Educational Process Modelling with Workflow and Time Petri Nets

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Abstract

The research presented in this thesis describes how to use workflow management technology to model educational processes with a time axis.

As workflow management technology has been widely used in modelling business processes, it has the potential to model educational processes. Based upon the components of workflow, educational processes and business processes have many common features such that educational processes can be modelled with workflow management technology. In addition, owing to the importance of the time component in processes, time Petri nets have been chosen as the design language for the modelling of the educational processes. The notation of time Petri nets has been illustrated in this thesis for the educational process.

In this thesis, three different educational processes have been presented and modelled with workflow management technology as well as with time Petri nets individually. Furthermore, the architecture of the educational process management system has been constructed by adopting the reference model from the Workflow Management Coalition.

To show the validity of using workflow management technology in the education domain, a sub-process of an educational process has been modelled and developed with certain developing techniques. It provides the potential research direction for further research on the modelling of educational process with workflow technology associated with a time component.

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Publications

Fung, I. P. W., & Ruan, Y. W. (2004). *On reasoning about time in education environments with time Petri nets.* In Proceedings of International Conference on Computers in Education (ICCE 2004), Melbourne, Australia. (pp.1265-70).

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Chapter 1. Introduction

1.1. Background

Workflow management technology is described as a technology that is able to manage, coordinate, and control the activities of a business process (Meng, Su, Lam, & Helal, 2002). Actually, a business process is defined with business events and rules. When business events are executed, they are enforced under business constraints, policies, strategies, and regulations, specified by rules.

The technology has been utilised to model many specific business processes (Ailamaki, Loannidis, & Livny, 1998; Buford, Hefter, & Matheus, 1998; Iwaihara, Jiang, & Kambayashi, 2004; Vouk, 1998; Xu, Qiu, & Xu, 2003). The flexibility features are required because of the nature of business processes. Therefore, some researchers are focused on establishing successful workflow models which have the capability to model dynamic changes of the business environment as their business is running (Cichoki & Rusinkiewicz, 1999; Meng et al., 2002).

However, an educational process has its own characteristics once it has been modelled and executed. An educational process indicates a pedagogy that includes theory teaching, practice, and educational strategies. A variety of processes relevant to educational areas comprise the educational system, whereas all kinds of educational activities are elements for the process in a defined order. In this thesis, an educational process will be analysed and modelled as the focus of the research.

Currently, there is a variety of research on the modelling of educational processes either with (Mangan & Sadiq, 2002) or without workflow technology (Fung & Ruan, 2004; Huitt, 2003; Martin, 2001; Rokou, Rokou, & Rokos, 2004; Shor & Robson, 2000). But none of them models the educational process integrated with time components. An exception is that Fung and Ruan (2004) integrate time concepts but only into course planning, although time is an important and integral part of all components in the educational process.

As workflow management technology has been widely used for modelling the business process, it provides the potential ability to improve its efficiency. Most business processes are concerned with modelling across different departments, manufacturers, or even different companies (Chiu, Cheung, Karlapalem, Li, & Till, 2004; Vidal, Lama, Bugarfn, & Barro, 2003; Xu et al., 2003). Therefore, in this thesis, the technology leads to a model of educational processes after a comparison of these two processes: business and educational processes. The author argues that the workflow management technology is equally applicable in modelling and analysing educational processes. For instance, Mangan and Sadiq (2002) suggest using workflow technology to model flexible processes in academic programmes.

Therefore, there is a gap between workflow technology and the emphasised time component for modelling educational processes. The purpose of this research is to fill this gap.

1.2. Motivation

Most current educational systems only use computer technology along with network technology to enhance functions of the educational system. In addition, previous research about workflow in the educational field always focused on utilising advanced information technology to map educational systems in the workflow model. Because of the very nature of an educational system, students and teaching staff involved in education can be treated as an individual node in the educational system with each node having been assigned tasks. For students, they must choose several papers for their study programmes and they also participate in the study procedures of papers for the completion of their programmes.

