Business Process Modeling and Implementation
A 3-Year Teaching Experience

Daniela Giordano and Francesco Maiorana
Department of Electrical, Electronic and Computer Engineering, University of Catania, Viale A. Doria, 6, Catania, Italy

Keywords: Business Process Modeling, Workflow Modeling, Petri Nets, Swim Lanes, Novice Errors, MS SharePoint.

Abstract: In this work we describe a three-year teaching experience in an Information Systems course for a Management Engineering Master degree, where the course's focus was on business process modeling and on the technical aspects related to process implementation in a commercial software suite. In particular, we underwent a modeling shift from a Petri Nets description of concurrent processes to a full, business-process oriented methodology as proposed by Sharp and Mc Dermott (Sharp and McDermott, 2001) (Sharp and McDermott, 2008). This latter methodology was extended with additional data models, such Entity Life History, dealing with entities life cycle and dynamics. The students engaged in modeling the business processes of a real Small Medium Enterprise operating in the local area. The model was implemented using Microsoft Share Point, which affords a tight integration with databases such as Access or Microsoft SQL Server. A comparison of the adopted modeling strategies is presented, as well as common student errors in the design and implementation phase, together with some lessons learnt.

1 INTRODUCTION

Business process modeling is an important topic that is gaining momentum in modern curricula, both at the undergraduate and graduate level (Topi et al., 2010). In a recent review (Bandara et al., 2010) the authors presents the Business Process Management (BPM) instruction programs in five universities around the globe. In their work the author identifies three major trends in BPM:

1) Methodologies to organize, manage and measure the organization based on its core processes;
2) the lean Six-Sigma BPM;
3) The technological trend that focuses on enabling the organization core process through BPM platforms emphasizing the technical aspects of BPM as "a set of new software technologies that make it easier for IT to manage and measure the execution of process workflow and process software applications" (Harmon and Wolf, 2008).

The authors identify, among the major challenges, the following ones:

1) difficulties in teaching the technical aspects of the topic, since both specialized skills and more time to set up and teach than other existing courses are required. The higher workload results, among other things, from testing in a complex technological environment in order to offer to the whole class a reliable platform;
2) only a limited pedagogical research specific to BPM education is available.

A recent interesting work (Djajalaksana, 2011) presents the results of a national survey in the United States on the instructional strategies used related to teach Information Systems (IS) courses.

This paper aims at contributing to current pedagogical research in Business Process Modeling and Management by reporting a teaching experience carried out in the Information System course of the Master Degree in Management Engineering, at the University of Catania. The course was designed at onset following an approach that seamlessly integrates two of the three major trends identified in (Bandara et al., 2010), namely trend 1) and 3); also, it was based on the use of design precedents, following an approach that has been extensively tested in the context of IS courses for Computer Engineering students (Faro and Giordano, 1998), (Giordano, 2004). The course was organized around two main phases: 1) the design phase, with a methodological approach that aims at integrating the

Giordano D. and Maiorana F..
Business Process Modeling and Implementation - A 3-Year Teaching Experience.
DOI: 10.5220/0004387604290436
In *Proceedings of the 5th International Conference on Computer Supported Education* (CSEDU-2013), pages 429-436
ISBN: 978-989-8565-53-2

process view, the data view and the user view; and 2) the implementation phase, that by adopting a software solution made available on line to the entire community of students allows for a business workflow implementation in which the students are shielded from the details of system installation, configuration and management.

The paper is organized as follows: section 2 presents the teaching context; section 3 details the pedagogical approaches; section 4 presents some comparison of the teaching experience; section 5 draws the conclusions and highlights future work.

2 TEACHING CONTEXT AND CONTENTS

The course is a 6 credits graduate course in Information Systems for the Management Engineering degree, requiring 60 hours of lessons and classroom activities. The students can register in the course after a prerequisite undergraduate course in database design, where they have to complete a project requiring the design of a conceptual model, its implementation in a Relational Database Management System (RDBMS), with the option of prototyping a web interface that exposes the data.

