

THE NEED FOR DATA WAREHOUSING IN SHARING LEARNING MATERIALS

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Abstract

The Internet has seen a great improvement in new knowledge to both learners and tutors or mentors. The traditional learning systems involved student-teacher interaction in classroom, but however there are now new methods that aid learning to both the teacher and the student.

Education, research materials and knowledge can now discovered and be shared world wide through the Internet, e-learning materials, e-portfolios, web portals and discussion forums. Websites have been development that helps learners and educators to upload and share learning materials. These learning materials are stored in repositories (databases, files, or data warehouses) stored over the Internet in dynamic websites.

This paper discusses the use of Data Warehouse resources to aid in the sharing of learning material in Zimbabwean schools, colleges and institutes of higher learning. This paper is also of great essence to most African countries, whose educational system needs improvement. Information considered relevant for the sharing of learning material is presented, as is the modeling of a data warehouse to store this information as well as the environment, which allows for knowledge discovery to be performed in the data warehouse.

Introduction

The late nineteenth century has seen an increase in learner numbers, more primary and secondary schools, tertiary institutions in Zimbabwe and world at large. Although there is an increase in learner numbers, there are many challenges that hinder education, among them lack of books, tutors going for greener pastures, lack of finance to further

studies, demands for more diverse courses. Educators simply do not have the time to help identify and solve each learner's unique conceptual problems.

A solution to the problem is to allow learners to access educational resources and get assisted by shared-learning resources/materials. This implies that an educator should find appropriate educational resources for each of the courses that he or she presents. A number of educators are turning to the Internet and other electronic media as a source for educational resources. The Internet is a vast resource; there are very few topics that one cannot find on the Internet. Its vastness, however, is also its greatest problem when it comes to finding appropriate educational resources.

One has to approach resources with caution, since there are some web pages that contain relevant learning materials and some that contain irrelevant materials. A resource might also not be appropriate for the level of learner. Educators can invest a lot of time and effort into finding or creating appropriate educational resources. It therefore stands to reason that once a resource has been found or made, that the educator would like a quick and easy way of reusing that resource.

Repositories (Data warehouses) of teaching/learning materials and learning objects are considered important to facilitate sharing and reuse of digital content to enhance the quality of teaching/learning environments. Until recently repositories were used by institutions mainly to store items associated with research output. Resources for teaching and learning were more commonly accessed via Web pages and Virtual learning environments such as Blackboard, WebCT, etc. There has been a realization among academic communities that capturing and storing of assets related to teaching and

learning in one place (a centralised data warehouse or distributed data warehouse) help provide examples of best practices and facilitate sharing across and within disciplines potential use of repositories to support the sharing of learning materials and stressed the important role of these repositories to promote wider.

One of the solutions that have been suggested is the use of computer technology as support for the traditional lecture or classroom situation is the use of the Internet and Web technologies has been particularly earmarked as a potentially useful solution to the large classes dilemma (Gillham, Buckner & Butt, 1999).

This paper discusses how the data warehouse and data mining resources can be used for the achievement of collaborative sharing of learning material. Often using a data warehouse is a superior and effective approach to that of using a file system or database management system (DBMS) or non-computerized systems. In this paper we discuss the need for sharing learning material and various forms of data sharing platforms. We then look at what a data warehouse is and the kind of data, which characterizes it. We also consider data mining as an enabling tool for transacting with the data warehouse. We further look at Data mining and knowledge obtained from data mining. We also look at strengths, weakness and appropriateness of use of data warehouses. We finally present a conclusion as to why data warehousing should be the platform of choice.

Why Learning Resources should be Shared

Educational resource sharing is emerging as a viable means to improve the quality of and access to education. To foster sharing, the following foundation principles for learning material need to be shared:

We Need Options

The current environment is moving to increased expense and tighter copyright restriction. We are now at a point where an alternative is needed. Waiting (or not doing anything) will result in a market where profit is the greatest focus of education, not learning.

