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Abstract

The information systems discipline is founded on the interplay between technical artefacts and their social and organisational contexts. Conveying this interplay is challenging in the classroom because the artefact is separated from its context, vendor material may limit teaching approaches, and students may perceive the benefits of an IS course in terms of technical training. This paper discusses these challenges with reference to three IS subjects, each using complex technological artefacts to convey learning outcomes. It opens a dialogue on design approaches to meet these challenges and enhance students' understanding of the importance of a sociotechnical approach to their studies. These approaches take account of context, the expectations of external groups, the nature of the subject, and the characteristics of learners and teachers. The concepts of boundary crossing, boundary objects, and synergistic pedagogies, are suggested as ways of moving towards a comprehensive and integrated sociotechnical approach to business education.

Keywords

Sociotechnical approaches, learning designs, boundary objects, synergistic pedagogies

INTRODUCTION

The socio-technical view has been subject to various uses and appropriated within different contexts over a number of years (Mumford 2000, p.34). Within the Information Systems (IS) research community, a range of theoretical lenses has been applied over time to study technologies within the contexts they are used, and in particular how "social and technical domains are inherently intertwined" (Orlikowski 1991, p.35). Central to these investigations is the IT artefact (Orlikowski and Iacono 2001). Similarly, socio-technical principles are reflected in IS curricula. The curriculum guidelines of the Association for Computing Machinery (ACM) and Association for Information Systems (AIS), for example, state that "IS professionals need both an excellent understanding of the domain within which they work and appropriate technology knowledge for their organisational role [and need to] understand that a system consists of people, procedures, hardware, software and data in a global environment" (Topi et al. 2010, pp.7-8).

Over recent years the affect and effect of technology on business education, including IT's enabling role in active forms of instruction and learning has received increasing attention (Rollag and Billsberry 2012). In considering how classroom technologies are likely to evolve over the next decade Gill (2009, p.227) identifies the need to design technological spaces that will offer "students a rich interactive learning experience" and from a social perspective, recognises that current student populations are sophisticated technologically and consequently "we need to offer them something very special" to keep them engaged in the classroom.

As IS educators in a business school our task then appears relatively straightforward - bring a socio-technical view into business education. However, this task presents a number of interesting issues and challenges. Conveying an understanding of IT artefacts, particularly from an enterprise view, and their context, is by nature challenging in a classroom environment, for several reasons: 1) the artefact is separated from its organisational context, and will not contain real data, 2) the teaching approach may be influenced by the availability of vendor materials, and, in some cases, the nature of vendor agreements; 3) students may perceive the benefits of an IS course in terms of the technical training, rather than in terms of developing their skills of critical analysis of socio-technical problems. This is further supported by a recent workshop on the design of socio-technical learning objects that: 1) identifies the fact students may have "little background in socio-technical studies," and

2) stresses the need for “good worked examples...[which may be] helpful for one student [but] not provide insight for another (Khoo et al. 2011).”

In the business education literature, research has revealed that the millennial generation, those born between 1980 and 2000, and largely representative of our student groups, are technologically savvy, but require detailed instruction and feedback to “sustain their performance” and “seem dispositionally less prepared for ...complexity,” amongst other things (Stewart et al. 2012, p.755-756). In addition, there is increasing demand for convenience and flexibility in course offerings (Gill 2009) and an educational environment facing competitive pressures with increasing expectations and accountabilities from governments and accrediting bodies for workforce development (Stewart et al. 2012). Finally, these trends are cast against a paradigm shift from a teaching focus to a focus on student learning, turning our attention to integrated instructional designs that are learning centred, incorporating active and experiential learning approaches (Gill 2009; Stewart et al. 2012; Whetten et al. 2009). Yet, despite “widespread belief” that such designs are valuable for developing student skills broadly (Stewart et al. 2012) and with respect to technology specifically (Gill 2009), there are mixed results about their effectiveness and limited integration into business curricula due to, amongst other things, not having the resources required to support such designs (Stewart et al. 2012, p.759).

