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An Interactive Learning Environment for a Dynamic Educational Digital Library

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Citation

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Abstract: - GeogDL is a digital library of geography examination resources designed to assist students in preparing for a national geography examination in Singapore. We describe an interactive learning environment built into GeogDL that consists of four major components. The practice and review module allows students to attempt individual examination questions, the mock exam provides a simulation of the actual geography examination, the trends analysis tool provides an overview of the types of questions asked in previous examinations, while the contributions module allows students and teachers to create and share knowledge within the digital library.

Key-Words: - Interactive learning environments, Education, Digital libraries, Geography

1 Introduction

GeogDL [2] is a digital library of geography examination resources designed to help students prepare for a national secondary-level geography examination in Singapore. Students can attempt past-year examination questions, view their solutions, explore related supplementary content, and share knowledge with others through annotations and contribution of new content.

The idea for GeogDL came from the observation that a popular approach to examination preparation involves students working on past-year geography examination questions and perusing their solutions. With these, students are able to see examples of the types of questions typically covered in the geography examination, look at possible solutions, judge the relative importance of certain topics, and even spot "trends" in the types of questions asked.

Past-year examination questions and solutions are currently sold as books organized by year and/or topic. While relatively popular, these solutions have several shortcomings. For example, because these solutions are produced by independent publishers, some answers may not be correct. Teachers are typically not able to discover all errors due to the range of publications available. Consequently, students who are not discerning will simply accept all solutions as correct. Further, students use these solutions to determine important areas in the examination and then focus only on them. As a result, students become "exam smart", knowing only how to answer certain questions but not necessarily demonstrating an understanding of the subject.

Though pedagogically debatable, past-year examination questions and solutions can be useful learning resources for students. Thus, GeogDL is unique in that it not only provides an environment for active learning [6] of geography, it also adopts a pragmatic approach that recognizes the importance and usefulness of examinations especially in the Singapore education system. In particular, we adopt the view that examination questions and solutions, when properly packaged with existing teaching materials, can help students better learn the subject and hence be better prepared for their examinations. For example, teachers could first locate or author acceptable solutions and supplement them with related topics for students to explore. Alternatively, students can work independently or in groups to

author solutions with the teacher working as a facilitator alongside them ensuring accuracy of content. These solutions can then be shared with other students.

The initial version of GeogDL was evaluated by a group of secondary-level students [9] and the results indicated that while students were excited about the potential of the system, they wanted a more interactive learning experience. The remainder of this paper describes the second version of GeogDL that incorporates the findings of the user study. The paper will highlight GeogDL's new interactive learning environment that helps students prepare for the geography examination as well as facilitates active learning by drawing interconnections between various aspects of geographical issues.

2 GeogDL's Interactive Learning Environment

GeogDL's interactive learning environment consists of four major components: the practice and review module, the mock exam module, the trends analysis module and the contributions module. Together, these modules provide a learning environment that fosters individual as well as group learning among users of the digital library. With these modules, GeogDL may be viewed as a dynamic digital library – one that provides an environment for supporting work practices and that allows collections to be modified by users [10].

2.1 The Practice and Review Module

This module allows students to attempt individual examination questions, review answers and explore related supplementary content. Students can either browse a hierarchically organized list of questions modeled after the geography syllabus [4] or perform searches over the collection.

Figure 1 shows how examination questions are accessed through the practice and review module's search interface. Students can either use a simple keyword search or opt for more advanced search features such as specifying question type (e.g. multiple choice or essay) or year ranges. Upon selection of a question in the search results listings, GeogDL displays it together with a set of possible answer choices (for multiple choice questions). When an attempt is made, GeogDL presents the solution as well as an explanation for it. At the same time, links to concepts related to the present question are also displayed as part of the solution. In the current implementation, such related resources are

geography-oriented Web sites selected by teachers after a review process.

