IS'97 Model Curriculum: Where Do Enterprise Resource Planning Systems Fit?

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Abstract

As businesses world-wide begin to adopt Enterprise Resource Planning (ERP) systems in increasing numbers, academics are deciding how to utilise these types of systems in Information Systems (IS) curricula. Alliances with some of the ERP vendors have enabled some universities to develop innovative courses and subjects. Nevertheless, the limited research in this area has only outlined case studies or examples of ERP use in IS. In this paper we outline how ERP systems can be incorporated into a broad IS curriculum model such as IS'97 thus providing a guide to institutions that may be contemplating the use of ERP in their curriculum

Keywords: Enterprise Resource Planning, Information Systems curricula

1. Introduction

Over a period of 40 years, the Information Systems (IS) discipline has become an essential component in the employment of information technology personnel in business and government organisations in Australia. Since its inception as a discipline in tertiary institutions, IS curricula has undergone continual, and at times, rapid change. In recent years, however, business has found fault with computer-based courses, particularly in the field of Computer Science, because computing has become an integral part of business processes rather than being a separate service function (DEET 1992, p.126). Although it would not be possible to obtain universal agreement on the exact components, Information Systems is a discipline which is oriented towards business, that is, it involves matching information systems requirements to an organisation's objectives. Nevertheless, information systems professionals require formal technical training in order to be effective and to have a '... sound educational foundation in their discipline so they can keep abreast of new technologies and be responsive to change' (Richards and Sanford 1992, p.219).

Over the last 5 years, a significant number of businesses world-wide have adopted Enterprise Resource Planning (ERP) systems in preference to disparate functional systems. The challenge for IS academics is to yet again modify their curricula to embrace the concepts of ERP so as to provide graduates with the necessary skills to assist business enterprises in the future. This paper examines the potential use of ERP in a broad IS curriculum as outlined in IS'97 (Davis, Gorgone et al. 1997) and provides a guide to academics who may be contemplating the use of ERP in their curriculum.

2. Enterprise Resource Planning Systems

There has been a plethora of attention given to the impact of the Internet on the commercial activities of business, but an increasing number of researchers believe that the adoption of ERP systems by business may be the most important use of information technology as we enter the new millennium (Davenport 1998)

An ERP system can be defined as 'an accounting-oriented information system for identifying and planning the enterprise-wide resources needed to take, make, ship, and account for customer orders' (APICS 1998). The ERP software infrastructure facilitates the flow of information between all functions within the business. This infrastructure is built upon a common database responsible for storing all of the data from processes that are essential for business operations and decision making. ERP systems are enterprise-wide and they claim to incorporate best business practices that replace separate functional systems and impact significantly on the existing processes and practices of business.

ERP sales now represent a significant proportion of total outlays by business on information technology infrastructure. It has been estimated that worldwide expenditure on ERP software was $14.8 billion in 1998 and that the ERP market will sustain strong growth to reach an annual revenue of $52 billion in 2002 which represents a 250% increase over the 5 years (Torsten 1998).

The main vendors in the ERP software market are SAP AG, Oracle, Baan, PeopleSoft, JD Edwards, McDonnell Information Systems, QAD, and Pivotpoint. SAP is the largest client/server and mainframe ERP software vendor with approximately 11,000 employees, 7,500 customers, and 1.7 million users (Stein 1997; SAP 1999). The latest version of SAP's ERP system is referred to as SAP R/3 and has approximately 39% of the world ERP market. In Australia there are approximately 400 companies using SAP R/3. Moreover, SAP R/3 is used in a broad range of industries and organisations such as automotive, consumer products, chemical, manufacturing, oil and gas, high-tech pharmaceutical, and communications (Richardson 1997).

SAP R/3, like all ERP systems, is based on an enterprise-wide business model that makes possible a uniform view of all data and business processes. SAP R/3's integration allows information to be entered into the system once only, but most importantly, this information becomes available to all functional areas of the business.

A major issue with ERP systems is the time required for their implementation. Depending upon the size of the business and the number of modules being implemented, the full implementation process can extend to five years and cost hundreds of millions of dollars. A major contributing factor to these high costs is the expenses associated with implementation consultants who are in short supply world-wide. This clearly presents an opportunity for graduates who have a knowledge of ERP systems to gain on-going employment for many years to come with high remuneration.

