Facilitating students’ learning outcome of business processes using an ERP

Abstract

A recurring problem when teaching Business Process Orientation (BPO) is the difficulty students have connecting conceptual knowledge and procedural knowledge. Literature suggests that one solution is to combine different forms of learning, such as hand-on exposure to enterprise resource planning (ERP) together with traditional teaching. This article presents a three step teaching case designed by the authors in order to explore students’ learning outcome by using ERP systems together with BPO. The learning outcome of the students was analysed with a focus on connections between conceptual and procedural knowledge. Using Bloom’s revised taxonomy we were able to identify connections between students’ conceptual and procedural knowledge together with the cognitive processes of understanding, applying and analysing. The result indicates that applying procedural knowledge in an ERP facilitates the students’ ability to understand, analyse and evaluate based on conceptual knowledge such as business process orientation.

Keywords

Learning outcome, Teaching, ERP, Business Process Orientation

Introduction

There are several reasons for students in Information systems to use an ERP in educational settings: an ERP is the backbone in many organizations (Strong et al. 2006), the majority of students (in business or IS) will certainly be confronted with ERP in their professional careers (Vluggen and Bollen 2005) and last but not least, ERP has fundamentally changed the business work processes (Watson and Schneider 1999). Since the late ‘90s, universities all over the world have to some extent integrated ERP into educational settings (Antonucci et al. 2004).

One pedagogical reason to use an ERP in education is that hands-on exposure to an ERP strengthens the student’s learning experience (Watson and Schneider 1999). That is, their ability to understand theories, concepts and principles regarding business, management and ERP-computing. Strong et al (2006) proposes the pedagogical reason in a slightly different way, which is that hands-on experience in ERP reinforces theory and principles from the textbook.

During the review on teaching ERP we found many articles that have a focus on the use of ERP in curricula (Peslak 2005; Vluggen and Bollen 2005). According to (Davis and Comeau 2004) there is a lack of articles addressing learning in relation to the use of core business IT tools and management theories. Opposite to the research on curricula, the research in this article takes a learning outcome perspective that is based on students’ gained knowledge and their learning process. Therefore, the research question addressed is: How can a teaching case supported by an ERP facilitate students’ learning outcome? The aim of the research is to identify how an ERP facilitates the learning outcome of students.
This article describes a teaching case where an ERP is integrated into courses (in the first year of a bachelor degree program) as a tool: to concretize abstract knowledge (such as a theory) and to give the students hand-on experiences in the ERP. The teaching case is one example where concepts relating to process orientation are much clearer to students in business process courses that include the use of an ERP. During the students’ first year in a bachelor degree program, half of the courses are in information systems and the other half in business administration. In the courses during the first year, the foundations of ERP and their role in organizations is introduced together with foundations of BPO. In the introductory courses ERP is defined as commercial software systems that automate and integrate many or most of a firm’s business processes (Gattiker and Goodhue 2005).

The challenge for the educators is to integrate different forms of knowledge and learning. We present theories and principles relating to business process orientation (Lockamy III and McCormack 2004) and enable students to (hands-on) execute processes and flows in an ERP designed for small and medium sized organisations. The design of the teaching case was inspired by the twelve step principle (Peslak 2005), which is further presented in section two. The last session of the teaching case was a reflective workshop that was held during the students’ second year. In the research process the knowledge acquired by the students and their learning processes was captured in the reflective workshop and analysed later on. The reflective workshop and the data analysis are presented in section 4. The result of the study indicates that applying procedural knowledge in an ERP facilitates the students’ ability to understand, analyse and evaluate based on conceptual knowledge such as business process orientation. One further contribution of the research is the important connections between the knowledge dimension and the cognitive processes in Bloom’s revised taxonomy (Krathwohl 2002).

The structure of the article is as follows: In the next section related theory is presented such as teaching ERP and business process orientation, the third section presents the Bloom’s revised taxonomy as an analytical lens in analysing students’ knowledge and learning. In the following section, the research setting is presented together with the teaching case. Thereafter, the empirical data together with an analysis is presented. The last part of the article contains a discussion which is followed by the article’s conclusion.

