

# Using YAWL in a Business Undergraduate Course on Process Management: An Experience Report

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**Abstract.** The paper reports on the use of the YAWL workflow management in a core undergraduate course in a business school. We describe the design of the course, and YAWL's position within it, learning activities and learning outcomes. The use of YAWL in an introductory, general business course, rather than an upper-level information systems course, entails several challenges. We report on these challenges and reflect on lessons learned and best practices.

**Keywords.** Workflow management, education, business, experience reports

## 1 Introduction and Background

Workflow management is an important aspect of business process management, and the wider business and management discipline. Approximately 1400 students are enrolled in three different undergraduate degree programs at the Faculty of Business Administration (FBA) at Memorial University of Newfoundland. Of these, the Bachelor of Commerce (BCOM) and the Bachelor of Business Administration (BBA) make up more than 95% of students. Approximately half of the students choose an accounting concentration, another third choose a marketing concentration, with the remainder in organizational behavior, entrepreneurship, or strategy. Due to lack of student interest and enrollment, the faculty does not offer electives in information systems (IS).

An academic program review in the mid 2000s recommended that a course on business process management and modelling should be introduced instead. We began development of this new course in 2009, with a first offering in the fall semester of 2011. The core course is required for the BCOM and BBA degrees, and is usually taken in the second year. The course is taught in classes of 75 minutes, twice a week, for 12 weeks per semester, with class sizes varying between 30 and 60 students.

The FBA is accredited by the AACSB and has, as part of the required assurance of learning process, defined the following learning goal and objectives, which are to be satisfied by and evaluated in this course:

- Students that successfully complete this course will understand business processes and the role of technology in enabling and supporting them. (Goal)
  - Our students will be able to identify, model, and evaluate the efficiency of an organization's main business processes. (Objective 1)

- Our students will be able to improve and redesign a business process using IT and non- IT-based solutions. (Objective 2)
- Our students will be able to identify points of a business process where IT support can improve the overall process, and be able to propose high-level requirements for suitable IT support. (Objective 3)

## 2 Course Design and the Choice of YAWL

The main challenge was to introduce the technical topic of workflow management into a general business curriculum where students are not enthusiastic about IS related topics. The approach to designing the course must take into account that it is not an IS elective, but is required for all business students and is typically taken in the first or second year of study. Students do not have a background in software technology, programming, databases, conceptual modeling, and other foundational technologies. Because no other courses in the curriculum include business process management, the topic had to be covered from all perspectives: strategic, managerial, and operational.

Experience with a computer science course that was replaced by this course showed that students did not enjoy learning about computer technology. Therefore, we adopted a “gentle” introduction from the managerial perspective to give students a foundation in the concepts of business processes and process-oriented enterprises before introducing them to workflow management. The course has to demonstrate the relevance of the topic and capture student interest as early as possible. Table 1 in the Appendix provides an outline of the typical course topics and reading list.

Our first challenge in course development was a dearth of textbooks that provide a balanced organizational and technical treatment of business processes and workflows. For example, some books cover workflow modeling and workflow systems [1-3], but do not provide a broader managerial perspective. These books are more suitable for IS majors than for general business students. Other books [4-5] focus on specific vendor’s products. We wanted to avoid these dependencies, and focus on vendor-independent concepts instead. Further, we could not rely on the support of the faculty to cover the cost of access, training, etc. Yet other books [6] include processes as part of a general course on IS, which would overlap extensively with an existing introductory MIS course. We finally settled on a combination of management articles (see third column of Table 1) and the YAWL book [7].

While the YAWL book is also targeted at IS majors rather than general business students, the choice of YAWL was motivated by the following considerations:

- YAWL provides a vendor-independent perspective on the theoretical concepts of processes and workflows. This allows us, in a university setting, to concentrate on teaching theory rather than product-specific skills.
- YAWL was the only workflow system that is built on a sound theoretical foundation (Petri nets and extensions). We felt this to be especially important in a university setting that focuses on theoretical knowledge, not only on skills.
- The YAWL book and system are developed by leading researchers in workflow management, and thus provides best available knowledge at the “cutting-edge”.

