners a rich environment for actively learning to manage SME operations. This equips students with practical skills that add value to their theoretical knowledge. When employed by SME companies, they will be able to contribute to the business from day one.

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PUBLICATION
II

ERP-based business learning environment

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ERP-BASED SME BUSINESS LEARNING ENVIRONMENT

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Abstract: Small and medium size enterprises are an important and growing part of economy. They lack adequately skilled workforce. Higher education is claimed to provide students with theoretical knowledge rather than skills. Enterprise resource systems, business simulation games and the practice enterprise model are all learning environments that aim at practical learning through experience. Each of them solves different learning challenges but does not provide a comprehensive learning environment. This paper presents a simulated learning environment that merges these three approaches together, allowing students to learn the daily operations of SMEs in a practice-focused manner. In addition, it provides a flexible environment where the instructor can create learning situations appropriate for the learning objectives at hand. The paper describes experiences of the learning environment pilot from both the student and the teacher perspective. An initial evaluation of the new learning environment shows positive learning outcomes on the long-term memorizing of declarative knowledge among the low and average students.

1 INTRODUCTION

Small and mid-size enterprises (SMEs) are an important and a growing part of economy. They need skilled employees that are work-ready when they are hired (Woods and Dennis 2009). Higher education is claimed to produce graduates who have good theoretical knowledge but lack practical skills (Martin and Chapman 2006, Holden, Jameson and Walmsley 2007). Regardless of the long term efforts to bring education closer to the business, there still seems to be a gap between the skills of the business graduates and the requirements of business life (Jackson 2009).

A learning environment is a combination of physical surroundings, psychological or emotional conditions, and social or cultural influences that affect the learner in an educational enterprise (Hiemstra 1991). Grabinger and Dunlap (1995) define “rich environments for active learning” as broad instructional systems that stimulate study and exploration within authentic contexts and create a feeling of knowledge building learning communities. Such environments utilize dynamic, interdisciplinary learning activities that promote high level thinking processes through realistic tasks and performances.

This paper presents a learning environment that supports the learning of the skills needed in SMEs. It is based on experimental learning theory that emphasizes learning through active practical experience. Learning is viewed as a continuous and iterative cycle of concrete experience, reflection, conceptualization and testing the concepts in new situations (Kolb 1984). Enterprise resource planning (ERP) systems are a used for acquiring the practical experience (Watson, Rosemann and Scott 2000, Davis and Comeau 2004, Cannon, Klein, Koste, and Magal 2004, Jensen, Fink, Møller, Rikhardsson and Kræmmergaard, 2005). Business simulation games are also experiential learning environments (Lainema 2009). Another less IT focused experiential learning environment is the practice enterprise model.

These learning environments are used to accomplish different business learning objectives (Nisula and Pekkola 2011). ERP systems focus on IT skills and business process understanding (Jaeger, Rudra, Aitken, Chang and Helgheim 2011) whereas business simulation games focus on strategy and decision-making (Faria, Hutchinson, Wellington and Gold 2009). The practice enterprise model emphasizes entrepreneurship, teamwork and communication (Kallio-Gerlander and Collan 2007). In this paper it is argued that the platforms should be combined into one to promote all skills at the same time. This article presents a new SME business learning environment which is a combination of the three, and reports an evaluation of its success.

2 SME BUSINESS LEARNING ENVIRONMENT

ERP systems give a good technical platform for hands-on learning of different disciplines and business IT-systems. They illustrate the integration between different business processes in practice. On their own; however, their pedagogical benefits are limited (Seethamraju 2011). They remain only a tool and need a case study to work on (Markulis, Howe and Strang 2005).

Business simulation games contain a dynamic and interactive case. In addition to integration of disciplines, simulation games require integration of cognition, emotion and action (Hofstede 2010). Business simulation games are widely used for learning active decision-making and teamwork (Faria et al. 2009). They typically focus on top management strategic decision-making or a specific business operation. They lack the SME perspective and a view of day-to-day operations. Many business simulation games utilize the ERP mindset or ERP-like system and some are even built on a commercial ERP system (Boykin 2004, Lainema 2006, Léger 2006, Ben-Zvi 2007). The challenge of business simulation games; however, lies in modelling the real life situations without oversimplifying them (Hofstede 2010, Goosen, Jensen and Wells 2001).

In the practice enterprise model, the students work in a virtual SME company without actual transfer of goods or money. Unlike the business simulation games, the practice enterprise model does not have pre-planned scenarios or contain an element of competition. The business environment is provided by an administrator who acts as the authorities, the bank, the insurance company, etc. The students trade with other similar student-run enterprises (Kallio-Gerlander and Collan 2007). The aim is to form customer-supplier-relationships, negotiate agreements and market to other virtual companies run by students.

The practice enterprise model lacks extensive raw material and consumer markets. The learning situations arise mostly from the student company cooperation. The practice enterprise model is strong on practical day-to-day SME operations and interaction between real people. But as there is no consumer market to create the initial demand, the trade between student enterprises soon becomes artificial (Santos 2006, Miettinen and Peisa 2002).

Jackson (2009) and Fernald, Solomon, & Bradley (1999) have investigated industry-relevant business competencies. Nisula and Pekkola (2011) compared their findings with the learning goals of the three experiential learning environments. Table 1 presents the synthesis of the competence requirements and the learning goals. As can be seen in the table, an optimal learning environment combines features and benefits of the three earlier environments: ERP, business simulation game and the practice enterprise model.

3 SYSTEM OVERVIEW

The core of the SME business learning environment is a GPL2 licensed open source ERP system Pupesoft. It is a well-functioning platform for a learning environment as it allows users themselves to modify and customize the system to their needs. Proprietary ERP systems users are heavily dependent on the software supplier (Johansson 2008).

Pupesoft is used by and was developed for commercial SME companies. The web-based user interface has a simple appearance and it is customizable to different roles. Both the administration and the student activities are done with standard ERP modules. The teachers follow their own student teams' progress with ERP reporting tools. The Finnish banking e-accounting standards are the basis for the financial data transfer as well as the virtual bank of the learning environment.

The SME business learning environment consists of three layers: the external, the internal and the system layer. The external layer is visible to the general public. The internal layer contains the activities inside each company and it is run in the ERP system. The system layer is the data traffic caused by transactions between the companies. The general setup of the learning environment is presented in figure 1.

Table 1. ERP, business simulation game and practice enterprise and their learning objectives compared to the SME skill requirements (Nisula and Pekkola 2011).

Competencies	ERP	Business simulation game	Practice enterprise model
Application and use of IT	X		
Problem solving, diagnosis		X	X
decision management	X	X	
Operating in organisational environment	X	X	X
Multi-tasking			X
Ethics and responsibility		X	
Information management	X		
Operating globally	X	X	
Intellectual ability, numeracy		X	X
Disciplinary expertise Sales, marketing, procurement Financial management Accounting HR, litigation and tax law Risk management Quality management Integration of disciplines	X	X	X
Understanding of the key drivers for business success		X	X
Work experience, accountability		X	X
Team- and interpersonal skills		X	X
Organisational skills	X		X
Cultural and diversity management		X	X
Autonomy, self-efficacy			X
Critical thinking		X	
Leadership skills		X	X
Adaptability & change management		X	X
Emotional intelligence Political skill, reliability		X	X
Stress tolerance		X	X
Entrepreneurship			X

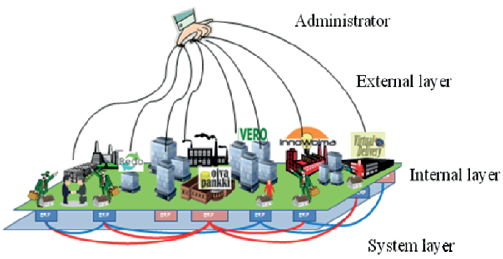

Figure 1: The SME business learning environment.

3.1 External layer

The external layer of the learning environment is built with web-pages. It sets the stage for the simulated environment: a fictitious market area with a number of basic infrastructure providers. There are a real estate agency, an electricity company, a telephone company, an insurance company, a transportation company, a health centre and wholesalers. These "support companies" are run by the system administrator. Each of the support companies has their own web pages with a logo, a slogan and a company history.

The students start and run their companies in this environment. They buy from and sell to other student companies and buy services from the support companies. The raw market is presented by a number of wholesalers with a wide product offering. If the student companies find no appropriate partners to source from, they can contact the "market area trade promoter" played by the system administrator, who sets up the needed company, product or service.

The student companies can promote their business by creating web pages for their company and attaching them to the environment. The media of the market area is provided by a web publication that contains imaginary local market area news as well as real-life external news received with rss-feeds. Companies can advertise in the web publication and get free publicity by sending in press releases. The visibility in the media affects the companies' business success.

The integrating factor between the companies is the virtual bank at which all companies have an account. The virtual bank provides financing as well as an online banking interface for the everyday banking services. The learning environment's tax authorities are accessed with an electronic tax account. It is a replica of the official Finnish electronic tax account which keeps track of taxpayers' self-initiated taxes such as value-added tax (VAT) and employers' contributions (Finnish tax administration 2009).

Figure 2 illustrates the tools that the students operate with in the learning environment. The company's internal processes (purchase and sales orders, inventory management, invoicing, etc.) are managed in the ERP system. Financing and cash management are handled in the virtual online bank. Web pages provide information about the external business environment (other student companies, infrastructure providers and the media). The day-to-day communication and transactions with other companies (inquiries, offers, invoicing, etc.) are done through e-mail.

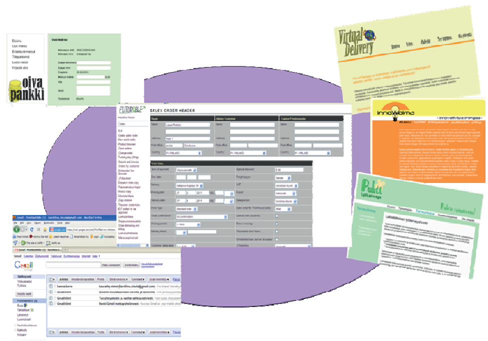

Figure 2: The student interfaces and tools in the learning environment: the ERP system (in the centre), e-mail, online bank and web pages of the support companies.

3.2 Internal layer

All companies run their internal operations in the Pupesoft ERP system. There are minor modifications to the core system to accommodate the learning environment: business game functionality, teacher reporting, bank operations and the tax account. The system structure is illustrated in Figure 3. The ERP systems of the various student companies, support companies, bank and the tax officials appear separate to the end users, but they reside in the same database. Access is managed with user rights and profiles.

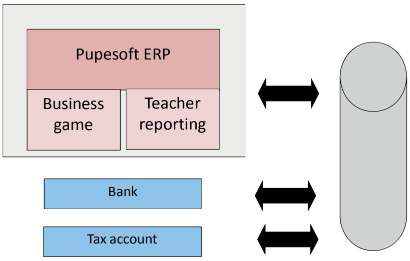

Figure 3: The learning environment database structure.

3.2.1 User roles and profiles

There are three user roles in the database: student, teacher and administrator. The profiles assigned to these roles define which activities are available to each user.

The student has access only to the simulated company he/she works in. The student profile is adjusted to the students' skills and learning goals. Junior students access the basic transactions whereas advanced students have access to more a greater variety of functionality such as reporting and analysis. The profile grows as the student learns following Kolb's experiential learning cycle where the learner is brought to a higher level of understanding each time the learning cycle is completed (Kolb 1984). The students manage transactions in the ERP and utilize its documents to communicate with other companies. For example, in the sales process they deliver and invoice the sales order in the ERP system. The invoice created in the ERP system is then e-mailed to the customer company. Goods are considered delivered when they are invoiced.

The teacher has access to all the student companies that he/she facilitates. To monitor the learning process in the environment, the teacher uses standard ERP reports such as sales, purchases, inventory control, financial accounting reports, etc. Additional customized reporting gives statistics of the students' activity level in the database.

The administrator has full access to all companies in the database. He/she sets up the companies and the user accounts, sets the ERP parameters and acts as a help desk on technical problems.

In addition to the technical administration, the administrator runs the learning environment. He/she is the hand that pulls the strings in the figure 1. He/she acts as the banker and manages the support companies. The administrator communicates through different e-mail aliases to give the students the illusion of communicating with several companies. Each support company has its own e-mail address.

Running a realistic business environment with minimal resources requires a balance between manual and automated processes. Some administrative activities are handled through a manual process to give them a sense of reality and credibility. The agreement negotiations on a lease or a telephone subscription or taking out an insurance policy are examples of such processes. Some activities are outsourced to students to reduce the amount of manual work. For example, student companies buy from the wholesalers through online stores that are connected with the wholesalers' ERP systems. Some administrative activities are automated such as the invoicing and debt collecting of the support companies. Another automated function is the consumer market, which is handled through the business game element.

3.2.2 The business game element

The business game element is administered in the ERP system. It is built into a trading concern that contains tens of subsidiaries, each with its own name, address and a logo. They are the customer base that represents the constant demand of the consumer market. The business game element sends automated purchase orders from the trading concern via e-mail to the student companies. It chooses the customer randomly and the items so that they match the student company's product offering.

There are two types of automatic orders: random and routine orders. The random orders are created regardless of the student company's business performance. The amount of work and profit are equal in all student companies.

The routine orders are related to how professionally the student company is running its business operations. A well performing student company gets financially more valuable orders than another company with a lower performance. The performance is checked through a set of indicators in the learning environment. The majority of the indicators are produced by the standard ERP system: for example, the amount of sales to other student companies indicates active selling. The costs of the lease, electricity, cleaning, decorating etc. give an indication of the size, the location and the appearance of the facilities. Marketing is checked through the marketing costs, the level of CRM activities and the visibility in the web publication.

The administrator manages the business game element through a set of parameters that adjust the frequency and intensity of the purchase orders to emulate the market fluctuations of the consumer market.

3.3 System layer

The system layer transfers financial data between the different elements in the simulation. Whenever a company invoices another company, the invoice data is transferred from the sender's ERP system to the recipient's ERP system. Bank transactions from and to the companies' bank accounts are transferred from the bank database to the ERP systems. The data transfer utilizes Finnish banking data standards (Federation of Finnish Financial Services 2010).

The data transfer creates a closed ecosystem with double-entry book-keeping. Every external transaction is recorded in two companies. It is first recorded in the seller's ERP system as sales. Then the data is transferred to the receiving company's ERP system and recorded as a cost. For example, when a student company buys marketing services and gets an invoice, it gets recorded in its ERP system as a marketing cost.

This provides the basis for the business game indicators as it populates the companies' ERP systems with income and cost data. It also enables the administrator and the facilitating teachers to stay up-to-date on the student companies' activities. The facilitating teachers now get company reports based on transactional data rather than the students' interpretation of the situation.

4 EVALUATION

The first version of the learning environment was piloted in the Tampere University of Applied Sciences (TAMK) School of business and services in 2010-2011. Before this pilot, the school of business and services had used the practice enterprise model since 2005. The pilot started with 170 business students in 17 simulated companies. 12 teams were first-year BBA students and five teams were second-year BBA students. The student teams were given a business sector where they would start their business-to-business company. They created a business plan and negotiated funding for the business with the cooperation of credit managers of actual banks.

The students operated their simulated company for a year. In addition to their other business studies they worked 4-8 hours a week in their simulated companies. The curriculum was scheduled so that teaching different disciplines was integrated into the life cycle of the simulated companies. For example when the companies were starting their business, there were lectures on budgeting, financing start-ups, etc. The teams had supervising teachers who coached and mentored them in the learning environment.

The learning process was based on Kolb's experiential learning model. The simulated student companies were divided into three departments of 3-4 students: marketing, logistics and accounting. Each student worked in a department for a period of time to gain practical experience. They were guided by their supervising teacher to reflect on their experiences. They also followed lectures, which helped them to conceptualize their experiences. At the end of each period, the department roles rotated. The students taught each other the tasks of their new departments. They were able to test their skills in new situations, which, again, completed Kolb's learning cycle. Each student worked in all the departments during the academic year. This gave them a full overview of a company's business processes (Nisula and Pekkola 2011).

4.1 Effects on learning

The first effort to evaluate the learning outcomes was focused on disciplinary expertise. It was measured by acquisition of declarative knowledge which refers to the concepts, principles, issues and facts presented in a learning situation (Noguera 2004).

The evaluation was conducted in the first year BBA studies at TAMK. It was done on two groups, 120 students in each group. The first group, class of 2009, used the practice enterprise model. The second group, class of 2010, used the SME business simulation.

The evaluation had three phases: a test in the beginning, at mid-term and in the end of the school year. The first test evaluated the students' pre-understanding. They were given seven open-end case-questions on business situations ranging from starting a company to marketing, production and accounting issues. The answers were graded from 0-3 (0 = no understanding, 3 = very good understanding).

The mid-year test contained multiple-choice and true/false questions on the disciplinary topics covered in the first half of the year. There were 44 questions that were shuffled to appear in a random order.

The year-end test also contained 44 randomly shuffled multiple-choice and true/false questions covering the contents of the second half of the year. It was not given immediately at the school end, but rather when the next semester begun, in order to measure long term learning effects instead of memorizing for the finals. The number of respondents was reduced from the original 117 because of the student movement to and from other universities.

Table 2: Average scores of the learning evaluation tests.

	Pre-test avg score	Mid-year avg score	End test avg score
Practice enterprise 2009	62% (n=117)	70% (n=99)	58% (n=73)
SME simulation pilot 2010	62% (n=117)	71% (n=103)	62% (n=60)

As can be seen, both groups had approximately the same pre-understanding with an average score of 62%. There was only a one percent difference in their scores at mid-year. In the long-term efforts the SME simulation scored a little higher with 62% against the 58% of the previous practice enterprise model group.

When looking at the distributions of the scores, some more distinctive results can be found. Figure 4 shows the score distribution for the pre-understanding test in the beginning. On both groups the score distribution follows approximately the same bell shaped curve.

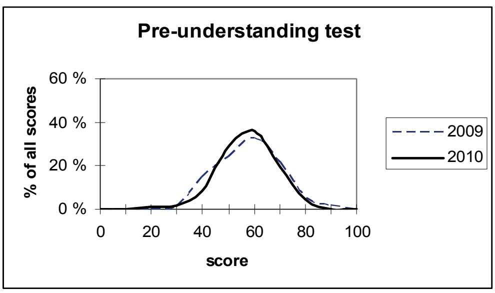

Figure 4: Score distribution on the pre-understanding test.

Figure 5 shows that at mid-year the same trend continues. The practice enterprise group has a slightly wider range of scores in both highs and lows whereas the simulation groups' scores were more focused on the average 60-70% range.