Digital Resource Sharing Doesn't Add Costs

When a publisher produces a text, each subsequent version requires physical resources. Digital resources can be duplicated without additional expense.

Structure Is Needed Before a Revenue Model

The infrastructure of the Internet allowed for the subsequent creation of value. If the initial model of the Internet required users to pay for each web page they viewed, we would not have the Internet we have today. The foundation of openness, created the opportunity to add commercial value later.

A similar mindset of open learning will also provide greater capacity for commercial content, allowing them to co-exist. Unfortunately, if a commercial learning object market develops first, it will be more difficult to develop an open market later.

To Preserve Public Education

Increased fiscal pressure (and the success of a few for-profit ventures) has the potential to threaten existing education markets. To compete on a scale of quality, educators must now embrace sharing of resources to ensure that the high ideals of public education are preserved.

Education Is Directly Linked To Quality Of Life

An expensive education market limits the ability for those most in need to improve the quality of their life. This is particularly true in underdeveloped nations. The greatest export of wealthy nations may be our quality of life as expressed through provision of educational resources. Open education is needed to provide these nations with access to improved quality of life. Expensive education (especially when the resources are shareable without significant expense) is the equivalent of denying education, which in turn equates to controlling and limiting opportunities.

Moving the Learning Object Economy Forward

Learning objects have been a point of discussion for several years - but they have yet to largely impact teachers and instructors. Why? Critical capacity has not been reached. Like any marketplace, it will only become viable once significant participants are present. The for-profit model will result in far slower adoption than the open education model.

It's All Too Big For One Person

The complexities of technology require a team approach. No one person can be an expert in all areas. Diverse skill sets are needed. For example, a biology teacher may have the ability to write excellent descriptions, but lack graphical skills. If this teacher produces a learning resource of value, and releases it into the public domain, other biology teachers with different skill sets can contribute to and extend the resource. Over

time, some may add graphics, learning activities, and animations. A copyright system doesn't allow for "joint content creation".

Communities of Practice

The heart of an open education market is the formation of communities of practice. Educators link and connect with others in similar fields from around the world and begin to share and improve on each other's work. These communities can foster improved excellence and quality.

Similar To Open Source Software

Many of the benefits realized by open source software may be applicable to the open education market. Some of these benefits are increased resource reuse, increased quality, reduced costs, increased access to resource authors and rapid development.

However open education is not about stating that learning materials must be free of expense. Learning resources may be financially free (this is the greatest benefit to "have not" institutions and countries like Zimbabwe), but it is not implicit to the concept of open education. Open education means that learning materials must be free for others to *use and integrate in the manner they choose*. Some type of commercial economy is needed to fund and support certain activities. An educator who spends day/weeks/months creating resources should have the option of earning an income based on that effort. The resources they create should be made available for others to innovate and extend. It's about the democratic freedom of a content creator to earn an income, balanced with the freedom of others to do the same.

The Role of the "Teacher" is Evolving

The role of the teacher in e-learning is not limited to being the presenter of knowledge. E-learning requires more from teachers than, say, merely presenting lectures. ICT enables teachers to package learning opportunities in an increasing number of alternative ways so as best to meet the varying needs of different students (and college deans). This is not new. One of the first ICTs to change the role of the teacher may well have been the postal service in its role as part of the delivery system for instruction material to distant learners. Even today, some schools, such as the University of Zimbabwe, rely principally on mail for the printed handouts are being replaced with web-based knowledge transmission. New ICTs offer new opportunities for teaching. They build on the same principles and opportunities of teaching to many individuals at each learner's own rate (compared with teaching to a class of students meeting at the same time in the same place). Indeed, even traditional classroom teaching is being supplemented by the lessons learned on how best to teach at a distance. In the traditional lecture-based education typically found in large universities, students and teachers are at the same place (often a classroom) at the same time, learning the same lesson. The traditional approach holds that teachers (and perhaps the textbook) are the principal source of knowledge delivered to students. Teachers can call upon ICT support, such as audio/ video materials, slides or films. Students can use supplementary means to obtain knowledge, such as manuals, books, etc.

