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Managing Assessment: Using Technology to Facilitate Change

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Key words: Computerised School Information Systems, Professional Development, Assessment, Effective School Development

Abstract: This paper describes a number of developments focusing on school-wide assessment, recording and reporting. Such factors as secondary school culture and change, the external pressures to comply, and action research elements are considered. Discussion of findings from these projects reveal: (1) the influential role that computer software can play in collaborative developments, and (2) the relationship between software system implementation and cultural change. This suggests ways that CSIS could be more productively used to assist with school development.

1. INTRODUCTION

The evolution of computerised school information systems (CSIS) in New Zealand secondary schools has been characterised by an emphasis on the automation, and quest to improve efficiency, of administrative processes. The emerging challenge is to utilise the power of the microprocessor to promote and facilitate school developments that impact positively on student achievement. This may necessitate a re-examination of the established, and often disparate, functions of professional development services and CSIS providers.

2. BACKGROUND

New Zealand schools have experienced unprecedented change during the last decade. Radical restructuring of the frameworks for both curriculum and qualifications followed a movement towards self-management in 1989. The curriculum framework, consisting of seven essential learning areas, has been progressively introduced with completion not expected until 2002. The new Qualifications Framework, based on unit standards, was launched in 1994.

The introduction of unit standards signalled an emphatic movement towards the use of internal assessment for awarding qualifications at the senior secondary school level. Each course had unit standards defined, which described the outcomes and the performance criteria that would be used to determine whether or not the standard had been achieved. Approximately five to eight standards would be used for each full year course and each standard had a number of credits associated with it. The plan, which has since been modified, was for these credits to contribute to a National Certificate of Educational Achievement, at years 12 and 13, and other, subject specific, National Certificates.

Secondary schools were faced with the task of recording and reporting unit standard results to the New Zealand Qualifications Authority[1]. This, by itself, was not a major issue as the significant suppliers of CSIS had modules available which satisfied this need. At this time a model was being presented to school audiences demonstrating how the recording, reporting and evaluation of assessment data, relating to the curriculum framework, could be relatively straight forward IF there was a common assessment 'currency' across the school. This model was converted into software form for demonstration purposes. However, the staggered introduction of curriculum statements for each of the essential learning areas, and their Maori equivalents, meant that schools were not ready to tackle whole-school implementation issues. Several school managers believed that this software model could be applied in an area where there was already an established school-wide assessment currency: unit standards.

Thirty-five secondary schools are currently involved with the unit standard component of this development. Thirteen secondary schools, most of whom also belong to the first group, are part of a more extensive project with the goal of improving student achievement by developing an approach to assessment in secondary schools based on standards and emphasising the essential role that formative assessment can play. In many, but not all, of the schools belonging to the second group, unit standards have served as a lever

[1] The New Zealand Qualifications Authority is a Crown Entity established to co-ordinate national qualifications.

to introduce a similar approach to assessment in the junior school. This paper is a commentary on developments involving schools from the second group.

Participation in these professional and school development projects is voluntary – schools may join or leave at any time. The schools vary in size from a little over 100 students to over 1000 with a mode of approximately 700 students. The junior division of these schools generally refers to years 9 and 10, or students in the 13-15 age group. All participating schools utilise the MUSAC[2] school information system and, in particular, the MUSAC *Pupil Files* program which is used to manage student personal data.

Although essentially self-managing, schools must comply with several sets of guidelines promulgated by the Ministry of Education (MOE). One of these guidelines, National Administration Guideline 1, or NAG1 as it is commonly called, refers to the collection and utilisation of assessment data based on the curriculum objectives contained in the national curriculum statements for each essential learning area. The Education Review Office[3] uses the guidelines to audit school compliance and, to a limited extent, school performance. Many, if not most, secondary schools have had difficulty in satisfying NAG1 and, consequently, ERO. Typical expressions included in the ERO generated audit reports[4] for secondary schools include:

- Implementation of an agreed school-wide system should enable the school to improve evaluation of student progress;
- The school is knowledgeable about the significance of assessment but has still to decide what is best practice for school-wide adoption; and
- The school needs to face the challenge of reviewing its approaches to assessment, recording and reporting, and develop systems that enable it to demonstrate student progress more effectively.

Secondary schools operate in a competitive environment with increasing student mobility contributing to significant fluctuation in school rolls. The public nature of the ERO reports therefore provides a strong motivation for action to address non-compliance issues, in particular. Most of the schools participating in these professional and school development projects derived their initial impetus in this way.

[2] Massey University School Administration by Computer (MUSAC) software is used extensively in a large number of New Zealand schools and is continually evolving to meet the needs of a rapidly changing educational environment. Refer to the MUSAC website at http://musac.massey.ac.nz

[3] The Education Review Office (ERO) is the government department which reports publicly on the quality of education in all New Zealand schools and early childhood centres, including private schools, kura kaupapa Maori (Maori language immersion schools), special schools and kohanga reo (Maori language early childhood groups).

[4] These reports are available from http://www.ero.govt.nz

The method used for these school developments varied according to the size of the schools and their state of readiness. However, the use of several in-school workshops for the whole staff (small school) or curriculum representatives (larger school) has been common. These workshops have covered:

- Issues surrounding the implementation of the curriculum framework;
- The need for transparency from assessment to reporting;
- Formative assessment and reporting;
- Agreement on the desirability of a common assessment currency and what this should be;
- Possibilities for the aggregation and analysis of achievement data – will it lead to better programmes and learning?;
- The benefits of school-wide consistency; and
- A means of achieving this.

