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# Towards Educating Boundary Spanning Professionals across BPM and BI Domains

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**ABSTRACT**

In today's business environments organizations deal with complex problems that require holistic solutions originating from both business and technical domains. Such initiatives require business professionals that have a deeper understanding of the holistic nature of the problems, and can offer integrated solutions that leverage practices from various domains. In order to equip professionals with a cross-disciplinary skill set, we turn our attention to their education. In this paper we aim to open a conversation between both Business Process Management (BPM) and Business Intelligence (BI) communities of educators and contribute towards: 1) setting up a foundation for integration of domain-specific practices, and 2) suggesting learning approaches that facilitate cross-disciplinary education. Specifically, we discuss how boundary objects can facilitate the integration of BPM and BI domain-specific knowledge, and assist in educating the future boundary-spanning professionals. We highlight opportunities for learning at a deeper level achieved by cross-disciplinary education and illustrate the approach with an example of an integrated learning activity.

**Keywords (Required)**

Business process management, business intelligence, integration, boundary objects, spanning, cross-disciplinary education.

## INTRODUCTION

For many years, Business Process Management (BPM) and Business Intelligence (BI) (also known as Business Analytics) have been identified as top organizational priorities, for both business and technical domains (Gartner 2010). Frameworks, methods, and solutions found in both areas, support organizations in solving complex business problems in innovative ways, as well as creating new opportunities for competitive differentiation. In the case of BPM, such differentiation is achieved through more efficient and effective business processes, while BI focuses on more effective use of information for decision-making at all organizational levels. In recent times, both fields have evolved well beyond technology (Davenport, et. al, 2010; May, 2010) and are now recognized as emerging business rather than technical disciplines.

Despite their own independent practices, both BPM and BI communities are now aiming to join forces in exploring and employing new opportunities created at the crossroads of these two disciplines, especially around operational business processes (Davenport et al. 2010; May 2010). Such initiatives are complex undertakings that require practitioners to have a deeper understanding of the holistic nature of the business problem, and to offer holistic solutions that leverage and integrate knowledge and practices from both BPM and BI domains. However, a major challenge is transferring knowledge and practices across boundaries and within different communities of practice (Carlile 2004; Sawyer et al. 2010).

Given the need for such integration and lack of guidance in current literature and practice, there is no surprise to note that the skill level required to take such a holistic approach to business performance is still quite low (Conway and Vasseur 2010). Furthermore, the skill level required goes beyond the data and/or process-centric views of organizational practices, and emphasizes the identifications of the best possible ways to leverage both BI and BPM practices, beyond technology itself. In order to equip business professionals with a cross-disciplinary skill set, we turn our attention to their education.

If our graduates are to cope successfully with tomorrow's business challenges, the role of higher education is to find innovative ways to develop a cross-disciplinary skill set during their education. While the challenges of educating BPM and BI workforce have been identified by the respective academic communities (see, for example Bandara et al. (2010) and Wixom and Ariyachandra (2010)), the challenges of, and opportunities for systematic approaches to cross-disciplinary education are yet to be recognized and explored.

This paper aims to open a discussion between the BPM and BI communities of educators, as well as to make an important contribution towards setting up a foundation for better integration of teaching practices across the two, up to now, quite divergent professional domains. Staring form an integrative framework for managing knowledge across boundaries (Carlile 2004), this research uses BOs and aims to design and evaluate a set of patterns for sharing teaching practices across two disciplinary boundaries (i.e., BPM and BI).

Our main objectives are twofold: 1) to open possibilities for cross-pollination of ideas, sharing and possibly co-design of teaching practices across these two emerging teaching fields in order to develop a more rounded workforce; and 2) to offer potential learning approaches to develop the cross-disciplinary education. We argue that our objectives are both equally important and relevant to other disciplines or domains, let alone the emerging ones, with their respective teaching know-how still evolving, as recently confirmed by Bandara et al. (2010) and Wixom and Ariyachandra (2010).