- YAWL provides a good integration of a system with a textbook. This combination cannot be found for any other system or product.
- The YAWL system is open-source and (mostly) multi-platform capable. This provided use with free access for the greatest number of students. However, platform-specific components of YAWL, such as the worklet designer, or platform-specific related tools described in the YAWL book, such as CPNTools, meant that these were in principle not suitable for use in the course.
- In contrast to other systems, YAWL allows the easy exchange of workflow and resource models, convenient for homework and exam submissions.

### 3 Using the YAWL system in the Course

Experience has shown that an early demonstration of the use and benefits of workflow management systems can considerably improve student interest and motivation. We introduce YAWL in the second class of the course as a group activity, using the Genko Oil Case in Appendix A of the YAWL book that is provided as an example with the YAWL system. Applying Kolb's experiential learning approach [8] where no explanation of the system itself and only little information of the process is provided, students role-play one of the process participants in the company. This allows students to experiment with the system, observe its behavior, and notice the actions they can take with respect to work items. The lecturer maintains an updated administrator view of all cases and work items on the classroom projector. According to Kolb, this type of learning can be defined as knowledge creation resulting from the combinations of grasping and transforming experience. Students are generally impressed by the capabilities of a WfMS and convinced of its usefulness and value. By engaging students to consider the business value generated by WfMS the instructor can overcome the innate technology resistance that is likely present.

After students receive an introduction to Petri nets and workflow nets using the WoPeD tool, we introduce the three perspectives of YAWL, the flow, data, and resource perspective. For each of these, the first class discusses the workflow patterns, and a useful exercise is for students to identify an example for each workflow pattern from their own work experience. The second class on each perspective occurs in the computer lab. Students are asked to form groups of between two and four members. We have developed tutorial scripts that guide students step-by-step through the development and execution of an example process. Students access a shared YAWL server and are able to again experience the capabilities of a WfMS in a realistic environment.

Students also use YAWL in a major assignment. The assignment is based on a Harvard Business School Case ("Pharmacy Improvements at CVS", HBS number 9-606-015). As part of the assignment, students model the described process in YAWL, including all resource and data perspectives. This part of the assignment is assessed using the following criteria:

- Is the model valid and sound?
- Is the process well-structured?
- Are there unnecessary OR splits or joins?

- Are the major exceptional paths handled?
- Are process loops and iterations correctly modeled?
- Is net-level and task-level data defined using appropriate data types?
- Are net-level and task-level data mappings defined?
- Is net-level data used for flow-control for all XOR-splits?
- Are appropriate resources defined and assigned to each task?
- Does the workflow model load and execute on the YAWL engine?

Only when these formal criteria have been satisfied, do we examine the “correctness” of the model with respect to the case description.

## **4 Challenges**

### **4.1 Student Preparedness and Motivation**

The readings presented in the first five weeks focus on the genesis of the concept of process-orientation from the early 1990s to the mid-2000s. However, students often lack a basic understanding of fundamental concepts in organizational theory and organizational behavior. This requires instructors to delve relatively deeply into these concepts to give students a sufficient basis to comprehend the course readings.

Workflow management could be seen as an abstract concept on its own but when the potential business benefits are discussed the level of student interest rises. First- and second-year students are unlikely to immediately relate an improved business process to an increase in business value. However, the concept of a reduced wait in a line-up is clear to them. Expanding on practical examples of business processes and the impact of their improvements allows the instructors to slowly move towards the technology portion of the course while maintaining student interest.

Another course element to maintain relevance to students are weekly reflections (“journals”, “blog”) that focus on personal experiences with the material covered in that week. They encourage students to make sense of the material through relation to familiar situations, while at the same time demonstrating relevance.