Their only programming experience is with Visual Basic for Application (VBA) to manipulate data inside the Microsoft Access RDBMS. About 60 students enroll each year, with a roughly equal distribution between males and females. The IS master course has been centered traditionally on teaching systems analysis and design methodologies, for business process modeling (Weaver et al., 2002). The first time when business workflow analysis and design was introduced was in the 2007/08 academic year (a.y.) and used Petri net for workflow modeling (Van der Aalst and Van Hee, 2004); in the 2008/09 a.y. the swim lane workflow modeling and the complete design methodology proposed by Sharp and McDermott in (Sharp and McDermott, 2001) were introduced and refined in the 2009/10 academic year as proposed in (Sharp, 2008), where a swim-lane “shows what is done, by whom, in what sequence”. The swim-lane diagram (Figure 1) shows:

- Actors vertically aligned at the beginning of the horizontal line, one actor for each line;
- Tasks, represented as rectangles;
- The flow of actions represented by an arrow from left to right that joins consecutive tasks.

The handoff, represented by an arrow that crosses the swim-lines of two actors.

Figure 1: An example of a swim-lane involving two actors performing two tasks with an handoff.

The swim-lane allows to represent constructs such as sequence, collaborative task, choice, parallel flow, conditional parallel flow, temporal constraints.

In all the three editions of the course the objectives, with particular emphasis on the workflow modeling part, were:

- Acquire the basic techniques and skills for business process and workflow modeling with the ability to work out the scope of each technique, as well as its strengths and drawbacks.
- Acquire the capacity to use and to program workflow modeling and management tools.

Complementary objectives were the development of critical thinking skills, capability to analyze problems from different perspectives, draw conclusions and apply these conclusions in the design phase; as well as improving communication and collaboration skills.

The lessons typically started with a presentation of the key concepts, concepts to be applied as soon as possible in a case study during interactive sessions, where the solution was often reached with the intervention of all the students with the teacher and tutor mostly involved in a facilitator role, with a recap phase at the end of the design activity. The interactivity was simply managed by posing a question, even complex ones such as "design a system capable of …", and then let the students work alone or in group during class activities. After a reasonable amount of time the instructor asked to the students to volunteer for presenting their solution. The solution was discussed in class by letting the students, in turn, ask questions, propose different designs, compare different solutions and so on. Each class ended with small assignment meant as a reinforcement activity requiring a practical application of the main concepts and methodology exposed during class. Examples of these small assignments are: designing from a use case schema the E/R model, correcting a swim line, designing a swim line, correcting and designing an E/R schema and so on. The small assignments were deliberately not graded but critically discussed in class. The

choice of no grading policy was meant to increase the students' confidence and lower the fear in public intervention. The syllabus of the project for the 2007/08 (a.y.) is presented in Table 1. Particular emphasis was given to the workflow design and workflow pattern using Petri Nets. During the course it was requested to the student to read journal and conference paper such as (Hammer, 1990) and (Russell, 2006). The syllabus of the course for the 2008/09 (a.y.) is presented in Table 2.

Table 1: Course syllabus for the 1st edition of the course.

Topic	N. hours
Business Process reengineering	2
The five level of analysis: mission; strategy and goal; Business Process; Presentation; application logic	1
Reference model: Set of definitions to describe the knowledge domain.	1
Petri Net	6
Petri Net extension: color, time, hierarchical	2
Workflow representation using Petri Net	4
Workflow patterns	4
Total	**20**

Table 2: Course syllabus for the Workflow modeling in the 2nd edition of the course (including implementation).

Topic	N. hours
Business Process reengineering	2
The five levels of analysis: mission; strategy and goal; Business Process; Presentation; application logic	1
Workflow modeling (business process modeling)	6
Use case and use case scenario (presentation)	2
Transaction modeling (application logic)	2
Entity model (data model)	2
Process identification	2
Initial evaluation and metrics	2
Synthesis poster	2
Tour of Share Point Portal Server and Share Point designer	1
Application and site creation. User and groups	1
List and Document library. Web Pages and Web Part available in SharePoint Designer.	1
Workflow: conditions and actions available in Share Point Designer	2
InfoPath and form design	2
Visual Studio .Net. Workflow Testing	2
Total	**30**

The Synthesis Poster, according to (Sharp and McDermott, 2008), "takes the main elements of framing the process – the process scope and contents, and the case for action, vision, and differentiator – and puts them on a single piece of paper. In the 2009/10 academic year the set of design tools were incremented with dynamic data behavior by the Entity Life History.