The use of CSIS to promote consistent approaches to assessment was to be an essential feature (see James, 1998).

3. USING CSIS TO FACILITATE CHANGE

Progressing with these projects meant overcoming significant barriers. Autonomous subject departments in secondary schools, the staggered introduction of curriculum statements, and the legacy of decades of reliance on external examinations have been the most prominent obstacles. The software developed to support these projects has played an integral part, not only in helping teachers conceptualise the underpinning model, but in actually implementing their developmental plans. It is a collaborative development with all participating schools and is continually evolving as our experiences with and knowledge of assessment, reporting and evaluation expands.

Table 1. The evolving software

Program characteristic	Evolutionary rationale
Networkability	As the reporting aspect gained momentum, simultaneous access by a number of staff was enabled.
Portability of data	Constraints on teachers' in-school time created a need to export or import subsets of data to be used on a remote workstation. As well as maintaining the integrity of the database, issues such as low machine memory and speed of the remote workstations needed to be addressed.
Ease of use	Teachers bring with them a range of experiences and skills, and unnecessary complexity or procedures discourages rather than facilitates the utilisation of CSIS.
Security and backup	Experience demanded that multiple backup scenarios were built in, *e.g.* automatically saving data when a window was closed. Password protection was needed to maintain global configuration integrity.
Limited flexibility	It transpired that there needed to be a balance between flexibility (to allow for departmental or school peculiarities) and the use of 'constants' (to emphasis the desired assessment model and ensure school-wide consistency).
Reporting	The ability to generate reports directly from assessment data was an important principle, which was incorporated.
Data entry	Apart from report comments (which can be automated) this is achieved, though not exclusively, through mouse manipulation. A compromise needed to be made between data complexity and ease of use.
Compatibility	Data transfer from MUSAC or other systems is seamless and automatic.
Evaluation/analysis of data	This is at a formative stage as schools come to terms with a school-wide assessment 'currency' and the use of the available technology tools.[5]
Year to year continuity	The facility to archive reports and assessment information generally was anticipated. This does present some issues, however[6].

The temptation to develop a flexible open-ended program needed to be tempered with the current state of computer literacy among secondary school teachers. As Ayres, Nolan and Visscher (1998) point out, senior managers and administration staff are the major users of CSIS, predominantly for administrative purposes. There appears to be a direct relationship between the flexibility of and the complexity of the software used in this context. A conscious decision was therefore made to restrict the flexibility in an attempt

[5] Described by Nolan, Fulmer and Taylor (1998) as moving from data management to information management.

[6] Frank and Fulmer (1998) explain that multi-level data is very powerful but can also be very condemning.

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The Distance Ecological Model to Support Self/Collaborative-Learning in the Internet Environment

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Key words: Distance Education, Teacher Training System, Distance Educational Model, Learning Ecology, School Based Curriculum Development, Training System

Abstract: With the rapid development of information technology, computer and information communication literacy has become extremely important. As a result, teachers require new skills. A new teachers' education framework is necessary to enhance multimedia teaching skills and information literacy about the Internet environment. The purpose of this study is to propose and develop a Distance Educational Model, which is a School-Based Curriculum Development and Training-System (SCOUTS). In this environment, a teacher can learn subject contents, teaching knowledge, and evaluation methods of students' learning activities, related to the new subject called "Information", via an Internet based self-training system. In this paper, we describe the structure, function and mechanism of the Distance Educational Model, and then describe the educational meaning of this model in consideration of the new learning ecology, which is based on multi-modality and new learning situations and forms.

1. INTRODUCTION

Recently, with the development of information and communication technologies, various teaching methods using Internet, multimedia, and so on, are being introduced. Most of these methods emphasise, in particular, the aspect of collaborative communication between students and teacher during interactive teaching and learning activities. Therefore, now-a-days it is

extremely important for a teacher to acquire computer communication literacy (Nishinosono, 1998).

So far, there have been many studies concerning system development, which aim at fostering and expanding teachers' practical abilities and comprehensive teaching skills by using new technologies, such as computers, Internet, multimedia, and so on. In Japan, systems using communication satellites such as SCS (Space Collaboration System) are developed and used as distance education systems between Japanese national universities. In the near future, a teacher's role will change from text based teaching to facilitating, advising, and consulting. His or her role will be more that of a designer of the learning environment. Therefore, a teacher has to constantly acquire new knowledge and methodologies. We have to build a free and flexible self-teaching environment for them under the concept of "continuous education". At the same time, we need to build a collaborative communication environment to support mutual deep and effective understanding among teachers.

In this paper, we propose a Distance Educational Model, which is based on the concept of School Based Curriculum Development and Training System, advocated by UNESCO and OECD/CERI (Center for Educational Research and Innovation). We describe the structure, function, mechanism and, finally, the educational meaning of this model. It is necessary to construct an individual, as well as a collaborative, learning environment that supports teachers' self-learning and training, by using Internet distributed environments and multimedia technologies. A teacher can choose the most convenient learning media to learn the contents (subject units) that s/he desires.