In e-learning systems, the principle source of knowledge is not a teacher, but knowledge-bases collected, assembled, and sequenced by the teacher, along with possibly links to other sources of information, typically accessible via the Internet. The teacher role shifts from lecturer to that of course developer and, once a course is in session, the

course facilitator. The main differences between models of education are shown in Table 1.

Table 1: Types of education models

| Model | Traditional model of education | Distance Education (e-learning) |
|------------------------------|---|--|
| Main knowledge source | Teacher | Knowledge bases in education systems, any knowledge source accessed via the Internet |
| Additional knowledge sources | Books, manual, audio, video materials | Traditional sources, teacher, fellow students |
| Assessment | Only by teacher | System and teacher who is responsible for final assessment |
| Quality of Education | Depends on teacher's quality, level of knowledge and ability to share knowledge | Depends on quality of electronic knowledge sources and other didactic materials |

The students' role in e-learning can and should become one of problem solvers. When used properly, e-learning systems enable students to be active in their own knowledge acquisition, often using the following forms of cooperative learning. Common learning within the team, (students no longer need to find a time to meet, as many meetings can be held asynchronously)

Learning Objectives

Learning objects and learning object repositories are gaining momentum in education. After years of theoretical discussion and promises about learning objects, development is now at a critical stage. Institutions are creating their own repositories,

standards are being adopted to make objects shareable, and understanding is growing that learning objects are the centerpieces of a new digital education economy.

Many definitions exist for learning objects. For the purposes of this article, a learning object is simply defined as a digital resource used for learning. In many cases, learning objects are digitized versions of existing learning content. Much like the Internet allowed organizations and individuals to make their information available to a global audience; learning objects make learning resources available to a larger audience as well.

Learning Object Repositories

Associating and storing metadata about the learning object with the learning object makes it possible for a course designer to search for and locate existing learning objects. For this to work, those objects must be stored in an accessible location and form. Such locations are called Learning object Repositories. There are two types of learning object repositories. The first type contains only the metadata for learning objects such as MERLOT (<http://www.merlot.org>). The actual learning objects are stored in various locations. The second type holds both the metadata and the learning objects in one location. An example of this type of repository is DSpace open software provides a list of learning object repositories. A repository for local (university) needs and a general clearinghouse for learning object from across many different sources.

Some Scenarios in Education Involving Web Services

Web services are going to appear in many types of education scenario. Below are brief notes on a few of the scenario types that we have found interesting for various levels of research. Hypothetical (near future) scenarios for education providers, e.g., an

interviewee may consider seeking a job and may make use of learning materials to refresh knowledge and revisit forgotten areas:

- Almost all Universities already use a campus portal as an access integration device. Web services are affecting portals in increasingly sophisticated ways, e.g., consider not only that a portal uses Web services as part of its runtime operation but also that Web services are exploitable dynamically for the initial construction and evolving reconstruction of the portal
- Scenarios involving learning objects and learning object repositories. Consider the various approaches to aggregating learning objects. In this context we are investigating questions like “to what extent should simple and composite learning objects adopt Web service interfaces?” and “to what extent should a contemporary repository for learning objects be compliant with UDDI (Universal Description Discovery and Integration protocol) a directory model for web services?”
- Learners will build cognitive paths through the learning materials that will be tracked within metadata profiles, thereby rendering explicit the creation of communities of practice within the team-based learning. These learning paths will be available for others to follow as a kind of preferred path based on previous experience, though there is a danger that “learning ruts” will become entrenched.

The Use of Database Driven E-Learning Platforms in Sharing Learning Material

Before we can move on to discuss the sharing of learning material through Data Warehousing, it is worth while here to discuss aspects of sharing through databases (DBMS) systems that distinguish them from data warehousing platforms, with the goal of creating a good bases of comparison.