**Related theory**

Since the late '90s universities have integrated ERP into educational settings to make students understand business process orientation (Antonucci et al. 2004). There are examples from business schools and Information Systems departments (Strong et al. 2006) where the schools have used an ERP together with management theories. The business operations are tightly integrated with the ERP covering all operations, including suppliers, customers and other stakeholder’s information systems. An ERP can be regarded as an enabler for organizations to become process oriented (Motiwalla and Thompson 2012). Over the years, ERP has become crucial in supporting the modern organizations’ never ending efforts to be competitive.

Therefore, it is important for universities to integrate ERP in educational settings (Strong et al. 2006), as it is almost certain that the majority of students (in business or IS) will be confronted with ERP in their professional careers (Vluggen and Bollen 2005). In this effort there are several pedagogical challenges for educators designing a teaching case involving an ERP, including balancing between micro level skills, acquisition processes and general comprehension of management theory and principles (Davis and Comeau 2004), as well as designing teaching materials that go beyond the training material provided by the vendors and sample data that supports teaching the different modules such as CRM and HR (Strong et al. 2006).

A proposed approach that addresses the challenges on how to design a teaching case is presented by (Peslak 2005). The approach consists of twelve steps with a strong emphasis on SAP R/3, business function fundamentals, processes and management. The twelve steps are: (1) basic background in business and management; (2) study of business functions; (3) transition to business processes; (4) exposure to SAP R/3; (5) study of theory of ERP including case studies; (6) hands-on SAP R/3 training; (7) hands-on module exploration; (8) new SAP R/3 company setup; (9) setup of all actors, customers, vendors; (10) setup of necessary ancillary hardware/software; (11) standard reporting for SAP and (12) introduction to ABAP.
Having a foundation in business process orientation is the idea of cross functionality and reporting to customers (McCormack 2001). In order to understand business process orientation we adopt the definition of process as a specific order of work activities across time and place, with a beginning, an end, and clearly identified inputs and outputs: a structure for action (Davenport 1993). McCormack (2001) has identified three elements of business process orientation: business process management, process jobs and process view. The importance and benefits of adopting business process oriented perspectives of business value are well recognized within academic literature (Mooney et al. 1996).

In the following section, Business Process Orientation is regarded as one example of Conceptual knowledge and to some extent also procedural knowledge.

**Bloom’s revised taxonomy**

All over the world, educators at universities have been designing and developing course curricula and their learning objectives based on Bloom’s taxonomy. The taxonomy was published in 1956 (Bloom et al. 1956) and is still used by many educators. During the last ten years, a revised version of the taxonomy (Krathwohl 2002) has raised attention among educators and the application of the taxonomy has been growing. The main reason behind the interest is that the new taxonomy is built on how a learning instruction is usually framed: the first part regards the subject (or content) and the other part a description of what is to be done with or to that content. If we take an example from our own field: Which are the main elements in Business Process Orientation (BPO)? The subject is BPO and the task is to describe the elements.

In the revised taxonomy two dimensions, knowledge dimension and cognitive process dimension, are described (Krathwohl 2002). According to Krathwohl (2002) the two dimensions are extracted from the subject and what the students shall do in general learning instruction. According to (Ferguson 2002) and (Airasian and Miranda 2002) the two dimensions guide educators in creating instructions and assessments. The more social aspects of learning such as collaboration between students are not included in the taxonomy (Gerogiannis and Fitsilis 2005).

**Knowledge dimension**

The knowledge dimension contains four main categories (Krathwohl 2002); factual knowledge, conceptual knowledge, procedural knowledge and metacognitive knowledge. The first category; factual knowledge, is described as students dealing with the basic elements within a discipline in order to be acquainted with the discipline (Table 1). The second category; Conceptual Knowledge, contains relationships among the basic elements and the larger structure that enables them to function together. Krathwohl (2002) describes three types of Conceptual Knowledge (Table 1).