The remainder of the paper is organized as follows. First, we discuss the need for BPM and BI educational integration. Then, we review relevant literature on boundary objects. Next, we propose an example of a hypothetical integrated learning approach for achieving cross-disciplinary education. Last, we conclude with a discussion of the implications for both practice and research.

## EDUCATIONAL INTEGRATION OF BPM AND BI DOMAINS

To achieve the goal of cross-educational integration, we now discuss the need for integration of knowledge and practices originating from both BPM and BI domains. We then explain why cross-educational integration is needed and required by the two communities of practice.

### The Need for Knowledge Integration

Recently, it has become quite clear that both BPM and BI's views and disciplinary understanding of the fundamental concepts and frameworks, such as "business process", "business Intelligence," or even "business process intelligence" are often very different and mutually inconsistent (Marjanovic 2010), hence the need for a mutual integration. Although achieving a shared understanding of the concepts and frameworks is still a challenging task, it can open important avenues for future dialogue among the two communities, leading to new cross-disciplinary opportunities.

Going beyond knowledge integration, prior research confirms that problems of organizational (both business and technical) integration of BPM and operational BI is becoming an important multidisciplinary task to which solutions cannot be found in the individual domains alone, or even through simple applications of frameworks and methods known in one domain, to a problem found in another one (Marjanovic 2010). By focusing solely on solutions originating in one domain, organizations could miss on a more holistic and integrated solution to their problem, and with limited impacts on improving their performance. That is, the "sum of two parts is greater than its two parts".

Despite, the interests of the two communities to integrate their efforts in a holistic way, organizations find very little guidance in the existing literature, both academic and practice. Apart from recognizing the importance of such integration, the current reports and trade press, both in BPM and BI domains do not seem to provide any systematic approach to crossing the boundaries, let alone sharing of existing theoretical frameworks and methodologies.

### In A Quest for Cross-Educational Integration

In addition to the needs for integrating the content and frameworks of BPM and BI domains, there are other equally important educational reasons for sharing teaching practices and approaches. More precisely, in spite of obvious differences related to the content covered by each domain (process versus data), these two domains share a number of similarities and therefore could benefit from sharing of teaching practices. The following similarities have been identified from very recent literature published in both domains (see, for example Bandara et al. (2010) and Wixom and Ariyachandra (2010)), and are confirmed by our shared experience of teaching in both BI and BPM domains for many years.

From an educational perspective, the two domains have to manage dynamic content, address cross-functional integration, and focus on developing meta-learning skills. Here we briefly discuss each.

First, both domains constantly deal with business challenges that continue to be created by fast-changing, emergent technologies, and a very dynamic and complex business environment. Compared to more traditional and structured teaching disciplines (see, for example, accounting, marketing, finance, science, etc.), with well established content and teaching methods, both BI and BPM domains are treated as emerging teaching disciplines, still without an agreed upon disciplinary body of knowledge ((Bandara et al. 2010; Wixom and Ariyachandra 2010)

Second, compared to the functional specializations, such as accounting, marketing, finance, both BI and BPM domains focus on cross-functional integration, even though their respective approaches are either data or process centric. However, in order to address challenges by functional "silos", it becomes an imperative for cross functional teams to traverse the domain-specific knowledge boundaries and develop a shared understanding of their needs and provide integrated solutions to succeed in their performance improvement endeavors (Reich and Benbasat 2000). Gulati (2007) further supports the argument: "In many organizations their organizational knowledge and expertise are housed within organizational silos, and they have trouble harnessing their resources across those internal boundaries in a way that customers truly value and are willing to pay for."

Third, in today's dynamic environments, the role of higher education is to prepare graduates with skills they require in order to find solutions to ever changing situations and problems. Educators must therefore go beyond building competence (i.e., what students know regarding a domain specific content and knowledge) and focus on facilitating the development of their capability *(*i.e., students' ability to adapt to change, generate new knowledge, and continuously improve their performance) (Fraser and Greenhalgh 2001). Moving beyond content, there is therefore a greater need and emphasis on *meta-learning skills*, that is, the development of students' ability to "learn how to learn" in order to make their skills and knowledge transferable to the future, yet emerging unknown environments. The need for focus on meta-learning is supported by the following quote: "One of the major changes defining the new competitive environment is the requirement to know more about knowing. You are going to have to expand your ability to think critically about your own thinking. Experts sometimes refer to this as meta-cognition: knowing about knowing" (May 2010). Further, latest research on executive decision making puts one's ability to engage in "thinking about thinking" as the best predicator of good judgment, even ahead of one's intuition, experience, or intelligence (Lehrer 2008).