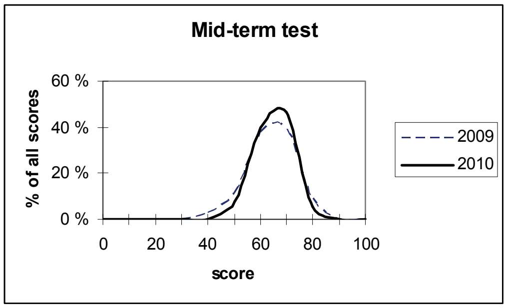

Figure 5: Score distribution on the mid-term test.

In the figure 6, at the year end, there is a difference between the groups. The curves are identical in the high scores, but the low and average scores are better in the simulation group. This seems to indicate that the high performers score well regardless of the learning environment where as the low and average performers benefit from the simulation environment.

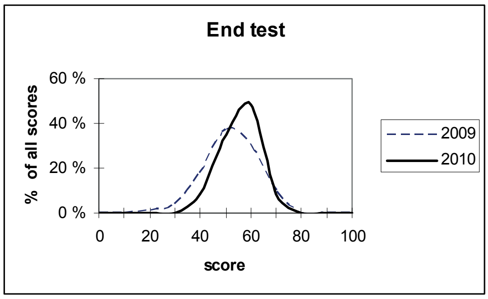

Figure 6: Score distribution on the year-end test.

This evaluation shows some promising signs of improvements in the long term memorizing of the low and average performing students. However, alone it does not provide enough evidence to show the SME business simulation's superiority to the practice enterprise model.

This evaluation was restricted to the learning goals of the disciplinary expertise which is just one learning objective among many. A study on the efforts on other learning objectives is an interesting area for further research.

4.2 Student feedback

The first year TAMK BBA students were asked for feedback on the learning environment with a web questionnaire halfway through the academic year in February 2011. They were presented with arguments and asked to evaluate them on a Likert-type scale 1-5 (1=strongly disagree, 5= strongly agree). There were 101 responses. The average scores are presented in the table 3.

The best scores were on applying theory to practice and making studying versatile. This provides encouraging evidence to the experiential nature of this learning environment. Integration between the simulation environment and the curriculum also scored well. Moreover, students appreciated the simulation in creating the big picture of the business processes. The motivational aspect and the uneven distribution of workload received the poorest scores. The uneven work load is a typical challenge in a team-oriented learning method. Likewise the practice enterprise model was heavily criticized for the workload distribution.

Table 3: Student feedback on the learning environment.

Argument	average score 1-5
The simulation environment makes studying versatile.	4,1
The simulation environment enables applying theory to practice.	4,0
The simulation environment is well integrated to the rest of the curriculum	3,8
The simulation helps understanding the big picture.	3,8
It is motivating to run the student company.	3,2
Work is distributed evenly between the student team members.	2,8

In the questionnaire all respondents additionally answered two open-end questions:

1. What works well / what are the good sides in the simulation?
2. What does not work well / what are the bad sides in the simulation?

Table 4 presents the most frequently mentioned issues and the number of responses they were mentioned in. The most frequently mentioned positive sides reflect Kolb's learning cycle: practical, hands-on approach (concrete experience), combining theory with practice (reflection and conceptualization) and versatility, variation and change to traditional studying methods (testing the concepts in new situations). Also, team work was seen as a positive factor, which promotes the learning objective of team work and interpersonal skills. Critical feedback focused mostly on the uneven distribution of work load, simplification vs. reality, technical problems and communication challenges.

Table 4: Student feedback on the learning environment.

Discussed topics	number of times mentioned
1. What works well?	
practical hands-on approach	55
team work	49
combining theory with practice	31
connections to real work life	20
versatility, variation and change to traditional studying methods	16
2. What does not work well?	
uneven distribution of work load, free riders	30
technical problems	23
difficulty to draw the line between the simulation and real life	20
scheduling challenges between the simulation and substance teaching	17
problem-based learning orientation	16
lack of instructions from teachers	10
poor communication by the teachers	9

4.3 Teacher feedback

After two months of operating the learning environment, the supervising teachers were asked about their experiences in the learning environment with a web questionnaire. They were asked a set of open-end questions:

1. How have students responded to the learning environment?
2. How does the learning environment affect your own work (learning needs, motivation, work environment, etc.)?
3. How is the learning environment visible in the team work and coaching?
4. How is the learning environment utilized in the teaching of different disciplines?

5. How does the learning environment differ from the previous practice enterprise model?
6. How does the learning environment affect the students' learning?

Seven out of nine supervising teachers responded to the questionnaire. According to the teachers, the student reaction varied from neutral to excited. The criticism was focused on technical problems. Some students wanted more time to work on the simulation. Five out of seven responses mentioned that the simulation increases the students' motivation or activity level compared to the previous years' practice enterprise model.

The teachers felt that the students had learned to use the systems quickly. "It seems that a simulation is a natural extension to the virtual realities that the kids are used to", was a comment from one of the teachers. On the other hand, this learning environment seemed to require more intensive coaching and guiding. One teacher noted: "We need to be there to coach them through the questions and problems that they face. If they have to wrestle the problems on their own, they soon get frustrated and lose momentum." Also, one teacher noted that it is challenging to be on the "front line" solving both the student and the technical problems and being the coach, the customer service and the disciplinary expert all in one person.

The teachers felt more uneasy with the IT orientation than the students. They also found the new environment challenging because it required a lot of general business knowledge as well as understanding of business IT and ERP systems. Teachers are typically experts in their own specific domains. The supervising teachers wanted more time and resources to properly familiarize themselves with the new environment. On the other hand, most of them found it motivating to be able and even forced to learn new things.

According to the teachers the students recognized that part of the action was provided by a game engine, but most still took it seriously. A lot of learning took place in a problem-based fashion where the students asked for advice on a business issue. The teachers then went through the theory or background of the issue, as they addressed to the problem. Many of the teachers also utilized the simulation environment in their lectures by discussing situations that had taken place in the simulation environment or by assigning tasks to be done in the student company operations.

In the end of the academic year (May 2011) there was a group interview to the supervising teachers about their experiences. 8 out of 9 teachers and the system administrator participated in the interview. None of the teachers was willing to go back to the previous practice enterprise model. They felt that they had more knowledge and understanding of their student teams' activities than before. A few teachers reported a notable difference in their students' attitudes compared to earlier years: this year the students seemed to show an increased appreciation of their own business understanding and skills. Some students had noted their improved skills on business processes and ERP systems when entering summer jobs.

The teachers felt that they had increased opportunities to combine theory with practice by using examples of the learning environment in their lectures thus emphasizing the experiential nature of the learning environment. On the other hand they felt that the learning environment required a lot of engagement and energy.

5 RELATED SYSTEMS

ERP systems have been used as a teaching tool for approximately 10 years (Jensen et al. 2005, Jaeger et al. 2011, Boykin 2004, Watson and Schneider 1999, Becerra-Fernandez, Murphy and Simon 2000, Guthrie and Guthrie 2000, Antonucci, Corbitt, Stewart and Harris 2004, Johnson, Lorents, Morgan, and Ozmun 2004, Hayen and Andera 2006, Targowski and Tarn 2006, Pellerin and Hadaya 2008). SAP is a widely used ERP system in education. The challenges of SAP and other large proprietary ERP systems are the costs, complexity and the requirements put on the teaching staff and IT administration (Hawking, McCarthy and Stein 2004, Bradford, Vijayaraman and Chandra 2003).

ERP systems can be used as visualizations of organizations. Motivation to learn increases when students can participate rather than passively listening to lectures. The students get to practice the theories of different disciplines hands-on and they enhance their IT skills. ERP systems can provide a nerve system to integrate different disciplines and remove redundancies between them (Joseph, George 2002). On their own, though, ERP system remains a mechanical tool for training rather than a comprehensive environment for deep learning (Seethamraju 2011).

Business simulation games are widely used in strategic management courses (Faria et al. 2009). Total enterprise simulations are descriptive and mathematical models of the general activities associated with operating a total company. They contain the background story, expect students to make decisions and show the scenario following the decisions. INDUSTRYPLAYER (Faria et al. 2009) is a global online multiplayer game with an entrepreneurship focus. INTOPIA (Thorelli 2001) and MULTINATIONAL MANAGEMENT GAME (Keys 1994) focus on international business. MICROMATIC simulates a small manufacturing company (Washbush and Gosen 2001) whereas in CYCLOAN the participants run a branch office of a service company (Scherpereel 2005). These are only a few examples of the wide range of business simulation games available.

ERP systems can be used as basis for a business simulation game. Some business simulation games use operational logic of an ERP whereas other are built onto proprietary ERP software. RealGame is an example of real-time, online, continually processed top management business simulation game. It can be customized to different manufacturing business sectors. Student teams run companies that compete against each other in a common environment (Lainema 2006, Lainema and Makkonen 2003). It is not based on a commercial ERP system, even though it contains some ERP-like functionality to enter offers, deliver orders, check accounts payable, inventory, etc. The company external data is delivered by market report screens. The players interact with both the game engine and the other participants. RealGame differs from traditional batch processed business simulation games in its time intensive environment. The clock is running independently of any operator or participant actions. The participants need to make well-timed decisions in order to manage the game processes.

ERPSim is a business simulation game based on SAP. It was originally designed by a team of academics in HEC Montreal. It is now used in over 20 leading business schools in the world. (Seethamraju 2011). Student teams operate companies that each have own SAP environment. The teams make business decisions that influence their profitability. The decisions are uploaded into simulation software (external to SAP) which decides the number orders that the company will receive. Based on the orders the teams do business operations manually in their SAP environment. They use the SAP reports to analyze the company's operations and profitability based on transactional data. (Léger 2006, Léger, Charland, Feldstein, Robert, Babin and Lyle 2011, Pittarese 2009)

Business simulation games impart skills in business acumen and operating with other companies. There are time restrictions and other rules that teach time management, decision making, stress tolerance, critical thinking and other work-life skills. Business games are typically played in teams, which enhances skills in communication, leadership and emotional intelligence. An ERP-based business simulation game gives a good platform for diverse simulations that resemble running real-life operations. However, the business simulation games have some features that limit their sense of reality. They normally have pre-planned scenarios and time runs artificially in batches (Lainema, Makkonen 2003). Some business simulations consider cooperation and networking as an important element (Thorelli 2001), but the interaction with other students focuses mainly on competition rather than cooperation. The business simulation games tend to take the top management decision making view or focus on a specific functional area. They are not optimal in learning the day-to-day activities, especially from an SME perspective.

6 CONCLUSIONS AND FUTURE RESEARCH

The main difference between the new SME learning environment and the related systems is twofold: First, the new SME learning environment excels the related systems because it combines their specialized features for an improved result. It contains both the hands-on tools as well as the dynamic business environment with a network of actual people. Second, it is a flexible, comprehensive learning environment where the instructor can choose how to utilize it and integrate it into learning. The new SME learning environment fulfils the criteria of a "rich environment for active learning" (Grabinger, Dunlap 1995). The learners are situated in an authentic context of an SME business. The focus is to simulate the day-to-day activities of a small company – a perspective which is rarely present in business simulation games. The tools are the same as a small entrepreneur would have: a mid-size ERP system, an e-mail, an online banking system and an online tax account. However, unlike ERP education, the tools are not the centre of attention. The focus is on business competencies, IT-skills being just one of them.

The learners become active participants in the learning process. They experience Kolb's learning cycle with realistic, practical tasks. The cycle is repeated several times giving the learners opportunities to reflect their experiences and lessons learned in similar situations. The team members coach each other in the learning process.

In addition to simple task delivery, the learners face unexpected, instructor created problems that do not always have simple solutions. Unlike business simulation games, which apply pre-made scenarios that are based on specific business administration theories (Goosen et al. 2001), the environment facilitates versatile learning situations that are derived from the instructor’s or teacher's requirements. The learners can apply knowledge gained from courses or other practical situations. This enhances critical thinking and creativity. The instructor can train the learners’ multi-tasking skills and stress tolerance by creating several simultaneous problems that need to be solved.

The first evaluation on the learning results indicates improvements in the long-term memorizing of disciplinary declarative knowledge. It is particularly interesting that the improvements happened with the low and average scoring students. However, more research is needed to study the learning outcomes on other business skills. For example the students’ internship experiences combined with the perceived effects of the SME learning environment could bring interesting insight into the other learning objectives.

Based on the experience of one academic year the new learning environment appears to provide a well-functioning practical environment for learning SME business skills. Students appreciate the versatility of the hands-on learning environment and get motivated by the extensive team work. On the other hand they criticize the technical problems and demand improvements on the facilitation and instructions on the simulation. The actual effects on learning are a good topic for future research.

The teachers’ reaction has been positive. The learning environment requires the teachers to expand to outside their comfort zone both professionally and mentally. On the other hand the learning environment is motivating and gives an opportunity to learn together with the students. The element of play and joy brings motivation to both students and teachers. A deeper research into the effects on the teachers’ work would be of interest.

The pilot was run in one university business faculty. Expanding the learning environment to cover more educational organizations would bring more interaction and thus reality to the simulated world. On the other hand, administration requires a lot of effort. The administration needs to be developed, but an expansion would be an interesting experiment.

The learning environment is still only a tool and a medium for teaching and learning. The main users, the teachers and supervisors give it meaning. It is crucial that it is integrated into other teaching and the whole curriculum. Curriculum integration of the learning environment is another interesting topic for future research.

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PUBLICATION
III

How to move away from the silos of business management education?

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How to move away from the silos of business management education?

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Abstract

Business management education is criticized for being too theoretical and fractional. Despite the numerous efforts to build integrated and experiential business curricula, learning is still organized in disciplinary silos. The curriculum integration efforts are carried out in separate sections of the curriculum rather than the core. There are theoretical, holistic models, but a lack of concrete examples of holistic business curriculum implementations. In this paper, we bring the separate sections together by developing a holistic core curriculum model with three perspectives: a structure to bring intellectual coherence, people organized in learning communities, and an ERP-supported learning environment to bring the practical training ground. We present a concrete implementation in a case study with first year undergraduate business students and present our lessons learnt.

Keywords: curriculum integration, ERP-system, learning environment, learning community

Introduction

Business management education produces graduates that are not well prepared for employment (e.g. Jackson, 2009; Pfeffer & Fong, 2002; McMillan & Overall, 2016; Sheppard, Minocha, & Hristov, 2015). Business schools still have a heavy emphasis on technical expertise whereas businesses are looking for competencies such as problem solving, critical thinking, interpersonal, and organizational and communication skills (Abraham & Karns, 2009; Brown& Rubin, 2017; David, David, & David, 2011; Jackson, 2009).

The global business community requires graduates to have a holistic understanding of a company and its business environment, but business curricula are based on individual disciplines (Porter & McGibbin, 1988; Rynes & Bartunek, 2013; Weber & Englehart, 2011). Business education is also criticized for being too theoretical (Minzberg, 2004). Although Kolb's cycle of concrete experience, reflection, conceptualization and testing has been widely studied and utilized in business learning for 40 years (Kolb & Kolb, 2005), the traditional mode of passing information from lecturers to students remains the prevailing design.

An ideal business school curriculum combines multi-disciplinary integration with experiential learning methods (Caza, Brower, & Wayne, 2015; McMillian & Overall, 2016). The core curriculum is considered as the most important area of integration, but the efforts tend to focus on separate capstone courses, projects, or case studies implemented on a relatively small and incremental scale (Athavale, Davis & Myring, 2008; Fenton & Gallant, 2016; Navarro, 2008; Strempek, Husted, & Gray, 2010; Weber & Englehart, 2011).

Still the companies call for a holistic business perspective. Students demand and appreciate disciplinary integration (Ducoffe, Tromley, & Tucker, 2006). Business school deans see a strong need to integrate the core curriculum (Athavale, Davis, & Myring, 2008). But still it has not become mainstream. There is a lot of research on the need for the curricular reform as well as theoretical examples of how the business curriculum should be integrated but only a few reports of successful implementations of the whole core curriculum (Fenton & Gallant, 2016; Jaiswal, 2015; Liesz & Porter, 2015).

How can we implement an integrated, experiential business curriculum? In this paper, we study the elements of successful curriculum-wide integration from three perspectives: the structure, the people and the systems. We develop a holistic business curriculum model and present its implementation in a practical case study.

The paper is structured as follows: First, we review earlier research on business curriculum integration. We then present a holistic business curriculum model that considers different aspects of curriculum integration. We proceed to introduce a case study of a 1st year undergraduate business curriculum where the model is tested. We provide observations based on student and instructor feedback. The paper ends with conclusions, limitations and suggestions for further research.

Related Research on Curriculum Integration

To get an understanding of the recent research on the business curriculum integration, we conducted a systematic literature review (Kitchenham 2004). Using all potential combinations of ‘business curriculum’, ‘MBA curriculum’, ‘curriculum integration’, ‘inter-disciplinary curriculum', 'multidisciplinary curriculum', and 'curriculum framework', we searched several databases [1]for all articles published within the past 5 years (January 2013 and November 2017).

The search resulted in 1442 articles. The analysis of their titles and abstracts reduced the number to 178 articles, and an evaluation based on the full text reduced the number further to 72. Our inclusion criteria were English peer-reviewed journal articles, conference proceedings, and book chapters that focused on business curriculum integration or development. We excluded studies that were not in English or not related to our research questions. We will next review the literature review findings, amendment with older studies on curriculum integration.

Systematic literature review shows that a typical integration method is the use of capstone courses that integrate previously learnt skills and knowledge through a theoretical case study, a business-related project (Desai, Tippins, & Arbaugh, 2014; Schwering, 2015; French, Bailey, van Acker, & Wood, 2015; Karagozoglu, 2017; Misra, Ravinder & Peterson, 2016; Weber & Englehart, 2011) or a case competition (Pleggenkuhle-Miles, Lundmark, Meglich & Bass, 2016). In the business studies context, capstone courses are often on business policy or strategic management, organized at the end of the studies when the students are prepared to analyse cases in the light of earlier coursework. They may also integrate students from different disciplines to work on the same case or a project (Franchetti & Ariss, 2016). Capstone courses need to be based on the effective deployment of a well-designed curriculum to ensure that students have appropriately developed knowledge and skills before enrolling (Bailey, Oliver, & Townsend, 2007). On the other hand, a cornerstone subject, a course that integrates business

[1] Academy of Management (http://aom.org/search.aspx), Proquest (www.proquest.com), Sage (http://journals.sagepub.com/), Science Direct – Elsevier (https://www.elsevier.com/), Springer (http://www.springerlink.com), Taylor & Francis (tandfonline.com) and Google Scholar (https://scholar.google.com)

perspectives and illustrates the business environment and processes, can be used as a roadmap to demonstrate how each discipline interrelates throughout the studies, and leads into the capstone course (Bajada & Trayler, 2013). Capstone courses increase student competencies and motivation (Bailey, Oliver, & Townsend, 2007; Usry, White, & Olivo, 2009).