<table>
<thead>
<tr>
<th>Factual knowledge</th>
<th>Conceptual knowledge</th>
<th>Procedural knowledge</th>
<th>Metacognitive knowledge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge of terminology</td>
<td>Knowledge of classifications and categories</td>
<td>Knowledge of subject-specific skills and algorithms</td>
<td>Strategic knowledge</td>
</tr>
<tr>
<td>Knowledge of specific details and elements</td>
<td>Knowledge of principles and generalizations</td>
<td>Knowledge of subject-specific techniques and methods</td>
<td>Knowledge about cognitive tasks, including appropriate contextual and conditional knowledge</td>
</tr>
<tr>
<td></td>
<td>Knowledge of theories, models, and structures.</td>
<td>Knowledge of criteria for determining when to use appropriate procedures</td>
<td>Self-knowledge</td>
</tr>
</tbody>
</table>

Table 1: Summary of the knowledge dimension modified from (Krathwohl 2002)

Procedural Knowledge; the third category, is about skills, methods and techniques. The fourth category; Metacognitive Knowledge, is described as knowledge of cognition in general as well as awareness and knowledge of one’s own cognition.
Cognitive process dimension

The second dimension in Bloom’s revised taxonomy is the cognitive process (Krathwohl 2002), often referred to as the verb aspect of the knowledge: What should the students do? There are six categories in the cognitive process dimension; remember, understand, apply, analyse, evaluate and create. Remember is about retrieving relevant knowledge from long-term memory (Table 2). Determining the meaning of instructional message and communication is referred to as understand. The third category, apply, is all about carrying out or using a procedure in a given situation. Analyse, the fourth category, is described as relating parts to one another and to an overall structure or purpose. Other authors, such as (Mayer 2002), focus on analysis as an important learning outcome.

Making judgements based on criteria and standards is the fifth category, referred to as evaluate. The last category, create, putting elements together to form an original product (Table 2).

Table 2: Summary of the cognitive process dimension modified from (Krathwohl 2002)

<table>
<thead>
<tr>
<th>Remember</th>
<th>Understand</th>
<th>Apply</th>
<th>Analyse</th>
<th>Evaluate</th>
<th>Create</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recognizing</td>
<td>Interpreting</td>
<td>Executing</td>
<td>Differentiating</td>
<td>Checking</td>
<td>Generating</td>
</tr>
<tr>
<td>Recalling</td>
<td>Exemplifying</td>
<td>Implementing</td>
<td>Organizing</td>
<td>Critiquing</td>
<td>Planning</td>
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<td></td>
<td>Classifying</td>
<td></td>
<td>Attributing</td>
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<td>Producing</td>
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<td></td>
<td>Summarizing</td>
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<td></td>
<td>Inferring</td>
<td></td>
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<td></td>
<td>Comparing</td>
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<td></td>
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<tr>
<td></td>
<td>Explaining</td>
<td></td>
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</tbody>
</table>

Table 3: Summary of the cognitive process dimension and examples

<table>
<thead>
<tr>
<th>Factual knowledge</th>
<th>Remember</th>
<th>Understand</th>
<th>Apply</th>
<th>Analyse</th>
<th>Evaluate</th>
<th>Create</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conceptual knowledge</td>
<td>Ex 1, Ex 2</td>
<td>Ex 2</td>
<td>Ex 2</td>
<td>Ex 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Procedural knowledge</td>
<td>Ex 3</td>
<td>Ex 3</td>
<td></td>
<td>Ex 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metacognitive knowledge</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The taxonomy table

The two dimensions, knowledge and cognitive process, are related to each other in a taxonomy table (Table 3). Three fictive examples are presented to illustrate how to apply the taxonomy in order to relate students’ learning outcome to the knowledge dimension and cognitive process dimension.

Example 1: Select the basic elements of process orientation and write them in a summary. In this example the important words are ‘select’, ‘write’ and ‘summary’, which correspond to understand and conceptual knowledge (Ex 1, Table 3). The object in focus is process orientation which is an example of conceptual knowledge (Knowledge of theories, models, and structures; Table 1).