The workflow was implemented and deployed using Share Point. In the first edition of the course some minor attention was given to the installation and configuration of Microsoft Share Point, attention that was completely eliminated in the subsequent editions of the course by giving to the students either an on-line system or a pre-installed and configured virtual machine. Share Point was also used for visualizing OLAP cube in the second module of the course were data-warehousing was treated.

Share Point Portal server was chosen after a review of the available collaboration and workflow suites due to: its tight integration with the Microsoft Office suite, that is the most used set of tools used in the industry by business manager; its simple usage powered by the availability of out of the box tools to perform a vast set of operations with no need to develop code; its great flexibility in developing powerful workflows by designing and coding within the Visual Studio .Net framework.

The tight integration with the Excel spreadsheet using the Excel Services, as well as the possibility to synchronize data with Relational Database Management Systems (RDBMS) such as Microsoft Access and Microsoft SQL Server allows the students to implement and integrate quite easily the design project developed using the methodology.

The availability of a rich set of conditions and actions in Share Point, even richer in Web-site design tools (Share Point Designer) used in the course, as well as third part components (e.g. for (D'Urso et al., 2009), allow for a fast prototyping with no or minimal coding intervention in most cases. In this way students cognitive effort can focus on the design activity that is at the core of the course.

At the end of the course lessons the students had to develop a project requiring to model the business processes of a real or simulated Small Medium Enterprise operating in the local area. Many projects, however, were based on existing small/medium enterprises and students designed the existing "as is" scenario and proposed possible improvements through the "to be" scenario.

In the project the student had to follow the methodological approach sketched in Figure 2 (Sharp and McDermott, 2001) and (Sharp and McDermott, 2008), using the design tools mentioned above, i.e., the project data model, use cases, an use case scenario, transactions and process metrics with detailed specific of the enterprise Information System.

The students had also to produce a working prototype of the project developed with Share Point portal server. The project was not the only element

to make up the final grading of the course, which was based on the assessment of three assignments:

1) Quality and usability analysis of an enterprise web site (20%)
2) Written test with open questions concerning the theoretical aspects of the course (40 %)
3) Project regarding the complete workflow analysis of a small/medium enterprise, including a working prototype of the project developed with Share Point portal server (40 %).

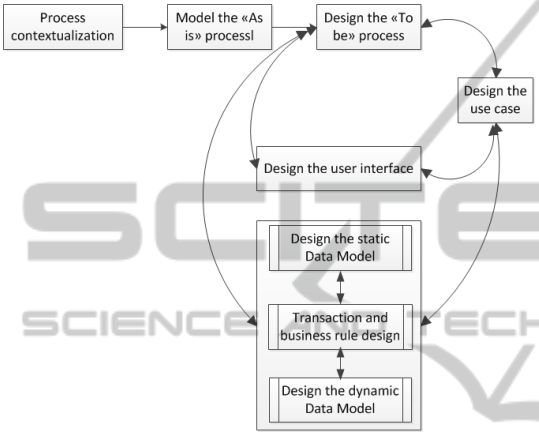

Figure 2: The BPM methodological approach used for the project.

The model prototype had to be implemented using Microsoft Share Point with a tight integration with databases such as Access or Microsoft SQL Server and spreadsheets such as Excel.

The project was considered as a capstone to apply the design methodologies in a real world scenario, improving creative thinking while developing better solutions for the “to be” process, critical thinking while comparing solutions from peers; improving communications skills (verbal and written), and collaboration skills during teamwork.

The typical number of team members was three, allowing for a good deal of interaction and point of views, yet avoiding overcrowded groups that hinder tasks and responsibility allocation and often lead to a lesser engagement by some members of the team.

Tasks and responsibilities were self-allocated by the students and verified by the tutor.

It was stipulated that in the final presentation of the project, discussion of the various aspects of the project from the team members was randomly chosen despite the original work subdivision. In this manner all the team members have to know all the details of the whole project. Along the years, the business domains have been ranging from insurance companies, to laboratories for clinical analysis, to banking, to photovoltaic panels production on demand, to car workshops, to tour agencies, to an international food industry and so on.

The tutoring activity was quite demanding, requiring consultation both on a variegated set of application domains and on some implementation and deployment details. Figure 3 represents a disciplined way of thinking about the tutoring support activity, using the graphical notation of the horizontal swim lanes adopted in the course. The key interactions among the main actors are highlighted as well as the most relevant aspects in the tutoring process.