3. Barriers to Teaching ERP Systems in Universities

The incorporation of ERP systems into a university's curriculum has been driven by a number of factors: students realise there is a potentially lucrative job market; industries are looking for graduates with appropriate ERP skills; and academics are attempting to keep abreast of current issues in the information technology industry.

Even though there are a number of pressures for the inclusion of ERP systems into the IS curriculum, there are a number of barriers preventing this from happening. One significant hurdle is the limited knowledge and experience of academic staff charged with the

responsibility to integrate ERP into IS courses. Those who possess the required attributes are often lured away from the university into lucrative jobs in private industry. The shortfall of academic skills and experience is further compounded by the limited access to relevant ERP professional development activities. Moreover, there has only been a limited amount of research into the use of ERP systems and that which has been undertaken is usually proprietary in nature and is therefore not seen to be available to universities (Gable, Van Den Heever et al. 1997).

Another significant barrier to the use of ERP systems in universities is the perceived need for students to gain *hands-on* experience to master the concepts inherent in these types of systems (Watson and Schneider 1999). In the past, if a university decided to incorporate a major software product into its curricula, it would have purchased the software and set up the necessary infrastructure to support it. ERP systems themselves are expensive but there are the additional associated costs of hardware and professional development for the computer support staff together with the necessary incentives to retain these people in their current positions. Most universities find that the barriers associated with introducing ERP systems are just too great!

However, there are increasing numbers of universities presently investigating strategic alliances with ERP system vendors to provide the support for incorporating ERP systems into their curriculum (Hawking 1998). The SAP University Alliance Program in Australia is an example of a strategic alliance between a number of universities and an ERP vendor. As part of it's University Alliance, SAP provides approximately $2.5 million worth of its product, and technical and professional support for the integration of SAP R/3. The ERP vendor benefits from these alliances by increasing the supply of skilled graduates that can support their product in industry thereby enhancing its marketability.

4. ERP Curriculum

Academics world-wide are now considering which direction to take in incorporating ERP systems into their information systems curriculum (Gable, Van Den Heever et al. 1997; Hawking 1999; Watson and Schneider 1999).

However, before universities attempt to incorporate ERP systems into their programs they need to determine which curriculum development path they will follow. Research of these Alliances in Australia found that curriculum development paths could take one or more of four different directions (Hawking 1999).

The first direction, which is least preferred by academic institutions, focuses on the instruction or training in a *particular* ERP system. There is increasing pressure from both students and industry for universities to offer subjects based on this type of curriculum direction. In the case of SAP, however, the Alliance specifies that specific training of SAP R/3 is the domain of SAP in Australia.

The second curriculum path retains the focus on business processes but uses the ERP system to assist in the presentation of information and skills development. Most ERP system vendors argue that their particular system incorporates *best business practice* and, as a consequence, students use the system to enhance their understanding of the processes and their interrelationships, especially in the area of supply chain management.

The third direction is the use of ERP systems to teach and reinforce information system concepts. ERP systems provide students with the opportunity to study a real world example of a business information system, often incorporating *state of the art* technology.

The final curriculum direction is to teach about ERP systems and concepts. This is different from the first curriculum direction outlined above in that it deals with *general* ERP issues and the implications for an organisation for implementing this type of information system.

There are a number of questions that need to be addressed before the process to incorporate an ERP system into information systems curriculum can commence (Gable, Van Den Heever et al. 1997). Some significant questions include:

1. In what ways are ERP systems utilised in Information Systems curriculums at present?
2. Is there a need for ERP systems to be specifically addressed in an Information Systems curriculum?
3. If ERP systems are to be addressed, then in what ways and to what extent should this be done?
4. How can ERP be covered in subjects which make up an IS major in an undergraduate course?

5. Information Systems Curriculum

Information systems curriculum has undergone rapid and continuous change in recent times. Today, the function of information systems is often one of supporting innovation, planning and coordinating resources and systems, rather than one where a specialist or group of specialists work in isolation. As the discipline has become more sophisticated it has moved from processing data to providing an information infrastructure with applications aligned to organisational strategy (Longenecker, Feinstein et al. 1994, p.175)

> *Computer based IS are complex socio-technical entities that have taken on critical roles in local, national and global organisations. IS provide support for the goals of the organisation and its management - strategic, tactical and operational – in a timely and cost effective manner. The applied*

nature of the discipline suggests a critical link between education with the practicing professional community

Figure 1 highlights the differences between three computer-based disciplines. The movement along the horizontal axis ('hard' to 'soft') represents a spectrum from hardware oriented to more human involvement in the development of applications. Given the growth in recent years of computer use and, in particular end-user computing, it is understandable how IS has changed during that period of time.