Another commonly used integration method is the case study (Bianco et al. 2014; Brunel & Hibbard, 2006; Walker & Ainsworth, 2001; Yuliana, Sagala, Trianasari & Amani, 2015). The students use the same case material, and apply concepts from different courses to the case (Markulis, Howe & Strang, 2005). To ensure its success, faculty members need to be involved in building the integrative case. Both the faculty and the students need to be motivated about the rationale and the learning path involved with the case (Markulis, Howe, & Strang, 2005).

Service learning programs are real-life projects that provide benefits both to the community and the students' learning (Godfrey, Illes, & Berry, 2005; Niehm et al., 2015; Steiner & Watson, 2006; Wozniak, Bellah & Riley, 2016). They combine features of field experiences, volunteerism and community-services to a credit-bearing educational experience. For example, the students can create plans to develop the community or provide consulting to nonprofit organizations. In addition to gaining practical experience and integrating knowledge from different disciplines, the students can reflect the experience onto their earlier theoretical learning (Gallagher & McGorry, 2015; Govekar & Rishi, 2007; Tyran, 2017).

Team teaching allows students to learn different topics simultaneously in a cross-functional setting (Lafond, Aleer & Wentzel, 2016). When the course has more than one teacher, each brings increased consolidation and multiple perspectives to the issues (Usry, White, & Olivo, 2009). Team teaching is often combined with organizing the subjects into larger modules (Athavale, Davis, & Myring, 2008).

Other integration methods include structuring the curriculum around business processes or integrative themes, guest lecturers, problem-based learning exercises, cross-disciplinary discussions, work-integrated learning, and interaction with local businesses through multi-disciplinary projects or internships (Alstete, 2013; Athavale, Davis & Myring, 2008; Smith & Worsfold, 2015; Sroufe & Ramos, 2015; Waddock & Lozano, 2013).

Approaches to develop integrative curriculum are numerous. However, Bajada & Trayler (2013) argue that the most effective learning method is integration throughout the entire degree program. Jaiswal (2015) describes a holistic business core curriculum reform that used integrative modules with interdisciplinary case studies, team teaching, student team mentorship programme and an international experience. Brunel & Hibbard (2006) present a business core course that integrates marketing, operations, information systems and finance. The disciplines are integrated through a semester-long project where the students work in teams. Ramesh & Gerth (2015) introduce an implementation of the integrated IS core curriculum with clustered modules and student cohorts working on integrative cases and projects. At the end, the students played a simulation game in conjunction with their ERP course.

These examples, however, are rare. Holistic, theoretical curriculum models have been introduced (e.g. Allen, Miguel & Martin, 2014; Fenton & Gallant, 2016), but there are few concrete examples, implementations, and their evaluations (Jaiswal, 2015). For example in 2008. in a survey of 143 American business schools, only 22% had implemented a *plan* to integrate the undergraduate core curriculum (Athavale, Davis & Myring, 2008). In 2010, sixteen integrated curriculums with varying integration methods where studied (Strempek, Husted, & Gray, 2010). Their results show that integrated programs delivered core business content as effectively or better than traditional programs. Several integrated curriculums reported improvements on the learning outcomes. Despite the benefits, only ten out of the sixteen had survived, the rest had been abandoned or significantly modified.

Why are integration efforts struggling? One reason is that no discipline owns the integration (Herrington & Arnold, 2013). Many academic institutions encourage the silo orientation by emphasizing and rewarding discipline-based research at the expense of research on pedagogy and application (Hambrick, 2005).

Team-teaching throughout the whole curriculum could break these silos (Athavale, Davis, & Myring, 2008). This necessitates curriculum restructuring (Weber & Englehart, 2011). It requires intellectual coherence to indicate how disciplines, courses, projects, and different course components (e.g. cases) influence each other (Teece, 2011). A coherent, overall framework would enable the students to understand how and why topics interrelate.

A structure also needs to be implemented in practice. Experiential learning environments such as simulations (Green, 2004; Seethamraju, 2011; Magnuson & Good, 2016) and enterprise resource planning (ERP) systems (Fedorowicz, 2004; Johnson, Lorents, Morgan, & Ozmun, 2004; Ruhi, 2016) have been successfully utilized in integration endeavours.

All these elements need to be brought together. This article presents an integration model and the practical implementation of a holistic core curriculum, addressing the need for concrete curriculum integration examples (Jaiswal, 2015) for holistic, practical learning (Brown & Rubin, 2017; McMillian & Overall, 2016).

Breaking the Silos in the Curriculum

Teece (2011) suggests using the business theory of dynamic capabilities as the overall curriculum framework. Dynamic capabilities are defined as an organisation's capacity to purposefully create, extend, or modify its resource base (Teece, 2007). They enable the company to keep ahead of its rivals by managing competencies and resources to create unique, yet renewable and modifiable capabilities.

The dynamic capabilities framework consists of three sets of activities (Figure 1): sensing, seizing and transforming (Teece, 2007). Sensing refers to the detecting and evaluating an opportunity. It includes entrepreneurial capabilities to find technological prospects, scanning markets and other business surroundings. Seizing indicates mobilization of resources to address an opportunity, such as creating business models and acquiring the necessary capital and human resources. Transforming capabilities are required for continuing renewal when new opportunities appear. They also prevent operations from becoming static and enable the company to reconfigure its operations and offering.

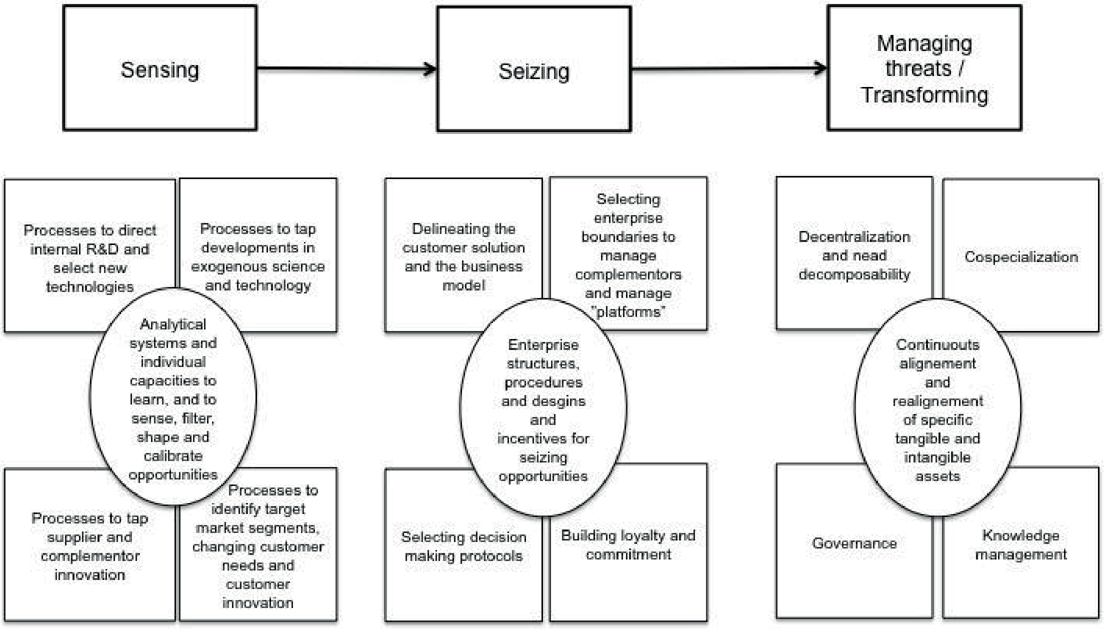

Figure 1. The dynamic capabilities framework.

The dynamic capabilities provide an intellectual framework to connect and interrelate the different functions that exist in a business enterprise. They could be utilized for the same purpose in the business curriculum.

Breaking the silos between the people

No structure works without the interest and the commitment of the people. The faculty members have to let go of their specialized expertise status, explore new areas and acknowledge the contribution of other business disciplines (Athavale, Davis, & Myring, 2008). The organizational structures need to be cross functional and support team building of both the faculty and the students (Strempek, Husted, & Gray, 2010). The role of the faculty has changed from knowledge creator to coach, integrator and experience facilitator (Longmore, Grant, & Golnaraghi, 2017; Steward & Gregg, 2015; Waddock & Lozano, 2013). They are the role models for the future business professionals (Caza et al., 2015).

Learning community is "*an intentionally developed community that exists to promote and maximize the individual and shared learning of its members. There is ongoing interaction, interplay, and collaboration among the community's members as they strive for specified common learning goals*" (Lenning, Hill, Saunders, Solan, & Stokes, 2013, p. 7). Student learning communities are small groups organized for student-student, student-faculty and student-curriculum interactions that enhance both group and individual learning. There are different types of communities (Lenning et al., 2013; Levine & Shapiro, 2000):

- **Student cohort/integrative seminar**, where a relatively small cohort of students attends large classes together. The faculty does not coordinate between the classes. An integrative seminar is arranged for the cohort to help the students make intellectual connections between the courses.
- **Clustered or paired courses**, where students see the courses as an integrated set. They complete common assignments across the courses and are encouraged to collaborate on their learning efforts. Faculty members are independent of each other and are not expected to collaborate on syllabi, assignments or activities (e.g. Asare, McKay-Nesbitt, & LeMaster-Merrick, 2014).
- **Coordinated studies** (or team-taught programs) where the students and the faculty are assigned to the learning community in a complete program of study (Abbondante, Caple, Ghazzawi, & Schantz, 2014). The participating faculty focuses on collaborative learning.

These learning communities are large – 60-100 students and 3-5 faculty members that teach only in coordinated study programs. The faculty-to-student ratio is generally 1:20 and the faculty typically change each academic calendar term.

Faculty needs a learning community of their own. A professional learning community typically involves specialists of one or more fields working together to learn and apply perceived solutions to problems. Professional learning communities in education are small collaborative faculty groups that develop and implement strategies for optimum student learning (Lenning et al., 2013).

Breaking the silos with the learning environments

Learning takes place in a combination of physical surroundings, psychological or emotional conditions, and social or cultural influences affecting the student in an educational enterprise – the learning environment (Hiemstra, 1991). Skills and knowledge are best acquired in *rich environments for active learning* that enable studying within authentic, realistic and complex contexts; involve dynamic and interdisciplinary learning activities; and promote student initiative (Grabinger & Dunlab, 1995). In our context, we refer to learning environment as the physical surroundings and tools, and use the term learning community to illustrate the community of faculty and students, their interactions, emotions and social influences.

Curriculum integration has been implemented in a variety of experiential learning environments. Business simulations have often been utilized in the capstone and strategic management courses towards the end of the studies (Blackford & Shi, 2015; Faria, Hutchinson, Wellington, & Gold, 2009; Tiwari, Nafees, & Krishnan, 2014). ERP systems used by companies integrate the different functional areas through a business process view. They have also been used in curriculum integration projects (Cannon, Klein, Koste, & Magal, 2004; Davis, & Comeau, 2004; Holsing, 2007; Hepner & Dickson, 2013; Jewer & Evermann, 2015; Johansson, Zimmerman, & Rehnström, 2014; Mulenga & Wardaszko, 2014; Ruhi, 2016; Saraswat, Anderson, & Chircu, 2014). For example, ERPSim is a business simulation game that combines simulated market data and automated business functions with the user interface of a real SAP system (Léger et al., 2012). It has been used in learning enterprise integration and business processes (Seethamraju, 2011), management information systems courses (Hayen & Holmes, 2014) and integrative capstone courses (Legner, Estier, Avdiji, & Boillat, 2013; Ramesh & Gerth, 2015).

Business simulations and ERP systems have been used to support paired and clustered course approaches (Hejazi, Halpin, & Biggs, 2003; Johnson, Lorents, Morgan, & Ozmun, 2004; Payne & Whittaker, 2005). They are the practical environments where disciplinary concepts, business processes and executive decisions have been implemented on a concrete level. Draijer and Schenk (2004) describe a case resembling a coordinated studies learning community-approach. Teams of 3rd or 4th year students from different departments operated and developed simulated companies on SAP. They worked half the time with routine workflows and half the time with business development. After each semester, the groups handed the companies over to the next group with appropriate documentation and analysis.

Even the successful simulation and ERP system integration efforts have remained isolated and fragmented (Hepner & Dickson, 2013; Holsing, 2007; Strempek, Husted, & Gray 2010). The systems created bridges and tunnels between the silos, but did not remove them

(Markulis, Howe, & Strang, 2005). The integration has to happen in all the areas: the curriculum, the people and the learning environment (Cannon, Klein, Koste, & Magal, 2004; Caza, Brower, & Wayne, 2015; Davis, & Comeau, 2004; Payne & Whittaker, 2005).

The holistic business curriculum model

When we want to move away from the disciplinary silos, we need an overall perspective for the whole educational structure. The dynamic capabilities framework provides a comprehensible context to communicate the overall learning objectives and break them into sub-objectives and courses. It can also act as the basis of a common vision between the administration, the faculty and the students.

Breaking the silos in the people's minds requires a major change both in the attitudes and the concrete organizational structures. A professional learning community of the key faculty members can support their personal transformation as well as work in planning and implementing the integrated curriculum. It also transforms the organization towards collaborative ways of working. The student learning communities break the traditional boundaries of faculty and learners and enable new kinds of interactions between the students.

The curriculum needs contemporary tools to concretize the integrated perspective. Business simulations are experiential learning environments where learning is done through operating a business. ERP systems provide the concrete tools to run the business processes. Both have been used successfully in individual integration efforts, but not as a holistic, integrative learning environment.

We suggest that a successful business learning integration needs three elements (Figure

2):

1. An overall curriculum structure
2. Combination of student and teacher learning communities
3. An experiential learning environment

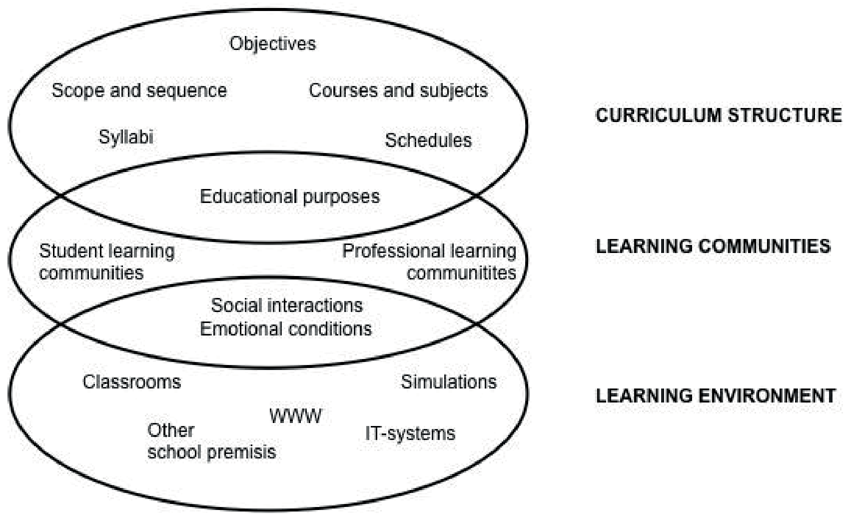

Figure 2. The key elements of the holistic business curriculum model.

We will now proceed to test this model through a practical case example.

The case: first year undergraduate core curriculum

In 2005, TAMK school of business and services, with a class of 117 students, converted the first year undergraduate business studies into an integrated, multi-discipline curriculum. In 2005-2009, the curriculum was implemented with the practice enterprise model, which is a manual role-play for student teams to run virtual companies without real monetary transactions or physical products (Gramlinger, 2004). The student companies trade with each other and are supported by central practice enterprise offices playing the role of the bank, the tax office and the external environment. In 2010-2011, the ERP-supported learning environment was piloted. After the pilot year, the learning environment was taken into permanent use.

The studies focused on gaining the basics of business management: marketing, sales, logistics, finance, economics and law. The first year curriculum consisted of four successive quarters of 10-15 credit unit multi-disciplinary modules that followed the life cycle of a company: 1. Setting up a business enterprise, 2. Running a business enterprise, 3. The profitable business enterprise, and 4. Developing the business enterprise. A full-year module "The skills and competences for working life" had a specific focus on generic competencies such as teamwork, responsibility, critical thinking and creativity. Foreign languages and math were separate courses throughout the year (Tampere University of Applied Sciences, 2010).

In the beginning of the academic year, the students were organized into teams of ten. Each team had a teacher-coach, who mentored the students in their individual and team studies and gave them support in the learning environment. Educational coaching on collaborative as well as individual level has been found to enhance problem-solving, study and interpersonal skills (Devine, Meyers, & Houssemand, 2013). Each coach had a specific disciplinary expertise such as economics, marketing, logistics or law. They also gave lectures to all the teams and acted as disciplinary "consultants".

In addition to lectures and exercises, the students worked 4-8 hours a week with simulated companies. The teams were organized into three departments of three students: marketing, logistics and accounting. One student acted as the CEO.

The learning process followed Kolb's cycle of concrete experience, reflection, conceptualization and testing the concepts in new situations (Kolb, 1984). Each student worked in a department for a quarter to gain practical experience. The coach helped the students to reflect on their experiences. On lectures the experiences were conceptualized. At the end of each module, the department roles were switched. The students briefed each other on the tasks of their new departments. This made them test their skills in new situations, which, again, completed Kolb's learning cycle. Each student worked in all the departments during the academic year and got a full overview of a company's business processes.

The module deliverables were combinations of multi-disciplinary reports, such as the business plan, and disciplinary specific, such as the company financial reports. Some deliverables were individual and some created by the teams.

We will now review our case from the different holistic business curriculum model perspectives.

The curriculum structure

The curriculum is mapped to the dynamic capabilities framework in the Figure 3. It went through the basics of the dynamic capabilities framework from sensing to transforming in a logical, process-like sequence within the year. The three activity clusters, sensing, seizing and transforming, were taught conceptually and then tried out in the simulated business environment.