When teaching business information systems (BIS) we construct ‘possible worlds.’ The presence or absence of the technologies affects the course content. Hence, the way that we plan and design our courses, the technologies we use, and the spaces where they are practiced (university and industry) are theoretically important for our instructional design. It is our contention that the IT artefacts that make teaching BIS both necessary and useful are becoming the “missing masses” (Latour 1992) in our curriculum design. By treating the complexity of this material work, such as demonstrating and using the software, designing the instructional materials, as something epiphenomenal, we neglect the important role that they play in mediating our interactions with each other (faculty) and students. Consequently, our instructional practices will remain incomplete regardless of the chosen pedagogies.

This paper examines the nature and consequences of bringing a socio-technical view to learning centred design, grounding the discussion in a reflection of our experiences and practices of a particular BIS curriculum. We seek to demonstrate that the IT artefact, as a key situational factor in socio-technical learning contexts, matters in negotiating and designing learning objectives, developmental learning assessments and engaging learning activities, the three elements central to learning-centred course design (Whetten et al. 2009). We argue that the presence or absence of the IT artefact affects the content of deliberations and course design. In doing so, we highlight the importance of taking contexts into account bringing “more attention to the nuts and bolts of design elements in the classroom” (Stewart et al. 2012, p.772). We use Whetten et al.’s (2009) model of learning centred design because of its focus on student centred learning as well as an analytical tool to assist in framing the discussion of our experiences. Based on this analysis, we make suggestions for a research agenda in moving forward.

We first present three units of study, technologies in use within them, and vendor relationships. We then discuss the challenges of a sociotechnical approach, the implications, and ways forward.

UNITS OF STUDY

Business Process Modelling and Improvement

The Business Process Modelling and Improvement unit is core to the BIS major and should, ideally, be studied before the other two. This order of study is not mandatory, and, indeed, the way in which the three units articulate is complex. The unit is taught with the goal of enhancing students’ understanding of the role of business processes and their management in organisations. It aims at offering student learning that focuses not only on transferring theoretical knowledge but also on gaining practical experience with real life projects and tools, and contains considerable hands on using IBM Websphere Business Modeler, the BPM tool of choice (IBM 2012). Students are gradually introduced to key business process management (BPM) concepts and activities including the development of business process architectures and their representation in the tool repository, and the analysis of current (as-is) processes as well as the development of improved to-be processes using both well-documented techniques and the tool simulation capabilities.

To achieve an in depth understanding of both the business context for BPM activities and the tool functionality and integration capabilities we engage students in a mix of learning activities such as: lectures on theoretical concepts, and seminars applying these to real cases, and workshops on BPM tool capabilities. Both the individual and group assignments are based on a real case scenario with business processes in need of improvement.

Enterprise Systems and Integrated Business

The Enterprise Systems and Integrated Business Unit is designed to convey the way in which the large scale integration capabilities of Enterprise Systems (ES) affect organisations, both during implementation and use. SAP is used as the example ES, and studies centre around hands-on exercises in using the system for such processes as “procure to pay” and “order to cash.” Students learn about the concepts of master and organisational data, and how these data are embedded in every process. They also learn how tightly integrated these processes are, largely through the financial accounting module, and are given an overview of management accounting concepts. Through the discussion of various cases, and through an individual assignment based around a complex and conflicted implementation scenario, students are exposed to some of the organisational and social issues surrounding such systems. A group assignment then ties this work to the technical artefact by means of hands-on design and development of a SAP solution for a specific scenario, which also requires students to consider the business model for the organisation being modelled.