### Educating Boundary Spanning Professionals

Even though their approaches to business problems may significantly vary, both BI and BPM domains are aiming to help future graduates to acquire a unique competitive advantage of becoming boundary-crossing and spanning individuals. By designing learning approaches that support boundary spanning roles, graduates could become the promoters of sharing domain specific knowledge and practices in organizations. "As enterprises drive towards achieving high value and improving customers' experiences, they look to break down internal boundaries and integrate up, down and across the extended value chain … Boundary-spanning roles become pivotal towards the expression and capture of business value." (Gartner 2010)

As both domains focus on improving business performance, each with different, but highly complementary practices, our interest is therefore to explore the most effective ways of educating the future workforce capable to integrate the two different disciplinary mind-sets and create "the sum that is greater than its components." Consequently, we aim to shed light in finding ways of designing and using BOs for educating the future boundary spanning professionals. We focus on the role of BOs in facilitating knowledge integration and cross-disciplinary education, that is, equipping our graduates with an integrated and comprehensive skill set they require to address today's business challenges, especially those found at the disciplinary boundaries.

## THEORETICAL BACKGROUND

Although both BI and BPM domains, on their own, can equip business students with domain-specific skill set required by their industry and practice, we observed that the cross-disciplinary skill-set does not develop automatically when students engage in traditional learning approaches. Given the complexity of both domains' concepts and practices, the development of appropriate learning approaches is a complex process that involves knowledge sharing and transfer across various bodies of knowledge and practices; that is boundary spanning (Lave and Wenger 1991).

In order to address the complex process of boundary-spanning we turn our attention to literature and concepts from organizational science. The organizational literature has distinguished a key concept that helps us understand the process of boundary-spanning: *boundary objects*. In the next sections we introduce and discuss how BOs can facilitate the BPM and BI educational integration.

### Boundary Objects Overview

The term boundary object (BO) has been introduced by (Star and Griesemer 1989) in their study of the ecology of a natural museum. BOs describe things or artifacts that serve as translating devices and are used as shared tools or techniques when solving problems across various domains. BOs can therefore assist in developing and maintaining coherence and shared meanings across intersecting communities of practice, i.e., BPM and BI communities (Bowker and Star 1994).

Example of BOs include: prototypes(Bechky 2003; Carlile 2002), design drawings and use scenarios (Bodker 1998), engineering sketches (Bechky 2003), and standardized reporting forms (Bowker and Star 1994; Star and Griesemer 1989). BOs encompass therefore a broad range of artifacts that are useful in supporting the development of boundary spanning capability (Carlile 2004; Levina and Vaast 2005).

Since their introduction BOs have been used in various fields and domains, among those, information technology, knowledge management, project management, and communities of practice. Specifically, BOs have been successfully applied in contexts such as: new product development (Carlile 2002), design teams (Henderson 1991), and implementation of information systems (Yakura 2001), to name a few.

BOs can bridge knowledge gaps between various domains and practices, and facilitate mutual learning in multi-contextual settings (Carlile 2002). For example, they have been extremely successful in facilitating knowledge sharing in an integrated design process (Carlile 2002), because they possess the capability to drive and facilitate people's behavior and learning (Lave and Wenger 1991). Although BOs have been successful used in a variety of disciplines, to the best of our knowledge, BOs have not been broadly used in education, despite viewing classrooms as perfect environments for their application (East 2009).