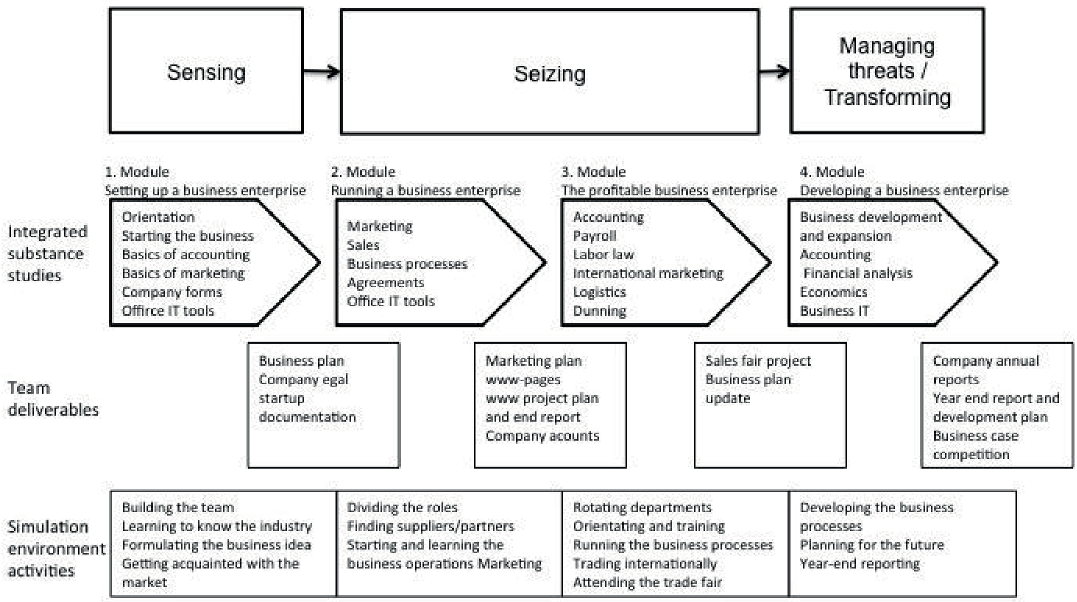

Figure 3. The 1st year undergraduate business curriculum mapped to the dynamic capabilities framework.

"*Sensing is an inherently entrepreneurial set of capabilities that involves exploring technological opportunities, probing markets, and listening to customers, along with scanning the other elements of the business ecosystem*" (Teece, 2011, p. 514). In the first module, "setting up a business enterprise", teams were formed and they identified target market segments; developed product or service offerings; and investigated potential business partners and funding opportunities. As a deliverable, they created a business plan and presented that to real-life bank credit managers in practiced loan negotiations. The disciplinary teaching supported the sensing activities. For example, basics on business management, marketing and financial management gave background information to the business plan.

The seizing capabilities focus on designing business models; securing access to capital and human resources; and establishing relationships with customers and suppliers (Teece, 2011). In the second module, “running a business enterprise”, the teams started their simulated business operations by setting up company structures and processes. They received a loan from the simulation environment bank, created a marketing plan and started marketing activities. They outsourced the company web-pages from information management students, combining disciplinary learning from marketing, project management and purchasing. They also started the sales, purchasing, and inventory management processes. The team deliverables included the company accounting reports; the web page project documentation and outcomes; and the agreements with business partners.

The transforming capabilities are required when new business opportunities arise. They also keep the company aligned with the business environment and safeguard it from losing its market position (Teece, 2011). The third and fourth module took the learning process into a deeper level, combining the dynamic capabilities’ transforming activities to the sensing and seizing. The coaches developed unexpected learning situations to support the disciplinary teaching. For example, concurrently to lectures on dunning, some simulated customers stopped paying their bills forcing the students to react. To practice international trade and integrate to foreign language learning, the student companies received orders from simulated companies abroad. The academic year ended with a business case competition, where the teams competed on creating innovative business solutions to actual customers.

The learning communities

Each coach mentored two student teams, reflecting a typical student learning community instructor-student ratio of 1:20 (Lenning et al., 2013). The core of their teamwork was the business of the simulated company. Their coaches gave instructions, but the main responsibility resided at the students. The deliverables and their assessment were combinations of individual and team efforts, emphasizing the teams as student learning communities. The students also assessed their own and their peers' activities within the team which reflected in their grades.

One of the barriers for integrated curriculum is that the faculty make decisions based on their own disciplinary interests rather than the needs of the students (Holsing, 2007; Seethamraju, 2011; Teece, 2011). Another challenge is that integration is left to individual faculty members (Seethamraju, 2011; Strempek, Husted, & Gray, 2010). In the pilot case, the coaches formed the professional learning community. A reasonable amount of their working time was allocated to the integration and coaching activities.

A head-coach had the overall responsibility of the coordination. Before each module, the coaches and the disciplinary teachers planned together the deliverables that integrated several disciplines and agreed on their evaluation criteria. The outcome was communicated to the students in a module plan.

Another coach was responsible for creating the schedules for the modules. She coordinated the lecture and exam schedules with the student-companies' life cycle. Every Monday there was a weekly meeting where the coaches reviewed the lessons learned from previous week and made plans for the upcoming week. They agreed on how to communicate the upcoming general issues so that all the teams would get the same information in the same manner. They also decided the coaching methods for the different situations.

The ERP-supported Business Learning Environment

The ERP-supported business learning environment was a business simulation that utilized a real open source ERP system (Nisula, 2012). The business environment was a fictitious market area with a bank, wholesalers, infrastructure providers, government authorities and a local media, all operated by a systems administrator. It was represented through web pages. The basic infrastructure consisted of real estate, electricity, telephones, insurance, transportation and health services. The raw material market was available through wholesalers' web-stores. A virtual online banking system provided financial services. The tax authorities were accessed with an electronic tax account. An administrator managed the environment with the help of automated transactions such as automatically generated consumer demand. Svane & Johansson (2015) experimented with a similar type of a simulated environment that combined automated, fictional data with manual input.

The student companies traded with each other and the administrator-run companies. They managed marketing communications through e-mail, company web-pages, the web-publication, as well as phone and face-to-face communication with other student teams. The internal operations were managed in the ERP system. The coaches monitored the student companies' activities through the ERP system reporting tools and log files.

The student teams also had a physical team room or a "company office" with computers and a mobile phone. They held weekly "management meetings" on company issues such as cash flow and finances; profitability; sales situation; marketing campaigns; and current projects.

The holistic business curriculum model in practice

Our case illustrates that a holistic, integrated business curriculum can be implemented by combining the three elements (Figure 4):

1. The dynamic capabilities framework as the curriculum structure
2. Combination of learning communities: student learning community of coordinated studies and an educational professional learning community
3. ERP-supported simulation as the experiential learning environment

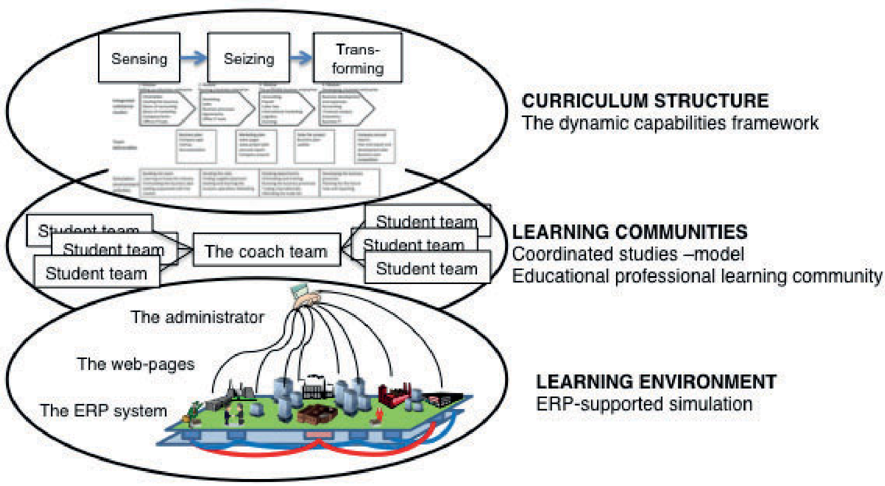

Figure 4. The practical implementation of the holistic business curriculum model.

We now proceed to analyze the benefits, the challenges and the lessons learnt of our implementation through student and coach feedback.

Feedback on the holistic business curriculum model

To evaluate the model, we collected feedback from the students through the general course feedback system, a learning environment survey, and a focus group interview.

At mid-term, two people from each student team were randomly selected to a focus group interview on experiences, feedback and improvement possibilities. The students were also given a survey with Likert-scale 1-5 questions (Table 1) and open-end feedback. The open-end feedback was analysed for frequently mentioned issues as presented in Table 2.

Table 1. Student evaluations of the learning environment.

Argument	Average score (1-5) n=101
The learning environment makes studying versatile.	4,1
The learning environment enables applying theory to practice.	4,0
The learning environment is well integrated to the rest of the curriculum.	3,8
The learning environment helps understanding the big picture.	3,8
It is motivating to run the student company.	3,2
Work is distributed evenly between the student team members.	2,8

Table 2. Student feedback on the learning environment.

Discussed topics	Number or times mentioned n=101
1. What works well?	
practical hands-on approach	55
team work	49
combining theory with practice	31
connections to real work life	20
versatility, variation and change to traditional studying methods	16
2. What does not work well?	
uneven distribution of work load, free riders	30
technical problems	23
difficulty to draw the line between the simulation and real life	20
scheduling challenges between the simulation and disciplinary teaching	17
problem-based learning orientation	16
lack of instructions from teachers	10
poor communication by the teachers	9

The coaches' perceptions in the curriculum integration were gathered by analysing twenty-nine weekly coach meeting memos. The coaches were also given a survey with open-end questions in the middle of the academic year. In the end of the academic year, there was a lessons learnt session.

Based on the gathered materials we will next make some observations of the different aspects of the model.

Observations on the curriculum structure

In the survey, the curriculum integration perspective of understanding the big picture received a score 3,8. The open-end feedback varied from great appreciation to frustration. The change from the high school traditional pedagogies and individual learning orientation required adjusting which was appreciated by some and disliked by others. Combining theory with practice was brought up as a positive aspect by a third of the students. The versatility, variation and change to traditional studying methods were mentioned by 16% of the students. At the same time, 16% of the students were unhappy about the problem-based learning orientation. They were dissatisfied that the disciplinary topics were lectured simultaneously or even after the issues had arisen in the simulated companies.

Based on the coach meeting memos, the students reacted quickly when the integration was not working. If the disciplinary topics did not bring the needed theoretical knowledge to run the simulation, they voiced their frustration. Similarly, if the simulation did not provide training ground for the new disciplinary topics, they lost their motivation. Scheduling challenges between the simulation and disciplinary teaching were mentioned by 17% of the students in the open-end feedback.

Another challenge identified in the coach feedback was that students tended to get stuck on their original business plans, not making use of their dynamic capabilities. If they were asked for a product or a service not included in their original offering, some teams immediately turned it down. This geared the interaction towards routine transactions with administrator-run companies instead of dynamic student-company business situations.

Observations on the learning community

Motivation to run the student company scored neutral (3,2) in the survey. Some students did not feel they were learning properly while others appreciated “having to find out things by oneself”. Responsibility for the simulated companies and the requirement to make own decisions motivated some students greatly. In the open-end comments, half the students mentioned teamwork as a positive side but 30% gave negative comments on workload division, which also scored the poorest in the survey (2,8). According to the coach discussions, the students wanted more workload balance between the different parts of the curriculum as well as between the students in the teams. They urged the coaches to be more aware of the group dynamics and see what really is going on in the teams. Also, they asked for more versatile activities in the simulation and preferred large, aggregated assignments rather than lots of small tasks.

As indicated in earlier research (Bajada & Trayler, 2013; Ramesh & Gerth 2015), communication was of key importance. There were weekly meetings where the coaches would update each other of the disciplinary issues and fine-tune the following week's agenda. They also had a collaboratively maintained Excel-based ”year clock” with all the key activities and dates. The communication to the students was done in Moodle learning management system and in weekly student company meetings. The six coaches all communicated somewhat differently to their teams. The general communication points and guidelines were agreed upon, but there were still discrepancies and scheduling challenges between the simulation and the disciplinary teaching. Some coaches got very involved whereas others took a more distant approach. This caused frustration and feeling of inequality amongst the students, which was reflected in the open-end comments as lack of instructions and poor communication. It is very important to keep the students informed and motivated throughout the whole study year (Bajada & Trayler, 2013).

Observations on the ERP-supported learning environment

The students adapted to the learning environment well. The practical, hands-on approach received a score 4,0 and was the most frequent positive point, brought up by over half the students in the open-end feedback. The challenges seemed bigger for the coaches, who felt that the new environment required a lot of general knowledge and business IT understanding. They would have wanted more time to properly familiarize themselves, reflecting the previous research about the importance of resources and time needed for adaptation (Badley, 2009; Pharr, 2000, Strempek, Husted, & Gray, 2010). The coaches appreciated the monitoring capabilities provided by the ERP log files and reports, but regretted that they had not taken the time to properly learn to use them.

There was a typical simulation challenge: simplification versus reality. 20% of the students notified difficulties to draw the line between the simulation and real life. At times students were confused whether they should act as realistically as possible or to simplify for the simulation purposes. Also, keeping the students engaged was a constant topic of the coach meetings. Some teams indulged in the simulation activities while others did not want to participate in “the artificial child-play”. The coaches needed to actively carry on the “story” of the simulation and motivate the students. Another challenge was that the student teams exchanged orders with the agreement “if you buy from us, we buy from you to keep the coaches off our back”.

The majority of the effort in the pilot year emphasized routines and basic business processes. Getting all the coaches and students familiar with the ERP system and dealing with the technical challenges noted by 23% of the students took most of the energy. The main focus was in the order-to-delivery chain. Marketing communication got relatively little attention despite the possibilities that the simulation would have offered. That was noted as a point for further development.

Discussion and limitations

For years, business education has tried to break away from the disciplinary silos, with little success. One of the major problems has been the lack of ownership (Herrington & Arnold, 2013). We took the suggestion of the team teaching further (Athavale, Davis, & Myring, 2008) and organized the faculty as a professional learning community. Curriculum planning and implementing was given to a team of disciplinary expert teachers, which is a key success factor in contemporary curriculum planning (Caza & Brower, 2015). Responsibilities were clearly assigned. There was a head-coach with the coordination responsibility, another coach responsible for the scheduling and each of the coaches responsible for two dimensions: facilitating their own teams and consulting on their disciplinary expertise. The “core coordinator” role and the ability to use faculty expertise in a flexible were key success factors, supporting the findings of Ramesh & Gerth (2015).

Tools and processes, such as the year clock, were developed to keep track of the implementation. The coach team standardised communication methods to the students and other members of the faculty. In addition, the professional learning community was a peer support group that coached each other in growing to the new role of the coach, supporting Devine, Meyers & Houssemand (2013) claim that peer coaching is vital in building new learning cultures.

Another challenge has been the resistance, caused by a mandate for curriculum integration without adequate management support (Badley, 2009). In the pilot case, the coach team received training and resources for planning, communication and coordination. The coaches felt that the implementation resources were adequate, but they would have wanted more time to familiarize themselves with the technology of the learning environment.

Student motivation has been another hurdle. Students tend to view integrated courses as rigorous and detrimental to their grades, regardless whether this is true or not (Pharr, 2000). Tackling this requires a constant motivating, encouraging and even marketing. Student centred-ness and sense of belonging are important contributors to student satisfaction (Gibson, 2010). In the pilot, the learning communities enhanced the connections between the students and faculty and increased the sense of belonging to a team. Ramesh & Gerth, (2015) also reported dissatisfaction: their IS students felt less connected to the rest of their classmates because they spent so much time with the cohort. Yet we did not experience this. In our case, the students were satisfied with the teamwork but frustrated with the uneven workload. The ownership of the simulated company and the learning process resided with the students, which motivated many.

The intellectual coherence of the curriculum (Teece, 2011) was built through the life cycle of a start-up company, from business planning through starting the operations to running and developing the business. Similar approaches have been used in entrepreneurial curriculum integrations (Abbondante et al. 2014; Addams et al., 2014). However, they focus on starting the company, and lasted only for a short period of time, i.e. one semester. Our implementation included the whole business core curriculum and lasted for a whole year. Long duration allows in-depth reflections on the topic, and broader integration of topics. Our curriculum mapped well to the dynamic capabilities framework. Our theoretical framework provides the understanding of how and why disciplines interrelate. In order for the theoretical knowledge to become skills, we need to practice the how's and why's in concrete settings. There the ERP-supported learning environment provided the practical training ground.

The majority of the earlier curriculum integration examples concern only some parts of the curriculum (Jaiswal, 2015; Fenton, 2016). Our solution consolidates different approaches into a comprehensive solution that integrates all business studies from a whole study year. Our approach differs from other holistic core curriculum endeavours (e.g. Jaiswal, 2015; Ramesh and Gerth, 2016) by building the framework onto the simulated ERP learning environment that combines all learning experiences and facilitates the work and collaboration of the learning communities. The integration model turned out to be fully functional as it is still in active use at the university – six years after the first pilot.

Our case is still only one experiment, and further studies in different surroundings are thus needed. Our pilot covered the first year of undergraduate business studies. Extending the holistic curriculum model to cover the rest of the studies would provide interesting insights to deeper levels of business learning.

Conclusions

Over the last decades, there have been numerous attempts to break the disciplinary silos of business education. They have however remained isolated, fractional and short-term. The improvements have taken place on the edges rather than at the core of the business curriculum (Jaiswal, 2015). In this paper, we have studied earlier integration efforts and improvement suggestions, synthesized them into a model and viewed that through a concrete case of first year undergraduate business core curriculum. As a result, we offer following contributions:

- An enhancement to the conceptual, theoretical business learning models (e.g. Allen, Miguel & Martin, 2014; Fenton & Gallant, 2016) that takes the business learning model to a concrete level of the curriculum structure, the learning communities and the learning environment. This is presented as Figure 4.
- A concrete implementation of a holistic curriculum, called for by Jaiswal (2015), with
  - a curriculum structure that follows the sequence of a company life cycle. This is similar to Abbondante et al. (2014) and Addams et al. (2014), but also maps to a coherent, framework of dynamic capabilities (Teece, 2011) to add intellectual structure and tie different curriculum components together.
  - a student learning community approach (Abbondante et al., 2014; Brunel & Hibbard 2006; Ramesh & Gerth, 2015) which is enhanced with a professional learning community of the coaches that coordinate curriculum integration. They have dual roles of disciplinary teaching and consulting, and of coaching the student teams.

- an ERP-simulation resembling Ramesh & Gerth (2015). In our case, the ERP-supported learning environment is a comprehensive curriculum integrator throughout a complete study year. This is a novel approach, not found in earlier research.

evidence that the model can be successfully implemented in real-life settings for an extensive period of a whole year, as opposed to smaller courses lasting only a few semesters (Abbondante et al., 2014; Addams et al., 2014; Brunel & Hibbard, 2006; Ramesh & Gerth, 2015; Saraswat, Anderson, & Chircu, 2014). In addition, during the curriculum integration and systems development we derived several suggestions and lessons learnt from the students and the faculty:

- faculty commitment needs to be concretised by clearly assigned responsibilities, and by tools and processes to manage the integration.
- maintaining day-to-day integration between the simulation and disciplinary studies requires good planning, constant monitoring, and the ability to react quickly.
- successful curriculum integration needs clear, consistent and well-planned communication within the teachers and with the students (c.f. Ramesh & Gerth, 2015).
- using a simulation in the curriculum requires creativity and imagination from the teachers. They need to show example on how to throw oneself into the role-play.
- student motivation requires constant attention: encouragement to take the initiative, justification of the learning methods, and the feeling of balanced workload
- implementing a new system requires a lot of effort: the tools are of little use if people lack the skills or the time.