2. DISTANCE EDUCATIONAL MODEL BASED ON SCOUTS

Until now, when a teacher wanted to take a class on "IT-education", s/he had usually to leave the classroom or school. However, it is now possible to learn various kinds of subject contents by building a virtual school on the Internet environment.

2.1 Distance Educational Model

Our Distance Educational Model is built on three dimensions. The first one is subject-contents, which represents what the teachers want to learn. The second one represents teaching knowledge and skills as well as evaluation methods of students' learning activities. From the third axis, a favourite

learning media (form) can be chosen, *e.g.* VOD, CBR, etc. By selecting a position on each of the three axes, a certain cell is determined. A cell stands for a "script", which describes the instruction guidelines of the learning contents, the self-learning procedure, and so on. Figure 1 shows the structure of this model. A more detailed explanation of each axis follows.

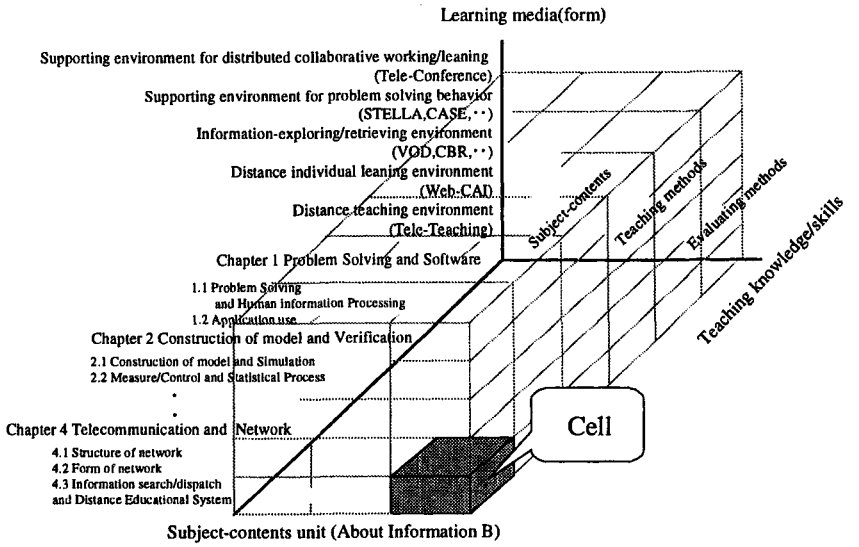

Figure 1. Structure of the Distance Educational Model

2.1.1 Subject-contents unit

In this study, we focus on the subject "Information", which is due to be established as a new obligatory subject in the regular courses of the academic high school system in Japan. The subject "Information" is composed of three sub-subjects, "Information A", "Information B" and "Information C". The contents of each sub-subject are as follows.

Information A: This sub-subject places importance on raising the fundamental skills and abilities to collect, process and transmit "information" using computers, the Internet and multimedia.

Information B: This sub-subject places importance on understanding the fundamental scientific aspects and the practical usage methods of "information".

Information C: This sub-subject places importance on fostering desirable and sound behaviour regarding participation, involvement and contribution in an information society. It focuses on understanding

people's roles and the influence and impact of technology in the new information society.

2.1.2 Teaching knowledge/skills

On this dimension, we have represented three items, which are: sub-subject contents, teaching methods and evaluating methods for "information" classroom teaching. The item 'teaching methods' stands for how to use and apply IT, in order to enhance a student's problem solving ability. This involves comprehensive learning activities, such as problem recognition, investigation and analysis, planning and design, implementation and execution, evaluation, report and presentation. We aim at teachers acquiring the proper respective evaluation skills of students' achievements, for each of the above activities.

2.1.3 Learning media (form)

This dimension represents five different learning environments: (1) "Distance teaching environment (Tele-Teaching)", based on one-to-multi-sites telecommunications; (2) "Distance individual learning environment (Web-CAI)", based on CAI (Computer Assisted Instruction) using World Wide Web facilities; (3) "Information-exploring and retrieving environment", using VOD (Video on Demand) or CBR (Case Based Reasoning); (4) "Supporting environment for problem solving", by providing various effective learning tools; and (5) "Supporting environment for distributed collaborative working/learning", based on multi-multi-sites telecommunications. Brief explanations for each environment follow.

1. *Distance teaching environment (Tele-Teaching)*: This environment delivers the instructor's lecture image and voice information through the Internet, by using the real-time information dispatching function via VOD (Video On Demand).
2. *Distance individual learning environment (Web-CAI)*: This environment provides CAI (Computer Assisted Instruction) courseware with World Wide Web facilities on the Internet.
3. *Information-exploring and retrieving environment*: This environment delivers, according to the teacher's demand, the instructor's lecture image and voice information, which was previously stored on the VOD server. For delivery, the function 'dispatching information accumulated on the VOD server' is used. In addition, this environment provides a CBR system with short movies about classroom teaching practices.

4. *Supporting environment for problem solving*: This environment provides a tool library for performance support based on CAD Modelling tools, Spreadsheets, Authoring tools, and so on.
5. *Supporting environment for distributed collaborative working and learning*: This environment provides a groupware with a shared memory window, using text, voice and image information for trainees.

2.2 "Cell" definition

The concept of a "cell" in the Distance Educational Model is quite important because it generates the training scenario, including information to satisfy the teacher's needs, the subject materials learning-flow and the guidelines for self-learning navigation. The frame representation of the "cell" is shown in Table 1. These slots are used when the system guides the process of the teacher's self-learning.