Information Protection and Assurance

The Information Protection and Assurance Unit is designed to introduce students to concepts, tools and techniques relating to the protection and assurance of information and IT enabled IS. As such, technologies are discussed both as a target and as a tool for the protection and assurance of information by examining governance, risk and compliance (GRC) frameworks, that may be applied and/or inscribed into ES. With regard to audit tools, the emphasis of the curriculum is on generalised audit software that assists in the evaluation of application control monitoring processes and determining compliance with policies and procedures. Audit Command Language (ACL) Desktop Edition software is used in class to analyse accounting transactions such as accounts payable, largely for pragmatic rather than educational reasons. Practical exercises are conducted in terms of how these findings can be used to formulate audit strategy and manage risk. Similar scenarios are captured in assessment items.

TECHNOLOGIES ‘IN USE’

Here we introduce the three technologies we use in the three units described above. IBM Websphere Business Modeler (IBM 2012) is a tool that enables users to design, model, document, and analyse processes and make decisions through static and dynamic simulation capabilities. It allows users to visualise and identify bottlenecks and inefficiencies in the process. The tool can be used across a number of different divisions and can be integrated with a number of software platforms. WebSphere is part of a large suite of software provided by IBM, and is often used in environment which include a number of other software tools. See Figure 1 below for IBM’s representation of this situation. Lab teaching focuses on the process layer. While the issues surrounding multiple departments are discussed, they are not currently mirrored in the exercises. Role based views of the software would be difficult to convey, and the scale necessary to understand this would still be lacking. Furthermore, the BPM tool is not used in conjunction with any other software.

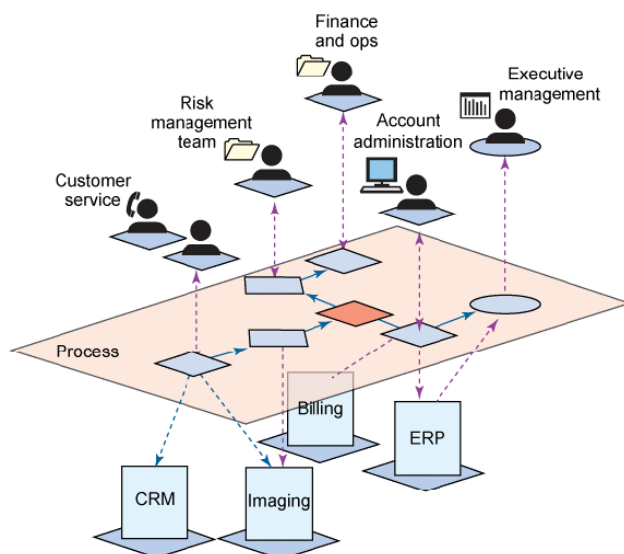


Figure 1: The IBM view of integration via Business Process Management tools (Portier and Fiammante 2012)

SAP is usually integrated into a large suite of software as shown in Figure 2. In addition to the SAP based software, organisations are likely to have information infrastructures that contain a range of other software, and process modelling tools such as Websphere, or SAP’s own BPM tools (Schaub 2009). Lab teaching focuses on billing, invoicing, receivables management, sales and accounting. Teaching materials are based on a fictitious case study, and assume an entirely SAP-based environment. Students have administrator access. It is hence difficult to convey role-based use of the software, its use in conjunction with other software, and processes where it is not used.

Enterprise Management	Strategic Enterprise Management	Business Analytics	Business Intelligence & Decision Support	Accounting	Alignment			
Customer Relationship Management	Marketing		Sales		Service			
Waste Logistics	Container Management	Fleet Management	Labor Management	Disposal Facilities	Waste Classification	Legal Permissions & Approvals	Traceability & Legal Reporting	
Waste Services	Industrial & Commercial Waste	Municipalities & Residential Waste	Cleaning & Winter Maintenance	Loose & Bulk Waste	Other Services			
Waste Processes	Order Creation	Resource & Capacity Planning	Order Output	Confirmation: Weighing & Completion	Interfaces to External Systems			
Revenue Management	Billing	Guarantor Billing	Third Party Billing	Invoicing	Receivables Management			
Business Support	Human Resources Operations Sourcing & Deployment	Procurement	Financial Supply Chain Management	Treasury Corporate Finance Management	Fixed Asset Management	Real Estate	Industrial Hygiene & Safety	Occupational Health

