

EDUCATIONAL MANAGEMENT INFORMATION SYSTEM DESIGN, AND PROTOTYPE APPLICATION
AS *DATA CUPBOARD*.

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ABSTRACT

A model for information system development is proposed. It endeavours to cater for the diverse needs of schools more effectively. It involves the integration of Information Needs Analysis, Human Computer Interaction and Information System Evaluation, with the individual user as a central focus. An implementation of a prototype, *dataCupboard* is described. It provides a shell-like interface to existing educational management systems.

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INTRODUCTION

For some time, schools have grappled with attempts to put to good effect a continual stream new information technology (IT). Most attention has been paid to implementing IT in the domain of teaching and learning. However, although IT is a growing part of educational management, the systems that currently exist, are inadequately serving the unique needs of schools (Vissher, 1997). Schools are not usually seen as unique cases for information system (IS) development, but as small versions of commercial businesses using transposed business models, rather than school-specific models (Bloch, Hedberg & Harper, 1994).

While business information needs are often centred on profitability and efficiency, schools needs are generally about the more qualitative tenets of quality teaching and learning. An IS that will aid the effective management of the teaching and learning process, and analyse its effectiveness, must be capable of coping with its diversity.

The interaction of all stakeholders in school education is substantially less clear than the business/client model that dominates the commercial world. Another IS dimension that sets schools apart from business is in IT investment. Businesses invest in IS predominantly because there is a financial and competitive benefit in doing so. Businesses usually recoup the costs of their investment through greater profitability and improved efficiency. Schools cannot follow this principle, and tend to spend less money on IS than businesses, yet often require more complex systems to cater for their diversity and uniqueness. Software companies are less likely to enter into development of school products, if they are unlikely to gain the rewards that are available by working in the business IS sector.

An implementation model is proposed that was oriented specifically to educational management. Cannon Hill Anglican College (CHAC) provided a suitable environment for a number of reasons. It is typical of many schools in that administrative data were stored, but not available in a way that educational administrators could access required information quickly and easily.

For example, information such as timetables are held in more than one database, making it difficult to determine appropriate interface software to use. Additionally, information related to student reporting is in a system that is designed more for storage and printing than for analysis of results. The systems are designed for information retrieval in specific modes that have been determined by the system developers. A mismatch is evident between the end users' information needs, and the ability of the IS effectively to meet these needs. This is despite the fact that present systems in their own right are well constructed and possess most of the qualities of modern business IS.

Surveys of the administration staff at CHAC reveal a very wide range of information needs, typical of educational establishments in general. These range from personal student information (including soft data such as family difficulties), to analysis of student results by year or gender over a period of years. Information is required on a daily basis about the whereabouts of students and teachers, their studying and teaching, and extra activities in which they are involved. The administration staff need to track student unit choices, course pathways and career possibilities. The existing IS provides financial information, simple generation of student reports and enrolment information. Although this information is useful, it does not adequately meet many of the more complex needs identified.

A means of system intermediation that could be readily adapted to the needs of specific users was required. With this in mind, the literature of IS development was reviewed with emphasis on information use analysis. A model was then developed for conceptualising use within the organisational culture. This was used as a basis for improved identification of IS requirements, and implementation of a prototype system based upon the situation at CHAC.

The model draws together three areas: Information Needs Analysis (INA), Human Computer Interaction (HCI), and Information Systems Evaluation (ISE). It is significant for schools, since it accounts for the diversity of school administrators' information needs, the individual (as opposed to the corporate) user, and the usability of the IS.

LITERATURE SURVEY

An investigation of recent literature of INA, HCI and ISE was undertaken to see if they could contribute to the development of an effective Educational Management Information System (EMIS) in a school setting. In particular, material emphasising the need to personalise systems, was sought. For example Havens (1979) stresses that decision-makers must be part of the process of providing information, and that if they are to make good decisions, information must be provided in a manner appropriate to them.

Information Needs Analysis

There is a significant body of literature on INA, much of which notes that users are often constrained by the requirements of an IS, rather being able to influence those requirements specifically for their own needs. A work that has had influence beyond the business community in focusing on user needs is that of Rockart (1979). His 'critical success factors' approach to identifying management needs was not limited to commercial enterprises, and provided examples of application in non-profit institutions. Significant also, was that the factors were determined by personal agenda of individual executives, rather than by a consolidated organisational perspective. This approach is now advocated in texts that emphasise user needs analysis, for example Nicholas (1996).