Table 1. The frame representation of the "cell"

Frame-name:		
		Slot-value
Slot-name	Learning objectives for a student	Subjects which should be understood Subjects which should be mastered
	Subject-contents	The unit topic
	Teaching method	The students' supervision method and instructional strategies
	Evaluating method	The students' evaluation method
	Useful tools	The software used for the training activity
	Operational manual of tools	The software operation method used for the training activity
	Prepared media	The learning media which can be selected
	Guide script	The file which specifies the dialog between the trainee and the system

3. OUTLINE OF THE TEACHER TRAINING SYSTEM

The system configuration of the teacher's training environment is composed of two subsystems based on the Distance Educational Model. One of the subsystems is the training system, where a trainee can select and learn the subject s/he needs, guided by the script in the "cell". The other subsystem is an authoring system with creating and editing functions for "cell" description. The users of the second environment are, for example, IT-

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Educational Centres as Knowledge Organisations Training Future Knowledge Workers: The Role of IT

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Key words: Information Technology, Knowledge Management, Education, ITEM Systems

Abstract: The main objective of this paper is to propose an IT related educational framework for centres which are responsible for future knowledge workers – primary schools, high schools, and universities. First, we analyse the latest changes in the business world due to the arrival of a new knowledge era. According to empirical and theoretical evidence, the first step necessary to succeed in knowledge management seems to be information technology (IT). After clarifying both the conceptual differences between information and knowledge, and the different knowledge types which are necessary to be managed, we analyse how IT can be a very useful tool for knowledge management in organisations. Second, we reflect upon the academic and social aims of educational centres, relating them to the inherent aims of knowledge based organisations. The goal is to try to integrate two perspectives that are not always easy to merge. As mentioned, the key point throughout this process can be IT, but it is necessary to train students of different levels in the basic skills, not only to accomplish the academic objectives, but also bearing in mind the role they are going to play in a more globally competitive environment. Finally, we consider the influence that these changes can have on educational centres, making them adapt to the environment by means of a learning attitude that allows them to become real knowledge centres. In this respect, information technology for educational management (ITEM) systems can play a vital role as catalysts for the process of change.

1. INTRODUCTION

The economy of every country is a direct reflection of its degree of business structure development. Corporations, the major employment creators, are under growing pressure from the increasingly competitive environment. Therefore, they have to continuously adapt and transform their business practices to survive. In this adaptive process, corporations are focusing their strategies more and more on the so-called intangible resources, fundamentally knowledge management and corporate learning. This trend has meant a dramatic change in traditional business management practices which were typically centred around physical assets.

This recent trend affects the training and skills that corporations now require from their present and future employees. Clerical and non-clerical workers are becoming knowledge workers and an important part of their job is to manage corporate knowledge appropriately. Consequently, educational centres of every level, as the main suppliers of qualified human resources, must rapidly adapt to the demands of the job market and give students the necessary skills to work successfully within corporations. The success of educational centres and, in many cases, their very survival, will depend on the compatibility of their students' training with the requirements of business corporations.

One key point in achieving this is the education and training given to students in information technology (IT) matters. Empirical evidence shows that the very first step necessary to succeed in knowledge management is to know and to master IT potential. Therefore it is necessary at every educational level – primary school, high school and university – to clearly identify the likely missions and functions of the respective graduates in the jobs in today's market place. Consequently, an important task for those responsible for education is to effectively plan the IT tools that students at each level must know and master.

Bearing in mind previous considerations, this paper attempts to propose an IT educational framework with the most suitable tools, objectives and training methodologies at each educational level. This framework must be adapted to the socially established general educational objectives and, at the same time, satisfy the demands of the business world in which most students will develop their professional activities in the future.

To achieve this goal it is also necessary to redefine the role of educational centres. Knowledge[1] is the most important resource that educational centres have in order to ensure that the output (students who have completed their education) are prepared for the functions that they will

[1] Not only the knowledge that they pass on to students, but, above all, the know-how to carry out the educational function in a more effective way.

perform in the future. In this process of knowledge acquisition, the centres become organisations that learn and the ITEM constitutes an important agent for learning, making a definitive contribution to defining this new role of educational centres.

The paper starts with an analysis of the latest changes in the business world due to the new knowledge era, which leads us to the conclusion that the knowledge management efforts of companies begin with the implementation of IT. Following this, we explain the role of IT in organisations whose competitive advantage is based on knowledge management using the hypertext style of organisational structure, as well as the new concept of heterarchy.

At this point, we review the social and academic aims of the educational system at the present time, which constitute the reference that must be taken into account. This is because companies' goals could cause conflict between their demands for employees' training and the socially settled objectives of the educacional system. However, it is important for the growth of joint attempts to closely integrate both sides – academic and economic – to improve the general performance at all levels, including the social one. Hence, knowing the business trend – that of companies relying on better knowledge management – and a potential way of integrating it with education aims by means of IT, we propose an educational framework for IT, trying to identify the computer skills that could be included in the formative curriculum of students according to their educational level.