Example 2: From an organizational chart (or other description) decide if the organization is process oriented or a hierarchical organization? In this example the important word is ‘decide’, which corresponds to evaluate (making judgments), but first the students must understand (by comparing) and then analyze based on two theories (Conceptual knowledge; Ex 2, Table 3).
Example 3: Create a process model using BPMN on a procurement process in an ERP. In this third example, the important words are ‘create’ and ‘using’ but not only that, the students should also execute (apply) a procurement process in an ERP and analyze (organize) the process which corresponds to procedural knowledge. The students are expected to create a process model which relates to both procedural and conceptual knowledge (Ex 3, Table 3).

The research approach and the teaching case

The research approach in this article is inspired by interpretive and qualitative research (Myers 1997; Myers and Avison 2002). We have applied Myers (1997) framework for qualitative research where the underlying philosophy is interpretive (Walsham 1995). A literature review on ERP together with teaching or education was made in JISE (Journal of Information Systems Education – www.jise.org), AIS electronic library (aisel.aisnet.org) and some highly cited articles from google scholar. The literature review revealed that there were few articles that took a learning outcome perspective. This led us to the research question: How can a teaching case supported by an ERP facilitate students' learning outcome?

The data collected is derived from the teaching case (Next sub section) performed with 20 students during their second year. The teaching case is divided into three steps (Figure 1) and the empirical data was collected during step 3, which was arranged as a reflective workshop. The workshop started with a demonstration of the ERP used in step 1-2, which was performed by students during their first year. Thereafter the 20 students were divided into groups of five students and given four group assignments based upon step 1 and 2 (Figure 1). During the group assignments each group presented their answers in written text relating theories and practices from step 1 and 2.

The analysis on the empirical data was inspired from thematic analysis (Miles and Huberman 1994) where the themes are grounded in Bloom’s revised taxonomy (Krathwohl 2002). The empirical data from the reflective workshop (Step 3 in fig 1) and the actual description of the teaching case was analysed from the knowledge dimension and cognitive process dimensions according to the thematic analysis. In the analysis we especially had a focus on the taxonomy table (Table 3). The rest of this section is a description of the teaching case.

Describing the teaching case

The design of the teaching case was inspired by the twelve step principle (Peslak 2005) presented in section 2. The teaching case consists of three steps described in figure 1. The first step (Fig 1) took place in the introduction course and relates to step 1-5 in (Peslak 2005). The second step (Fig 1) took place on the final course during the first year and relates to step 6,7 and 9 in (Peslak 2005). The remaining steps 8, 10-12 in (Peslak 2005) are not included in the teaching case. In Peslak’s (2005) proposed approach the steps are related to SAP R/3, however these steps are applicable when designing teaching cases using other ERP’s.
while the value chain is used to understand business processes and integrated nature of business functions.

To facilitate the understanding of benefits and problems with the process oriented organization in step 1 (Fig 1), we use an ERP after the theoretical models have been examined and discussed. For the vast majority of students it was the first time they worked in an ERP. The tour within the ERP is led by the instructor were navigation between different modules is performed and functionality is described. During the tour students must register customers, suppliers and articles, as well as specify chart of accounts, fiscal year and manage accounts- and paid attestation in various business flows.

The learning objectives of the exercise in step 1 (Fig 1) was twofold; first to apply a simple procure- and sales process using the data the students have previously registered and secondly to develop an understanding of how cross-functional activities can be supported by an ERP. The cross-functional activities were based upon McCormack’s (2001) second element of business process orientation, process jobs.

At the end of the first undergraduate year, in step 2, the students returned to the managerial theories about process oriented organization (Fig 1). They applied their knowledge gained from the mandatory courses during the first year. The students worked through a case in the ERP on their own that dealt with sales and procurement processes that extend traditional functional boundaries. This relates to McCormack’s (2001) first and third element of business process orientation: business process management and process view.

In step 2, the students made traditional analysis’ of economic measures based on real sample data that they had worked with, such as total net income and net income over a period. The students also made an analysis of the procurement process- and sales process.

Step 3 of the teaching case (Fig 1), the reflective workshop, was conducted with second year students. In the first assignment (A1) the students had to place the different business concepts from a sales process into correct logical order. The students were also asked to write comments and explanations regarding their sales process. The next assignment (A2) in our workshop involved students to reflect upon how they solved their case in step 2 using the following questions: Did they work together outside the groups? Did they collaborate with student groups? Did they use the support function in the system, trial and error or did they ask the teacher? The third part of the reflective workshop (A3) consisted of us asking students to describe in their own words what they have learned by accomplishing the teaching case.