An additional dimension to INA in the school setting is provided by the inclusion of 'soft data'. Such information cannot easily be represented in a purely objective form. In contrast to hard data such as a student's name, age, address, and year level, soft data may include family and psychological assessment information. Vissher (1997) notes that it is not sufficient merely to provide the hard data. He suggests that a foundation to providing appropriate information is in determining the quality of that information, and that INA should account for the often 'soft nature' of decision making in schools. Reliance on the hard data alone may result in more teacher pressure on the student to perform, whereas use of the soft data (higher quality) may result in counselling for the student to help them cope. This is significant not only in the way in which INA should be approached in schools, but also in substantiating the need for the development of an IS model specific to schools.

Human Computer Interaction

Developers of traditional IS for schools have had little interest in applying quality HCI standards to their work – particularly when they make significant profit from selling training to those who buy their software. Thimbleby (1993) highlights the importance of including HCI in a model for system development, and along with McCain, Ntuen & Park (1996) emphasises that usability should be part of the development process. They see that HCI should be adaptive, and that learnability be transparent. They propose strategies such as obtaining user requirements in the early stages of design, evaluating user experiences on systems that have already been built, including evaluation of user experience in the design cycle, and taking into account user background knowledge and behaviour.

Interface design generally presupposes that a simple consistent intuitive interface to all information is desirable. Thimbleby (1993) supports this, as do Flur, Lockhart & Yalamanchili (1995), who note that simplicity and consistency are features of a Web interface, as browsers have well defined protocols for describing different types of information in a uniform way. Nguyen & Strinivasan (1996) also support Web browsers, and indicate how they can be used effectively to access relational database management systems (RDMS)

Information Systems Evaluation

Evaluation is a critical component of IS development (McCain, Ntuen & Park, 1996). Care must be taken however, that models for evaluation produce truthful results. Applegate (1993) for example identifies the issue of 'false positives' that occur "...when a consumer is satisfied with an inferior product." She notes that this is a common occurrence when material or emotional models of user satisfaction are adopted in the evaluation of an IS. The material model specifies the users satisfaction in terms with system performance. The emotional model specifies

user satisfaction in terms of ‘did I get what I wanted?’ She proposes a counter model based on disconfirmation, product performance measures, and product setting parameters.

While Applegate’s work is on general evaluation of user satisfaction, O’Mahony (1997) explores the difficulties of effectively evaluating IS in schools and arrives at a model that is based around Parents, Administrators, Children and Teachers (PACT). Two domains of information needs are identified: a qualitative (effective) domain involving students and teachers and a quantitative (efficient) domain involving parents and administrators.

Educational specialists see the need for useful evaluation to be guided by an underlying framework, such as the model of DeLone and McLean (Fung, Visscher, Barta & Teather, 1997). This ‘IS Success Model’ suggests a framework of six variables: system quality; information quality; use; user satisfaction, individual impact; and organisational impact. It correlates to some extent with Applegate’s model with more emphasis on individual issues.

CONCEPTUAL APPROACH

Common threads can be found in INA, HCI and ISE that have significant implications in the design and development of EMIS. Research in each domain supports the importance of the user in all aspects of IS design, development and implementation, and giving the users an amount of ‘self-determination’.

The characteristics of personalisation, adaptability, and usability flow from the centrality of the user. Providing information that meets these characteristics is supported in literature across the domains, but many writers also warn of the danger of providing too much information. Overabundance stems largely from a consolidated organisational approach to meeting information needs. The implications for EMIS are to use the personalisation characteristic to restrict information in such a way that it is more usable for the end user.

Planning for EMIS at CHAC assumed that INA, HCI and ISE should be integrated based on their common characteristics. Central to all three areas is the user, and global to all is the culture and context of the IS environment – specifically, the school. Core threads throughout the model include usability, adaptability and personalisation.

This conceptual approach is represented in Figure 1. The user is represented by a triangle at the centre of the model. Each point of the triangle intrudes on one of the three domains of the model (HCI, INA & ISE). This signifies the users input into these elements of the IS. The domains are within one circle indicating the non-linear interaction between them – this is particularly important as it moves away from the potential to view INA, HCI and then ISE in a sequential fashion. Across all elements of the model and embracing the user are the three key characteristics of the IS (personalisation, usability and adaptability). These are set within the context of the culture of the organisation, which encompasses all other dimensions of the model, and are key objectives of the implementation.