To be able to put this educational framework into practice it is necessary to redefine the role of the educational centres. We consider a vision based on knowledge management to be necessary, and this is acquired after a process of continuous learning about how to teach or educate in a better way. With this purpose in mind, we reflect at the end of the paper that, in order to be successful, it is necessary to know how to take advantage of the potential offered by IT, and more specifically of the diverse tools that make up ITEM. By combining qualified human resources with the use of IT, the appropriate conditions for those changes required by the future environment can be created.

2. KNOWLEDGE AND INFORMATION TECHNOLOGY

Static theories of competition, associated with neoclassical microeconomics and the "structure-conduct-performance" school of industrial economics, are being displaced by the more dynamic approaches associated with the Austrian school of economics, especially with Schumpeter's concept of competition as a process of "creative destruction" (Schumpeter, 1934). This displacement has had profound implications for strategic management

thinking and it has generated the resource-based view of the firm, which places more emphasis on the "supply-side" than the "demand side". This new strategic view has been closely associated with recent works on organisational capabilities, such as Prahalad and Hamel's work (1990), which argues that sustainable competitive advantage is dependent upon building and exploiting "core competences". These are capabilities which are fundamental to a firm's competitive advantage and which can be deployed across multiple product markets.

Indeed, competitive conditions in product markets are driven, in part, by the competitive conditions in resource markets. Thus, the speed with which positions of competitive advantage in product markets are undermined, depends upon the ability of challengers to acquire the resources needed to initiate a competitive offensive. Sustainability of competitive advantage, therefore, requires resources which are idiosyncratic (and therefore scarce), and not easily transferable or replicable. These criteria point to knowledge as the most strategically important resource which firms possess.

Many researchers have pointed out that for many firms their ability to create, share, and use knowledge will have a major impact on their future competitiveness; and some even state that the only sustainable competitive advantage in the future will be good or excellent organisational knowledge creation and good knowledge management (Toffler, 1990; Drucker, 1993; El Sawy *et al.*, 1997; Teece, 1998; Miles *et al.*, 1998). One hypothesis is that theories of organisational knowledge creation and a resource-based view can give new ideas on how to design and implant IT. Nowadays, there are two main reasons for the changing role of IT. First, there is a paradigm shift from information processing to knowledge creation. Second, the literature on knowledge management is to a large extent ignoring IT (Carlsson *et al.*, 1996).

On the other hand, from the empirical point of view, studies such as that conducted in 1997 by the Ernst & Young Center for Business Innovation, whose objective was to describe what firms are doing in order to manage knowledge and what else they think could be or should be done, show that 22% of the 431 US and European organisations studied think that restrictions over IT are a hindrance to the transfer of knowledge. Furthermore, many companies are progressing along similar lines when their knowledge management efforts start with the implementation of a technological capability, although when respondents were asked whether their organisations' ability to compete based on knowledge depends more upon people, process or technology issues, their aggregate responses placed the emphasis heavily on people (50%), with the other two areas carrying equal secondary weight (25% each). So, there is evidence of the knowledge management efforts of companies, starting with the implementation of a

technological capability, which allows them (at least in principle) to capture and share corporate know-how. Only after this capability exists do the firms realise how vital other factors are (Ruggles, 1998).

3. INFORMATION TECHNOLOGY: A TOOL FOR KNOWLEDGE MANAGEMENT

To explain the role of information technology in organisations whose competitive advantage is based on knowledge management, we use the hypertext style of organisational structure, defined by Nonaka and Takeuchi (1995), as well as the new concept of heterarchy *versus* the classical concept of hierarchy, as defined by Hedlund (1994). The heterarchy arises from: (1) the dispersal of knowledge and strategic action initiative to "lower levels"; (2) shifting bases of leadership and composition of teams; (3) the importance of lateral internal communication and integration through shared culture; and (4) change of roles at all levels of the corporation. Therefore, a business organisation should have a nonhierarchical, self-organising structure working in tandem with its formal hierarchical structure. The most appropriate metaphor for such a structure comes from a "hypertext", which was originally developed in computer science. A hypertext organisational structure will have three layers: the business-system layer, the project-team layer, and the knowledge-base layer.

The central layer is the "business-system" layer, in which normal, routine operations are carried out. Since a bureaucratic structure is suitable for conducting routine work efficiently, this layer is shaped like a hierarchical pyramid, that is, this layer has a strong focus on vertical communication (Nonaka & Takeuchi, 1995). The IT community knows quite well how to design and implement systems for the business-system layer, mainly from an information processing perspective. Computer-based systems such as transaction processing systems, accounting information systems, and management information systems are good examples of this type of system (Carlsson *et al.*, 1996).

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Developing Software for School Administration and Management

Incorporating Flexibility

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Key words: Software Flexibility, Business Rules Technologies

Abstract: Flexibility is one of the most important characteristics of software systems for computerised school management and administration, in particular if the software has to be used in several institutions. Given that school institutions are diverse in many aspects and have their own specific needs, several problems are faced when developing unified software. In this paper we describe an approach to information system planning and development, which we believe can help to gain the required software flexibility. The main purpose of the paper is not to examine technical issues on information technologies but to emphasise the possibilities that have to be considered when developing software in support of management and administration in schools.