Relationships may also be drawn across examination questions. For example, a related link found in a particular solution might be a reference to another examination question. Students following that link will cause GeogDL to display that question. The ability to find related information including other examination questions provides a further benefit to students over print versions of solutions. With print, students tend to study solutions in isolation. Using GeogDL however, students are able to gain a broader perspective of the geography examination as well as the subject itself.
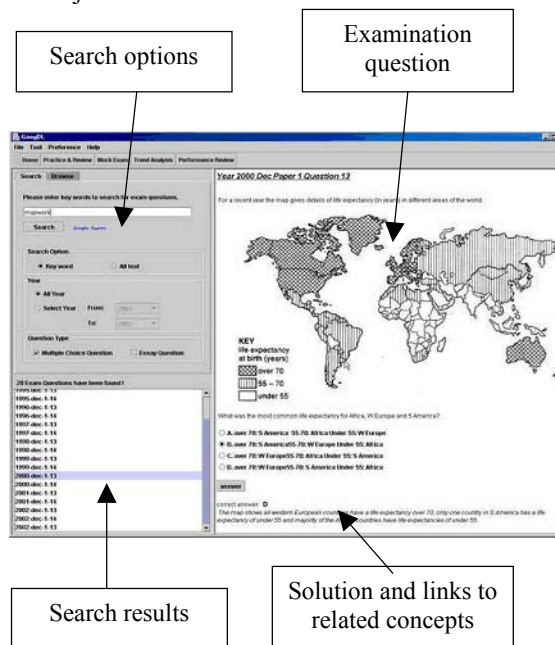

Fig.1. Attempting individual examination questions.

2.2 The Mock Exam Module

Figure 2 shows GeogDL's mock exam interface for multiple choice questions. Upon reading a question, users provide an answer and proceed to the next question. Users may also revisit previous questions to modify their answers. GeogDL monitors the time taken for each question to give an indication of how difficult a particular question is to a student.

Upon completion of the mock exam, GeogDL grades it and displays a performance report which contains a summary of the results and includes the total score and total time taken (see Figure 3). Performance data for individual questions are also provided. This includes the correct answer, time taken, question topic and difficulty level. Students and teachers may use the performance report to gauge mastery of geography concepts as well as areas for further improvement. Students may also review

the solutions and explore supplementary resources from the report interface.
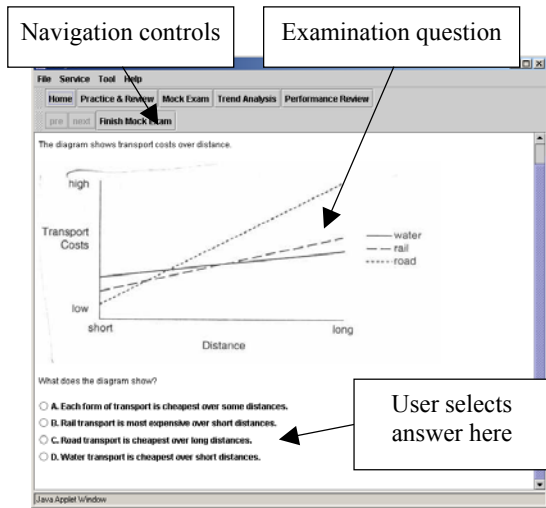

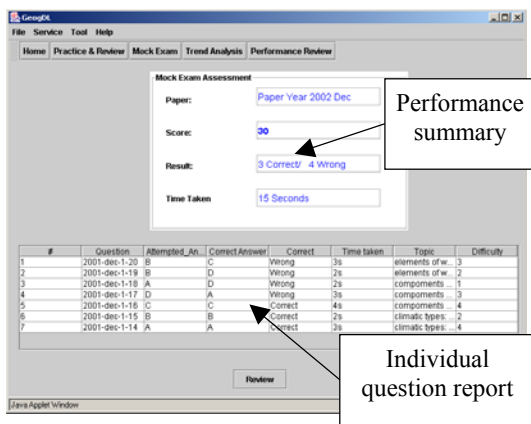Fig. 2. GeogDL's mock exam interface.

Fig. 3. The mock exam report.

The structure and content of a mock exam is defined by a mock exam paper – a virtual collection of examination questions. The paper is virtual because questions are not predefined. Instead, an author (e.g. a teacher) indicates the characteristics of questions that should appear. These include question type (e.g. multiple choice, essay), topic area (e.g. "natural vegetation"), number of questions and level of difficulty, as indicated by the questions' metadata. When a mock exam session is initiated, GeogDL selects questions using the characteristics set in the paper. Students are thus presented with a unique exam each time a session is run, allowing them to attempt a wider variety of questions. Authors may also create static mock exam papers so that each session results in the same set of questions. This feature would be useful when a teacher wants to measure the performance of his/her class, when a

teacher wants students to attempt certain questions that are important in the geography examination, or to emphasize a certain topic learnt in class.