BOs display a number of characteristics that are particularly relevant to education and learning. A key characteristic of BOs is that they are common enough to more than one world to be recognized as translation objects, although their meanings vary in the particulars that make them significant in each community (Star and Griesemer 1989). They are robust and plastic at the same time. For example, instructors and students treat a case-based assignment as a set of tasks to be completed and graded (East 2009). Instructors, on one hand, treat the assignment as a way of: 1) assisting students in understanding and applying the knowledge to a specific context, and 2) assessing whether students have done the research needed in completing the assignment. Students, on the other hand, see the assignment as a way to: 1) learn about the content; 2) apply the knowledge acquired; and 3) finally get a desired grade. Despite differences in additional meanings, both communities still maintain a shared perspective on assignment as a task to be completed and graded. Apart from the shared meanings, BOs offer a common reference point; that is, they can be used by different communities for different purposes. For example, students can focus on assignments as a path to a good final grade, regardless of the instructors' focus on the learning process. This characteristic allows BOs to become the basis for meaningful dialogue, engagement, and negotiation across various communities; hence facilitating the process of boundary spanning (Carlile 2004).

### An Integrated Taxonomy of Boundary Objects

As Carlile (2002) suggests, BOs play a key role in establishing processes where knowledge needs to be shared, represented, learned, or transformed. Below, we discuss the taxonomy of BOs with regards to boundary characteristics.

Derived from organizational theory, Carlile (2004) discusses three different approaches to share, integrate, and transfer knowledge across boundaries dividing various domains, i.e., the BPM and BI domains in our situation. Carlile's integrative framework for managing knowledge across boundaries assumes the existence of three levels of boundaries: syntactic, semantic, and pragmatic. Carlile (2004) then suggests that specific types of BOs are required to facilitate the crossing of specific boundaries. Below we briefly introduce and offer examples of each BO type.

#### *Syntactic Boundary Objects*

*Syntactic* BOs are useful for information processing and provide a means for knowledge transfer at a boundary. Syntactic BOs are usually represented in forms of repositories (e.g., databases, libraries) and supply a common reference point of information that provides shared meanings and values for solving problems. Such BOs establish a shared syntax or language for individuals to represent their knowledge. They function successfully as shared resources from which cross-boundary problem solving can emerge. Examples of syntactic BOs and their relevance or implications are discussed in Table 1.

#### *Semantic Boundary Objects*

*Semantic* BOs are needed when novelty or complexity at boundary occurs. They provide a "concrete means for individuals to specify and learn about their differences and dependencies across a given boundary." (Carlile 2002) They serve as translating devices when differences occur or meanings are ambiguous across a boundary. They therefore facilitate the creation of shared meanings and understanding by engaging the communities in dialogue and negotiation in order to solve problems. Individuals belonging to communities change and adapt their domain-specific knowledge and interests in order to reach a shared understanding that facilitates an agreed problem solving approach (Brown and Duguid 1991; Wenger 1998).

Examples of semantic BOs are forms and methods because they provide a shared format for solving problems across different settings (see Table 1). The example in Table 1 illustrates the fact that certain methods at the first sight appear to

have meaning within a specific community. However, by pointing out the links and relevance of the method to the two communities, as well as engaging students in a problem solving task using BS, the method can be seen as semantic BO. Specifically, the use of semantic BOs emphasizes the development of a shared meaning across the boundary when individuals engaging in novel problem solving tasks; that is, the development of a common disciplinary body of knowledge and practices.