The concept of time is the natural feature which should be integrated into educational activities. For example, a paper has been scheduled with time, such as beginning classes, lecture timetable, assignment due date, and examination time. Furthermore, each participant in the educational system also has other tasks besides study tasks, like the enrolment procedure, or the procedure on borrowing and returning books to the library, which also have time constraints. Therefore, the concept of time-driven workflow management is the basic idea on modelling educational processes in this thesis.

The educational system consists of diverse processes. No matter which event is occurring, single or multiple processes occur and schedule in parallel, sequence, or asynchrony to reach the final point of the event as output. To model all kinds of educational processes is an effective and efficient way to construct the educational system. Concerning the term 'process', it represents the bridge to fill up the gap between the education domain and the model derived from workflow management technology. The educational process has the potential to be organised and managed by the employment of the workflow technology which created efficiency in the business domain. It is the motivation for this research.

1.3. Scope

The research focuses on modelling various educational processes grouped by the characteristics of their features. In addition, owing to the concept of time in educational processes, they will be modelled by appropriate language associated with workflow management technology and time. After modelling these processes, the architecture for the educational management system will be worked out.

However, due to the limitation of research time available, the development of a comprehensive architecture for an educational system is beyond the scope of this project. Nonetheless, an important component of the architecture will be developed to verify the validity of using this technology and time concept to model educational processes and to construct the educational management system.

1.4. Research Questions

In this research, the author is trying to use workflow technology associated with a time component to model educational processes. To achieve such a purpose, several questions should be answered progressively

- What are the conceptual requirements for process-oriented educational activity modelling?
- Why has workflow technology been chosen and utilised in the modelling of educational processes in this research?
- When workflow technology has been used in educational process modelling, what aspects of the system would become more efficient and effective derived from the application of such technology?
- As modelling tools are essential in modelling various processes, why choose Petri nets as the modelling tool in this research after analysing several other modelling tools?
- Why does time have to be emphasised in modelling educational processes? What is the function that time plays in educational processes? What are the advantages of using a

time component in modelling educational processes besides the original time concept in the workflow technology?

- How has the time concept been integrated with classical Petri nets to model the educational processes?
- How would various educational processes be modelled with workflow technology and time component using time Petri nets?
- What are the advantages of using such technology in modelling educational processes? What should be highlighted in this research? In addition, what further developments can be explored in this field from this research?

1.5. Aims and Objectives

The aims of the research are:

- To identify the common features of educational processes and business processes.

  Note: After analysing these processes, this work addresses and distinguishes the common characters of both processes. This is the basic step in setting up an educational process model, with the technology to model business processes.

- To investigate aspects concerned in the development of the underlying reference model of business processes, which will contribute to the development of the model for educational process with workflow management technology.

  Note: From the current study of workflow management technology in business, aspects considered to build a suitable reference model in different business processes need to be investigated for the educational processes.

- To develop models for various educational processes using both workflow technology and timing components.

Note: After stating the characteristics of educational processes and after considering aspects in setting up business process models, this will contribute to the establishment of these models for various educational processes with workflow technology. In addition, as timing is the significant component integrated in various educational activities, the functions of timing in educational processes will be illustrated and expressed. Therefore, timing is emphasised in modelling educational processes besides the workflow technology.

- To improve the efficiency of educational processes, the time component has been expressed and emphasised in the model.

  Note: Although the traditional workflow process has a time notion, it is considered as inadequate in representing the time features in the educational process. For an educational process, time is the axis and mainstream of the process that leads the process to move from one status to another.

- To apply the model in one particular process as a case study.

  Note: To show the applicability of the model, one sub-process model will be developed as a case study. A web-based assignment management system is chosen to be implemented to show how the workflow technology and timing component work for the assignment management process, which is a small part of an educational process.