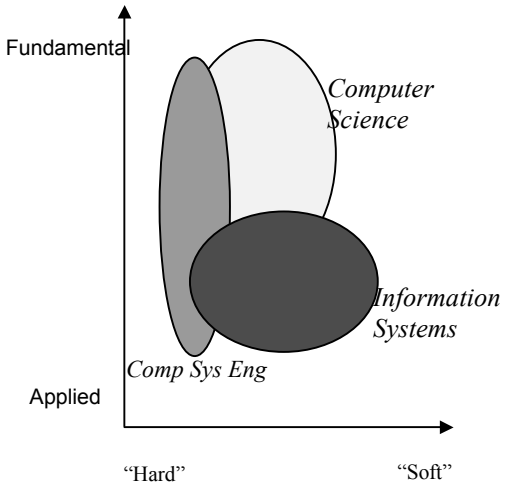

Figure 1: Information Technology Principal Subject Clusters
Source: DEET et al, 1992: Figure 2.1

It is immediately apparent that there is considerable overlap between the various computer-based curriculum areas. IS, however, is a discipline which is oriented towards business or commerce, that is, it involves matching information systems requirements to an organisation's objectives. As an academic study, IS needs to educate students in the efficient and effective application of all components of an information system (computer hardware, software and people) to solve business and organisational problems. The popularity of ERP in business, therefore, requires academic institutions to incorporate aspects of these systems into their IS curriculum.

The IS'97 Model Curriculum was developed by a number of professional IS-related associations, and reviewed by individuals from both the industry and academic sectors. The model provides guidelines and resources in an endeavour to facilitate the development of quality information systems curriculum at the undergraduate level. It is interesting to note that, although this model curriculum is just three years old, it makes little mention of the use of ERP systems.

There has been considerable research into the content of a model IS curriculum in Australia and overseas. Computer-based disciplines frequently change their curricula to incorporate new technologies and match the requirements of business for graduates and it is logical to expect that much of the published material makes little mention of ERP systems (Ang and Lo 1991; Gambill and Wade 1992; Fabbri and Mann 1993; Goslar and Deans 1994; Haworth and Wetering 1994; Longenecker, Feinstein et al. 1994; Bonnici and Warkentin 1995; Davis, Gorgone et al. 1997).

6. IS'97: Outline of a Model Curriculum

IS'97 identifies 5 Curriculum Presentation Areas (CPA) containing individual subjects and a suggested sequence in a typical IS undergraduate program in the U.S.A.:

1. Information System Fundamentals
2. Information System Theory and Practice
3. Information Technology
4. Information Systems Development
5. Information Systems Deployment and Management Processes

In addition to the identified curriculum areas, the model requires students to have prerequisite computer skills and knowledge of PC application packages commonly used in business. It is now common to find that most students who enter an undergraduate degree have acquired some of these skills from their high school studies or through previous work experience. Nevertheless, these basic skills are reinforced and extended in a compulsory first year subject in most IS degrees in Australian universities. In the case of the IS degree at Victoria University, Australia, students must pass the unit, Computer Applications, before they can proceed onto further IS subjects.