More and more learning institutions are moving on to the electronic platforms known as e-learning platforms, which encourage collaborative learning. E-learning platforms include services such as:

- Discussion forums
- Chat facilities
- Assignments uploading and downloading
- Course descriptions
- Library facilities and others

Such a platform using a database has limitations on the type of information, which can be derived from it. For instance, it is difficult to determine the trend in the utilization of e-learning platform at the University of Zimbabwe in the past 5 years. Such trend analysis would help in deciding whether or not it was a worthwhile investment

Therefore, to enhance the quality of material to be shared by learners, there is a need to explore other forms of technological applications, which can accommodate a broad spectrum of data formats

Limitation of Databases in Housing Learning Material

Databases keep current data and therefore are not optimised for reporting and analysis, which should be the core of shared content over time. A database is a reservoir

having operational data needed for daily business and they are ever changing. Since the new data is always overwriting the old one there is no way to compare the changes in data. This is where a data warehouse comes into picture. *A data warehouse has historical data and the current data* so comparison becomes very easy for business analysis.

Data Warehouses and Data Marts

Data-mining projects have been pursued, or at least attempted, for a long time. Data warehousing implements the process to access heterogeneous data sources; clean, filter, and transform the data; and store the data in a structure that is easy to access, understand, and use. The data is then used for query, reporting, and data analysis. As such, the access, use, technology, and Performance requirements are completely different from those in a transaction-oriented operational environment. The volume of data in data warehousing can be very high, particularly when considering the requirements

Data warehousing is a method of storing and organising an enormous amount of data for the purposes of analysis, pattern matching and trend finding. The characteristics of a data warehouse include its ability to store detailed as well as summarized data. Integrated data provides easy access to what would normally be stored in separate tables. Metadata is an important facet of data warehousing. Metadata puts data into context, i.e. it defines what the data means. A data warehouse should be more than capable of storing educational resources, along with their categorisations, descriptions and metadata. The data warehouse could also store the learner records and curriculum models, which will determine what resources the learners receive. Another important facet of the data warehouse is that it allows for straightforward data mining (Inmon, 1996).

Characteristics of a Data Warehouse

There are generally four characteristics that describe a data warehouse:

- **Subject-oriented:** data are organized according to subject instead of application e.g. an insurance company using a data warehouse would organize their data by customer, premium, and claim, instead of by different products (auto, life, etc.). The data organized by subject contain only the information necessary for decision support processing.
- **Integrated:** When data resides in many separate applications in the operational environment, encoding of data is often inconsistent. For instance, in one application, gender might be coded as "m" and "f" in another by 0 and 1. When data are moved from the operational environment into the data warehouse, they assume a consistent coding convention e.g. gender data is transformed to "m" and "f".
- **Time-variant:** The data warehouse contains a place for storing data that are five to 10 years old, or older, to be used for comparisons, trends, and forecasting. These data are not updated.
- **Non-volatile:** Data are not updated or changed in any way once they enter the data warehouse, but are only loaded and accessed.

Processes in Data Warehousing

The first phase in data warehousing is to "insulate" your current operational information, i.e. to preserve the security and integrity of mission-critical Online Transaction Processing (OLTP) applications, while giving you access to the broadest possible base of data. The resulting database or data warehouse may consume hundreds

of gigabytes - or even terabytes - of disk space, what is required then are efficient techniques for storing and retrieving massive amounts of information.

The data warehouse thus retrieves data from a variety of heterogeneous operational databases. The data is then transformed and delivered to the data warehouse/store based on a selected model (or mapping definition). The data transformation and movement processes are executed whenever an update to the warehouse data is required so there should be some form of automation to manage and execute these functions. The information that describes the model and definition of the source data elements is called "metadata". The metadata is the means by which the end-user finds and understands the data in the warehouse and is an important part of the warehouse. The metadata should at the very least contain;

- The **structure** of the data;
- The **algorithm** used for summarization;
- The **mapping** from the operational environment to the data warehouse.

Data cleansing is an important aspect of creating an efficient data warehouse in that it is the removal of certain aspects of operational data, such as low-level transaction information, which slow down the query times. The cleansing stage has to be as dynamic as possible to accommodate all types of queries even those that may require low-level information. Data should be extracted from production sources at regular intervals and pooled centrally but the cleansing process has to remove duplication and reconcile differences between various styles of data collection.