Figure 2: The SAP view of integration via Enterprise Systems- waste management solution (SAP Help 2012)

ACL™ software solutions are described as business assurance analytics for auditors, financial executives and compliance professionals (<http://www.satorigroup.com.au/sg-static-pages/about-acl>). It enables testing and monitoring of transactional data ranging from ad hoc analysis through to repeated and scheduled reviews. The software can be used with diverse types of data, including ODBC-compliant databases and variable length record files from different systems. The standalone desktop version used in the unit of study incorporates features such as read-only access to enterprise data, to ensure that data integrity is maintained and log records, which assists in reviewing past analysis and comparing results.

ACL Desktop is part of a suite of ACL software offerings that also provides “certified integration with SAP® ERP systems” for accessing SAP data. The ACL suite of software is part of a larger product offering by Satori Group in GRC, fraud detection and prevention, and continuous control monitoring solutions, including Caseware Monitor, a workflow management system for exceptions. These applications are used in GRC environments, which often include a number of other software tools. See Figure 3 for IBM’s representation of the landscape.

In labs these applications can only be demonstrated in terms of the functions available as there are no case studies, organisational roles nor exceptions set. It is therefore difficult to convey the way in which the ACL software is used in conjunction with other software, such as CaseWare or SAP, across different business areas, and GRC platforms.

In summary the lab based use of tools is based on isolated subsets of functionality, does not reflect human roles within the workplace, is not integrated with other software, and does not use real data.

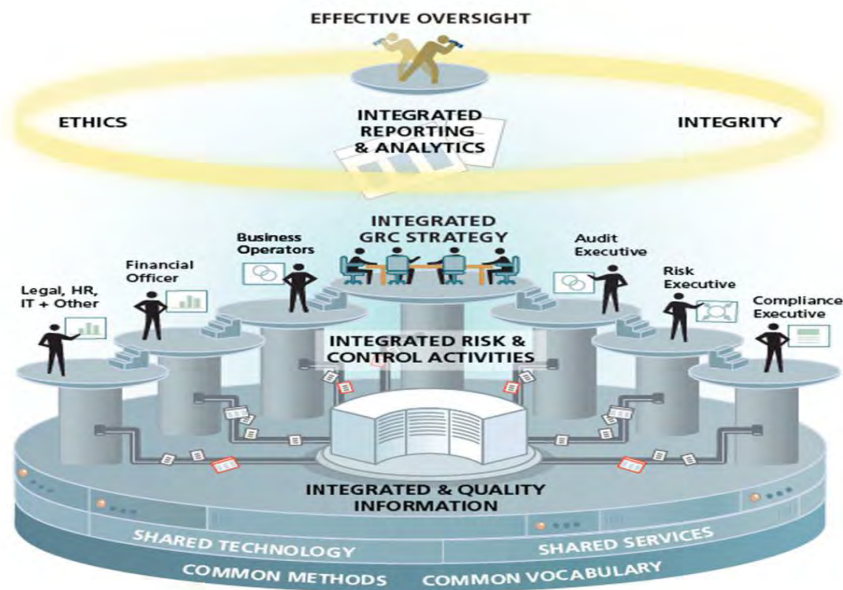


Figure 3 GRC Maturity: From Disorganized to Integrated Risks and Performance, Corporate Integrity, 03/12
(Illustrated in IBM Open Pages – Overview 2012 IBM Corporation)

VENDOR RELATIONSHIPS

The main vendors with which these three units of study deal are SAP, IBM, and the Satori Group, each with different models of cooperation. We now present the vendor relationships from two perspectives: the software licensing model and the training materials made available.