Table 1. IS'97 Curriculum Model

Curriculum Area and Subjects	*Subject Description / Topics*
1. Information Systems Fundamentals	
1.1 Fundamentals of Information Systems	• Introduction to systems, systems development, IT and application software. • Uses of information and the role of IT.
1.2 Personal Productivity with Information Systems Technology	• Use of packaged software, individually and in groups. • Consideration of functionality and design in small systems development.
2. Information Systems Theory and Practice	
2.1 Information Systems Theory and Practice	• Organisational systems, planning and decision processes. • Requirements for providing viable information to the organisation.
3. Information Technology	
3.1 Information Technology Hardware and Software	• Systems architecture (hardware and software) and tradeoffs required for effective use in the business environment. • Single user and networked.
3.2 Programming, Data and Object Structures	• Algorithm development and program design. • Logical and physical structures of programs, files and of data.
3.3 Networks and Telecommunications	• Requirements of data communications and networking, including telecommunications. • Analysis, design, implementation, management and evaluation of telecommunication networks within an organisation.
4. Information Systems Development	
4.1 Analysis and Logical Design of an Information System	• Object-oriented analysis and design, data modelling tools and life cycle standards. • Evaluation and selection of system development methodologies. • Role and significance of users. • Interpersonal development with clients, users, team members, etc.
4.2 Physical Design and Implementation with DBMS	• Information systems design, construction and implementation in a DBMS environment.
4.3 Physical Design and Implementation with a Programming Environment	• Physical design, programming, testing and implementation of an object-oriented system in a client-server environment.
5. Information Systems Deployment and Management Processes	
5.1 Project Management and Practice	• Technical and behavioural aspects of project management. • Success factors for enterprise-level systems.

In addition to the 5 CPA's students are expected to gain skills in communications, quantitative and qualitative analysis, and organisation functions. In Australia, a substantial number of undergraduate IS degrees are offered within a Faculty of Business, and it would be common to find elements of Communications, Quantitative and Qualitative Analysis, and Organisation Functions in the business core of an IS degree. At Victoria University, the Bachelor of Business (Information Systems) includes compulsory subjects of Law, Accounting Systems, Management and Organisational Behaviour, Business Statistics, Quantitative Methods and Economics.

Each Curriculum Presentation Area is composed of subjects. The title, scope and topics of each of these areas is outlined in Table1

7. The IS curriculum and ERP

The incorporation of an ERP system into an IS curriculum enables many of the concepts identified in the curriculum areas of the IS'97 Model to be studied using state of the art technology. The most popular ERP systems amongst business enforce rigorous standards to ensure that the maximum benefits of an ERP system are achievable. Moreover, these systems are most productive when used on the latest wave of computer systems. ERP systems provide lecturers with access to a modern, efficient and practical tool which can be used to reinforce many of the concepts covered in the IS'97. The following subsections provide more details on each of the Curriculum Presentation Areas. They are numbered according to details given in Table 1. Each subsection provides suggestions of how an ERP system in general, and more specifically SAP R/3 can be used to support this model.

1.1 Fundamentals of Information Systems

An ERP system can be best described as an organisational system designed to support business processes and to facilitate the flow of information within a business. When integrated into an IS curriculum, an ERP system provides the opportunity for students to examine the information flows between key business processes and how this is aligned with the goals of a business. SAP provides universities with the International Demonstration and Education System (IDES). IDES is a model enterprise consisting of an international group with subsidiaries in several countries and comprises sample data that demonstrates various business scenarios. Students can enter data enabling them to create and manufacture a new product within the system. They can then process orders for the new product and invoice customers accordingly. Lecturers can use the IDES system to demonstrate how an ERP system can support elements of the supply chain and provides a practical example of how to enhance the competitiveness of a business.

Students have the added benefit of being able to examine an ERP implementation system in detail, enabling them to evaluate the advantages and disadvantages of such a system. They gain knowledge of the widespread use of an ERP system in a business enterprise and can see the range of people who are involved in using and supporting the system. Many decisions have to be made about an ERP implementation, which will determine the scope and structure of the system. At a technical level, the hardware platform and the operating system need to be determined.

In addition, the all important database system must be configured. ERP systems can operate on a variety of databases, on a range of hardware platforms.

1.2 Personal Productivity with IS Technology

Although this subject seems to be primarily concerned with popular applications such as word processing and spreadsheets, there are many aspects that can be enhanced with the ERP example. An investigation into the comparative advantages and disadvantages of an ERP system would involve coverage of such topics as:

- software functionality in relation to supporting personal and group productivity;
- the organisation and management of software;
- selecting a computer solution; and
- the design and development of a user interface.

2.1 Information Systems Theory and Practice

This subject expands on the concepts introduced in the earlier subject, Fundamentals of Information Systems. The implementation of an ERP system is usually the largest information systems project a business will undertake. It frequently involves the re-engineering of business functions and processes. The exact structure, including the areas covered by an ERP system, will vary from business to business. An ERP system implementation in one or more organisations can be used to reinforce many of the aims in this subject. Issues that could be discussed include:

- How it was decided to select an ERP system over other types of system options;
- How a particular ERP system was selected over other ERP systems;
- The difficulties associated with aligning the proposed ERP system with the existing business model;
- The implementation process and the extent to which this process was outsourced;
- The roles of persons involved in using the system; and
- Post-implementation issues such as job redesign, security and the related social and ethical concerns.