1. INTRODUCTION

Studies on the use of Computerised Information Systems in schools have proved the correlation between the existing variance in the type and extent of School Information System usage and the ability to adapt software to institution-specific needs (Mahnic, 1997; Wild & Fung, 1996). Flexibility is an example of a software characteristic that makes transition to new software smoother and easier. Of course, there are several other indispensable features that can affect the decision whether or not to use or adapt the system. In our opinion, system developers have to be aware of all the requirements in order

to develop adequate systems. Business users, in our case school managers, also have to be aware of the possibilities offered by contemporary technologies and approaches in information system development. A few years ago it would not have been expected that a system would be able to take instructions only by voice, without using a keyboard or mouse – this was simply not possible. New technologies, however, made this dream a reality.

We will use this opportunity, therefore, to introduce a rather unknown approach to information system development. Since our domain is information science, and we have some experience in planning and developing software for school administration and management (Rupnik *et al.*, 1997; Mahnic, 1997), we believe that school management and administration is a good example of an application domain that can fit several modern development concepts. One of these is a Business Rules Approach that primarily focuses on software flexibility issues.

2. WHY FLEXIBILITY?

The need for new approaches and technologies emerged from the problems that we experienced with the development of an information system for higher-education institutions in Slovenia (Rupnik *et al.*, 1997) and later with the system maintenance. The project was funded by the Ministry of Education and Sport and took place at the beginning of 1995. The objective was to develop an information system that supports centralised processing of enrolment applications, which is a common process for all Slovenian universities and independent colleges. As there were many institutions (with many different study programmes), each of which had followed its own enrolment policies and rules, we had a tremendously difficult job developing a rigorous, and at the same time flexible, enrolment policy model. Even today, five years from the launch of the Enrolment System, we still have to make changes required by faculty management.

Similar findings were discovered when developing a students records information system (Mahnic & Vilfan, 1995) for the University of Ljubljana, the largest university in Slovenia. It has 26 member institutions (twenty faculties, three academies and three colleges), more than 40,000 students, over 2,600 teaching and research personnel, and an administrative staff of about 1,250. The purpose of the development project was to support entrance examinations, enrolment, examination records, alumni records, various analyses and statistical surveys. All the applications were written in co-operation between the Faculty of Computer and Information Science and the University Computing Centre, with the support of the European Union

Tempus program (project IEP 1852 "Computerisation of Administration and Management in Higher Education", 1991-94). As Mahnic (1997) states, in Slovenia faculties have substantial autonomy within their universities, and they often have their own policy regarding the use of information technology. Thus the development of an integrated university information system was not only a difficult technical task, but required a substantial organisational effort. Among the other findings discovered through close examination of the experiences of other institutions and initiatives in foreign countries (McDonough, 1992; Powell, 1991; Frackmann, 1991, 1992; Schutte, 1991), was that the system has to offer a certain level of flexibility in order to handle all the differences among the member institutions (in organisation, administration, etc.). Even though some specific solutions required by particular institutions were not a part of an overall agreement, the project team was forced to consider them in order to retain user satisfaction. Again, the question was, how to achieve the required level of flexibility?

2.1 Business Rules and Flexibility

Recently, much effort has been put into developing applications that are flexible and easier to change and adapt. Unfortunately, most of today's applications do not apply to these characteristics, as changes require the modification of low-level program code. Of course, not all changes are equally difficult. If a customer wants to have an additional dialogue box incorporated into the user interface, we can (usually) do that without any substantial effort. But what if, for example, a process of entrance examinations has been changed due to some additional rules that have been put into operation? Or what if a current system allows a student to select four course offerings for the coming semester, but now management would like to allow students to select four course offerings plus two alternative choices, in case the student cannot be assigned to a primary selection? From an organisational point of view, these changes are rather trivial, but in terms of a software change, they are difficult and time consuming. In fact, this is commonly the case: the rules change constantly at a policy level, while we cannot keep up with the software that is used to implement them.

These kinds of rules are known as "Business Rules". Although the name is rather confusing[1], it has become a widely accepted term within information science. Since there is no common definition that would clearly explain the concept of a business rule, various inconsistencies can be noticed

[1] The adjective "business" only causes confusion, as it forces us to think that business rules can apply to the development of business applications only. In fact, they apply to all kinds of applications.

when reading papers on business rules or using tools that claim to support them. For the purposes of this paper, a business rule will represent a statement that defines or constrains some aspect of the organisation's behaviour. Here are some examples:

- A candidate can apply to a maximum of three study programmes at the same or different institutions.
- Each study programme is composed of several courses.
- A date must be specified for an examination and cannot be changed after it has been published.
- A student must register for an exam at least three workdays before the examination date. After that, any registration is rejected.
- If a candidate is not a full-time student, her/his registration to an exam is automatically cancelled, unless she/he has preliminarily paid for the examination.
- If a student has failed an examination more than three times, the board of examiners must be convened. In addition, the student must pay for the examination.

According to various discussions (GUIDE, 1995; Barnes & Kelly, 1997; Ross, 1997; Hurwitz, 1997), business rules have a significant impact on software flexibility and scalability. If not presented properly, for instance if buried in the program code, they can be very difficult to manage and maintain. The most common problems that arise as a result are:

- Every change of business rules requires programming.
- Business rules are distributed across the application logic; thus the place where the change has to be made is hard to find.
- Business rules are dependent and interrelated chunks of logic. Therefore they have to be modified carefully, considering the possible effect on the other rules.
- It is very difficult to control business rules, as there is no common place where they are stored.
- Since the need for changes to rules usually arises from organisation requirements with which developers are not necessarily familiar, there is a risk the requirements will be misunderstood.