The fourth assignment (A4), which concerned Porters value chain and how it was supported by business processes in the ERP was excluded in the study. The students’ written replies indicated that the assignment was too complex to solve.

**Analysis and discussion**

In step three, the reflective workshop, the first assignment (A1) was to organize business concepts from a sales process (register sales order, offer, register payments, invoice and order) in a logical order from start to finish in the ERP. The result of A1 expressed that all groups had an understanding by organizing the business concepts. The students also expressed analyzing skills by organizing the concepts relating to the sales process in a logical order from start to finish (A1 in Table 4). The interpretation of the written comments by the groups expressed a conceptual knowledge (Krathwohl 2002) by relating the sales process (A1 in Table 4) to the theory of process orientation (McCormack 2001).

In the written comments, one of the groups also added specific details and elements to the sales process and thereby showed knowledge of terminology, “when the customer pays the account receivable disappears and becomes money in the account”. Here we can identify a connection between factual knowledge (Krathwohl 2002) and the cognitive processes of remembering, understanding, applying and analyzing when explaining the business processes in the ERP (A1 in Table 4).

The second assignment (A2) in the reflective workshop handled the way students worked with the teaching case. The written comments showed that trial and error was the first choice by all student groups as one group put it “we just went for it and tried, if it went wrong, we tried again”. Secondly, they asked their fellow students and tried to solve the problems together.
When they worked with the case, the students expressed that they collaborated between groups to solve the assignment. One group expressed it in the following way, “when we were finished we discussed the assignment with other groups that confirmed that we had done the process in a correct way”. The idea of the more social and collaborative aspects of learning is not mentioned in Bloom’s revised taxonomy (Krathwohl 2002). We relate the collaboration between student groups to the cognitive process dimensions of applying, analyzing (Mayer 2002) and evaluating (A2 in Table 4). During the collaboration students evaluated each other’s execution of the sales process (Krathwohl 2002). The students’ expressions concerning their working process indicates insights in conceptual, and in some sense, procedural knowledge (A2 in Table 4). Finally, the students expressed that the lectures and demonstration during the teaching case (Step 1,2) were very useful and supportive when students tried to solve the assignment.

The third assignment (A3) was an open question regarding what the students had learned while working with the teaching case. The students expressed an understanding regarding how an ERP supports the business processes, exemplified by the sales process. Our interpretation is that this statement relates to factual and conceptual knowledge (Krathwohl 2002) as well as understanding and applying in the taxonomy table (A3 in Table 4). Some students mentioned that they gained a more holistic perspective on the business processes and how they are executed in organizations. We relate the holistic perspective to conceptual and procedural knowledge as well as understanding (A3 in Table 4). Our belief is that in order to make an analysis you need a holistic perspective, therefore we connect holistic perspective to the cognitive process of analysis.

In many written comments by the students they claimed that the hands-on experiences in the ERP supported the understanding of activities and their logical order, as one student put it, “now I understand the importance of the process perspective”. The quote by the student connects the ability to apply their procedural knowledge (A3 in Table 4) to an understanding of conceptual knowledge.

In some of the written comments the students discussed benefits from an organizational perspective using an ERP. The students expressed, that the use of an ERP supported the organizations possibility to measure processes and to integrate resources. The students comments are in line with the elements of process orientation (McCormack 2001) which is regarded as understanding and conceptual knowledge (A3 in Table 4). The organizational use of an ERP as a tool for standardisation and streamlining was pointed out in the written comments by the students as an important insight. This insight indicates that the students obtained conceptual knowledge and an ability to evaluate (A3 in Table 4).

In the written comments the students pointed out pedagogical benefits from the teaching case, “easier to understand theories after hands-on practice”, another student expressed that they were, “applying theories learned from other courses”. The third quote we want to highlight is “relating theories to each other” as an important knowledge gained.