2.3 The Trends Analysis Module

Although trends analysis is sometimes frowned upon by teachers, it is much loved by students as a revision aid. In essence, trends analysis involves sifting through past-year examination questions to determine the likely questions (or topic areas) that will appear in the current examination. It is not surprising then that the GeogDL team, in focus group sessions with students, found that most students wanted to have this feature included in the system.

GeogDL's trends analysis tool provides statistics on topic areas that appear within a user-specified range of years. These are generated using metadata associated with each examination question. Topic areas are based on the geography syllabus [4] and users have various options for viewing their trends. For example, Figure 4 shows the number of questions for a single user-selected topic ("weather and climate") between a user-specified range of years (1993 to 2002). Within each year, questions are further classified as "very easy" to "very hard". Figure 5 provides an alternative view to the collection of examination questions. Here, the bar chart shows the overall distribution of all geography topics that appear in the examination within a user-specified range of years. Once again, questions within each topic are classified as "very easy" to "very hard".
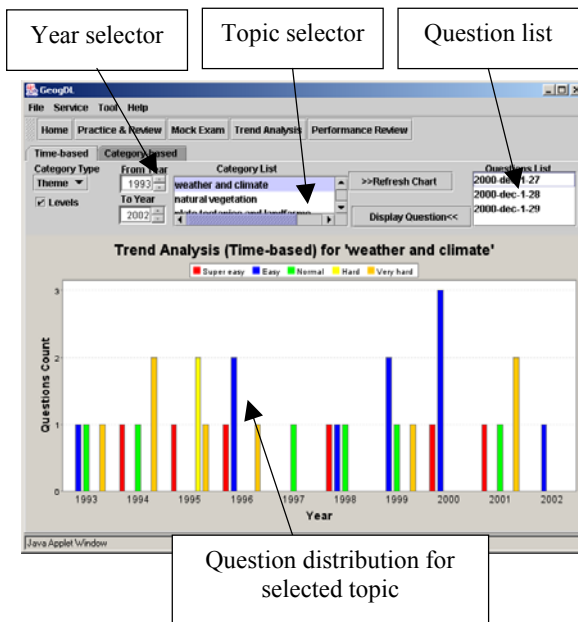

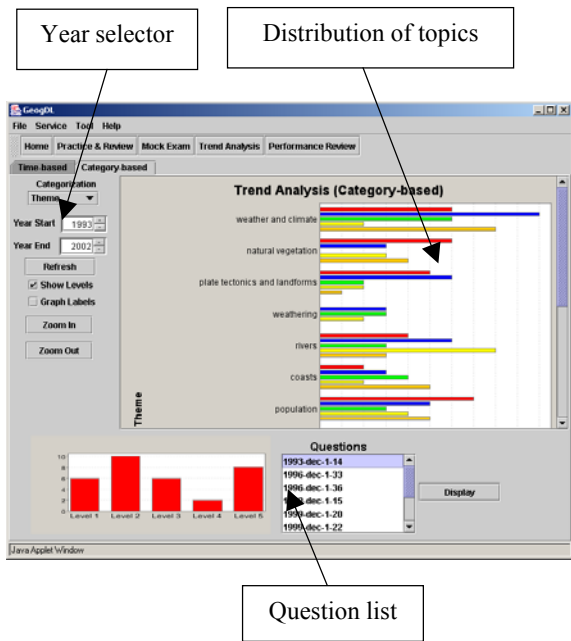Fig. 4. Viewing trends for individual topics over a range of years.

Fig. 5. Viewing overall distribution of topics.

Selection of a particular bar in either chart will cause GeogDL to retrieve and list the associated questions. Upon selection of a particular question, GeogDL will display that question together with its answer and supplementary content. We expect that these visualizations will provide students with an idea of the importance of each topic as well as the level of difficulty of the questions for that topic. Note that trends analysis is very difficult to achieve with print versions of examination questions and solutions, and the only way for teachers or students to view such trends is to construct these charts manually – a tedious and time-consuming task.

2.4 The Contributions Module

GeogDL provides an environment for collaboration and knowledge sharing, one in which content in the digital library is dynamic, constantly evolving through the contribution of new information by students, teachers and other stakeholders. This is facilitated through the contributions module, and in GeogDL, contributions can be in the form of annotations for existing content in the digital library or new content (examination questions, solutions and supplementary resources).