Software Licensing Model

The most formal software licensing model for which payment is made, is the SAP model. SAP offers their main product, ECC 6.0, together with a range of teaching databases, hosted by a nominated regional site known as a University Competence Centre. While access to SAP software is free, Universities pay to run the teaching databases on an annual basis. The Unit of Study described in this paper is currently using this model. SAP has two other models available. One is the new cloud-based offering provided from a single Universities Competence Centre in Germany; and the other is known as the SAP uAcademy. Since we do not use these models, we do not discuss them in detail.

By contrast, both IBM and Satori group offer their training software for free and assist on matters relating to the installation of the software. IBM, as part of their Academic Initiative offers free downloads for students and staff on their home machines (BPMAI 2012). The Satori Group provides software licences for ACL Desktop and Caseware monitor, amongst other applications, for free for educational purposes.

Training Materials

SAP ECC6.0 teaching materials are provided via the SAP Universities Alliance. These materials are often developed on a cooperative basis with Universities, with SAP always retaining joint copyright. IBM offers university staff and students the curriculum materials used in their business training courses, and staff are able to modify curriculum materials. IBM also provides basic models of case studies for further development in house. These training materials are designed for business users, not students, and are delivered in an intensive model, as opposed to our 13 week, semester long model. The Satori Group provides workshop training materials. Similarly, their materials are designed for training internal auditors with different levels of expertise in an intensive delivery mode. With the exception of SAP, where materials are designed by and for the academic environment, the other vendors offer business focussed training materials. Hence the delivery of materials needs to be adapted for our student context. In the case of SAP, the areas of the company which liaise with Universities are completely separate from other parts of the company, and do not have immediate access to experience of the contexts in which their products are used.

CHALLENGES OF THE SOCIOTECHNICAL APPROACH

Challenges of using technologies as part of a sociotechnical approach can be described in terms of interaction between technological artefacts, vendors, students and academics. The technological artefacts are necessarily isolated from the infrastructures and business environments in which they would normally reside, and, are never used with real data. These challenges are discussed below.

Degree of Use of Tools in Organisations

Teaching ES, such as SAP ECC 6.0, presents difficulties in conveying to students how the system is used in a business environment. The standard front end, which is used for teaching, is likely to look very different from the range of customised front ends used in business. Crucially, users in industry see a subset of functionality based on the roles that they play – a financial accountant, for example, would see screens related to accounting, but not those related to manufacturing processes. By contrast, our students have access to all screens, which, while it helps to illustrate the scale of the software, can be overwhelming, and hence limit their learning and understanding.

In addition, SAP exercises are designed to show the extraordinarily tight integration in some areas of SAP – for example the integration of the customer order process with the financial accounting and procurement processes. However, what is harder to show is where such integration might be detrimental or unachievable.

With regard to BPM tools, there is the issue of understanding how such tools are actually used in industry. Despite the recognised benefits, in reality only a small number of organisations is actually using these tools to their full capabilities. Many organisations use the tools for drawing processes that facilitate the understanding of the way the organisations operate, leaving aside the use of the tool for capturing the entire organisation's business process architecture. Further, simulation capabilities are used by only 6% of industry respondents to a recent survey on BPM (Harmon and Wolf 2011). Although the tools' advanced capabilities are attractive to students, there is yet limited support for their use in the corporate world.

Availability of Organisational Data

Another challenge we face, is the lack of contextual or organisational data. When running process analysis and simulation in Websphere, for example, assumptions must be made about several data including duration, costs, and resources allocated. Without having access to an organisation's business users, documents, procedures and rules, it is extremely difficult to perform a full analysis of current processes as well as obtaining realistic results from simulation.

In addition, the exercises based on training materials and case studies cannot convey the complexity that comes with scale. There are questions raised regarding: the integration between various models when the number of process models in a repository scales up to above a thousand; the use and accessibility of these models, the enactment of version control, and the availability of specialist staff to maintain the repository.