The project presentation, performed by the tutor, is concerned with highlighting the main goals of the final project, the grading policy and some project management issues. Then the teams freely choose the application domain of their work also by consulting a shared pool of former projects, as in (Giordano, 2004). The student are also required to peer review one project of their colleagues. The first year that the business workflow was introduced in the course, given the discontinuity with the former methodology, the support that could be obtained from the pool of previous projects was limited to getting a sense of the complexity of the various business domains and to seeing instances of the applications of use cases and E/R modelling, whereas the actual workflow and business processes were "hidden" in the Data Flow Diagrams, instead of being explicit in swim-lanes. In the third year of the course, the "shared memory" of the course provided a more stable and comprehensive resources pool reflecting the consolidation of the methodology adopted for BPM.

At the end of this consultation phase the team produces a project proposal that is evaluated by the tutor. If approved, the team starts working on the project and submits project milestones to the tutor, who reviews the milestones following a guided inquiry process. Meetings with the tutor are scheduled upon teams' request.

The process ends with the final deliverable preparation, where students produce the entire design, highlighting each major decision taken and explaining the reasons behind the decision, possibly comparing two or more different approaches to the same problem. After the final deliverable is approved by the tutor the project is presented and discussed, together with the working prototype, in the final presentation in front of the teacher and the tutor.

The workflow schema in Figure 2 can help in a

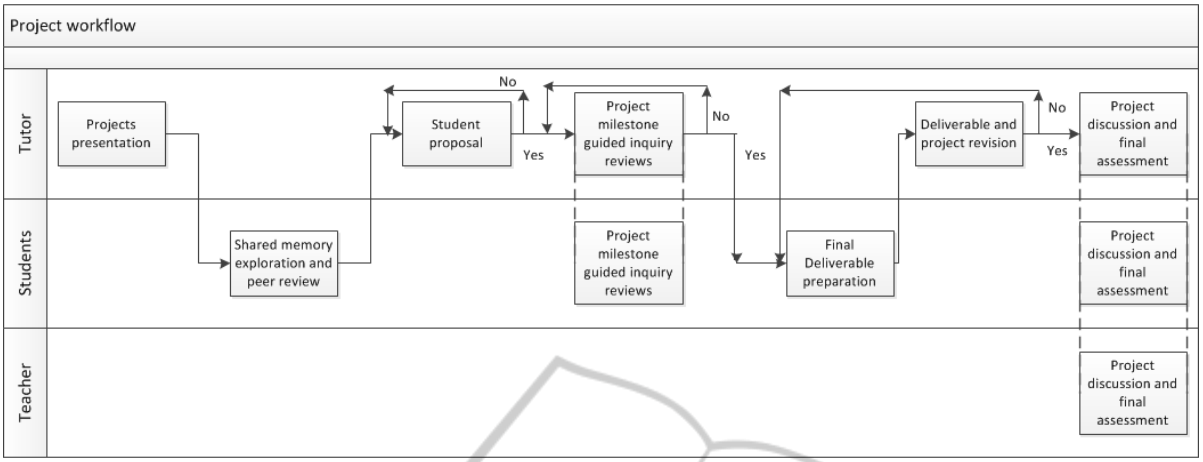

Figure 3: Project management workflow.

better management of the whole project development phase, by offering a clear view of all the phases and progresses, and thus facilitating the communication among all the actors involved, namely students, tutor and professor, also through documents exchange.

Work can be found in literature describing the advantage of using a collaborative system, such as Share Point, to improve interaction among teacher, tutor and students such as (Rockinson-Szapkiw, 2011) or to improve content management (Tallapragada et al., 2012).

The project required 4 to 6 weeks work for completion after the end of classes.

3 PEDAGOGICAL HIGHLIGHTS

The main pedagogical approaches and instructional strategies followed during the course are the following:

1) Use and sharing of previous projects and experience: students used and reviewed the projects from the previous academic years in a "shared memory" fashion (Giordano, 2004). Projects are shared without the final teacher feedback, thus encouraging critical analysis.
2) Using interactive lesson focused on reviewing cases, and on in class collaborative analysis and design of a solution for small practical cases;
3) A guided inquiry style of interaction, both in class and in the tutoring sessions during project development;
4) Video screen recordings of the technical implementation procedure inside the Share Point portal server.