Once the data has been cleaned it is then transferred to the data warehouse, A data warehouse can be used in different ways for example it can be used as a central store against which the queries are run or it can be used to like a data mart. **Data marts**, which are small warehouses, can be established to provide subsets of the main store and summarized information depending on the requirements of a specific group/department. The central store approach generally uses very simple data structures with very little assumptions about the relationships between data whereas marts often use multidimensional databases which can speed up query processing as they can have data structures which reflect the most likely questions.

The data warehouse model is illustrated in the figure 1.

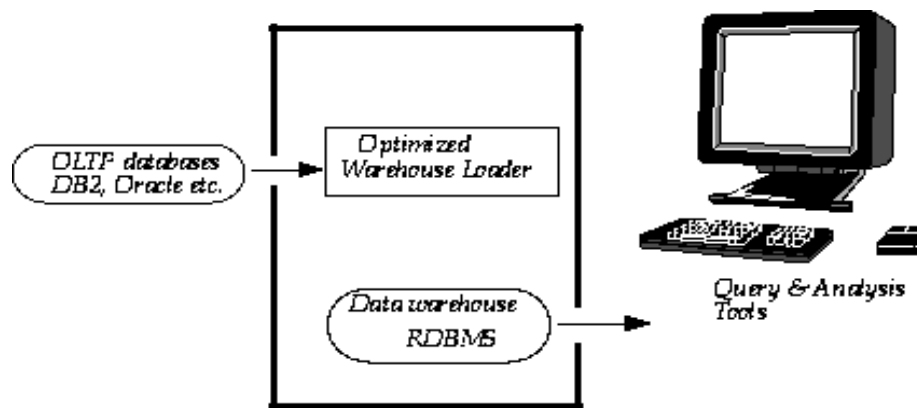


Figure 1: A data warehouse model

The data within the actual warehouse itself has a distinct structure with the emphasis on different levels of summarization as shown in figure 2.

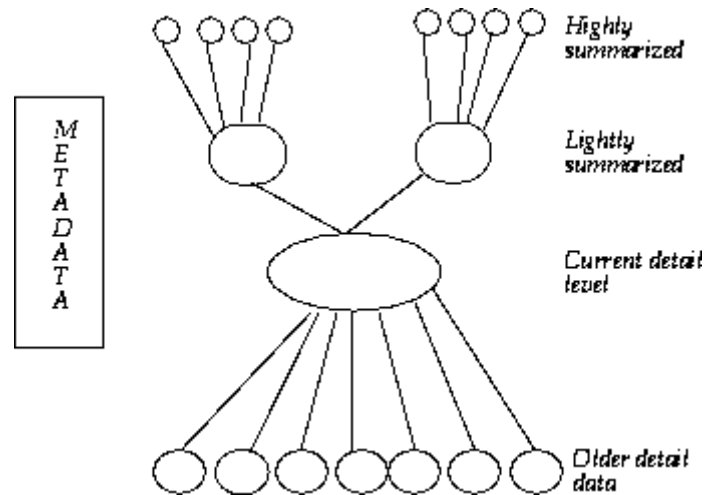


Figure 2: The structure of data inside the data warehouse

The *current detail data* is central in importance as it reflects the most recent happenings, which are usually the most interesting. *Older detail data* is stored on some form of mass storage; it is infrequently accessed and stored at a level detail consistent with current detailed data. *Lightly summarized data* is data distilled from the low level of detail found at the current detailed level and generally is stored on disk storage. When building the data warehouse there is need to consider what unit of time is summarization done over and also the contents or what attributes the summarized data will contain. *Highly summarized data* is compact and easily accessible, and *metadata* is the final component of the data warehouse and is really of a different dimension in that it is not the same as data drawn from the operational environment but is used as:

- A directory to help the Decision Support Systems analyst locate the contents of the data warehouse,
- A guide to the mapping of data as the data is transformed from the operational environment to the data warehouse environment.