IMPLEMENTATION

The prototyping and implementation of *dataCupboard* was carried out within a three month timeframe, but the success of the initial test meant that the intended prototype moved from test into an implementation phase prior to expectations, and because of administrative demand. The name was chosen to indicate a small datawarehouse, but primarily to provide a metaphor that is useful both in development of the system and presentation of a user interface. The *dataCupboard* consists of users with given usernames and passwords. Users belong to groups that are logical representations of roles that they perform in their daily work. The *dataCupboard* contains only information about itself. It provides access to information by way of boxes. Each box has a unique function in retrieving a specific piece of information. Boxes are organised on shelves. Each group has access to one or more shelves depending upon the information needs of that group.

Unlike conventional database applications, the graphical interface only exists when the user logs in at which point it is built according to the relationships between that user and the groups, shelves and boxes in the *dataCupboard*. Management scripts are accessed via a pop-up menu in a *dataCupboard* box on the system administrator shelf, which is accessed only by the system administrator group. An interface example is shown in Figure 2.

Web Interface

Using a Web browser for the client interface, means that all users already have the skills they need to access information. All client software was already installed and no new client software had to be written. This strategy also provided the prototype with a level of abstraction from the databases it was accessing, enabling a freedom of development without interfering with the client interface. The reverse was also true in that the client interface could be dressed up, modified or even completely restructured if necessary, without interfering with the actual information gathering tools.

Because the server completes all of the hard work, the browser requirements are relatively minimal. In fact, *dataCupboard* would run on a text-based browser if that were required. To enable the provision of a quality user interface however, the browsers were required to support tables and javascript. This enabled certain features to be provided in forms with a minimum of screen space and without sending the user to multiple consecutive Web pages. This proved advantageous in making the interface more usable and the information more accessible.

Database

To satisfy the objectives for the prototype, specifically the ability to personalise information, a database was needed to hold information about the users, the information sources and the IS itself. For the prototype, PostgreSQL (an object oriented RDMS) was used on the same Linux server that runs the Apache Web server. A hypertext preprocessor called PHP3 takes scripts that include HTML and embedded SQL, processes them, and forwards the results as pure HTML to the web server. The client does not see any of the database access information that is embedded in the scripts, thus providing an additional layer of security that could not be achieved with client-based solutions.

Implementation of INA

An initial INA was performed using unstructured interviews, with each of the members of the senior administration team to provide a direction for the prototype. In hindsight, this initial INA was not as necessary for the development of the prototype as originally thought. This was mainly because the model proposed required an ongoing INA as opposed to a single formal analysis at the beginning of the project. The ongoing approach proved to be successful.

Despite the fact that the users could have requested much more complex information, nearly all information needs specified are reasonably easily satisfied with existing resources. It would appear that if the users had relatively easy-to-fulfil information needs, the existing systems should be capable of meeting these needs. The fact that this was not happening adds weight to the importance of usability as a key characteristic.

Evaluative Strategies

Initially the strategy for evaluation of *dataCupboard* was to have two formal evaluations of the prototype, with changes made to it based on the results of each evaluation. In practice however, the evaluation was much less formal. Because of the relative speed of development that is possible within the *dataCupboard* shell, prompt action was able to be taken on feedback from users. Mostly, this feedback was requests for need features. As users began using the prototype, they saw the potential for further development of the system. This essentially resulted in an *ad hoc* evaluation but in such a way that the end users were empowered to set the direction of the development.

FINDINGS

Throughout the prototyping process, *dataCupboard* evolution varied considerably from the original plan. Observations on the implementation of the model indicate that the notion of integrating INA, HCI and ISE, is an appropriate approach to development of EMIS. However, although the prototype supported the integration of the three domains, the primary emphasis in practice was on the key characteristics of usability, personalisation and adaptability. These characteristics dominated the model in its practical form, and as with the three domains, can be attributed to the centrality of the user.

Information evaluation revealed several positive findings: (a) enthusiastic use by administration staff quickly led to requests from office and teaching staff; (b) a number of HCI elements were identified as worth modifying; (c) initial complaints were a result of the prototype not being available due to system modification, which was encouraging as it strongly indicated the degree to which it was being used; and (d) users were encouraged to think about their own information needs more - they were able to suggest improvements to facilitate the meeting of these needs, and thus actively contributed to the development of *dataCupboard*.