These are only a few of the problems that stimulated the development of a new strategy that is primarily focused on business rules. The main idea of this approach is to conceptually, logically and physically separate business rules from the other parts of application, data and functionality, while

making them easy to access, view, modify and manage. Achieving those goals results in improved application flexibility and scalability.

Before discussing the concept of a business rules approach and its associated technologies, we will first examine how the rules are managed within the traditional application development life cycle and traditional applications.

3. TRADITIONAL APPROACHES TO FLEXIBILITY AND ADAPTABILITY

In order to make applications adaptable and flexible, developers have been using several different approaches for a long time. The most common traditional methods include parameterisation and using database mechanisms.

3.1 Parameterisation

One method of adding flexibility and adaptability to an application is to parameterise the application and its components. These parameters may be then set in a configuration file or in a database, and can be managed through a configuration utility. In doing so, the application can be adapted to different environments and situations just by parameter settings, without any programming effort.

The parameterisation technique proves useful when used to provide parameters for the business rules. Although the business rules remain hidden in the application logic, they can be modified through parameters, without any need for changing the program code. In addition, end users can make business rules modifications, if they are provided with simple and user-friendly configuration utilities.

However, this approach presupposes that the development team can foresee all kinds of changes that are likely to be required. Moreover, it presupposes that the development team able to programme and parameterise all additional cases. This requires the parameterisation of all logical decisions (decision logic has to be used or bypassed, and the variables used have to be stored as modifiable parameters). Consequently, this is an extreme burden on the application developer. In addition, application testing suffers from a combinatorial explosion effect that sometimes requires an additional application in order to configure the parameters correctly. These parameters themselves will often be interrelated, requiring assumptions and rules to be encoded in the parameter-modifying application, with similar problems.

5

Open ITEM Systems are Good ITEM Systems

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Abstract: Many educational authorities and third-party developers have, in the past, built ITEM (Information Technology and Educational Management) systems mainly for the benefit of central education authorities rather than schools. In some cases these systems have been designed without thorough consultation with schools. The result has been that many schools have not been able to get as much out of them as might otherwise have been possible.

Experience in designing the hardware and software components of business information systems has shown that *open systems*, in conjunction with formal software standards, are required to produce systems that can meet their full potential. It has also been shown that end-users will make much better use of systems that they have had a part in specifying. An inflexible system imposed from above is much less likely to be used effectively than one that clients are able to modify to suit their own requirements.

In this paper we advocate that future ITEM systems should be built as 'open systems' that can be adapted and modified by their users. In this we are arguing for much more than users just being able to select one of several pre-designed reports. What we are arguing for is systems that can be added to by the user, and that can be adapted to suit the users' own requirements.

1. INTRODUCTION

As the university travel department is running behind schedule, you have to pick up the airline tickets for your forthcoming conference trip yourself. You have driven into the city and parked next to a fire hydrant outside the travel agent's premises. When you come out after collecting your tickets you note a

young woman smartly dressed in a City Council uniform standing next to your car, typing some data into a hand-held device with a short aerial. The device then prints out the parking ticket which she sticks onto your windscreen. It will do you no good trying to catch up with her to protest that you were in a hurry and were only parked there for a minute or two anyway, as your packing infringement has already been radioed through to the City Council's computer system.

A technician from Telstra[1] has just spent twenty minutes connecting your new computer network to a Telstra cable for fast Internet access. Before leaving, he types some numbers into a special device connected to his mobile phone. He then gets into his van and plugs this device and the mobile phone into its cradle before driving to his next assignment. When he starts the engine of the van the mobile phone automatically connects to Telstra's head office and up-loads details of the work he has just done at your site. The device also receives details of new jobs to be done later in the afternoon, and commences downloading another part of the new operating system to be installed in the van's computer next week.

The question we will address in this paper is why don't schools make use of technology like this for tasks like checking student attendance, operating library borrowing systems, running school sports meetings and entering student results? The answer is that to some extent, they do. It is possible to purchase systems using technology like PDA (Personal Digital Assistant) terminals and student swipe-cards for this purpose, but what tends to be missing from these systems is the link to the central database in the school administrative system. Our research has shown that although quite a number of Australian schools do use technology like this, they normally have to use it as a *separate system* unconnected with the school's main administrative system. These special systems operate separately largely due to the inflexibility of central ITEM systems, and the difficulty of using data from one system in the other, with the result that the same data is stored in multiple locations in each school.

2. SYSTEMS FOR RECORDING STUDENT ABSENCES

After encountering serious problems with student absences from class during the middle of the school day, Flower Meadows High School[2] implemented a new swipe-card system for recording student attendance. In this system students are issued with their own plastic ID card. Each card has the

[1] An Australian telephone company.
[2] A fictitious name for a real Australian school.

student's name, date of birth and photograph imprinted on the front, and a magnetic data stripe on the back. Each classroom has a card-reader at the door, and students swipe their ID card through this at the beginning of each class during the day. As the card-readers are networked back to the school administrative office, it is not difficult to see how the system could be used to record student attendance. Special software could then compare data from cards swiped though a card-reader each period with a central student database and print an exception report of student absences. The system could easily be programmed to flag special occurrences, such as when a student who is present in first period and absent in second and third periods is present again in period four. The system would then bring this information to the attention of relevant school staff.