The holistic business curriculum model has great potential, but it also requires great efforts. The plans often look great on paper but erode when the day-to-day activities take over. This is evident in the past curriculum integration attempts that have not been long-lasting (Athavale, Davis, & Myring, 2008; Strempek, Husted, & Gray, 2010; Liesz, & Porter, 2015). Motivation and mindset have to be built throughout the institution, from the administration to the students. This is easier said than done - but the effort will pay off in motivating learning experiences.

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PUBLICATION
IV

ERP based business learning environment as a boundary infrastructure in business learning

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ERP based business learning environment as a boundary infrastructure in business learning

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Abstract
Business education has been criticized for being theoretical and distant from the dynamisms of the business life. To answer to this criticism, different types of experiential learning environments, such as manual role-plays, computer simulations, and enterprise resource planning (ERP) systems, have been used. In this paper, we study how a holistic learning environment, combining a practice enterprise model, an ERP system and a simulation, improves learning results and why. We present a full-year long case study to compare the learning outcomes of the holistic learning environment with a manually-oriented practice enterprise model. Our findings indicate improvements on different domains of Bloom's taxonomy. We suggest that the improvements are due to the holistic learning environment acting as a boundary infrastructure where the practice enterprise model, the simulation and the ERP system are all different kinds of boundary objects. This boundary infrastructure functions as a point of interaction and communication, and enables the students and teachers to cross social, cultural and conceptual boundaries between different communities of practice, and importantly, between theory and practice.

Keywords Business learning · Boundary object · ERP simulation · Experiential learning environment · Practice enterprise

1 Introduction

In the recent years, there has been much criticism of business education for becoming too theoretical, fractional and distant from the business life (Arbaugh and Hwang 2015; Datar et al. 2011). Business management is much more complex than a set of theories or individual learning topics (Chia and Holt 2008). Disciplinary expertise needs to be accompanied by soft skills such business acumen, communication, teamwork, ethics,

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and social responsibility (Jackson 2009; Jones et al. 2017; Robles 2012). In addition, the business graduates need an integrated perspective to business (Jaiswal 2015).

All this is difficult to acquire in traditional classroom settings where the teacher transfers knowledge to students (Brown and Rubin 2017; Chia and Holt 2008). Instead, education needs to weld together imagination and natural experience in a collaborative process between the students and the teachers (Chia 2005; Lenning et al. 2013).

Several means to provide such an experience exist. For example, business skills laboratory and practice enterprise model mimic real workplaces and place students in physical spaces to participate in a role-play in fictitious businesses, including day-to-day business decisions (Blaylock et al. 2009; Bianchi et al. 2017; Gramlinger 2004). They provide a risk-free training ground to practice business transactions in cooperation with other students and teachers, and promote the learning of soft skills (Borgese 2011; Collan and Kallio-Gerlander 2007). Enterprise resource planning (ERP) systems offer tools to learn business processes (Angolia and Pagliari 2016; Jewer and Evermann 2015). Business simulations provide dynamic learning situations (Anderson and Lawton 2009; Kim and Watson 2018; Tiwari et al. 2014).

Despite the attempts to provide realistic learning experiences, each approach has several deficiencies. The practice enterprise model is in a need of tools and dynamism that information technology (IT) can provide. ERP systems and simulations, on the other hand, lack the holistic perspective. The combination of IT and human-to-human interaction results in more effective learning than the technology or the face-to-face environment alone (Cao et al. 2008). This sets the motivation for our study to contribute to the discussion on learning outcomes and the design of efficient business learning environments: how does a holistic learning environment, that combines a practice enterprise model, an ERP system and a simulation, improve learning results, and why.

The paper is structured as follows. First, we view related research on the practice enterprise model and IT-oriented business learning environments through Bloom's taxonomy. We proceed to introduce a case study that compares the practice enterprise model with the ERP-based business learning environment. Then we review the learning results and continue by discussing the reasons for them. We conclude with discussion, limitations, contributions, and suggestions for further research.

2 Related research

We first view research on the practice enterprise model and IT oriented learning environments through Bloom's taxonomy where learning objectives are classified into three domains: cognitive, affective and psychomotor (Krathwohl 2002). Cognitive domain considers knowledge and comprehension, affective domain attitudes, emotions and feelings, and psychomotor domain refers to skills.

2.1 The practice enterprise model

The practice enterprise model is a virtual company that resembles a company but does not trade actual money or physical products. The practice enterprises manage their internal processes and trade with other practice enterprises (Borgese 2011; Bianchi et al. 2017; Deissinger 2007). The model aims at business and entrepreneurship learning (Gramlinger 2004; Santos 2008) through interactions between real people. It is a non-computer based, interactive role-play simulation (Lean et al. 2006).

The model has positive effects on the affective learning on teamwork, communication and motivation (Deissinger 2007; Glombitza 2012; Greimel-Fuhrmann 2006; Santos 2008), but cognitive, disciplinary learning on business domains and their integration leaves room for improvement (Krauskopf and Frei 2012). Low performing students appear to benefit the most from the practice enterprise activity (Borgese 2001; Graziano 2003).

Despite the benefits, the model is criticized for being artificial and static (Santos 2008; Greimel-Fuhrmann 2006; Neuweg 2014). It does not contain a clear business environment or business scenarios, making it more conceptual and abstract than concrete. It lacks standardization and clear processes. It is a role-play of business operations rather than a concrete practice ground for actual business. It also lacks the concrete tools that modern companies use in their day-to-day operations (Nisula and Pekkola 2012).

2.2 ERP systems

ERP systems are often used in teaching business operations, integrating different disciplines and increasing the business process understanding (Jewer and Evermann 2015; Monk and Lycett 2016; Springer et al. 2007; Zabukovšek et al. 2018). The main learning objectives are ERP system skills and integrating information technology to business (Hepner and Dickson 2013).

Earlier research on the ERP systems has identified transfer of learning (Dunaway 2018) as well as positive learning outcomes in the cognitive domain (Johansson et al. 2014; Jewer and Evermann 2015; Rienzo and Han 2011). In the affective domain, there have been indications of increased motivation, attendance, and engagement (Alshare and Lane 2011; Jewer and Evermann 2015; Scholtz et al. 2012).

However, if hands-on learning focuses on executing tasks and ERP technical skills, the value is limited (Wang and El-Masry 2009). Especially in the large, complex ERP, the students struggle to understand the links between information, business processes, and managerial decisions (Monk and Lycett 2016). When learning is carried out with pre-planned cases (Bradford et al. 2003) or point-and-click exercises (Angolia and Pagliari 2016) learning situations tend to be static and predictable.

2.3 Business simulations

A computer simulation is an exercise involving reality of function in an artificial environment (Thavikulwat 2012) where computer model attempts to reflect the basic dimensions of a business environment (Anderson and Lawton 2009). Business simulations consist of open-ended, changing situations with many dependable variables (Thavikulwat 2012). They are often used in summarizing capstone courses when learning from different disciplines is integrated, although there may also be benefits to using them early in the studies (Angolia and Reed 2019).

ERP-simulations use the ERP system as the student interface into scenarios that are mediated by a simulation. An example of such business simulation game is widely used

ERPSim that combines simulated market data and automated business functions with the user interface of a real SAP system (Cronan et al. 2012; Chen et al. 2015; Labonte-LeMoyne et al. 2017). The ERPSim is normally played in short rounds taking less than a day.

Business simulations have shown to improve learning on the cognitive domain (Anderson and Lawton 2009; Clarke 2009; Cronan et al. 2012; Palmunen et al. 2013; Seethamraju 2011). There have also been positive affective learning results such as increased motivation, improved analytical and decision making skills, transferred knowledge, and engagement to real business situations (Cadotte and MacGuire 2013; Chen et al. 2015; Clarke 2009).

Research on psychomotor or skill-based learning has focused on the progression in the simulation performance rather than business task performance. Several studies indicate improvement between the beginning and the end of the simulations (e.g. Davidovitch et al. 2008; Olhager and Persson 2006). Pasin and Giroux (2011) detected that the simulation aided those who had learning deficiencies from the lectures.

Business simulations also have their drawbacks and challenges. They emphasize strategy formulation and management decision making (Faria et al. 2009). When they aim at reproducing multi-faceted business problems, they often become too complex for the students to comprehend (Teach and Murff 2009). In fact, rather than focusing on recreating actual business problems, simulations should create the feeling of real situations (Kibbee 1961). Simulations are typically played in short rounds where the time lapses in compressed business episodes, further reducing the feeling of reality (Lainema and Makkonen 2003). In addition, for a simulation to be a real learning experience, all participants need to have some degree of commonality in understanding the simulated environment (Teach and Murff 2009).

The communality can be provided by the practice enterprise model, where the core benefit is the interaction between the people. We will next introduce our case that investigates whether a combination yields in improved learning results.

3 The CASE

In TAMK School of business and services, first year business students, fresh from the high school, were taught by using an integrated curriculum approach, supported by the practice enterprise model. This method had been used for some years, so evident improvement needs have emerged, for example the dynamics of a business environment were missing. A project was initiated to replace the practice enterprise model with an ERP-based business environment. This study focuses on the assessment of the learning results in this learning environment change.

Our target is the total population of the two groups of 117 first year students each. The first freshman class using the practice enterprise model is the control group, the PE group. The second freshman class using the ERP-based business learning environment is the experimental group, the ERP group. Both groups followed identical curriculums (Fig. 1), consisting of four modules that reflected the life-cycle of a startup company: 1. Setting up a business enterprise, 2. Running the business enterprise, 3. The profitable business enterprise, and 4. Developing the business enterprise.

Each module combined different disciplinary studies emphasizing its theme. The students were divided into teams, who were supervised, coached and mentored by an appointed teacher-coach. Altogether six teacher-coaches acted as consultants to the other teams, representing different areas of expertise – business law, marketing, accounting, finance, logistics, and management. They also provided most of the disciplinary teaching. The coaches planned each module implementation and held weekly updates to plan the upcoming activities. This setting was the same for both student groups.

3.1 The practice enterprise model

In the practice enterprise model used by the control group, the PE group, the studies included operating a simulated company in a practice enterprise model administered by the national practice enterprise center. In addition to lectures, the student teams worked 4–8 h a week in their simulated companies for one year. They traded with administrator-run and student companies. There was an online bank, but the rest of the business transactions were handled manually with e-mails to and from the national practice enterprise center administrator. The simulated companies and their life-cycles were synchronized with lectures and exercises. For example, when the companies were starting their business, there were lectures on budgeting and financing start-ups. The teams also had a physical "company office" with computers and a mobile phone. The teams were divided into three departments of 3–4 students each: marketing; logistics; and accounting and finance. Each student worked in a department for one module. The teams organized themselves and rotated responsibilities.

3.2 The ERP-based business learning environment

The ERP group used a learning environment where the practice enterprise model was combined to an open source ERP system with a business simulation. The simulation was a fictional city, presented in the form of a web-site with the city facts and links to basic infrastructure providers: real estate, electricity, telephones, insurance, transportation, and health services. The raw market was made of wholesalers that each had a web-store where goods could be purchased. A virtual banking system provided financial

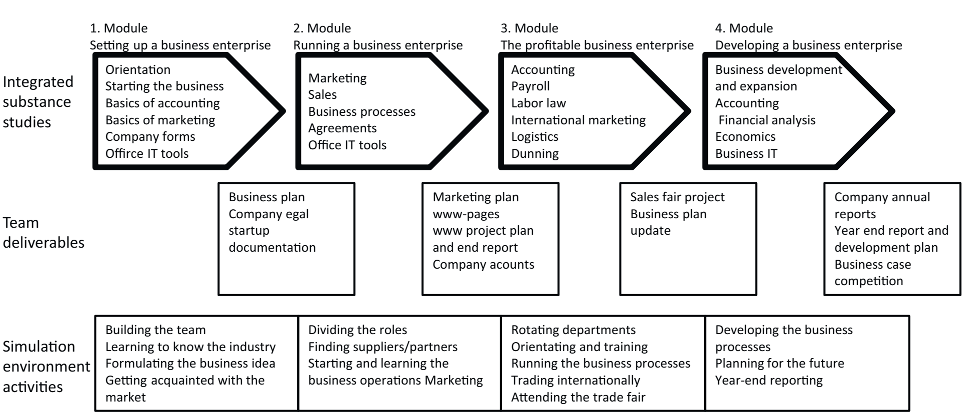

Fig. 1 The first year BBA curriculum

services. Taxes were reported with an electronic tax account. A web publication simulated local media by combining imaginary local news with real external news from rss-feeds. The environment was managed through simulation-generated transactions and activities managed by a systems administrator.

Simulated student companies traded with each other and with the administrator-run companies. They managed their finances in the online bank and their internal operations in the ERP system. The operating procedures were standardized and brought clarity and rigor to the activities. The coach monitored the students' activities and business success through the ERP reporting. The simulation created a momentum by generating consumer demand, again bringing the sense of reality and concreteness.

4 Evaluation of the learning outcomes

4.1 Learning outcomes in the cognitive domain

According to Gosen and Washbush (2004) and Hutchinson (2016), assessing the effects of the simulation on learning, the study should include both pre- and post-tests; and experimental and control groups. Also the importance of defining the learning objectives and identifying appropriate, objective measurements for them, are emphasized (Gosenpud 2018).

The cognitive learning objectives focused on the disciplinary understanding of business management: marketing, sales, logistics, finance, economics, and law. Knowledge levels were evaluated in three phases: at the beginning of the year, in the mid-term and at the end of the school year. An identical set of tests was presented to both groups, being independent from each other.

The pre-test analyzed the students' previous understanding and provided a basis to compare the Practice enterprise (PE) and the ERP groups. As the students had no prior business training or experience, open-end questions were considered a suitable method to evaluate their general understanding. The students were given seven case-questions on different business situations, ranging from starting a company to marketing, production and accounting related issues. The answers for both groups were graded by the same teachers with mutually agreed grading principles on a scale 0–3 (0 = no understanding, 3 = very good understanding).

In the mid-year test, we followed Wolfe's (1985) model on assessing simulation learning on functional business areas and business integration with multiple-choice exam. Our test contained 44 multiple-choice questions on different disciplinary topics: marketing, sales, logistics, finance, economics and law. The disciplinary teachers created the question on their area of responsibility according to the learning objectives. The online test was carried out at the same time to all students to avoid information passing between them. The students were not informed in advance, but they were encouraged to use it as a self-test. The test did not affect their grade.

The year-end test was designed with the same principles. Again it contained 44 multiple-choice questions. The test was not given immediately after the school year in May, but after the summer break, at the beginning of the next semester in August to measure long-term learning effects, not just short-term memorizing.

The number of respondents in each test is provided in Table 1. The total population declined due to absences, dropouts and transfers to other universities. Also, a group of 20 students moved to another department as a normal part of their studies after the first year.

The quality of the test questions was assessed with an item analysis (Livingston 2006). Difficulty index of a question measures the ratio of correct responses to all responses. A high percentage indicates an easy question. The discrimination index of a question describes the ability to differentiate between the more and less knowledgeable students. A discrimination index varies between −1 and 1; and it should be positive to show discrimination. Values over 20% are acceptable, over 30% are good and over 40% are excellent (Ebel 1972). The mean index values for the questions in each test are shown in the Table 2. In the pre-test, the item difficulty was high – as expected, since the students had no prior business knowledge. In the mid-term and year-end tests, the questions were easier. Our questions' discrimination indexes averaged on acceptable level, above 20%. The item analysis thus shows that our test questions were not too easy, being able to differentiate knowledgeable and less knowledgeable students.

Table 3 presents the test results. In the pre-test, the means and the standard deviations were close to each other, indicating that the groups had approximately the same basic knowledge. There were no significant differences between the groups in the mid-term test either. However, the year-end test showed a significance increase in the mean value of the ERP group, indicating improvement in learning. Also, the ERP group had a smaller standard deviation indicating that the test results were less spread out.

A t-test analysis for independent samples was performed to check whether the differences in the results were significant. In the pre-test and the mid-term results the p values were significantly over 0.05. This indicates that no significant differences in the groups' prior knowledge nor learning at the mid–term existed. The p value for the year-end test was 0.005, indicating a significant difference in the results in favor of the ERP group. It thus seems that ERP improved and harmonized learning results.

Figure 2 shows that there are little differences in the score distributions of the pre-test.

The same trend can be observed in the mid-year test, shown in Fig. 3. The PE had a slightly broader spectrum at both ends whereas the ERP group had scores that were more focused on the average 60–70 range. However, there are no remarkable differences between the groups.

In the year-end test, differences between the groups emerged (Fig. 4). The graphs are identical at the higher end of the distribution while low and average scores are significantly improved in the ERP group. This pattern indicates that better students perform

Table 1 The number of respondents in the tests

	Number of respondents	
	PE group	ERP group
Pre-test	117	117
Mid-term	100	101
Year-end	73	60

Table 2 Item analysis of the tests

	Mean for question difficulty indexes	Mean for question discrimination indexes
Pre-test	7%	23%
Mid-term	50%	23%
Year-end	45%	27%

well regardless of the learning environment, whereas lower and average performers seem clearly to benefit from the additional boundary structures provided by the ERP-based simulation. This also suggests some improvements in the long-term learning. This concurs with earlier research indicating that the ERP systems and simulations benefit the lower performers (Monk and Lycett 2016; Pasin and Giroux 2011).

4.2 Learning outcomes in the affective domain

Halfway through the academic year in February, the students were given a questionnaire on the learning environment. Although our main goal was to collect feedback for immediate improvements in the learning environment, the test also allowed us to measure affective learning, since questionnaires are a typical method for that in business simulations (Anderson and Lawton 2009).

Six statements (Likert-scale 1–5) and two open-end questions, based on the curriculum objectives were included: integration between disciplines, overall business process understanding and teamwork. We also wanted to know the effects on motivation and the feeling of versatility for the interests of the learning environment project. Altogether the average Likert-scores were very similar between the groups, and reflected satisfaction and motivation. The highest scores of over 4 for both groups were on applying theory to practice and making studying versatile. The biggest challenge was the division of labor between the team members, scoring around 2.5 for both groups.

The open-end responses contained feedback and learning points. The responses were analyzed inductively, by counting the frequency of different topics. Table 4 shows that both groups brought up similar learning points on teamwork, concrete work-life orientation and connections from theory to practice. The greatest difference was on the practical hands-on approach that was mentioned twice as often in the ERP group than in the PE group. This indicates that standardization and practical tools provided by the ERP system and the business game functionality increase the sense of concrete hands-on work.