Regarding ACL, the issue relates to how assurance tools deal with messy data. A major benefit of ACL is that it allows access to diverse types of data including ODBC-compliant databases, variable length record files, legacy files and report files. Despite this feature, the student view, which uses data in a pre-formatted, ready to analyse state, does not convey this, and yet access to organisational data is widely recognised as a key challenge, particularly in a continuous assurance context.

As presented above, we are challenged in conveying the contextual understanding of the organisational environment and how these technologies operate in the real world. The social present in the sociotechnical approach is somewhat undermined by these challenges.

Demonstration of Systems Integration

Another challenge is demonstrating how BPM tools integrate with process centric software such as ES. Recent trends in the BPM arena highlight the development of BPM suites or systems (BPMS). These tools integrate process modelling with runtime execution and can incorporate rule management and process monitoring capabilities. These tools are newer and are just beginning to gain a foothold in most companies.

Turning to ES, the challenge translates in how do business process models actually interact with ES software. Figure 1 illustrates IBM's view of how this might occur, and Figure 2, by contrast, illustrates the SAP view. In an organisation running both SAP and IBM Websphere, for example, how is the support for, say, a customer order process divided between the two products, when both products claim they could be used for the same purpose? To what extent are BPMS being used as a process layer to define and implement new business processes whose

activities can be supported or executed by ES? Conveying such integration without a physical implementation in a laboratory environment of such an architecture is therefore very difficult.

Furthermore, how do GRC tools, interact with both BPM tools and ES? Business processes, alongside information, are critical assets from a GRC perspective. Business process modelling could provide insight into how processes have been designed, including GRC processes themselves and assist assurance providers in designing audit and compliance processes.

In the labs it is difficult to convey the way in which ACL software is used in conjunction with other software, such as CaseWare or SAP. A common challenge that arises in practice is being able to access data from the different tables in SAP. As described before, Satori Group also supplies Direct Link for SAP® ERP that enables direct and seamless access to SAP ERP data. However, without a physical implementation and integration in our labs, this feature cannot be demonstrated.. Using Direct Link would also mean integrating two different sets of teaching materials from two different vendors.

Despite the range of offerings from both vendors, understanding the technical configurations and how SAP, ACL, and Data Link technologies are integrated in organisations is complex and beyond the technical knowledge required by business students. Yet, not having an understanding of the technical issues may lead to an underestimation of the scale of the exercise when translating from the conceptual to the operational view.

Furthermore, critically, conveying how people behave and interact with these systems is a major challenge without using the systems in their real business environment. Currently we use case study discussions, and draw on the experience of students to convey this in the classroom.

WAYS FORWARD: “CREATING SIGNIFICANT LEARNING EXPERIENCES” WITH AND ABOUT THE IT ARTEFACT

How, then, can we move forward? What do we need to do to create “significant learning experiences” (Fink 2005 cf Whetten et al. 2009, p.257) about the IT artefact? Based on our experiences we examine the possibility of an integrated approach for designing business courses that involve IT artefacts. This approach is an adaptation of a learning centred model framework developed by Fink (2003). The model is guided by three key questions: 1) What do we believe is most important for students to learn?, 2) How can we reliably assess students’ mastery of the learning outcomes?, and 3) Which experiences will contribute the most to student learning? (Whetten et al. 2009). Specifically, the model consists of an alignment process among three design elements: significant learning objectives, developmental learning assessments, and engaging learning activities.

Underpinning the design elements is the *learning context*. Essential to a successful and comprehensive design is the understanding of key situational factors, described by Whetten et al. (2009) as the specific context of teaching and learning; the expectations of external groups; the nature of the subject; the characteristics of the learners; the characteristics of the teacher; and the special pedagogical challenges. As socio-technical learning contexts are the primary focus of this paper we frame our examination and discussion around these separate but related factors.