1.6. Methodology

The research will focus on how to model and manage various educational processes. In addition, the framework of an educational management system will be established based on previous efforts. Thus, the thesis adopts a research methodology from Bourner (1996).

- **Research the field of study**

  It is important to collect information on current educational systems and to analyse them to look for an appropriate technology that is applicable to the construction of the mechanism of the educational arena.

- **Develop a model or frame**

  The framework consists of all kinds of educational processes operating in educational programmes. At this stage, cataloguing different educational processes is the first step. After analysing them, applying workflow management technology is the approach to modelling these processes.

  Furthermore, an attempt will be made to establish a framework for the educational management system with such technology.

- **Test the model**

  Testing the whole model by developing a comprehensive all-round educational system is beyond the scope of the thesis. Therefore, a subprocess of the main educational process is chosen as a subset of an overall generic model. The established system for the subprocess is a reasonable compromise to verify the validity of the framework.

  Specifically, the assignment management process is chosen to demonstrate the whole lifecycle[1] of assignments from beginning to end, which is similar to other educational processes having life duration.

- **Evaluate and reflect**

  The last step of this research is to evaluate and reflect. Time is described as the most important component to be integrated in modelling the educational process. Time Petri

[1]Lifecycle: the survival period of an object. ıtilised to present different educational processes. In addition, the assignment management process has been developed as a case study to test the workflow model. Following the time line of the lifecycle of assignments, time Petri nets present the status of the process under different time constraints.

1.7. Report Structure

The report has the following structure, which is aligned with the Aims and Objectives as set out in section 1.5 and the Methodology in section 1.6.

Chapter 1: Introduction

The background of this research is presented in this chapter to illustrate the reason to carry on this research direction, together with a description of the research problem and lists the main aims of the research.

Chapter 2: Educational Processes

This chapter elaborates the features of various educational processes. Then, from the viewpoint of education, educational processes have been classified into three different types. A number of process modelling tools are described. The reasoning behind the choice of the most effective tool to model the educational process according to the features of the educational process is explained. Moreover, the reason why various educational processes should be modelled with this modelling tool is discussed. In addition, the time component is shown to be an important component that should be considered in modelling such educational processes.

Chapter 3: Workflow Technology in Educational Processes

This chapter concerns the expression of the original concepts of workflow and reference models. The application of workflow management technology to business is investigated to

form the educational process model. In addition, workflow concepts can be modelled with the model tool which was chosen in Chapter 2. The time concept which has been emphasised in workflow technology is integrated into workflow technology with the time features of the educational processes.

Chapter 4: Time Reasoning in Educational Processes

In Chapter 4, the issue of 'time' is emphasised in educational processes. A time component will be integrated into the process modelling tool associated with workflow technology to model various educational processes.

Various educational processes are also presented and analysed in this chapter. Petri nets have been chosen as the suitable design tool to model these educational processes owing to the features of educational processes. Hence, the time component has been emphasised and integrated into traditional Petri nets to model educational processes. In addition, from these process models, an attempt is made to construct an architectural model of the educational process system that focuses on every task related to education.

In addition, the time-driven concept has been raised as a significant component in modelling educational processes. Owing to the time concept, a temporal database is elaborated to store time information along with the general data.

Chapter 5: Case Study: A Web-based Assignment Management System

Chapter 5 shows previous research on the assignment management. According to the lifecycle of assignments and the function of the assignment management process, a part of the student learning process, implementation for the process model is an effective way to illustrate the validity of modelling educational processes with both workflow management technology and the time component. In addition, it has been evaluated with the assignment management part of WebCT. The result of this evaluation shows whether a time component and workflow technology deserve to be used in educational processes.

Chapter 6: Conclusions and Future Work

This final chapter provides a summary of the findings of this research and discusses their relevance to the main aims stated in Chapter 1. Furthermore, it discusses the future studies which may be addressed based on this research.

References - Referred articles and papers are listed.

Appendices - The user manual of a developed system and relevant publication from this project will be presented.