- A guide to the algorithms used for summarization between the current detailed data and the lightly summarized data and the lightly summarized data and the highly summarized data, etc.

5.3 Advantages of Data Warehouses for Sharing Learning Content

5.3.1 Low-Cost Knowledge Management Tools for Every Person.

Individual faculty, students, staff, and other college/university citizens need access to simple, low-cost, interoperable knowledge management tools so that they can create and manage intent/context for personal use and sharing. These knowledge management tools should be multipurpose and not limited to the construct of the course or to any particular knowledge use. The knowledge and content management tools associated with data warehouse applications adequate to this task. The open source movement continues to provide a challenge to the established vendors, and better tools are likely to emerge.

5.3.2 Capacity to Liberate Knowledge Objects for Exchange.

Many learning objects are developed within existing repository architectures (e.g. databases, file systems) or applications architectures that do not allow for comprehensive sharing. Data warehouse capabilities of interoperability support such heterogeneous platforms as Learning management systems, enterprise portals, and knowledge management tools ensuring that they can be part of an adequate migration path for institutions seeking to unleash value through e-knowledge.

5.3.3 Interaction With and Tracking of Content

When users interact with content—for example, when they take a course, complete a quiz, or annotate an article—the results must be tracked in ways that are independent of the technology platform being used. Data warehouses are therefore appropriate as they are not platform specific.

5.3.4 Enhances Learners' Access to a Wide Variety of Data

Through the presence of historical data, associations, classifications and trends new meaning can be discovered which a user could never have dreamed of.

5.3.5 Analysis of Trends to Derive Hidden Patterns in Data

Librarians and learners can obtain various kinds of trend reports e.g. the author with the most popular book in Advanced Databases in the Computer Science library given the number of borrowings for the last two years. This may be helpful for future investments in particular textbooks.

5.4 Data Mining

Data stored in data warehouses must be retrieved, queried or mined for it to be used by an educator or student. Data mining lets the power of computers do the work of sifting through vast data stores. Data mining (DM), or knowledge discovery, is the computer-assisted process of digging through and analyzing enormous sets of data and then extracting the meaning of the data nuggets. DM is being used both to Mining and Refining Data describe past trends and to predict future trends.

The DM process generally starts with collecting and cleaning information, then storing it, typically in some type of data warehouse or data mart (see figure 3). Data sources are typically flat files of point-of-sale transactions and databases of all flavours

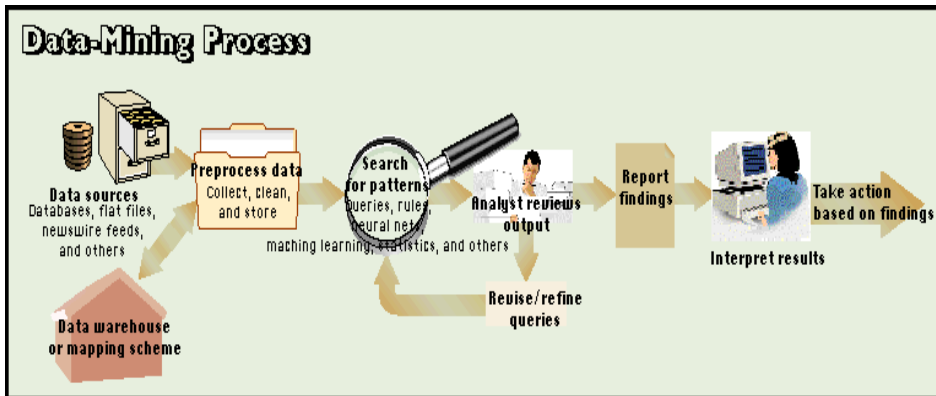


Figure 3: The Data Mining Process

DM tools search for patterns in data. This search can be performed automatically by the system (a bottom-up dredging of raw facts to discover connections) or interactively with the analyst asking questions (a top-down search to test hypotheses). A range of computer tools -- such as neural networks, rule-based systems, case-based reasoning, machine learning, and statistical programs -- either alone or in combination can be applied to a problem.