Table 3 The results of the tests

	PE group Mean	ERP group	p value	PE group Std deviation	ERP group
Pre-test	62.4	61.6	0.29	0.11	0.10
Mid-term	70.8	69.8	0.16	0.07	0.08
Year-end	57.8	61.8	0.005	0.10	0.07

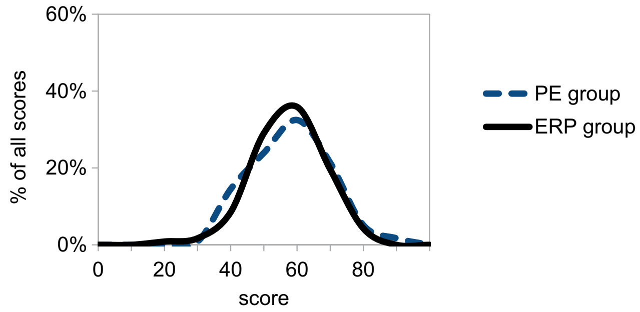

Fig. 2 Pre-test score distributions

4.3 Learning outcomes in the psychomotor domain

An appropriate measurement to assess psychomotor domain learning in both environments was a challenge. During the research process, we found a potential psychomotor measurement within the ERP system: the log files (Nisula and Pekkola 2016). They produce large amounts of transactional and log data. However, they do not serve for comparative purposes since the practical enterprise model does not produce such data.

Efficiency, accuracy, and response magnitude are psychomotor learning outcomes (Sharda et al. 2004). Efficiency is measured in terms of the time to complete a task. Effectiveness can be assessed counting the number of errors committed during task completion. Response magnitude is measured by the complexity of the task completed (ibid.).

We analyzed the efficiency of the order-to-delivery process, the purchase order process, and inventory management process. Psychomotor learning *within* the ERP-based business learning environment was measured by the development in processing times. The sales order processing time declined from fifteen minutes to three minutes, on average, during the course of the simulation. The other processes and their analysis showed similar decline.

Even if we did not find comparative learning data between the practice enterprise model and the ERP-based business learning environment, we argue that using the computers improves the students' efficiency in carrying out the business processes. In addition, the ERP system data repository provides new tools for the teachers to assess and guide learning and yet another common ground to discuss the learning process.

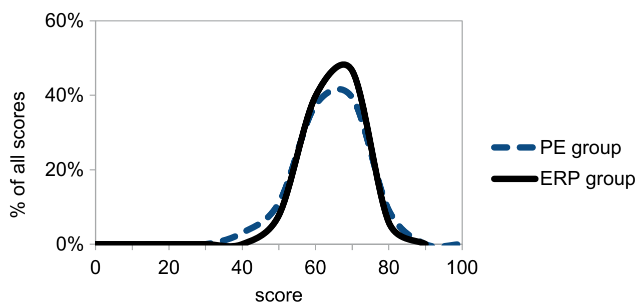

Fig. 3 Mid-term test score distributions

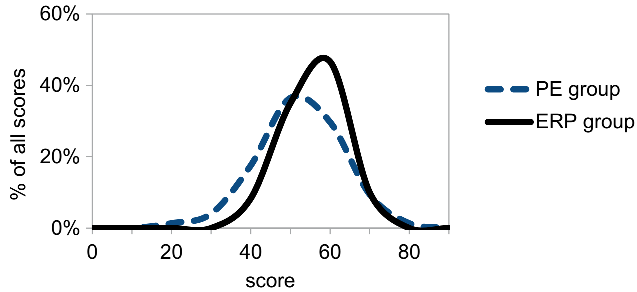

Fig. 4 Year-end test score distributions

5 Why does the ERP-simulation enhance learning?

Combining ERP-simulation with the practice enterprise model seem to improve the poor and average students' cognitive learning. This finding supports earlier research that low-performing students benefit from IT in the learning situations (Monk and Lycett 2016; Pasin and Giroux 2011). In order to understand why this improvement happened, we decided to analyze the situation through the concept of boundary object (Star and Griesemer 1989).

The concept of boundary object is used because learning often involves the crossing of social, cultural and conceptual boundaries between different social worlds of students, academics and business (Akkerman and Bakker 2011; Aprea and Cattaneo 2019). Marketing, logistics, accounting, and other disciplinary communities of practice all approach business from different perspectives. Teachers belonging to the social

Table 4 Frequently mentioned topics in the open-end questions

Discussed topics	Number of times mentioned	
	PE group ($n = 100$)	ERP group ($n = 101$)
1. What works well, what have you learnt?		
Practical hands-on approach	27	55
Team work	42	49
Combining theory with practice	34	31
Connections to real work life	20	20
Versatility, variation and change to traditional studying methods	12	16
2. What does not work well?		
Uneven distribution of work load, free riders	28	30
Technical problems	29	23
Difficulty to draw the line between the simulation and real life	16	20
Scheduling challenges between the simulation and substance teaching	14	17
Problem-based learning orientation	15	16
Lack of instructions from teachers		10
Poor communication by the teachers		9

world of academics aid the students, who in turn, aim at crossing the boundary between novice and expert.

Each community has its own social context, language and concepts (Bowker and Star 1999). Yet different communities need to be brought together to share goals and contributions (Rousseau 2012). In this setting the brokers, i.e. members that simultaneously belong to several communities of practice and form bridges between them by translating, coordinating and creating the alignment of perspectives, are significant players (Cobb et al. 2003; Pawlowski and Robey 2004). The role of a broker is demanding because it requires competence in several disciplines and sensitivity to social cues (Levina and Vaast 2005).

In any organizational context – be it a business organization or a university, the social and the material world are inseparable (Orlikowski 2007). There the actions between people are often mediated by objects (Bowker and Star 1999). A boundary object serves as a bridge between different social and cultural worlds and enables interaction and cooperation without having consensus (Star 2010; Nicolini et al. 2012). It provides a common ground that is "*plastic enough to adapt to local needs and constraints of the several parties employing them, yet robust enough to maintain a common identity across sites.*" (Star and Griesemer 1989, p. 393). A boundary object can be abstract or concrete, but it is always "*something… people act toward and with*" (Star 2010, p. 603). Different communities of practice can use it for their needs. They may use their own representations and terminology but still refer to the same object. This makes cooperation possible.

5.1 Practice enterprise as a boundary object

Analogies and metaphors can act as boundary objects, creating bridges between novice and expert understanding (Bruun and Toppinen 2004). Common discourses enable crossing boundaries between disciplines (Dillon 2008). Dillon (ibid.) analyzed books as boundary objects providing cross-disciplinary discourse. Christiansen and Rump (2008) studied thermodynamics as a boundary object discourse for physics, chemical and mechanical engineering. Münster et al. (2016) used the architectural structure of a cathedral as a boundary object to facilitate cross-disciplinary and expert-novice communication in a learning project.

Boundary objects simplify communication and coordination in multidisciplinary learning. Instead of taking coordination transactions between the disciplines, the actors interact with one common frame of reference, boundary object (see Fig. 5). This boundary object is concretized for example in teaching how logistics and marketing are interrelated. There, a case study, a group project, or some other approach of combining the disciplines is needed. The chosen approach functions as a boundary object, necessitating coordination of activities between the disciplinary teachers. Similarly, another boundary object is needed in illustrating the relations between accounting and sales, and yet other boundary objects to show the connections between other multiple disciplines. The disciplinary integration easily consists of a set of individual, isolated activities. However, a well-designed boundary object may serve several activities and relations. When all disciplines work towards a common boundary object, one artifact provides a common ground for them. The practice enterprise model connects different disciplines and provides a discourse for expert-novice communication. It thus serves as a boundary object, mediating discourse between different disciplines.

The practice enterprise discourse is rather generic and abstract. Highly abstract boundary objects are enough for the purpose of coordination between different communities of practice but, with the aim of creating a common understanding, boundary objects need to be more specific and combined to other objects that support and reinforce each other (Fujimura 1992). With the practice enterprise model, the common understanding was provided by different disciplinary teachers, whose interpretation of the potential of the learning environment varied. Consequently the discourse remained on an abstract level. This kept the students rather distant from the practical activities of the learning environment – as seen in Table 4.

5.2 Simulations and ERP systems as boundary objects

Technology-based boundary objects are "*software tools that adapt or extend symbolic artifacts identified from existing work practice, that are intended to act as boundary objects, for the purposes of employees' learning and enhancing workplace communication*" (p. 17, Hoyles et al. 2010). Examples of information technology-based concrete and specific boundary objects are document archives, database repositories, groupware and collaboration systems, and ERP systems (Forgues et al. 2009; Jonsson et al. 2009; Levina and Vaast 2005; Pawlowski and Robey 2004). The characteristics that make an ERP system a boundary object are modularity, abstraction, concreteness, accommodation and standardization (Abraham 2013; Levina and Vaast 2005). Different departments use only the modules they need. The common reference points between departments are on high levels of abstraction and yet the systems provide concrete tools for day-to-day work. Information in the systems is predefined, enforcing standardized local use and eroding the common perspective.

Simulations can be seen as technology-based boundary objects (Aprea and Cattaneo 2019). Simulations increase inter-organizational learning and innovation (Jensen and Kushniruk 2016; Dodgson et al. 2007). Business simulations contain scenarios where the learning objective is tied to a story or a narrative (Salas et al. 2009). People can create, apply and exchange knowledge through common narratives that allow coordination and interaction without consensus or shared goals (Bartel and Garud 2003). Each individual can interpret the narrative from their own perspective. Case studies, for

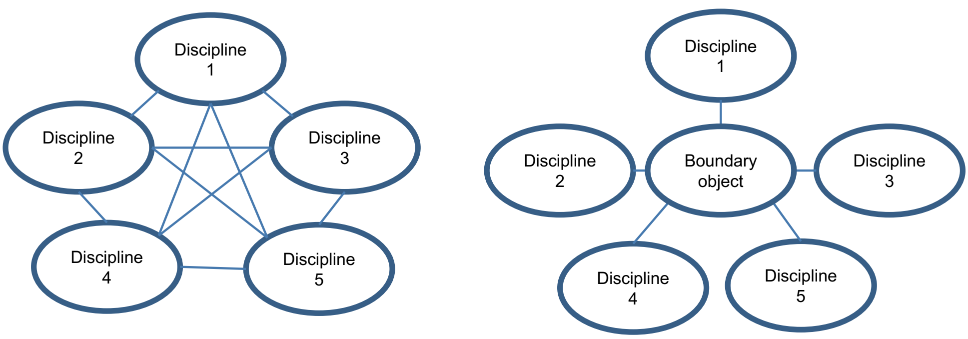

Fig. 5 Boundary object in multi-disciplinary teaching

example, have been used as narratives and boundary objects in the learning context (O'Leary et al. 2016).

In our case the ERP simulation converted the abstract discourse of the practice enterprise into a concrete form with a narrative (stories on the web pages and in the online publication) and concrete artifacts (ERP system, online bank, tax system). The ERP system is a repository for common business data and a platform for learning activities. It supplies tools for *how* to process the common issues across boundaries, and the simulation presents the content of *what* is being processed. Consequently, our ERP simulation provided a map to navigate within and across the other boundaries. With a dynamic business case, this combined the business network of the practice enterprise model to the activities performed in the ERP system. This aggregate became a boundary infrastructure (Star 2010) that is maintained through an interwoven network of related boundary objects (Oswick and Robertson 2009) reinforcing each other (Fujimura 1992).

6 Discussion and limitations

We set out to research whether a combination of an ERP system and a simulation would improve the learning outcomes in the practice enterprise model. The learning results were measured and compared by using two groups; an experimental group and a comparison group. Both groups consisted of the total population of the freshman BBA class. They followed an identical curriculum and 70% of the teachers were the same for both groups. The main difference between the groups was the learning environment. The experimental group studied in the ERP-based learning environment while the control group used the practice enterprise learning environment. The cognitive learning was measured using pre- and posttests that were based on the learning objectives of the curriculum and created by the responsible disciplinary teachers. An item analysis indicated the tests were able to differentiate between better and poorer students. The affective learning was measured using a questionnaire that collected feedback of the learning environment and posed questions about the overall affective objectives of the curriculum.

Our findings indicate improved learning on the cognitive and affective learning of Bloom's domain. The ERP-based environment improved the long-term cognitive learning of the poorer students. This supports earlier research suggesting that ERP systems and simulations benefit the lower performers (Monk and Lycett 2016; Pasin and Giroux 2011).

From the affective learning perspective, both the practice enterprise and the ERP simulation were seen as motivating learning environments, concurring with earlier research (Anderson and Lawton 2009; Greimel-Fuhrmann 2006). The ERP-based environment was particularly appreciated for the hands-on approach. This indicates that real-life tools increase the sense of learning by doing, which has been a challenge in the practice enterprise model (Greimel-Fuhrmann 2006; Santos 2008). The psychomotor learning was measured only *within* the ERP-based business learning environment and therefore cannot be used to assessing learning differences between the groups. The ERP log-file analysis, however, indicated significant improvements in the processing times, implying that some learning had taken place.

The ERP simulation improved the learning results. The practice enterprise discourse has been criticized for being too vague and artificial (Santos 2008; Greimel-Fuhrmann 2006; Neuweg 2014). For the novice students with little business experience, the discourse remains too abstract. The ERP simulation enhanced the abstract discourse of the practice enterprise to a boundary infrastructure that contains concrete artifacts, processes and narrative. This benefited particularly the lower performers.

The business simulation created narrative through scenarios and concrete artifacts, such as the fictional city web page with facts and a map. When the students founded a company, they “rented” an office space that got an address in the map, binding the virtual companies to a visual representation of the narrative. The abstract discourse was reinforced by other objects, suggested by Fujimura (1992): simulated service providers, supplier web-stores and tax officials resembling their real counterparts. The student teams created their own company web-pages to make their fictional company visible to other student companies. They operated in the common environment, combining intersecting social worlds of students and disciplinary teachers. The coaches were brokers at the boundaries representing different disciplines and bridging between the teacher and the student communities of practice.

The ERP system brought standardized forms and processes for running the operations. It made the business concrete and real. The basic data was standardized to keep coherence (Levina and Vaast 2005), but the system was flexible enough for a local student team use. It formed a common ground to discuss business operations among the group of students, coaches and disciplinary teachers. The lack of action (Santos 2008; Neuweg 2014) was tackled with a simulation-generated consumer demand and competition, further enforcing the narrative and the concrete activities in the environment.

When the coaches and the disciplinary teachers wanted to demonstrate a business issue or communicate the meaning of a theoretical or a practical concept, they used the ERP system terminology and the transactions. For example, the logistics teacher elaborated on the order-to-delivery flow whereas the accounting teacher discussed the profit and loss. They were operating through the same narrative of the student company and the artifacts of the ERP system without having to coordinate directly with each other on each exercise.

Using IT systems to monitor processes and event data also provides ways to cross boundaries (Barik et al. 2016; Jonsson et al. 2009). The ERP logs enabled the coaches to monitor learning in a coordinated way and further support the students’ learning efforts (Nisula and Pekkola 2016).

The ERP-based business learning environment was more than just a collection of web pages and ERP systems. It was a common infrastructure where the student companies formed relationships with each other. The teams were free to create their own internal rules and routines, as long as they carried out the required learning exercises. The boundary infrastructure was plastic and adaptive to the needs of the different actors and yet, it provided the common ground. The coaches acted as brokers between boundaries: they mediated between the student, the academic and the business communities of practice.

The role of a boundary object can change over the course of collaboration. A central object can move into the background and back into the center when needed (Nicolini et al. 2012). Representations, activities and physical artifacts are used in learning situations as scaffolds, or temporary supports that improve novice learning and get removed when learning has taken place (Pennington 2010). When an object becomes such a natural part of daily routines and processes that it is no longer thought of, it gets *naturalized*. If a boundary object is naturalized in several communities of practice, it loses its boundary nature (Bowker and Star 1999). When the students started understanding the terminology and processes of the business world, they began transforming from the novice to business professional diminishing the need for the boundary infrastructure to support their learning. Our business learning environment as a boundary infrastructure makes itself obsolete for the students – only to start with the novice students next year.

The greatest limitation is our single case approach. More research is definitely needed in broader settings. The learning tests should be replicated with similar curricular learning objectives. Also the research tools set limitations. The pre-test contained open-end questions, with subjective grading. We coped with this by having commonly agreed grading principles and anonymized answers to minimize intentional bias. Also the same teachers graded both groups. The mid-term and the year-end tests were done as multiple-choice to avoid the subjective grading. The item analysis showed that the cognitive learning tests were able to differentiate between better and poorer students, yet the discrimination indexes were relatively low. However, we did not aim to measure absolute learning per se, but rather the differences between the groups' business understanding. Another limitation is that the students may have underperformed as the tests were not graded. Yet this was the same for both groups. The limitation of the affective learning questionnaire was that it was originally intended for feedback on the learning environment, and consequently did not follow any pre-tested tool. Nonetheless, it reflected the affective learning objectives of the curriculum. Also, although the groups followed an identical curriculum, the differences in teachers caused some changes in the learning situations. Creating identical settings for independent comparison groups has also been a challenge in earlier research (Gosen and Washbush 2004; Gosenpud 2018). In fact, there are very few attempts to evaluate overall learning in simulations (Gosenpud 2018). Although the differences in learning outcomes may not be caused solely by the learning environment, knowing the case, settings, and the methods we argue that the learning environment had a significant impact there.

7 Conclusions

This study investigated how a holistic learning environment, combining a practice enterprise model, an ERP system and a simulation, improves learning results and why. We answered that by presenting

- An implemented example of a boundary infrastructure and a holistic learning environment that combines the practice enterprise model and the ERP-simulation
- Evidence that this holistic learning environment improves the poor and average students' cognitive learning. This is a domain that needs improvement in the practice enterprise model (Krauskopf and Frei 2012). This also supports the earlier research (Graziano 2003; Monk and Lycett 2016; Pasin and Giroux 2011) that the low-performing students benefit from an infrastructure of several concrete boundary objects

- An explanation for the improvements in learning: the holistic learning environment acts as a boundary infrastructure. The practice enterprise model forms the abstract discourse, while the ERP system concretizes it by bringing standardized forms and processes and the simulation constructs into a narrative that ties the boundary objects together. The boundary infrastructure gives a common ground for the students, the coaches and the disciplinary teachers. The ERP-simulation also provides momentum and sense of reality, which are lacking in the practice enterprise model (Greimel-Fuhrmann 2006; Santos 2008). This combination of concrete boundary objects reinforcing each other supports the creation of mutual understanding (Fujimura 1992) and crossing the boundary from novice to expert.
- Indications on the affective domain areas where the students appreciate the benefit of crossing the boundaries: joining theory to practice, integrating the learning environment to the curriculum and intersecting the social worlds of other students

These contributions will help us in developing learning environments that facilitate the students' transition from novice to professional. The worlds of students, teachers and business professionals are often far from each other. Also, there are boundaries separating the different disciplines from each other. Bridges at the boundaries increase the ability to understand the other worlds. A business learning environment, constructed as a boundary infrastructure prepares the future business managers for the complex, multi-disciplinary working environments in a continuously changing world.