Specific Context of the Teaching and Learning with IT Artefacts

In terms of the classroom context, several factors may be considered here, including: the location of the software (in the cloud or on local servers), the availability of computer labs for classroom instruction, and remote/local and out of hours support. The size of the class also impacts upon resources in terms of time, access to appropriate technical expertise, and the availability of physical spaces. In addition, the three units are positioned differently in our curriculum, one as a compulsory unit and the other two electives with no pre-requisites. Hence assumed knowledge is problematic. From an outward looking perspective, reducing experiences about organisational settings to make complex ES digestible and understandable together with orienting students to ES relevances is challenging. Whilst this is partly achieved via case studies, translating meanings from case studies to possible wider implications that provide students with engaging learning activities is not without difficulty. It requires engagement with outside parties, a situational factor we discuss next.

Expectations of External Groups: Inter- and Intra- Organisational Relationships

Managing expectations of external groups is considered at two levels. From an inter-organisational perspective, we traverse IS and business curriculum requirements set by various professional bodies: see, for example, Australian Computer Society (ACS), Associating to Advance Collegiate Schools of Business (AACSB), and EQUIS (European Quality Improvement System). In addition, access to technologies is achieved through engagement with vendors. Understandably, vendor offerings and materials have views which promote their products. At an intra-organisational level we need to adhere to faculty wide learning goals in the undergraduate

degree programs. In addition we need to coordinate and align with other teaching departments such as accounting, human resources, and logistics who have an interest in and share an IT artefact, i.e., SAP.

Nature of the Subject: Diverging and Changing

In our situation, the nature of the subject relates to considerations of divergence, working toward equally valid interpretations, when developing cognitive skills in rapidly changing fields (Whetten et al. 2009). Designing activities and learning assessments that take into account the complex and ever-changing socio-technical environments is thus challenging, particularly for our diverse student groups with different cultural and work experiences.

As mentioned above an IT artefact, i.e., SAP, can feature across units and teaching departments. Designing purposeful experiential components and coordinating their implementation within and across the three units is therefore not without challenges.

The pace of technological advancements means that the field of study changes often and there is more than one vendor in our teaching spaces. This requires ongoing considerations and revisions about the IT artefact being studied and the suite of offerings given the diversity of technologies available. For example, major vendors such as SAP and Oracle offer their own ES and BPM tools that can be explored for future considerations. Presently, GRC technologies are examined in terms of what vendors are in this space, the characteristics of offerings and how that compares to standards and frameworks in GRC. In addition, we see a range of products available that are broadly classified into audit productivity tools and generalised audit software. However, there are plans to provide hands on experiences for students with GRC management tools, such as IBM OpenPages

Characteristics of the Learners: Diverse Student Groups

This factor refers to a number of characteristics displayed by our students: age, familiarity with the subject matter, enrolment status, work-related experience, reasons for enrolment, learning styles, and cultural background (Whetten et al. 2009). Our learning environments are represented by diverse student groups, which impact upon their expectations in terms of: 1) classroom type instruction (e.g., demonstrations vs. hands on), 2) the subject content (e.g., becoming skilled in using a technology and technical configurations vs. general applications in a business context), 3) the knowledge about organisational settings and applications (e.g., technology vs. financial services, financial vs. human resources), and 4) the language issues (e.g., technical vs. business, English vs. other). Our experience show that students often see our courses as an opportunity to train in a specific software product, rather than engaging with the broader sociotechnical model.

Characteristics of the Teachers: “signature” and synergistic pedagogies

Each of the academics in these subjects has relevant content-related experience in industry and academia, multi and interdisciplinary skills and knowledge in the areas of BPM, project management, SAP, accounting and audit. Developing the required expertise in teaching with and about complex BIS requires continuity in the subject areas and combined efforts. On one hand, each academic has their “signature pedagogies” in terms of their: interactions with students, knowledge domains, and professional beliefs and attitudes shaped by different professional memberships and experiences (Shulman 2005). On the other hand, synergistic pedagogies are also required to design purposeful and integrated learning approaches for these complex sociotechnical environments.