| **Boundary Object Type** | **Examples of Boundary Objects across BPM and BI domains** | **The Role of Boundary Objects for Integration** |
|---|---|---|
| **Syntactic** | Any type of learning materials (e.g., learning notes, textbooks, other resources) | • Contain an integrated set of concepts relevant to both domains (see for example, business process, process measure, business intelligence analyses).<br>• Can be stored in learning content repositories such as Blackboard sites, where students can easily access them.<br>• Help crossing the boundary between BPM and BI domains by exposing students to an integrated and common lexicon of terminology.<br>Accessing and exchanging these materials will ensure: 1) the transfer of specific-domain knowledge; and 2) the development of a common disciplinary body of knowledge. |
| **Semantic** | Exposing students Kaplan and Norton's Balanced Scorecard (BS) in both BPM and BI courses.<br>Other forms and methods that provide a shared format for solving problems across different settings. | • Is a method that defines managerial responsibilities and aligns the strategy and measures used to assess (process, but not limited to) managers' performance.<br>• Links strategies to various organizational measures, such as financial, customer, process, and growth measures. On one hand, process measures are directly associated with process monitoring and improvement; hence, it is used by BPM community. On another hand, customer and growth measures can be associated with sophisticated analyses supported by BI tools capabilities; hence, it is used by BI community.<br>• Information related to process measures is also delivered by BI tools. |
| **Pragmatic** | To-Be process models.<br>Simulation tools | • Both students and practitioners when attempting to improve a business process will develop the so-called To-Be models.<br>• These models are developed with different perspectives in mind (focus on activities, a BPM domain, as opposed to focus on information used in activities, a BI domain) and are assessed for their potential consequences using simulation tools.<br>• Recognizing and assessing the organizational impact of consequences will lead to changes in the models until an optimal solution is obtained.<br>• Individuals involved learn and transform the knowledge they produce in form of a solution to a business case. |

**Table 1. Examples of BOs Used in BPM and BI Education**

### *Pragmatic BOs*

*Pragmatic* BOs facilitate a process where individuals can jointly transform their knowledge. By using pragmatic BOs, individuals should be able to represent various forms of knowledge, learn about their consequences, and transform their domain specific knowledge accordingly (Carlile 2004). Using such objects highlights the need of understanding the consequences of a specific solution to a problem that involves crossing a boundary. The pragmatic approach to boundary recognizes the need for a continuous process for transforming existing knowledge in order to address the consequences that might arise. Examples of pragmatic BOs are To-Be process models and simulation tools (see Table 1). From the discussion in Table 1, we can conclude that all individuals involved learn and transform the knowledge they produce in form of a solution to a business case.

Although, each boundary is spanned with the use of a specific BO type, Carlile (2004) suggests that all three BO types have an integrated or so called "portfolio effect." On one hand, the above-mentioned repository and BS method support the development and change of the To-Be models. They in fact support the changing aspect of To-Be model, a pragmatic BO. On another hand, knowledge created or transformed while negotiating and changing the To-Be models, can then be used to

enhance the content of the shared repository and the use of the method. In other words, the three types of BOs are part of an integrative framework for managing various knowledge types at a given boundary.

## EXAMPLE OF AN INTEGRATED LEARNING APPROACH

To illustrate an integrated learning approach, we take an example from two units of study we coordinate independently. One unit of study refers to Business Process Modeling and Improvement, while the other one refers to Business Intelligence (Business Analytics). Based on our understanding of the two domains and their respective professional communities, we present here the following learning activity (a boundary object): students are given a group case-based assignment that requires them to solve a typical real-life business problem: "*improve a customer-facing process in organization X, featured in the case study*." Note that this particular problem could be combined with *any* teaching or industry case that provides sufficient details about an organisation's customer-facing business process(s) – allowing students to focus on the BPM perspective as well as sufficient details on organisation's data sources, including for example its data warehousing environment. Good examples of such cases could be found on the Teradata University Network (www.teradatauniversitynetwork.com) – the largest international community of BI academics and industry practitioners.

We believe this business problem is complex enough and the solving approach requires the applications of integrated knowledge and practices from both domains. Even though it could be addressed by both communities independently, as it is often done in practice, we argue that an integrated approach could lead to creation of new inter-disciplinary *pragmatic boundary objects*, not possible to find in the individual disciplines alone.

To describe these types of objects and their creation, we assume that the same case study (syntactic boundary object) is used in both BPM and BI classes, without informing students of the connections between the two domains. We assume that the BPM class is taken before the BI class (e.g., in two subsequent semesters). However, it is important to point out, that this sequence is proposed only for illustrative purposes and is arbitrary.