Such a system is not new or particularly novel, and schools in several different countries successfully make use of technology like this (Selwood, 1996). In the case we are describing, however, there is a major difficulty, and when looked into further this becomes apparent. Flower Meadows needs to use the attendance system for initial entry of student enrolments as it must have new ID cards printed as early as possible. When enrolments have stabilised, the school then *prints* out class lists from the enrolment system and one of the office staff then *types* these into the main administrative system which is unable to accept external input other than via the keyboard.

Weir High School[3] issued all their teaching staff with a PDA (Palm Pilot III) at the start of the school year. Each PDA is loaded with special software and copies of student class lists for every class in the school, along with a copy of the school timetable. At the beginning of each period, teachers enter student absences (or lateness) into the device; it is presumed that all students not so marked are present. If a teacher is away then the replacement teacher who gets the 'extra' simply uses their own PDA which, like all the others, has been loaded with *all* the class lists. At the end of the day, or when a teacher has no more classes, they upload the absences into one of the PC data entry stations in each staffroom. As these PCs have been fitted with a special cradle to accommodate a PDA for data transfer, this is quite a simple task that normally takes only about 10 seconds.

During upload the system also checks to see when this PDA last had an update of its class lists, and whether there have been any changes since that time. If there have been changes a message appears on the PC screen asking the teacher to be patient and wait until new class lists have been downloaded to their device (Harper, 2000). After all teachers have uploaded their data, the central system is able to print out a series of reports, and lists of absences each period of the day.

[3] Another real Australian school with a fictitious name.

Although this is still a developing technology, some schools are also making use of this system on the portable PDAs on school excursions to ensure that no student gets left behind when the bus leaves. Others are entering disciplinary data such as when a student has been caught smoking, or fighting. Like the swipe-card system, however, the problem is that this system operates entirely separately from the school's central administrative system.

3. PROBLEMS WITH NON-INTEGRATED FUNCTIONAL SYSTEMS

Not only is the re-entry of data, required when using either of these systems, a waste of time and resources, but it also violates one of the main principles of database management (Date, 1983): that data should be stored in one place, and one place only. (It should be noted that there should always be a back-up copy of any database. What we are pointing out here is that there should only be one copy of the database *in use*.)

At this point a comparison with business information systems is useful. Traditionally, businesses have often been organised along *functional* lines. From early times, information systems were designed to support business functions such as accounting, manufacturing, finance, human resources, marketing and so on. In the early function-specific information systems, data was typically stored in file format, with data of a given type being stored in a particular file independently of all other data (Tatnall *et al.*, 2000). While these systems had their benefits, they also had problems (Reyes, 1998). For instance, data collected for use by one function-specific information system would typically not be available to another. This made systems of this type potentially quite inefficient. Specific information systems can, however, be designed to act together to produce an *integrated information system* whose purpose is to provide for the flow of information across all levels and functions of the organisation (Tatnall *et al.*, 2000). Data is stored once only, without duplication, and is able to support all activities relevant to the organisation, so improving communication between parts, or functions, of the organisation.

Using function-specific systems that are not integrated with the central database means that there will need to be multiple copies of the student database (for example), each of which must be frequently updated (Tatnall *et al.*, 2000). The difficulty is that when there are two or more different, unrelated student databases, any changes, such as new enrolments, changed student details and so on that occur, must be made to *each* database *every* time they occur. Human weakness means that with almost complete

certainty, there will be a time when this does not occur and only one of the databases is updated. This means that the other database then becomes inaccurate.

The reason that Flower Meadows and Weir High Schools are unable to transfer the data from one system to the other is that the school administrative system that they both use has been designed as a function-specific system. It has been designed *not* to allow the importation of data from other systems, and not to allow other systems to directly access its own database. Presumably the designers of the school administrative system, provided by the Ministry of Education, had concerns about data security and integrity and so designed it that way. This system allows *download* of data, but nothing more.

4. WHO 'OWNS' THE ITEM SYSTEM?

In several Australian states, schools' administrative computing systems were built by central educational authorities and issued free (or at low cost) to schools. The primary motivation for doing this was to provide a reporting mechanism from schools back to the centre. Schools' administrative computing needs were not the main consideration (Tatnall, 1995). The general distribution of these systems to schools meant that schools could then be *instructed* that they *must* use them to provide the required reports back to the central authority.

While understanding why this approach was adopted, and not wanting to denigrate the needs of central educational authorities for information, we would argue that in future it would be much better if *individual schools*, rather than *school systems*, were seen as the prime clients by systems developers.

At issue here is who should be seen as the client. Who should the systems developers speak with about the systems requirements? There is a great deal of information systems literature that points to the necessity of involving users in the process of designing information systems (Fuller & William, 1994; Lindgaard, 1994; Alter, 1996; Lawrence *et al.*, 1997) if we want those systems to be used to their full potential. Lawrence *et al.* (1997) stress the need to consult with users, and Lindgaard (1994) notes that a large body of research has shown that potential users do not make best use of information systems unless they feel that these systems have been designed with their involvement and in their interest. Fuller and William (1994) point out that when business users think that central computing departments have been unresponsive to their needs they often take application development into their own hands, do their own thing, and ignore the central authority. If the