Typically with DM, the search process is iterative, so that as analysts review the output, they form a new set of questions to refine the search or elaborate on some aspect of the findings. Once the iterative search process is complete, the data-mining system generates report findings. It is then the job of Students humans to interpret the results of the mining process and to take action based on those findings.

With the increased use of electronic communications and the World Wide Web (WWW), it has become quite easy and inexpensive to share information among trading partners. Prior to the mid-1990s, there were technical barriers as well as economic disincentives to the sharing of information. As these barriers have fallen, the potential for data-mining use and abuse has increased.

5.4.1 Problems of Data Mining

One of the main problems for data mining is that the number of possible relationships is very large, thus prohibiting the search for the correct ones by simply validating each of them. Hence, we need intelligent search strategies.

Another important problem is that information in data objects is often corrupted or missing. Hence, statistical techniques should be applied to estimate the reliability of the discovered relationships.

5.4.2 Accessing the Resources

Appropriate resources for learning and remedial purposes are supplied to learners by means of the curriculum and learner models. To facilitate the access to the learning materials, a suitable database model for storage and organisation of the resources should be found. Data warehousing, along with its close associate, data mining, hold some interesting prospects for the organisation, storage and retrieval of educational resources.

5.4.3 The Need for a Resource Database

Keeping a record of educational resources maximises the value of the resource and minimises the efforts of the educator. Once a resource has been found, the educator is able to retrieve the resource when necessary. This saves the educator the time it takes to continually search for resources (Barker, 1999).

A database can be used as an electronic method of keeping record of the educational resources. The latest databases are able to store a number of different file types. The file types can range from entire programs to hyperlinks and Universal Resource Locators (URLs). Hyperlinks and URLs are particularly useful when organising educational resources. Firstly, they reduce the size of the database. Instead of

storing entire web pages or programs, the database will just store the link to the relevant resource. Secondly, it effectively combats the issue of copyrights. Instead of undergoing the lengthy, and often expensive, copyright permission procedure, one can just store the hyperlink to the pages and point the learners to the resource.

By storing the information in a database, one can tailor the resources for an individual learner. Using dynamic web pages, which can access the database to get specific information, can do this. A typical use of a dynamic, database-driven web page would be a search function where the user enters a key word or phrase and the resulting, database-generated page is a list of related URLs. The dynamic web pages are also capable of delivering personalized web pages for each learner. A database thus offers the option of being able to provide each learner with his or her own unique set of educational resources.

5.5 Concerns in Using Data Warehouse

Though data warehouse and data mining act as important aids to sharing learning materials there poses to be challenges in their development and use .The challenges are outline below

- Extracting, cleaning and loading data could be time consuming. But this can be made easy with the help of warehousing tools.
- Data warehousing project scope might increase.
- Problems of compatibility with systems already in place can arise, e.g. transaction processing systems.
- Security could develop into a serious issue, especially if the data warehouse is web accessible.

6.0 Case Study on Current Efforts in Sharing Learning Material in Africa

In our efforts to discuss how data warehouses can aid sharing learning material we will look at current efforts to share learning materials in Africa in section 6.1 and 6.2.

6.1 *First Interactive3d Learning Object Now Available In an African Language*

The Naledi3d Factory, a resident at The Innovation Hub in Pretoria, achieved a historic milestone in March 2007 when, in collaboration with UNESCO, its Interactive3d learning object material on how to build a pit-latrine was translated into Shona by Worldlinks in Harare Zimbabwe.

Figure 4 shows a screenshot of the learning objective in Shona. The Shona version is the first one to be made available in an African language.



Figure 4: Interactive3d learning object material

According to Naledi3d Factory Managing Director, Dave Lockwood, previous Interactive3d learning object material had been translated into the more conventional European languages, such as French in Senegal (University of Dakar) and Portuguese in

Mozambique (Eduardo Mondlane University). The same material will soon be available in Ndebele, Sotho and Shangaan.