In order to illustrate the proposed approach, we first discuss the BPM perspective and its problem solving approach. This is followed by a short description of an integrated perspective with the differences in the potential outcomes being highlighted and discussed. Due to the limited space the BI approach is omitted but the most important aspects are shown within the integrated approach.

### BPM Approach

We expect that students exposed to the BPM domain will focus their approach by using solely knowledge and practices from the BPM domain. Suggested solutions might lead to process faster cycle time, savings on resources and costs, and improved customer service. In order to complete the assignment task, students might employ the following BOs (see Table 2).

| **Boundary Object Type** | **Boundary Objects Used in Completing the Assignment Task - BPM Domain** |
|---|---|
| **Syntactic (a sample)** | • Case Study Specifications<br>• BPM concepts available from various learning materials accessible via the BPM unit of study Blackboard site<br>• Library resources<br>• Other external resources students may decide to use |
| **Semantic (a sample)** | • Harmon's Process Scoping Diagram<br>• Cause-Effect Diagram<br>• Business Process Modeling Notation (BPMN) |
| **Pragmatic (a sample)** | • Improved To-Be Model(s)<br>• Simulation Tool |

**Table 2. BPM-Domain Specific BOs**

To complete the given task, students will start with identifying concepts that are relevant. They will usually use materials from Blackboard, library, or other external sources they might find; they will engage with syntactic BOs at this stage.

Next, students will select relevant methods, or techniques that will help in conducting their analysis; they will engage with semantic BOs at this stage. Given the content available from the BPM domain, they will most probably start with BPMN to capture the As-Is model. Next, they might turn their attention to Harmon Scoping Diagram. This method guides them to analyze a process according to the following five generic problem types: problems with process flow, output, input, controls, and enablers. Possible problems they might identify are: activities are in the wrong order, process does not produce the number of outputs required in a timely manner by the customer, inputs required to deliver the product/service to the customer are not available when required, employees involved may ignore certain business rules, employees lack the required skills to deliver the product/service to customer, etc. Next, students will most probably use a Cause-Effect Diagram to determine potential causes for the problems they have identified.

Once they have finalized the analysis part, they will proceed with designing a solution, an improved To-Be model. Here they start engaging with pragmatic boundary objects. Given the variety of problems and different backgrounds, students might prioritize and select to address only certain problems from the list they have identified. From practice, it is expected students will go over a number of iterations and use simulation tools to reach the best possible optimal solution to the business case.

Although nothing seems new in the above discussion, we believe students' solutions will be limited to the BPM domain. They usually will not employ any concepts outside the BPM domain. Here are some potential reasons: they do not have any knowledge of the BI domain, they do not realize the connections to BI, and they do not realize BI is relevant to the assignment task. Therefore, the solutions they produce are most probably incomplete and strictly limited to the BPM domain.

### Integrated BPM and BI Approach

Now suppose that students are given the same case study, but in a subsequent BI course. In this context, students are asked to apply a data quality methodology to improve the given customer-facing business process X. This is expected to lead to better decision-making, improved customer service, and richer customer-related information (customer analytics).

| Boundary Object Type | Boundary Objects Used in Completing the Assignment Task - BI Domain | Boundary Objects Used in Completing the Assignment Task -Integrated BPM and BI Domains |
|---|---|---|
| **Syntactic (a sample)** | • Case Study Specifications<br>• BI concepts available from various learning materials accessible via the BI unit of study Blackboard site<br>• Library resources<br>• Other external resources students may decide to use | • Case Study Specifications with both BI and BPM perspectives well described<br>• Examples of successful BI/BPM integration projects<br>• A combined set of syntactic boundary objects from both domains |
| **Semantic (a sample)** | • A data quality methodology (e.g., by TDWI)<br>• Davenport's framework for linking decisions and information<br>• A multidimensional model of data (e.g., star or snowflake) | • Relevant frameworks from both domains that consider both BI and BPM perspectives<br>• Other industry practices |
| **Pragmatic (a sample)** | • Improved To-Be Model(s) of the existing data-related practices in the context of the given process<br>• Possible extensions of the existing (used) data quality methodology | • Innovative solutions for different types of processes for different categories of customers<br>• Improved models or data quality practices, leading to the new To-Be Model(s) of processes<br>• BP-informed multidimensional model |