Especially during the tutoring and reviewing sessions, care was taken to avoid both a "no intervention" approach and a "solution offering" approach.

The teacher, in the role of facilitator of knowledge building, especially with the most brilliant students, answered the questions with further questioning, and in general, guided the students to discovering the solution, by offering practical small exercises as guidance to solving the problem, by suggesting to reviewing study materials and so on.

4 CRITICAL COMPARISON AND LESSONS LEARNT

The overall appreciation of the course was good as pointed out from student active participation in the lessons, effort put in the projects and answers to informal questions such as “what have you learned during the course?” The performance of the students in terms of grades was overall steady, more biased in the direction of higher grades, despite the increasing load in terms of concepts and competences they had to grasp.

In general, allowing the students to be immersed in a real world scenario, focusing on real problems, communicating and collaborating with the local enterprise domain expert and so on, was a definitive pro in the course.

We also agree with (Rockinson-Szapkiw, 2011) that, especially for older students with a more

comprehensive background and better reasoning skills, allowing them to choose the domain of application of the business process modeling methodology, or the "surface agenda", tied with their personal story, background and interests, greatly improves student involvement and participation in the project.

In this way the teachers and the tutor maintain the responsibility in choosing the methodologies, leaving the students to apply it in their preferred domain.

In particular, concerning an overall assessment of the quality of learning and of the efficiency of the pedagogical strategies adopted, taking into account the changes in methodology introduced in the three years, it is worth remarking the following points.

- Use of a complete design methodology such as the Sharp and McDermott one has several advantages compared with the usage of a single design tool such as Petri Nets. A comparison of the students usage of swim lane and Petri Nets design tool for workflow modeling, based on the frequency of requested tutoring interventions and on observing the speed by which the student were able to sketch a workflow on the fly in front of the tutor seem to suggest a steeper learning curve for Petri Nets. One of the reasons why swim lanes, and in particular the horizontal swim lanes proposed in the methodology could be easier to learn could be found in the visual span asymmetry (McConkie and Rayner, 1975; Pollatsek et al., 1981): for readers from left to right a visual span asymmetry consisting of 3-4 characters to the left of fixation vs.14-15 characters to right of fixation has been demonstrated. The swim lanes organization in different levels allows for an easier top-down design approach focusing in the overall process in the first level and increasing the detail in the second and third level. Overall, swim-lanes are more suited for a managerial environment; Petri Net are, of course, more suited for formal proof of correctness or synchronization.
- Using a complete methodology and a plurality of design tools and representations allows, in general, for a deeper understanding of the problem at hand resulting in a better analysis and design that take advantage from the interrelationship among the design tools (Giordano, 2002), which provides means for cross-verification and improvements of the design artifact under development. From a pedagogical standpoint it is a best practice to present as earlier as possible the application of all the needed design tools, starting from a small project and incrementally enlarging it step by step in order to let the student to deeply understand, integrate and use all the design methodologies. However, some limitations to the efficacy of self-correction of the methodology through cross-verification can be noted, as exemplified in the type of errors detected in the students projects, listed below.
- The most common errors detected in the students' deliverables are the following:
  a) Incomplete swim lane because of missing handoff. The most relevant cases are: a) not informing the client of a decision, and b) incomplete management of the revision cycle of a document or a production phase
  b) E/R diagram errors, especially concerning the correct usage of the association entity and how to associate an item in a N-N association with other entities;
  c) Inconsistency between different design models, e.g., information present in the use case scenario and missing in the E/R diagram; inconsistency between the ELH and the swim lane, such as a missing event in the ELH, presence of an irrelevant event in the ELH, inconsistency between use case scenario and swim lane;
  d) Incorrect identification of the critical success factors in business process modeling, and in particular, confusing process and product metrics.

The above type of errors, on the one hand, point to the aspects that deserve special attention and reiteration in communicating with the students during the in-class and tutoring interactions; on the other hand, they reflect the fact that the efficacy of any analysis and design methodology as a self-correcting instrument, can be affected by limited knowledge or practice with more advanced data modeling concepts and by the higher cognitive load involved in coordinating representations dealing with temporal aspects of processes and entities, respectively.