Case studies of ERP implementations help students appreciate the enormity of such systems and how problems must be viewed *enterprise-wide* rather than in isolation from other components of a system.

3.1 Information Technology Hardware and Software

ERP systems can be installed on a variety of hardware platforms and use a range of operating systems. ERP systems require hardware which is usually *state of the art* and it is not generally something students would get access to as part of their normal undergraduate studies.

Most ERP systems operate in a client server environment and require an open systems architecture that adheres to prescribed industry standards. The hardware and operating system must ensure adequate security and short predictable response times. It must also allow for the easy integration of peripheral devices that may be required to update an ERP system in the future. The technical infrastructure that supports an ERP system provides a *real life* application for students emphasising many of the issues covered in this subject. Using the system, students can examine the computer architecture and system configuration in a multi-user environment to study how they can be modified to best suit the needs of different businesses.

3.2 Programming, Data, File and Object Structures

An ERP system is based upon a database with a pre-defined structure. It is essential that students understand that structure if they are going to be able to use programming to manipulate the data. ABAP/4, the programming language of SAP R/3, is ideally suited to cover all of the aspects and techniques that are part of an introductory programming subject, such as sequence and control structures, algorithm development, validation, program presentation and testing.

3.3 Networks and Telecommunications

ERP systems operate in a multi user, real-time environment and, accordingly, there must be a reliable and robust network infrastructure in place to support the system. The issues associated with the selection, implementation and monitoring of a network are covered in this subject.

An installed ERP system can be used as the example to study a range of network architectures and their components and installation. The establishment of intranets and extranets are inherent in an ERP system, facilitating collaboration. Issues such as privacy, security, performance and reliability in LAN and WAN networks arise naturally as topics for investigation.

In recent years, ERP vendors have been placing greater emphasis on the technology in an effort to expand the ERP system to incorporate eCommerce. Most ERP systems provide for Internet access but this often requires substantial changes to existing ERP systems. An opportunity exists for students to examine the networking and telecommunications issues associated with incorporating eCommerce into ERP systems.

4.1 Analysis and Logical Design

As mentioned previously the implementation of an ERP system is usually the largest information systems project an organisation will undertake. Like other information system projects, there are various implementation methodologies available and these are usually well-documented. The SAP R/3 system Procedure Model is a methodological framework for the implementation and upgrading of SAP R/3 system. The model provides tools for each stage of an implementation and it is organised in a hierarchical structure detailing the sequence of activities necessary for a successful implementation. Each of these activities is a directly linked component of a SAP R/3 system.

Part of the Procedure Model is the Reference Model. The Reference Model documents the business processes and their interdependency within the R/3 system. It gives an extensive description of the R/3 system infrastructure using event, process, data and object models. The Reference Model enables students to identify organisational units, to understand the tasks that make up each business process and to identify their necessary inputs and outputs. Using traditional modelling techniques, students can start with a process model and *drill down* to view different aspects of each process until they finally reach the table definition level.

The ERP system provides the students with a unique opportunity to examine *real world* organisation without leaving the computer laboratory.

4.2 Physical Design and Implementation with DBMS

ERP systems require a database management system and most of the major database vendors support ERP systems. When an ERP implementation is made in a university, it follows that an industry standard DBMS will also be installed. In an IS curriculum, there is the opportunity to study various aspects of a DBMS which is independent of the ERP system or of one which is integrated with the ERP system. One advantage of installing SAP R/3 is that it comes with the IDES, which provides students with the opportunity to explore the various aspects of a DBMS in a practical scenario. This could vary from an examination of the data dictionary and database models through to performance monitoring and system conversion. Using some of the report querying tools supplied with SAP R/3, students can develop their own reports, which then can be exported to other applications such as Microsoft Excel or Word for further formatting.

Whether or not the DBMS is studied independently of the ERP system, it provides an opportunity for students to cover many of the topics specified in this fundamental subject.