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PUBLICATION
V

Assessing business learning by analysing ERP simulation log files

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ASSESSING BUSINESS LEARNING BY ANALYSING ERP SIMULATION LOG FILES

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Abstract:

Business education is facing increasing pressures to equip graduates with both practical competencies and functional knowledge. In addition to developing authentic learning environments where one can learn those competencies, we need to develop authentic assessment methods. Computer-assisted learning environments, such as business games and simulations, assist in achieving the intricate learning goals, and at the same time, provide copious quantities of data. In this paper, we present an authentic assessment approach to measure the students' practical hands-on activities rather than their theoretical knowledge. We analysed the log file data of an ERP-supported simulation to assess learning in a full year case study with first year BBA students. The analysis firstly demonstrates how and when log files can be used, and secondly indicated positive learning results on the cognitive and psychomotor domains of Bloom's taxonomy. The log file analysis holds potential particularly for formative assessment to guide the student's learning process during the simulation. These findings and our lessons learned can be applied to assessing learning in computer-supported learning environments, particularly in business simulations.

Keywords: assessment, business education, computer-assisted learning, log data, ERP simulation

I. INTRODUCTION

Business education is criticized for giving the graduates a fractional view of business, and not equipping them with the skills that the companies require [Holden et al., 2007; Jackson, 2009; Weber and Englehart, 2011]. Increasing pressure exists to modify education to fit the needs of the rapidly changing business world. As the learning objectives should reflect the competencies required by the industry, the assessments should also include practice-oriented components that are applicable in professional contexts. Instead of assessing the learner's ability to write about good practice, the measurements should aim at how the student can put his/her knowledge and learning into practice [Brown, 2004]. The focus on real world activities also makes the assessment meaningful and motivational to students, which correspond with better learning outcomes [Sambell et al. 1997].

The essence of business management is to control and manage multiple demands at the same time in many areas of expertise, and in a continuously changing environment [Chia, 2005]. This makes the business learning assessment challenging. Traditional assessment methods do not necessarily comprehensively capture all competencies and skills that are essential in modern workplaces, [Pellegrino et al., 2004].

Authentic assessment aims at measuring both competencies and knowledge. It focuses on the real world tasks that should be varying, complex and challenging or create a product as an output [Vos, 2015]. The tasks should also include developmental opportunities with feedback, as well as opportunities for reflection, interaction, and collaboration. One of the main objectives for formal education is to practice a skill or a set of actions [Darling-Hammond and Snyder, 2000].

Computers are increasingly used to bring authentic real world experiences to business learning. For example, business education may use enterprise resource planning (ERP) systems, large software packages used by companies to integrate the transaction-oriented data and business processes [e.g. Ask et al., 2008, Ayyagari 2011; Davis and Comeau, 2004; Targowski and Tarn, 2006]. Simulations, on the other hand, can be defined as being a kind of exercise in an artificial environment [Thavikulwat, 2004]. Business simulations can also be games with built-in rules and roles – and an objective to win [Gredler, 2004]. ERP-based business simulations are considered efficient in bringing the complexities of the real business life into the learning context [Cronan et al., 2012; Léger et al., 2011; Léger, 2006; Seethamraju, 2011].

All these technologies; ERP-systems, simulations, and games; collect large quantities of log data. In this paper, we conduct a case study [Yin, 2003] to identify how ERP-simulation log data can be used for learning assessment. We take the game-based assessment perspective and view learning objectives through Bloom’s taxonomy. We present examples of log file based assessments with a case study of an ERP-based business simulation that is used throughout the curriculum for a whole study year.

The paper is organized as follows. First, we review related research on assessment in computer-assisted business learning environments. Second, we give a brief introduction of Bloom's taxonomy and its usage as the learning objective framework. Third, we describe our illlustrative case study, i.e., an ERP-based business simulation environment and the learning context. Fourth, we provide descriptions of our experiences and suggestions with log file-based assessments from different perspectives of Bloom’s taxonomy. Finally, we discuss the results, present the lessons learned and introduce further research areas.

II. RELATED RESEARCH ON ASSESSMENT IN COMPUTER-ASSISTED BUSINESS LEARNING ENVIRONMENTS

Learning assessment can be described as summative or normative [Black and William, 2009]. Summative assessments test the overall achievements at the end of the learning process. They focus on measuring the competency of knowledge and skills for grading purposes. Formative assessments are done throughout the entire learning process to monitor progress and failure continuously [Boston, 2002]. They are more useful to educators, because they enable the educators to adjust the learning process as it proceeds. One form of formative assessment, feedback, is one of the most powerful ways to improve learning [Black and William, 2009; Loh, 2012]. Next we will discuss different types of assessment alternatives and their experiences in the light of previous research.

Game-based assessment

Instead of measuring knowledge and capability directly, game-based assessment enables us to measure the action and performance resulting in learning [Zeying et al., 2007]. In game-based learning, assessments can be distinguished in three categories: game scoring, external assessment, and embedded assessment [Ifenthaler, 2012]. Game scoring focuses on an achievement of targets or the time needed for reaching a target while playing the game. External assessment is realized for example through briefing interviews, knowledge maps, causal diagrams, test scores, and essays. Embedded assessment is part of the gameplay and does not interrupt the game. It gathers data about the learner’s behaviour while playing the game in the form of clickstreams or log files. Assessing game-based learning is mostly based on summative methods because they are the easiest to implement [Bellotti et al., 2013].

Game scoring

Some computer-assisted business learning environments support the game scoring assessment. Business simulation games, for example, provide measures of business success, such as cumulative profits; return on investment or sales; as well as inventory and asset turnover [Dickinson, 2003; Teach and Patel, 2007]. The games also offer statistics that can be compared to other team results [Markulis et al., 2015; Rudd et al., 2008]. Diverse opinions exist whether the business success in a simulation or in a game is an appropriate measure of learning [Gosen and Wasbush, 2004]. It is criticized for giving biased learning results as mistakes and wrong decisions lower the scores. But those mistakes and errors might actually be the best learning options. Mistakes can also be a source for assessing learning: Pasin and Giroux [2011] analysed the evolution of mistakes during an operations management simulation. They found that the simulation provided significant help to those who did not master all the areas presented in the lectures.

External assessment

Markulis et al. [2015]. have studied how external assessments are supported by different business simulations. For example, some large business simulations contain knowledge based multiple-choice questions or written essays with rubrics that can be tailored by the instructor. Also, assessing can be done with scaled-down versions of the simulation where the student performs the simulation activities individually instead of doing teamwork. Some business simulation assessment tools also provide observational questions that require reflecting the simulation progress, student behaviour, and end result.

Earlier research presents a myriad of summative, external methods for assessing learning in computer-assisted business learning environments [Anderson and Lawton, 2009; Clarke, 2009; Léger 2006; Monk and Lycett, 2011]. Those include self-assessments and surveys; instructors' evaluations of the students; multiple-choice and case-based exams; oral and lab exams; learning logs; take home cases; free recall; mid-term and end-of-the-course evaluations; performance-based testing; and evaluating business success in the simulation. The studies measuring learning outcomes tend to focus on subjective opinions and feelings instead of objective and measured data [Clarke, 2009; Monk and Lycett, 2011]. On the other hand, Cronan [2011] approached subjective learning measurement challenges by comparing self-assessed perceptions to objectively measured learning results and found correlation between them. As a result, he suggested triangulating with different assessment modes to obtain more valid evaluations of the learning objectives.

Embedded assessment

Embedded assessment of computer-assisted learning environments holds interesting potential. Data collected from educational settings has been used to increase understanding of students and their learning circumstances [Siemens and Baker, 2012]. In fact, some correlation between student involvement and his/her online activities have been identified in online courses [Wang and Tucker, 2001; Baugher et al., 2003] and elsewhere [Braender and Naples 2013]. Zhang [2015] found that student login consistency, i.e. how regularly the student was using the simulation, correlated positively with the student's contribution in the simulation, which was measured by peer-evaluation.

In addition to the summative assessments for grading purposes, formative assessments are also needed to guide the students in their learning process [Ifenthaler, 2012]. In business simulations and games, log files provide a new angle to an embedded in-simulation assessment that can be used both for summative and formative perspectives. Earlier research has focused on using log files to detect activity and engagement with the learning environment. We take this further, and study whether log data provides new insights into the learning process and learning assessment.

III. BLOOM’S TAXONOMY IN COMPUTER-ASSISTED BUSINESS LEARNING ASSESSMENTS

Bloom’s taxonomy is a widely used generic classification of learning objectives [Krathwohl, 2002]. It is well suited to develop educational objectives for experiential learning such as business simulations [Cannon and Feinstein, 2005]. The taxonomy is often used as a guideline for assessing learning in computer-assisted learning environments [Anderson and Lawton, 2009; Ben-Zvi, 2010; Ranchhod et al., 2014].

In Bloom’s taxonomy, learning objectives are classified into three domains: cognitive domain referring to knowledge and comprehension; affective domain describing attitudes, emotions and feelings; and psychomotor domain considering mechanical skills [Bloom et al., 1956]. These domains are subdivided into different levels of learning from low level, superficial learning to profound learning.

Assessing cognitive learning

Anderson and Lawton [1988] have described different cognitive domain assessment methods in a business simulation exercise. They list exams on the simulation rules, methods and outputs; exams on conceptual issues; evaluation of a written plan; ability to predict results; performance of the implementation of the team's plan; identification and recovery of mistakes; relative ranking of simulation results; analysis paper; oral presentation; and peer evaluations. Table 1 summarizes assessments that can be used in different cognitive domain levels in business simulation learning.

Table 1: Assessment on the cognitive learning in business simulations [adapted from Anderson and Lawton, 1988].

Learning Objective	Description of Learning	Assessment Process / methods
Basic knowledge	Student recalls or recognizes information	Answering direct questions/tests
Comprehension	Student changes information into a different symbolic form by restating it in his or her own terms	Ability to act on or process (conceptual exams)
Application	Student discovers relationships, generalizations, and skills	Application of knowledge to simulated problems (writing and implementing a plan in the simulation, accurately predicting result)
Analysis	Student solves problems in light of conscious knowledge of relationships between components and the principle that organizes the system	Identification of critical assumptions, alternatives, and constraints in a problem situation (identifying mistakes, recording from mistakes, analysis paper, oral presentation)
Synthesis	Student goes beyond what is known, providing new insights	Solution of a problem that requires original, creative thinking (oral presentation, analysis paper, assessment of one's / team's performance)
Evaluation	Student develops the ability to create standards of judgment, weigh, analyse	Logical consistency and attention to and detail (analysis paper and oral presentation)

We argue that log files could bring yet another perspective into the cognitive learning. Analysing the business processes and transactions in the simulation could aid in assessing the cognitive domain levels of comprehension, application and analysis of knowledge.

Assessing affective learning

The affective domain deals with interests, opinions, emotions, attitudes, and values [Anderson and Krathwolh, 2001]. The five levels of learning as described in Table 2 are receiving, responding, valuing, organizing, and characterizing [Krathwohl, Bloom and Masia, 1964].

Feelings and emotions are difficult to measure objectively. In business simulations, they are most often assessed with self-reports or questionnaires, measuring the students' attitudes towards the discipline or the simulation itself [Anderson and Lawton 2009; Clarke, 2009]. Despite its convenience, Picard et al. [2004] criticize the reliability of self-reported information. It can be coloured by the person's ability to articulate his/her feelings or reflections on how the report will be perceived. Instead, they suggest emotion recognition technologies that operate with sensors and cameras to recognize patterns of behaviour and attach them to the affective state of learning.

Before the ambitious techniques suggested by Picard et al. are widely available, we need to rely on more conventional technologies. We therefore suggest the use of a combination of evaluation methods, for example as presented in Table 2. Apart from Birbeck and Andre [2009], the studies have not directly addressed the objectives of affective domain. However we argue that these methods are appropriate.

Table 2: The affective learning objectives and suggestions for evaluating them in business simulations.

Learning Objective	Description of Learning	Examples of evaluating learning
Receiving	Student pays passive attention	Log file analysis on whether student is using the system [Zhang, 2015]
Responding	Student participates actively in the learning process	Questionnaire on student attitudes and perceptions [e.g. Hopkins and Foster, 2011, Chang et al., 2003] Observation of student behaviour [Antonucci and zur Muehlen, 2003] Log file analysis on how active the student is in the system [Zhang, 2015]
Valuing	Student attaches value to the learnt content	Questionnaire on student attitudes and perceptions [e.g. Hopkins and Foster, 2011, Chang et al., 2003] Peer assessment [Kwan and Leung, 1996]
Organizing	Student organizes the values, information and ideas into his/her own value system, resolves conflicts and elaborates what has been learnt	Focus group [Monk and Lycett, 2014] Interview and observation [Henriksen and Boergesen, 2015] Reflective writing [Boyd, Dooley and Felton, 2006, Wills and Clerkin, 2009] Debriefing discussion [Fritzsche et al. 2004]
Characterizing	Student consistently acts in accordance with the internalized values	Group reflection during and after the process about the roles and responsibilities that were originally agreed upon [Birbeck and Andre, 2009]

We claim that log files can give direct indication of the learning objectives of receiving and responding. In addition, they provide a concrete and realistic view on the activity levels that can be discussed in debriefing sessions, instructor evaluations and group reflection. As Picard et al. [2004] point out, self assessments tend to be bias. The students do not always see their own behaviour in a realistic light or they may intentionally want to give a better impression of their performance than what it actually is. Or conversely, the student may appear to be passive or lack interest, but the log files show high activity.

Assessing psychomotor learning

In the psychomotor domain, learning objectives address the change or development of behaviours, or capabilities such as efficiency and effectiveness [Zeying et al., 2007]. The six levels of learning as described in Table 3 range from the state of sensing stimulus and recognition of one's abilities and limitations to the mechanisms that form habits and abilities to use skills in new situations – just like expected by the industries [Simpson, 1966].

Comparing the simulation success to later career success has been used in evaluating psychomotor learning [Anderson and Lawton, 2009]. However, that approach cannot be used as an assessment method in education for obvious reason. Instead, we have collected a number of evaluation methods from previous simulation studies that could be harnessed to assess psychomotor learning. This is presented in Table 3.

Table 3: The psychomotor learning objectives and suggestions for evaluating them in business simulations.

Learning Objective	Description of Learning	Examples of evaluating learning
Perception	Student is able to sense objects, qualities and relationships via sensory organs	
Set	Student recognizes his/her own abilities and limitations	
Guided response	Student is able to perform a specific act under the guidance of the teacher	Observation of student behaviour in the classroom
Mechanism	Student is able to perform habitually without guidance	Log file analysis on how the student performs [Zhang, 2015]
Complex overt response	Student is able to perform a complex pattern of acts	Peer assessment [Kwan and Leung, 1996] A new round of the simulation (game) done individually [Markulis et al., 2015]
Adaptation	Student can alter an act to meet the demands of a new situation	Student monitoring [Wellington et al. 1995] Analysing mistakes [Pasin and Giroux, 2011] Peer assessment [Kwan and Leung, 1996] Testing the learning in another simulation setting [Monk and Lycett, 2014]
Origination	Student is able to develop new acts by applying unrelated skills	Student monitoring [Wellington et al. 1995]

We again suggest that log files could be used to assess psychomotor learning, particularly from a formative, guiding perspective. For example, time stamps would indicate whether the activities have become mechanistic. Error logs would detect the correction needs in the behaviour and would particularly help in mentoring the students' learning activities to right direction.

IV. ASSESSMENT IN CONJUNCTION WITH A BUSINESS SIMULATION

Next we will give an example of an assessment in a business learning environment that uses an ERP business simulation. The simulation was used in an assisting role, as a part of a “business skill laboratory” [Blaylock et al., 2009] where students worked in physical office spaces and operated with fictitious businesses, making day-to-day business decisions. The learning environment combined role-play, physical office spaces and the open source ERP system with other learning environments and methods such as classroom lecturing, group work, reports, and exams. The learning environment was the foundation the entrepreneurship oriented curriculum throughout the first year of BBA studies.

We present a retrospective analysis of 117 students operating in the learning environment for a full academic year 2010 at Tampere University of Applied Sciences (TAMK) School of Business and Services. In addition to demonstrating how log files were used in assessing affective learning, we also suggest additional methods of using them in other domains.

The learning environment and the curriculum

TAMK first year BBA studies focus on gaining the basic understanding and skills of business management: marketing, sales, logistics, finance, economics and law. The first year curriculum consists of four successive 10-15 credit unit modules that follow the life cycle of a company: 1. Setting up a business enterprise, 2. Running a business enterprise, 3. The profitable business enterprise and, 4. Developing the business enterprise. Each module lasts a quarter. In addition, there is a module called “The skills and competences for working life” continues throughout the year. It has the goals of team work, responsibility, commitment, critical thinking, creativity, ability to tolerate changes, cooperation skills, and acting in the organizational environment.

In the beginning of their studies, the students were introduced to a fictitious market area, presented through a set of webpages. The area included bank, wholesalers, infrastructure providers and government authorities. The students were divided into teams of ten, each team having three departments: marketing, logistics and accounting. The teams were instructed to establish a company in a specific business area, such as office equipment, IT appliances, or work clothing. The students wrote business plans and negotiated funding with the bank, the roles played by actual bank managers.

Next, they acquired the infrastructure needed, i.e., office space, telephones, electricity, and insurances. Virtual companies provided these services. There was a virtual online bank, administered by the learning environment administrator. The students communicated with the administrator-run companies through webpage feedback, order forms, and e-mails. The simulation also contained a business game element, which created consumer demand by generating purchase orders. Web-based wholesale stores were the source for raw materials.

The students conducted their business activities within an open source ERP system. They used it to generate sales and purchase orders, manage inventories and control expenses. The instructors were able to monitor the student companies’ activities and business success through the reporting tools of the ERP system.

After the initiation phase, the students began their businesses with other student companies and the administrator-run companies. The student company life cycles were integrated into the curriculum to create a consistent learning experience. For example, when the students began their businesses, there were accompanying lectures on budgeting and financing start-ups. Each team was also assigned a supervising instructor who mentored them in the learning environment. The students worked in their virtual companies 4-8 hours a week over one academic year, concurrently with their regular studies, lectures and workshops. Each student worked in one of the company's departments for one quarter. At the end of each quarter, the roles rotated. Throughout the year, the students recorded their working hours into the ERP system's work reporting system. The purpose was both to get them familiar with the workplace routines as well as gain data for guiding and assessment purposes.