The Naledi3d Factory has been building and testing educational tools that have shown strong potential for enhancing and advancing formal and non-formal education for rural and urban African learners. The concept of the Interactive3d learning object, which has evolved over the last three years, is now, through another recent project with UNESCO, turning into a reality.

The learning material combines virtual reality technologies with an emerging educational concept called the "learning object", which conveys a specific item of knowledge in an interactive, visual way that can be reused in different learning contexts. Over the past year the project has expanded, creating a wider network of partners, a repository of digital knowledge blocks and a fully-fledged working product that demonstrates how Africa's educational needs can be met through linguistically and culturally relevant material. At its core are Pan-African network members who can change the text and audio language elements of the different learning objects to suit local communities in different countries. This also helps to preserve local languages.

Currently, network members include over a dozen organisations in 10 countries: Senegal, Sudan, Uganda, Zimbabwe, Mozambique, Ethiopia, Kenya, the Solomon Islands, Rwanda and South Africa.

A Web site has been developed to store and share Interactive3d learning objects. The public can download the learning objects from the site, while network members can download and translate the material to suit local needs before reloading it to be shared by others. Currently, the Web site offers beekeeping for emerging farmers, PC literacy

(based on the ICDL) and the principles of basic hygiene (originally piloted at Nakaseke, Uganda in 2001 and now modified to follow the Interactive3d Learning Object framework)

For the Naledi3d Factory, the Interactive3d learning objects project has resulted in a medium- to long-term action plan to expand the network and increase the number of learning objects available to educators. This will include subjects such as rural development and agriculture with the WK Kellogg Foundation, industrial skills development, and energy conservation, heritage and science and technology of education.

6.2 Global Collaboration Aims To Promote Digital Inclusion in Developing Countries (November 2004)

To support their common goals of promoting socioeconomic development round the world, Microsoft Corp. (Nasdaq: MSFT) and the United Nations Educational, Scientific and Cultural Organization (UNESCO) today announced a cooperation agreement that will help increase access to information and communication technologies (ICT) and ICT skills training in underserved communities. At a formal signing ceremony in Paris, Koichiro Matsuura, UNESCO's director general, and Bill Gates, Microsoft's chairman and chief software architect, outlined details of the agreement. Under the alliance, UNESCO and Microsoft will collaborate on programmes that focus on the specific needs of developing countries round the globe.

Microsoft and UNESCO will establish a sub regional technology center that will provide North African youth with improved access to ICT and ICT skills development. The facility will share resources and expertise with other centers throughout the region, with the ultimate aim of helping develop North Africa's future work force. The project

will draw on resources and best practices from UNESCO's international information and data exchange network INFOYOUTH, and Microsoft's Unlimited Potential initiative. INFOYOUTH organizes national, regional and international consultations among a wide variety of stakeholders to facilitate exchanges of data, experiences and analysis on which national and international youth policies are based. Unlimited Potential focuses on improving lifelong learning for underserved young people and adults by providing technology skills through community technology centers. Under the alliance, UNESCO and Microsoft will also explore the potential to collaborate on additional Unlimited Potential projects.

7.0 Conclusion and Future Work

We have managed to evaluate how data warehouse can aid sharing of learning materials. There are many benefits associated with data warehousing and data mining technologies. A data warehouse can store the learner records and the curriculum models as well as the educational resources.

Some of the challenges of modern education such as a lack of library books and increasingly large classes can be defrayed by the intervention of Internet technologies.

Locating, creating and modifying resources take an enormous amount of time. Educators have to scrutinize each resource to ensure that it is appropriate for the learners and the course being taught. Appropriate resources, thus, must be organised and stored in such a way as to facilitate easy access, distribution and relocation.

The resource-base is, at the present, still a concept. Further research will entail the feasibility of the implementation of a resource-base using a data warehouse and data mining as the driving forces with the Internet/Web technology as the delivery mode.

Having outlined how data warehousing can be used in sharing learning materials, we intend to develop one data warehouse for sharing learning material in Zimbabwe, for Zimbabwe Open University.

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