**Table 3. BI-Domain Specific and Integrated Boundary Objects**

When approaching the given task from the BI perspective alone, students are expected to focus, for example, on the quality aspects of the existing data/information used within, and generated by this process, key decision makers and types of decisions they need to make within the process, and the best way of provisioning of the most relevant data and information

required. In the BI context, data could come from a number of internal and external sources (e.g., enterprise-wide data warehouse, one of more functional data marts, internet, etc.) Therefore, in the BI context, students might employ the following BOs in order to complete the assignment task (as shown by column 2 of Table 3).

Even though students might come up with high-quality solutions, we believe their solutions will be limited to the BI domain. This is because, the BI students may not see the big picture i.e., the fact that data is used and consumed within a process and decision making is not simply task-oriented (as it is typically the case with the traditional DSS systems), but it is done in the context of a business process. Interestingly enough, this single perspective approach has been observed in practice in both BI and BPM professional communities, see Marjanovic (2010). Consequently, students may not be able to see BPM as relevant, let alone highly complementary.

An integrated approach may result in a new type of multi-disciplinary pragmatic boundary objects, as illustrated by Column 3 of Table 3. More precisely, compared to only one perspective (BI), but being aware of the BPM perspective, students may come up with the following observations leading to new innovative solutions that cross the BI and BPM domains.

For example, they may observe that the so-called customer analytics enables organizations to identify different categories of customers, even estimate their value in real-time. This could then prompt students to think about different "versions" of the same customer-facing process, offered to different categories of customers. This is an example of a BP improvement as well as BI-enabled customer-facing BP, often found in practice these days. Then, they could use their understanding of the overall process to inform their multidimensional data modeling practices that could lead to design of a To-Be multidimensional model (e.g., star schema) that would be better aligned with organizational practices. Students could also observe that implementation of a data quality methodology could be observed as a set of processes, some routine, some knowledge-intensive, but never the less processes that could benefit from BPM practices. Similar thinking could be applied to the problem of BI governance and so on.

Finally, similar thinking applies to the BPM approach when implemented after BI. For example, BPM students may not understand that BPs could be improved in many different ways, including improvements of process-related data quality that requires an appropriate data quality methodology rather than purely BPM methods and practices (e.g., use of BPMN). Design and segmentation of different versions of BPs for different customer segments is also expected to lead to significant improvements of process effectiveness and efficiency.

By using an integrated learning approach, students are exposed to interrelationships among the two domains. Therefore, we can argue they engage in acquiring and developing their meta-learning skills.

## CONCLUSION

As highlighted by the hypothetical example above, we argue that designing appropriate integrated learning approaches originating from both BPM and BI domains, leads to more holistic and better integrated solutions to business problems. Our thesis is that boundary objects: 1) facilitate the sharing of knowledge and practices, 2) facilitate the co-design of teaching practices across emerging teaching domains; 3) are key in designing integrated learning approaches to develop the cross-disciplinary education; and 4) contribute to the development of skills graduates require to solve complex problems in today's changing business environments.

From a theoretical perspective, we propose the use of BOs in designing cross-disciplinary education. Educational integration can go beyond the two emerging domains discussed in this paper, and extend to other emergent domains, such organizational change, knowledge management, and so on. From a research perspective, our work opens new challenges related to possible evaluation of multi-disciplinary pragmatic boundary objects, relevant for both knowledge-management and educational research. From a practical perspective, we suggest that BOs are extremely useful in educating boundary spanning professionals. Specifically, organizations employing such professionals will be a better position to achieve more holistic solutions to their problems, spend fewer resources on knowledge management efforts and future education.

Out future directions are to develop a conceptual framework for educational integration and extend our investigation into the role of boundary spanners (we omitted it due to the limited space in this paper) and other theoretical frameworks. Our efforts will potentially aim at suggesting improvements and learning approaches for achieving a fully integrated IS curriculum.

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