THE ASSESSMENT PROCESS

The first year BBA studies had learning objectives in all Bloom domains. Obviously, there was a lot of cognitive learning on the different disciplines. But the affective element was also in focus, particularly on the work life skills. The knowledge and attitudes were required to present themselves through behaviour, bringing in the learning objectives of psychomotor domain.

In the beginning of each module, learning objectives and grading criteria were given to the students. In the end of each module, the students were graded by the criteria: 60% of the grade consisted of individual deliverables on the cognitive domain (tests, reports, assignments); 15% was individual performance (affective and psychomotor) in the virtual company assessed by self-, peer, and instructor evaluation; and 25% came from team deliverables, such as the business and marketing plans, project plans and financial reports. The full year module, "The skills and competencies for working life" focusing on the affective objectives was assessed with a portfolio and a learning diary.

Using log files in the affective domain assessments

In the end of each module, the students graded themselves and their fellow students on the individual performance. They also wrote a verbal justification for the grade. The instructor made a summary of the feedback and reviewed it with each student personally in the form of an employee review. The assessment was formative and used as a basis for immediate improvement, not only as result assessment.

The instructors were able to utilize log files as one indication of student activity. They were able to get a performance data report by a student company. The report included elements, such as

- The number of master data (customers, suppliers, and products) by the individual student, by the team, and comparison to the whole class average
- The number of transactions (sales orders, purchase orders, bank transactions, and CRM activities) by the individual student, by the team, and comparison to the whole class average
- The amount of working hours reported by the student him/herself

The instructors were able to compare the student's own perception to the peer perception of the student's work and the actual work performed. This provided for a fruitful feedback discussion. In addition, the instructors were able to use the standard ERP reports, for example on sales, financial statements, and inventory to guide the student teams in their learning process. Without the log data, the instructor would have relied solely on the students' perception of the situation.

The potential of using log files in the cognitive domain assessments

The cognitive assessments were done on more traditional methods, evaluating the outcomes of the individual and team assignments. However, in the retrospective analysis of the learning environment, we came up with new ideas to utilize log files in cognitive and psychomotor assessments. We will next illustrate and analyse them.

The ERP system records every user's transactions. Different activities and phases in the business processes are time stamped. Also, error situations can be found in the system logs. These log files can be analysed, for example to see what kinds of operations the student or his/her team has done; how much time they have spent on different business activities and processes; and what kinds of errors, mistakes, or wrong decisions they had made.

To test their usability, we studied the log files by retrospectively analysing the order-to-delivery process. The process integrates many internal business functions, processes and external parties, such as customers and suppliers. When a customer orders a product, either raw materials or goods need to be ordered from the supplier. Then, an appropriate entry has to be made into the inventory so that the material/good can be delivered to the customer. Finally, the customer needs to be invoiced. The order-to-delivery process, illustrated in Figure 1, takes place entirely within the ERP-based learning environment.

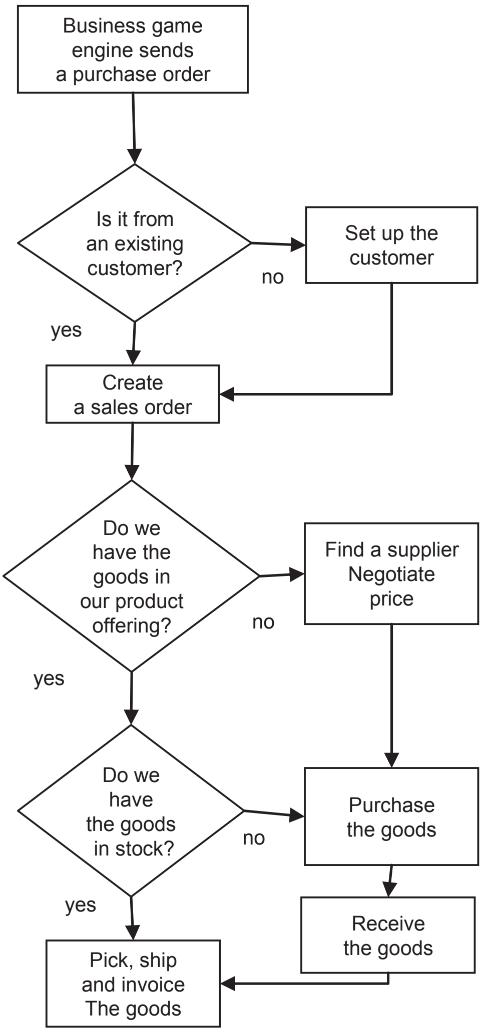

Figure 1: Order-to-delivery process in the ERP-supported learning environment.

To evaluate how the order-to-delivery process had evolved over the course of the pilot year, a sample of 111 orders from the ERP system log files were identified. The sample contained order-to-delivery chains that were traceable throughout the system. The limited sample size was due to technical challenges during the pilot program implementation. Nevertheless, it still provides an example in measuring the learning outcomes. For instance, improvements in the order cycle time, i.e., a shortening of the time period, from the purchase order creation date to the invoicing date reflected some level of learning. In fact, after the training period in October, the average order cycle time declined from 72 days down to a few days (see Figure 2).

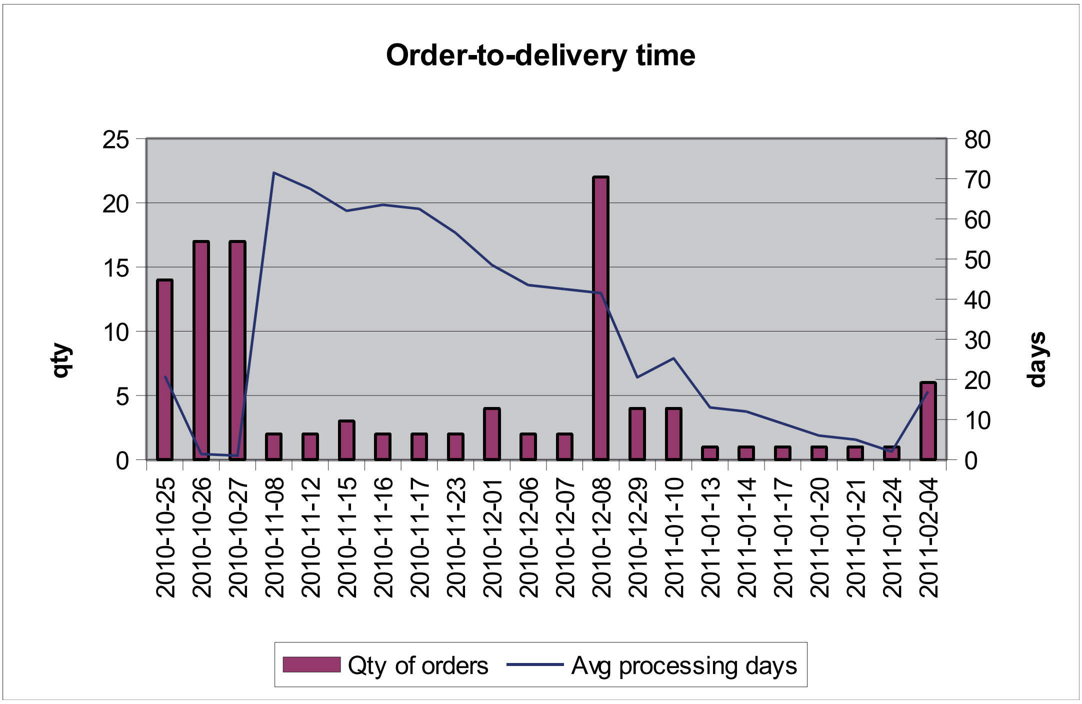

Figure 2: The weekly development of order-to-delivery time in the ERP-supported business learning environment.

The decline can be partially explained by the decreasing number of loops in the process; once a customer has been set up, the next sale activity to the same customer is streamlined. Yet, this is only a partial explanation to the lead-time reduction. One may as easily argue that the students have learned something because of the steep decline in processing times observed in December 2010. The students had learned to order supplies, update inventory, and invoice customers. The variance between the teams was also reasonably consistent throughout the year, which may correlate with the team composition. However, the sample is too small to produce conclusive, objective results on the learning effects. Despite this flaw, the approach offers new possibilities for measuring learning outcomes within computer-assisted learning environments with available log data.

Aforementioned measurement focuses on team learning, not on individual learning, as the order-to-delivery chain requires the involvement of both the sales and the logistics departments. Because the students worked in teams, extracting an individual student's learning curve is impossible. One active student can compensate another's poorer performance. Yet, this seems a truly authentic, ”in-game” assessment; it is not a test where one has to provide answers, but it demonstrates the hands-on, practical work that the students are intended to learn. They were not aware they were measured; they simply performed their work.

We identified the use of order-to-delivery measurement after the ERP-based learning environment pilot program was evaluated. The measurement requirements were not a part of the ERP-based learning environment specification, and the system was not designed to measure the entire order-to-delivery chain. To conduct this simple evaluation, we had to collect the data from many different places. This fact, obviously, reduced the amount of reliable data and the overall reliability of this evaluation. The issue could have been resolved simply by designing the measurements concurrently with the design of the learning environment and the learning process.

The potential of using log files in the psychomotor domain assessments

Similar to the cognitive assessments, we found that the log files offer interesting possibilities for assessing learning in the psychomotor domain. To demonstrate this, we did a retrospective analysis on the time spent on basic business processes: sales order, purchase order and inventory management processing. We now present how the sales order processing time developed for the whole student group.

The sales order process in the ERP system is illustrated in Figure 3. Each step in the process is logged with a time stamp. We measured the sales order processing time as the time difference between entering the order header and creating the invoice. In the simulation, 1046 sales orders qualified as valid research data[1].

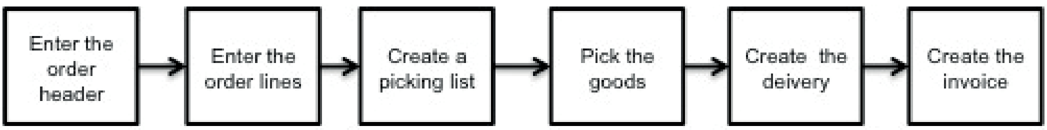

Figure 3. The sales order process in the ERP-supported business learning environment.

The average order processing time (Figure 4) declined from fifteen minutes to three minutes over the course of the academic year. As the sales order process is a straightforward and frequently repeated process in the simulation, it is logical to argue that there was some development in psychomotor skills.

[1] Of the orders, 30 were excluded because their processing time lasted several days. They were considered forgotten and not relevant for measuring the psychomotor learning objectives.

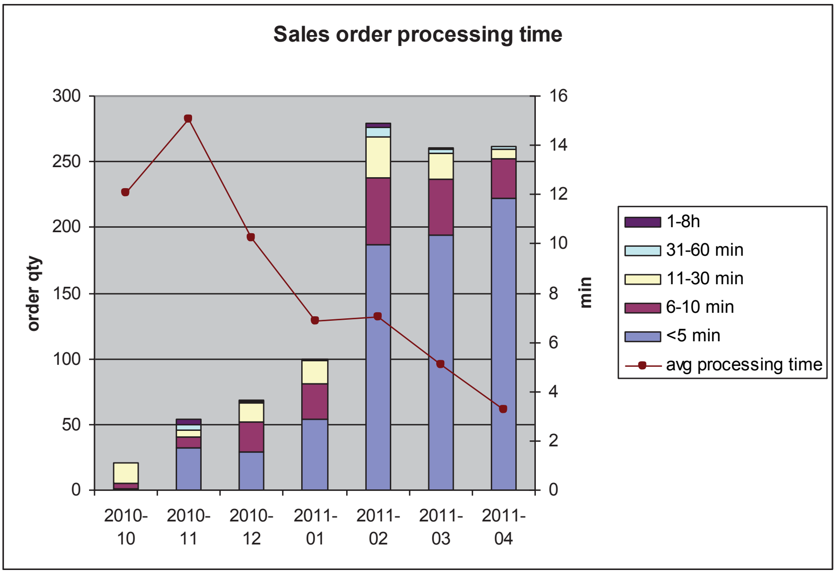

Figure 4. The sales order processing time during the simulation.

We conducted similar analyses for the purchase order and inventory management processes. Purchase order processing time declined from five to three minutes. The inventory processing time declined from 1.1 minutes to 0.6 minutes. This measurement provides an interesting angle from which to assess psychomotor learning in ERP-based learning environments: If the assessment results were presented on an individual level, the student performance could be compared with the average performance of all students. If the value were much lower than the average, we could drill down the process further to see if a particular part of the process is challenging and give the student guideline to additional learning. Another interesting source of analysis would be error logs: does the student have more errors than the average of all students? Are the errors concentrated on a specific area? Again, these equip the instructor with new methods to guide the student's learning efforts.

This measurement reflects the same benefits and challenges as the earlier order-to-delivery cycle analysis. Our analysis was not a separate test but measured genuine work. Contrary to the order-to-delivery chain, an individual student controlled this chain, enabling individual level measurement. Additionally, because the sales order process was simpler to measure than the entire order-to-delivery process, the standard ERP-system reporting tool provided reliable measurements. However, the concept measured – order processing time – is also much simpler.

V. DISCUSSION, LIMITATIONS AND FURTHER RESEARCH

Learning business management is much more complex than acquiring a set of theories or individual learning topics [Chia, 2008]. Assessments should reflect that diversity. Instead, they have traditionally focused on cognitive outputs and affective self-assessments. It is beneficial to use multiple methods for assessment to create a comprehensive picture of the student’s learning.

Simulation performance is not necessarily an appropriate measure of learning because mistakes lower the business success [Gosen and Wasbush, 2004]. But in fact, mistakes may be the best learning situations. Also, simulation performance is a result of team efforts. An individual student may learn poorly even if the team’s business is doing well or vice versa.

The log file activity levels can indicate affective learning [Zhang, 2015; Wolfe, 2013a; 2013b]. They are free from the bias of the self-assessments noted by Picard et al. [2014]. Following Thavikulwat's [2012] idea of measuring learning curves through the simulation company life span, we expanded the log file perspective to time spent in each process to get indications also of the cognitive and psychomotor learning. The initial results appear promising: the development of skills can be detected through a simple log file analysis.

The log data does not give a comprehensive picture of the student's involvement in the simulation. It is possible that the student is active in the ERP simulation business transactions but takes a more passive role in the discussions, decision making and role-play that happens outside of the ERP system. Also, the activity in the simulation does not necessarily result in learning. That is why these measurements need to be complemented by other self-, peer, and instructor assessment methods - thus following Cronan's [2011] suggestion of triangulating with several methods. This type of a 360 assessment also reflects the performance assessments in real business life: the employees may be assessed by their managers, their peers and also by their concrete performance.

The log data holds potential for formative assessment. Master data entries as well as business and bank transactions indicate the student's engagement in the learning environment. In the case example, instructor was able to check whether the student is active or passive, and provide feedback during the learning process accordingly. Additionally, detailed process logs could be used to detect of how the students perform on individual tasks. The amount of time a student spends on a process could be compared to the average time and potential learning challenges could be detected. We measured the time an individual student spent on sales order, purchase order, and inventory management to see skill development on individual business processes. Such log data is easily extracted from a standard ERP system. Similar measurements could be used as an indication of learning also in ERP systems training.

Activities and processing times in more complicated processes that involved more than one student, such as order-to-delivery, were more difficult to extract from the system, but they could provide interesting insights into the team behaviour and learning. The processing times could be compared with other teams. They could also be basis for analysis and discussions within the simulation teams. Error logs were not utilized in this study, but they could provide information about where the students need assistance. That remains a potential area for further research.

We have not checked how the individual processing times or quantities correlated with the student's learning outcomes measured with traditional, external assessments. That would also be an area for further research.

The evaluation of learning outcomes lacks rigor if available tools are not able to provide adequate amounts of reliable data. This is often a challenge when developing and piloting new systems and environments [c.f. Pekkola, 2003]. Therefore, the learning assessments can best be implemented after a pilot phase. Nevertheless, the measurements should be designed simultaneously with the pilot project design [c.f. Oinas-Kukkonen et al., 2010] to enable reliable data collection on the students' activities. This requires long-term projects to create and implement reliable and accurate learning systems with built-in measurement features.

VI. CONCLUSIONS

Assessment is an important part of the learning process. The industry requirement for business competencies calls for authentic learning tasks, environments, and also authentic assessments [c.f. Nisula and Pekkola, 2012]. The diversity of business operations emphasizes the importance of evaluating learning from many perspectives. In addition to being authentic learning environments, ERP-systems and business simulations collect data of the learning process and offer monitoring capabilities. Student involvement in a business simulation is very important for the student's learning, and yet the activity levels have received relatively little research attention

[Zhang, 2015]. In this paper, we have studied how log files, generated by the ERP-based business learning environment, can be used in assessing student involvement and learning. As a result, we offer the following contributions:

- Business management requires a complex combination of knowledge, attitude and skills. This article contributes to the discussion of how to expand the assessment of those skills from the narrow focus of cognitive outputs and self-assessments to include objective, concrete performance measurements. So far learning evaluations in business simulations have concentrated on perceived cognitive learning or attitudes towards the learning environment [Anderson and Lawton, 2009]. We have taken a step further and collected a set of methods that would be suitable for assessing different levels of affective and psychomotor domains.
- The log files provide a useful addition to the traditional assessment methods business learning in all domains of Bloom's taxonomy. Student skill weaknesses and motivation to engage with the simulation are some of the key issues of simulation assessment [Vos, 2015]. The log file data from the business processes and transactions of the ERP systems and business simulations provides material for embedded assessment. It can bring valuable insights into the learning, supplementing the subjective perspective of self-assessment. It also provides a concrete perspective for reflective discussions. Affective learning can be detected from *how active* the students are in the simulation. Cognitive and psychomotor learning can be indicated through *how well* the students perform in the simulation activities. In particular, these measurements are useful as formative tools to guide the students already during the learning process. The more passive students can be encouraged to participate more, whereas the students making mistakes or taking longer time than average, can be instructed appropriately.
- The ERP-supported business learning environment enables business learning. The log file analysis showed significant decrease in the processing time, indicating learning in the cognitive and psychomotor domains.
- The assessments need to be part of the learning environment design from the very beginning. Assessment strategies in business simulations have received little attention even if they are an important part of the learning experience, [Vos, 2015]. When learning and assessment strategies are planned together, the assessment becomes a natural part of the simulation and the infrastructure can be built to support the assessment activities.

Log files in computer-assisted business learning environments propose interesting potential for assessment purposes. The learning objectives and the assessment angle have to be included in the process early on as the environments are being developed. Data produced by the systems does not replace traditional assessment methods, but rather it presents a valuable addition to evaluate the students' learning and support their learning process even better.

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