The greatest indicator of the usability of the prototype was user demand. It has increased over time and as more people have started using the prototype, more still are requesting access. Another indicator of usability is the absence of user training. Because the *dataCupboard* can be administered from the *dataCupboard* itself, users were added to the system on the spot, and generally a five-minute explanation was given on the login in process and the boxes that they have access to. This is the only 'training' in the system and yet there has been no queries on how to use the system, or indications of problems on getting required information.

CONCLUSION

Schools are unique and diverse institutions when it comes to information needs. Many existing IS are not meeting these needs, or recognising the uniqueness and diversity present in schools. A new model for IS development is needed that caters for schools. Research has shown the importance of the user in IS development. It has also demonstrated advantages of personalisation, usability and adaptability in IS across three domains of INA, HCI and ISE. A model has been proposed that caters for these aspects in the educational context.

There are distinct benefits to be gained by letting the IS evolve over time driven by the users. One of the advantages of this approach is an IS that is not 'one size fits all', but is personal and usable by individual users. The user gets the needed information in a form that is appropriate, and does not get information that is not needed. Users also have greater ownership of the system and thereby promote its usability and functionality amongst themselves.

The primary disadvantage of the user driven evolutionary approach is that the IS could potentially develop in a very *ad hoc* manner, with little constraints on system developments for users. It is possible that this difficulty could be moderated by providing system administration tools that allow checking of mismatches and maintaining consistency of information provision. Such tools could also be used to maintain user interface consistency.

The most obvious way that the *dataCupboard* could be extended, is to a wider group of users than just senior administration. This has already occurred to some extent with office staff accessing some of the features. Teachers have expressed significant interest in gaining access, with year level coordinators requesting specific features for tracking student behaviour. It would also be possible to extend *dataCupboard* to students. This would potentially allow students to access timetable information, unit and course selection information and academic history. The *dataCupboard* itself is not school specific. It was developed within the education context but does not contain any dimension that would confine it there. It is feasible that the same model may work effectively in businesses, and in organisations that manage a diverse spectrum of information.

Another future possibility is to establish educational management as a specific area of IS development. Research is needed specifically into information management in schools. Existing research has yet to uncover the diversity and uniqueness of schools or explore the possibilities of new and creative approaches to EMIS.

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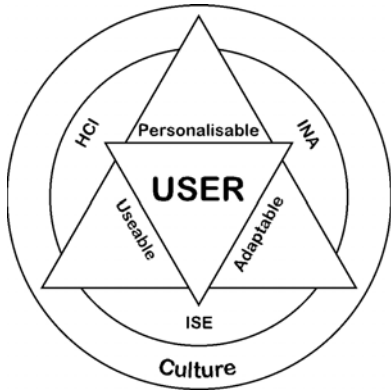


Figure 1: Conceptual analysis

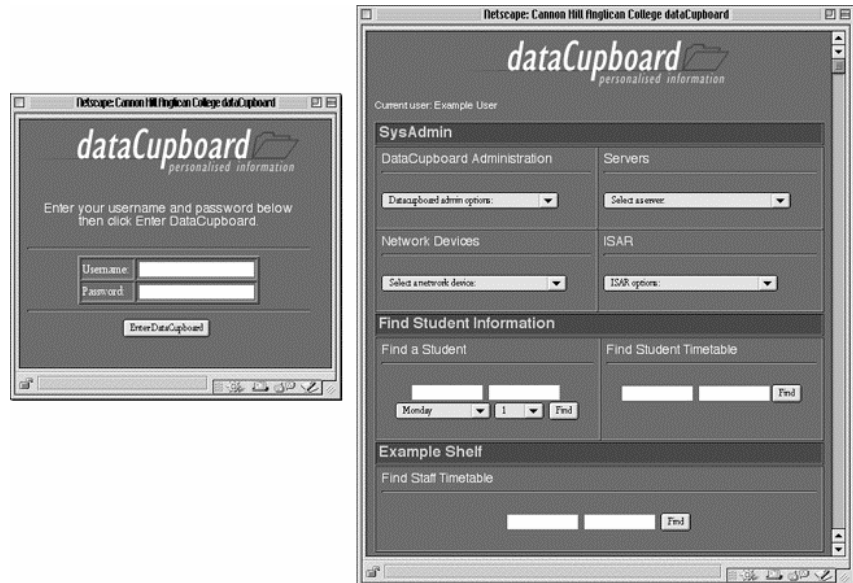


Figure 2: dataCupboard interfaces