- The use of the shared pool of previous projects, increased the quality of the final deliverable over time, especially in the last observed year. The shared projects database can be used to evaluate the didactic experience and objectively measure student improvements. This is in line with the approach adopted in (Giordano, 2002) and, more recently, in (Paul, 2012) and (Tenenberg and Mccartney, 2008) where the

authors suggest to look systematically at students' artifact to derive data that can provide insights into questions about learning. From a preliminary analysis of the student projects over the years we can observe:

- Increased complexity of the analysis and the design, as measured by the number of processes, actors, and steps in the processes in the swim lanes, and by the number of entities and association entities in the E/R diagram
- Increased degree of associations between the platform (Share Point Portal Server) and the underlying databases.

Table III shows some aggregate measures of these improvements between the 2008/09 and the 2009/10 academic years, computed on a random sample of 5 projects from each year cohort. The table reports the average percentage of improvement, if positive, for the 09/10 academic year over the previous one.

This preliminary data suggest an overall increase of the complexity of the analyzed process in the last year: a larger number of swim lanes both at the handoff level (Level 1) and the Milestone level (Level 2); a greater number of steps performed by less actors, increased number of tables, a smaller number of use cases explained in more detail, as indicated by the increase in use case scenarios, an increased number of transactions and an increased number of steps implemented in SharePoint.

Use case scenario, according to (Hamer et al., 2008) “depicts the dialogue between an actor and a system for a particular scenario”.

The observed increase in overall design complexity, although based on a limited sampling aimed at preliminary exploration of the data, is in line with the effect of "organizational learning" discussed in (Giordano, 2002) and (Giordano, 2004) when a shared memory of design artifacts is in place.

Concerning the technological challenge of setting up a relatively complex environment, prior installation of a virtual machine was made available on line and also distributed using a DVD upon students' request.

This allowed to eliminate all the steps required for software installation (operating system, Microsoft Office, Microsoft SQL server and Microsoft Share Point Portal Server) and configuration, and all students could working on the same initial configuration, thus facilitating debugging.

Screen video recordings greatly reduced the tutoring burden over implementation issues,

Table3: Comparison of two academic years projects cohorts: average number of handoff swim-lanes (L1), average number of milestone swim lanes (L2), average number of actors (A), steps (S), tables (T), use cases (UC), use case scenario (UCS), transactions (T) and Microsoft Share Point steps (SPS).

Year	L1	L2	#A	# S	#T	# UC	# UCS	#T	# SPS
09/10	3,0	0,6	5,5	20,7	10,8	5,4	3,6	8,6	7,2
08/09	2,0	0,4	6,4	13,0	10,2	7,8	0,2	3,8	4,8
Increase (%)	**5**	**50**	**-14**	**60**	**6**	**-31**	**n.a.**	**1**	**50**

allowing the teacher, tutor and students to focus on the design phase, since the students to perform the practical operations at their own pace and resolve most of the technical problem by themselves.

5 CONCLUDING REMARKS

In this work we described a three-year teaching experience in an Information System master course for Management Engineering students, with a focus on business process modeling.

The shift from workflow analysis and design using Petri Nets to a comprehensive methodology where Business Processes are modeled according to swim lanes affords several advantages. Technical aspects related to process implementation in a commercial software suite could be tackled by decreasing the implementation and deployment detail as much as possible.

As a further study we plan a more thorough comparison of the different approaches and methodologies that we have field-tested, by adapting the analytical evaluation grid provided in (Giordano, 2002) to include swim-lanes and process metrics, and applying it to analyze larger samples from the available cohorts of project artifacts.

This analysis will involve relating any detected misconceptions to evidence on how the students have coordinated the various analysis and design notations and to any common feature of the modeled enterprise/business domain.

The observed increase in overall design complexity, although based on a limited sampling aimed at preliminary exploration of the data, is in line with the effect of "organizational learning" discussed in (Giordano, 2002, 2004, 2009) when a shared memory of design artifacts is in place to reuse past experience.

REFERENCES

Bandara, W., Chand, D. R., Chircu, A. M., Hintringer, S., Karagiannis, D., Recker, J. C., van Rensburg, A., Usoff, C. and Welke, R. J., 2010. Business process management education in academia: Status, challenges, and recommendations. *Communications of the Association for Information Systems*, 27, 743-776.