The quotes from the students indicate that they obtained an ability to explain and analyse (Mayer 2002) based on different types of conceptual knowledge (A3 in table 4). The students also expressed an ability to relate procedural knowledge to conceptual knowledge (A3 in table 4).

<table>
<thead>
<tr>
<th></th>
<th>Remember</th>
<th>Understand</th>
<th>Apply</th>
<th>Analyse</th>
<th>Evaluate</th>
<th>Create</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factual</td>
<td>A1</td>
<td>A1, A3</td>
<td>A1, A3</td>
<td>A1, A3</td>
<td></td>
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</tr>
<tr>
<td>Conceptual</td>
<td>A1, A3</td>
<td>A2, A3</td>
<td>A2, A3</td>
<td>A2, A3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Procedural</td>
<td>A3</td>
<td>A2, A3</td>
<td>A2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metacognitive</td>
<td>A1</td>
<td>A1, A3</td>
<td>A1, A3</td>
<td>A1, A3</td>
<td>A1, A3</td>
<td></td>
</tr>
</tbody>
</table>

Table 4: Assignments in relation to Bloom’s revised taxonomy

The result of the three assignments in step 3 is related to the knowledge dimension and cognitive processes in table 4. The grey area in table 4 highlights intersections where the assessment of the
students’ learning outcome can be traced from two assignments in step 3. It is worth mentioning that the assessed learning outcomes are placed in the cognitive processes ‘understand’, ‘apply’ and ‘analyse’ together with factual knowledge and conceptual knowledge. Another interesting finding is that the students relate assignment two and three to applying procedural knowledge when an ERP is used in courses together with traditional theoretical elements from academia.

In table 4, the intersection between evaluate and conceptual knowledge is marked in grey due to seeing traces of evaluation regarding conceptual knowledge based on an interpretive deduction, even though it is not explicitly expressed by the students.

In the beginning of this paper the following question was addressed; how can a teaching case supported by an ERP facilitate students’ learning outcome? From a learning perspective the learning outcomes could be broken down into three knowledge dimensions according to Krathwohl (2002). The findings from the teaching case (Table 4) indicate that the three knowledge dimensions; factual knowledge, conceptual knowledge and procedural knowledge, are included in the students’ learning outcomes. It is important to note that the results indicate that integrating an ERP in teaching supports not only procedural knowledge (Table 4) but also a deeper understanding of conceptual knowledge such as students’ ability to analyze and evaluate.

Another aspect that is not included in Bloom’s revised taxonomy, but according to the students is important, is that an enterprise system supports collaboration and communication between students and student groups. In order to analyze all aspects of a learning outcome we need to take in account not only knowledge dimensions and cognitive processes, but also social and collaborative processes. In order to address those social and collaborative aspects of learning maybe future research could relate Bloom’s revised taxonomy with the socio-cultural learning tradition.

Furthermore, our teaching case demonstrates the importance of using an ERP in education for pedagogical reasons. The students were able to connect their conceptual knowledge with the practical use of ERP to understand and analyze both the ERP and business processes.

In the empirical data many of the students commented on the role of the educator. There were comments about the lectures, the demonstrations and also the support from the educator during their work in Steps 1 and 2 in the teaching case. One reflection from these comments is on the degree of involvement from the educator. The degree of involvement from the educator affects students’ approach in their problem solving and maybe also the learning outcome. In some situations the degree of involvement from the educator could be really high in order to facilitate learning and in other situations the educator could be less active in the involvement.

One final reflection from an educator’s perspective on Bloom’s revised taxonomy; it was really useful in evaluating the teaching case and the students’ learning outcome.

**Conclusion**

The aim of the research presented in this article was to identify how an ERP facilitates students’ learning outcomes. Based upon the results, the following conclusion can be made; by integrating an ERP in teaching business process orientation, students achieve conceptual and procedural knowledge together with the cognitive processes ‘understand’, ‘apply’ and ‘analyse’. Another conclusion is that using Bloom’s revised taxonomy (Krathwohl 2002) was relevant and interesting when conceptualizing students’ learning outcome. In order to address social and collaborative aspects of learning outcomes, future research could relate Bloom’s revised taxonomy with the socio-cultural learning tradition.

**REFERENCES**

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