4.3 Physical Design and Implementation with Programming Environments

It is possible, although difficult, for a business to transfer its existing data across to one of the ERP systems without any need to change the structure of the system. It is rare, however, that any of these prescribed systems will match exactly the functions and processes of every business and hence there is frequently a need to modify the ERP system in some way. In the case of SAP/R3, the system contains 7 million lines of code, 100,000 function calls and an extensive data dictionary.

All of the ERP systems available on the market today allow modifications to be carried out using either popular languages such as Microsoft Visual Basic or via their own proprietary languages (ABAP/4, is the proprietary language of SAP R/3). The SAP R/3 system contains a huge number of registered application programming interfaces (BAPI). Students have the opportunity to create their own BAPI using ABAP/4 or they can develop programs using languages such as Java and Delphi to interact with the ERP system.

A significant advantage to a lecturer of this subject is the ability to teach the fundamentals of programming yet be able to have access to a fully operational system such as IDES. Students have the opportunity to observe how data can move between systems without being language-specific.

5.1 Project Management and Practice

Project Management is an area of study that in the past has been often neglected in the IS curriculum of many universities. Project management is an important skill which an IS professional should possess (DEET, 1990). The Australian Computer Society now requires universities to document their teaching of project management in courses before they can gain Professional Level accreditation (ACS 1998).

As mentioned previously, the Procedure Model of the SAP R/3 system contains a methodological framework for its implementation and upgrading. The model provides tools for each stage in the implementation of the SAP R/3 system, supported by project management facilities that enable students to document and monitor each task as well as to assign resources. A range of graphical tools is available within the system to display various aspects of the project at any stage or, if desired, the data can be exported to another computer-based project management package such as Microsoft Project for further analysis.

Students have the opportunity to simulate the implementation of an ERP system while learning the fundamentals of project management and gaining valuable experience with the use of a project management software application.

8. Implementation

Although there is a significant argument in favor of implementing ERP systems into an IS curriculum, many tertiary institutions experience problems converting concepts into reality. One of the most significant barriers, as mentioned earlier, is the limited knowledge and experience of ERP systems amongst academics. One approach adopted by Watson and Schneider (1999) at Louisiana State University to alleviate this problem, was to develop knowledge modules called KnowDules. Each KnowDule is between 2 to 10 classes in length and is based around on-line learning. Experienced staff from the University identify a body of knowledge that is supported by an ERP system and then develop appropriate course materials. The KnowDules are developed independent of any subject and then are incorporated into one or more subjects. As an example, a Knowdule developed around the ERP system's administration may then be incorporated into one or more subjects from Information Systems and Decision Science courses.

At Victoria University the Department of Information Systems is refining the Knowdule concept. Using the curriculum topics identified in IS 97, experienced staff in collaboration with subject presenters develop specific ERP based units of work which are incorporated into existing IS subjects. There are many benefits in using this approach:

- ERP systems can be incorporated into a large number of subjects without radical change to the content of those subjects.
- Dissemination of ERP skills and knowledge amongst staff is essential.
- The collaborative development of units of work ensures a sense of curriculum ownership.
- Individual work units are less dependent on individual staff.

Victoria University intends to utilise a computer based training tool provided by SAP to develop and package the individual Knowdules. This will provide a standardised and portable educational medium for the presentation of ERP curriculum materials.

9. Conclusion

Some universities world-wide have entered into alliances with ERP companies which have enabled them to develop innovative courses and subjects. There are some examples in the available literature outlining the content and application of ERP systems in short courses or individual subjects, but only a few have addressed how ERP systems can be used throughout an entire IS curriculum. This paper has examined the potential use of an ERP system in a broad IS curriculum model such as IS'97 providing a guide to those who may be contemplating the use of ERP in their curriculum. Even now, changes are being made to this model curriculum

with the release of IS'2000 expected later this year and it is hoped that it will provide the opportunity for more flexibility in the use of ERP systems (Longenecker, Davis et al. 1999).

Enterprise Resource Planning systems are a tool that can be used to reinforce many of the concepts which are specified in the IS 97 Curriculum Model. SAP/R3 comes with a large and fully operational case study which can be used in a range of IS subjects enabling students to learn the fundamental of information systems on the one hand and yet at the same time gain experience with ERP systems. The next stage in the process is to expand the curriculum of each subject area.

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