Djajalaksana, Y. M, 2011. A National Survey of Instructional Strategies Used to Teach Information Systems Courses: An Exploratory Investigation. *ProQuest LLC*. Available at: http://www.proquest.com/en-US/products/dissertations/individuals.shtml.

D'Urso, D., Giordano, D., Maiorana, F., Chiacchio, F., 2009. Coding softly a SME-targeted information systems: towards the lean ERP age. *In Proc. of the 11th Int. Conf. on The Modern Information Technology in the Innovation Processes of Industrial Enterprises (MITIP' 09)*.

Faro, A. and Giordano, D., 1998. StoryNet: an evolving network of cases to learn information systems design. *IEE Proceedings Software*, 145, 4, 119-127.

Giordano, D., 2002. Evolution of interactive graphical representations into a design language: a distributed cognition account. *International Journal of Human-Computer Studies*, 57, 4, 317-345.

Giordano, D., 2004. Shared values as anchors of a learning community: A case study in information systems design. *Journal of Educational Media*, 29, 3, 213-227.

Giordano, D., Faro, A., Maiorana, F., Pino, C., Spampinato, C., 2009. Feeding back learning resources repurposing patterns into the "information loop": Opportunities and challenges. *9th International Conference on Information Technology and Applications in Biomedicine*, ITAB 2009, Larnaca.

Hamer, J., Cutts, Q., Jackova, J., Luxton-Reilly, A., McCartney, R., Purchase, H., Riedesel, C., Saeli, M., Sanders, K. and Sheard, J., 2008. *Contributing student pedagogy*. SIGCSE Bull., 40, 4, 194-212.

Hammer, M., 1990. Reengineering Work: *Don't Automate, Obliterate*. Harvard Business Review, 7/8, 104-112.

Harmon, P., and Wolf, C., 2008. *The State of Business Process Management —* 2008, BPTrends, available at: http://www.bptrends.com/surveys_landing.cfm.

McConkie, G. and Rayner, K., 1975. *The span of the effective stimulus during a fixation in reading. Attention, Perception, & Psychophysics*, 17, 6, 578-586.

Paul, J., 2012. *Living in a computing world: a step towards making knowledge of computing accessible to every student.* ACM Inroads, 3, 2, 78-81.

Pollatsek, A., Bolozky, S., Well, A. D. and Rayner, K., 1981. *Asymmetries in the perceptual span for Israeli readers*. Brain and Language, 14, 1, 174-180.

Rockinson-Szapkiw, A.J., 2011. Improving doctoral candidates' persistence in the online dissertation process In Z. Abas et al. (Eds.), *Proceedings of Global Learn Asia Pacific*.

Russell, N., ter Hofstede, AHM. van der Aalst, WMP, Mulyar, N., 2006. *Workflow Control-Flow Patterns*: A Revised View. BPM Center Report BPM-06-22, BPMcenter.org. 2006. Available at: http://workflowpatterns.com/documentation/documents/BPM-06-22.pdf. Accessed September 7, 2012.

Sharp, A. and McDermott, P., 2001. *Workflow Modeling: Tools for Process Improvement and Application Development*, 1st Edition Artech House.

Sharp, A. and McDermott, P., 2008. *Workflow Modeling: Tools for Process Improvement and Application Development*, Artech House, 2nd Edition.

Tallapragada, K., Chewning, J., Kombo, D. and Ludwick, B., 2012. Making SharePoint® Chemically Aware™. *Journal of Cheminformatics*, 4, 1 (2012), 1-7.

Tenenberg, J. and Mccartney, R., 2008. *Grounding the Scholarship of Teaching and Learning in Practice*. J. Educ. Resour. Comput., 8, 2 (2008), 1-3.

Topi, H., Valacich, J. S., Wright, R. T., Kaiser, K. M., Nunamaker,J. F., Sipior J. C. and de Vreede, G., 2010. IS 2010: *Curriculum Guidelines for Undergraduate Degree Programs in Information Systems. Communications of the Association for Information Systems* 26 (2010), pp. 359-428.

Van der Aalst, W. and Van Hee, K.M., 2004. *Workflow management: models, methods, and systems. Mit Press.*

Weaver, P., Lambrou, N., Walkley, M., 2002. *Practical Business Systems Development Using SSADM*. A complete tutorial guide. 3d Edition, Prentice Hall.