### **4.2 Group Work**

Because the benefits of workflow management can best be realized when multiple process participants access a common workflow system, the YAWL assignment was originally designed as a group assignment, so that each group can a process in a realistic shared environment. While this is beneficial to student understanding, it resulted in most student groups developing a single “YAWL expert”. This defeated our goal of all students having an understanding of the workflow management system. Thus, assignments are now done individually, whereas the lab work focuses on the cooperative group aspect. Another advantage of individual assignments is that they can now be used to satisfy the assurance of learning assessment required to maintain AACSB accreditation, which was not possible for group assignments.

### **4.3 The YAWL Data Perspective**

Data management in YAWL is arguably the most difficult aspect of the system for general business students with no prior knowledge in computer science or programming. It is also the aspect that contributes least to the general understanding of business process and workflow management. However, modeling data in YAWL is required for the workflow to be realistic, in the sense that students are able to view and edit work items. Thus, omitting the data perspective is not a good option.

As a consequence, as seen in Table 1, we have to allocate significant time to teaching even simple XML schema development, and XPath expressions. Due to many hands-on exercises, the general feedback from students is relatively positive, despite the level of difficulty. However, we have found that it is important to discuss the YAWL data perspective with built-in data types before introducing XML schema, so that students know the purpose of the XML schema they are developing.

As a future alternative, we are considering providing suitable XML schema to students for their YAWL assignment, so that students can focus on the input/output mappings from net-level to task-level variables and the flow-control for XOR splits and less course time needs to be allocated to this topic.

### **4.4 Integrating YAWL with Process Mining**

In earlier offerings of the course, we asked students to also execute their workflow 20 times for a follow-up assignment on process mining, to expose students to the full lifecycle of business process management. Students exported their execution log data using PromImport and mine the data using ProM. Technical and pedagogical issues forced us to abandon this. First, we experienced too many support issues with PromImport, where students were unsure how to install and use the program. Moreover, exporting data from YAWL with PromImport puts a considerable load on the YAWL engine, leading to frustration among students. We also found that the range of student's solution to the workflow modelling assignment made it difficult to provide a single relevant set of questions (and solutions) for the process mining assignment. We now omit this assignment and provide students with a hands-on introduction using the ProM tutorial developed by de Medeiros and Weijters [9].

### **4.5 Software Versions**

When we developed the course in 2009 and 2010, the then current YAWL version 2.0.1 reflected the newly published YAWL book, making for an ideal combination. As we also integrated process mining into the course, we “froze” YAWL at version 2.0.1, to work with PromImport (version 7.0), and ProM (version 5.2). While the later decision to remove PromImport from the course provides flexibility in the use of different YAWL (and ProM) versions, the fit of 2.0.1 with the YAWL book is our main reason for remaining with this version. We hope that the book may be updated at some point in the future to again accurately reflect the latest system.

## 4.6 YAWL Hosting

The nature of WfMS means that the best learning experience is in groups of students, each representing its own organization. Ideally, this requires a separate YAWL system for each student group in the course. We explored the following options:

- Multiple servers host separate YAWL systems. As the YAWL system is not resource intensive for our application, this was not a preferred configuration.
- A single server runs multiple virtual machines, each with its own installation of the stock YAWL system. While the configuration of YAWL in this scenario is simple, the configuration of the VMs and dynamic provisioning of additional instances requires more administration resources than the faculty can provide.
- A single server and servlet container hosts multiple YAWL engines, databases, resource services, etc., each configured with its unique set of ports. While this is technically the most efficient solution, it requires considerable administrative expertise, especially for automatic provisioning of additional YAWL instances.
- A single YAWL instance, with the use of naming conventions for the organizational model for different student groups. This is administratively the easiest solution, but requires some effort from students.

Resource constraints meant that it was impossible to internally host a single (or multiple) YAWL systems and that we could not develop an experienced YAWL system administrator. Hence, the task of hosting any system falls to the instructor. To avoid configuration issues, a stock version of YAWL4Study is hosted on an Amazon EC2 micro-instance, which is easily sufficient for dozens of concurrent users.