Special Challenges: Boundary Crossing and Boundary Objects

This particular factor focuses attention on things “that might get in the way” of the teacher and student in making a significant learning experience (Whetten et al. 2009, p. 259). IS, and in particular ES are much more complex than the types of technologies ‘traditionally’ discussed or taught in the educational context, see, for example, MS Office. Their instantiations raise challenging questions about what the technologies can do, to whom and where the knowledge about these technologies is situated in different organisational settings.

BIS topics and technologies present curriculum design and implementation challenges, similar to the real world environment. One way business curricula could manage this complexity is by involving *boundaries* and creating opportunities for crossing these boundaries. A boundary is a socio-cultural difference leading to discontinuity in action and interaction (Akkerman and Bakker, 2011). In education, boundaries can be viewed as the socio-cultural differences in the pedagogical values shown among the various participants involved in the learning process (Alsup 2006), namely technological artefacts, vendors, students, and academics, in our context. In response to involving and crossing boundaries, education researchers have become interested in investigating processes by which continuity in action or interaction is established despite the present socio-cultural differences (Akkerman and Bakker, 2011). Two key concepts are recognised in describing potential forms of continuity:

boundary crossing and boundary objects (Suchman, 1993, Star, 1989). A *boundary crossing* refers to a person's transition and interactions across different domains or sites (Suchman, 1994), while a *boundary object* (BO) refers to an artefact that does the crossing by fulfilling a bridging function at the intersection of domains, social worlds, or sites (Star, 1989).

BOs have been used in various fields and more recently learning portfolios in education (Akkerman and Bakker, 2011). BOs have the ability to bridge knowledge gaps between various domains and practices, and facilitate mutual learning in multi-contextual settings (Carlile 2002). Boundary crossing and objects are used to refer to ongoing, two-sided actions and interactions between contexts, a challenge we face in integrating complex technologies in business education. Specifically, we suggest that our learning content and approaches need to take into account the human interaction with technological artefacts, and the interplay of the social and technical elements must be thoroughly embedded in the sociotechnical approach (Whitworth and deMoor, 2009).

CONCLUSIONS AND FURTHER DIRECTIONS

Our main objective in this paper was to highlight the challenges we face when teaching complex technical artefacts in a sociotechnical curriculum for business education. Specifically, our analysis is based on the interpretation and reflections of our educational experiences and practices with three units of study taught as part of a BIS undergraduate major. Based on our experiences we argue that a high level of complexity arises from engaging with IS, such as ES, BPM and GRC tools. This complexity creates significant challenges in our endeavour to convey an understanding of the technical artefacts as well as the organisational contexts in which the artefacts would normally operate, that is, the sociotechnical approach to business education.

We argue that these challenges are associated with the learning context in which we operate and the fact that technological artefacts matter in designing curriculum in order to achieve high quality student learning experiences and outcomes. We frame our arguments using Whetten et al.'s (2009) learning centred model and in doing so not only highlight the importance of the IT artefact as a key situational factor in the learning contexts but also highlight the potential usefulness of this model in socio-technical curriculum designs. Consequently, this assessment represents a preliminary foundation towards a more comprehensive and integrated sociotechnical approach to business education.

Despite its limitations as a conceptual work, rather than an empirically validated study, this paper presents a number of future research opportunities related to the development of a leaning-centred model in business education that involves technical artefacts. Our future work will draw upon literature on boundary crossing and objects, as well as learning-centred course design with an overall aim to develop an integrated curriculum design model that will account for these factors and will align with the learning objectives and activities needed in business education

In this way we seek to contribute to both theory and practice. From a theoretical perspective, we aim to develop a conceptual framework of factors that contribute to the sociotechnical learning context and integrate boundary related concepts to curriculum design in education. From a practical perspective, we aim to offer a learning centred design model for complex technical artefacts in business education.

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