## 5 Conclusions and Recommendations

In conclusion, we have successfully introduced the YAWL system and textbook into an undergraduate, required course for general business students. As this paper has demonstrated, the approach taken is different from one for a IS majors that have a technical understanding and interest in the topic. In light of the challenges we have encountered, we offer the following recommendations:

- Early demonstration of business use and benefits to achieve student “buy-in” into technology aspects of business process management.
- Demonstrate the importance and relevance of business processes by not focusing on technological aspects, but through managerial considerations.
- Constant focus on business applicability and relevance, through
  - Case studies
  - Personal reflections
  - Appropriate process examples

In summary, developing the course proved to be more of a challenge than had the course been offered as an IS elective to interested majors. The fact that the YAWL book, as most other books, does not present the topic in the larger business context

requires a large amount of extra material. For this, we have mainly drawn on Harvard Business Review articles and Harvard business cases. Thus, there is a need for future pedagogical material on YAWL, and workflow management in general, to extend the scope. The newly published book by Dumas et al. [18] takes some steps in this direction and may be considered for a future course revision.

We believe that we have achieved a successful balance of managerial and technical issues that successfully introduces students to the area of business process and workflow management. All course materials, including slides, reading notes, lecture plans, student handouts, exercises and assignments are available from the authors in the hope that they may be useful to others.

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## 7 Appendix

	Topic	Readings / Materials
1	Introduction to business process and workflow management	
2	Introduction to the YAWL workflow management system	YAWL book preface (pp. v-vii)
3	Business processes and process-oriented organizations	Hammer (1990) [10]
4	Organizational change and change management for implementing business process	Hammer and Stanton (1999) [11] Champy (2006) [12]
5	Process and Enterprise Maturity Model	Hammer (2007) [13]
6	Process and Enterprise Maturity Model	Harvard Business School Case “Siemens Rolm Communications” (HBS# 195214-PDF-ENG)
7	Business process metrics, analysis and process improvement	Harvard Business School Case “Body Scans and Bottlenecks” (HBS# KEL592-PDF-ENG)
8	Business process metrics, analysis and process improvement	
9	Business process management lifecycle	Miers (2006) [14]
10	Workflow management - YAWL overview and architecture	YAWL book chapter 1 YAWL book chapter 7
11	Petri nets	Reisig and Rozenberg (1992) [15]
12	Workflow nets	YAWL book section 2.3
13	YAWL Language and Design Environment – Control flow perspective	YAWL book Section 2.1 YAWL book Section 2.2.1 YAWL book Section 2.4
14	YAWL Language and Design Environment – Control flow perspective ( <b>computer lab</b> )	YAWL book Chapter 3 YAWL book Section 8.1 YAWL book Section 8.2 YAWL book Section 8.5
15	YAWL Language and Design Environment – The resource perspective	YAWL book Section 2.1 YAWL book Section 2.2.2
16	YAWL Language and Design Environment – Resource perspective ( <b>computer lab</b> )	YAWL book Section 2.5 YAWL book Section 8.2 YAWL book Section 8.3
17	YAWL Language and Design Environment – Data perspective ( <b>computer lab</b> )	YAWL book Section 2.1 YAWL book Section 2.2.3
18	Web services, XML, and XML Schema	YAWL book Section 2.6

	<b>Topic</b>	<b>Readings / Materials</b>
19	YAWL Language and Design Environment – Data perspective ( <b>computer lab</b> )	YAWL book Chapter 10 YAWL book Section 8.4 Treese (1998) [16] Bratosin (2009) [17]
20	Process Mining using ProM ( <b>computer lab</b> )	YAWL book Chapter 17
21	Other modelling languages – BPMN	YAWL book Chapter 13
22	Other modelling languages – EPC	YAWL book Chapter 14
23	Other modelling languages - BPEL	YAWL book Chapter 15
24	Business process examples – Logistics	YAWL book Appendix A

**Table 1.** Course schedule and reading list for the business process management course for the Winter 2013 semester