All registered GeogDL users are able to contribute annotations, which are in the form of threaded discussion topics. This is designed to be similar to Usenet newsgroups or Web-based discussion forums that most users are familiar with. Discussion topics are associated with a particular examination question-solution pair and provide a means for users

to comment about their opinions about the question/solution, to provide additional information, to seek clarification about certain issues, or simply to chat with other users. Figure 6 shows GeogDL's interface to access and contribute discussion topics. Upon selection of a question, the user invokes the annotation interface and browses the various topics found there. The user is also able to create a new topic or reply to an existing topic.
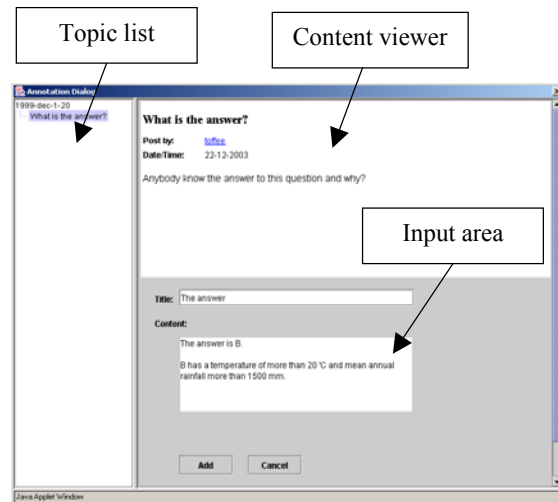

Fig. 6. Viewing and contributing discussion topics.

Unlike discussion topics, new content contributions are restricted to a limited set of authorized users in order to maintain the quality of the collection in the digital library. These users are typically teachers, GeogDL administrators or other stakeholders familiar with the geography syllabus. As a further means of ensuring quality, contributions are subject to review. Thus, contributions are not immediately added into the digital library. Instead, they are stored in a holding area pending review either by a teacher or a stakeholder with an editorial role. If a resource is judged to be acceptable, the reviewer "publishes" it, after which it becomes available to all other GeogDL users. Contributions that are not judged to be of "publishable quality" will be returned for revision. Alternatively to facilitate student contributions, teachers could assist students with authoring of their resources to ensure that the content is accurate and acceptable.

Figure 7 shows GeogDL's interface for contributing new content. For each contribution, users have to provide its associated metadata to facilitate searching, browsing and use by other modules, for example, the mock exam and trends analysis modules. The left panel of the interface lists the various metadata fields to be completed while the right panel allows users to enter data for a selected

metadata field. In the current implementation, metadata for all content in the digital library complies with the SingCORE metadata standard [7], a Singapore-defined standard to describe courseware for interoperability in different learning environments. SingCORE itself is an adaptation of the Instructional Management System (IMS) specification, an international e-learning metadata standard [5]. Note however that the system itself is not tied to any particular metadata standard as the metadata field list and data entry interface are dynamically constructed by reading a descriptor file in XML schema.
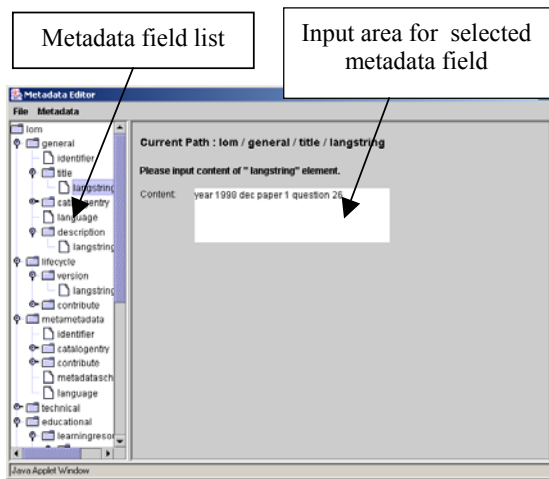

Fig. 7. Contributing metadata for new content.

3   Implementation

GeogDL is implemented as a Java applet and its major system components are shown in Figure 8. The collection of the digital library is maintained in two databases. The question database stores examination resources (questions, answers, supplementary content and mock exam papers) while the metadata database stores metadata for these resources.

The mock exam module extracts questions from the question database given a mock exam paper and stores individual student's performance results in the user database. The practice and review module allows students to attempt individual questions, review answers and peruse related supplementary content. These are retrieved by the browse and search service. Using this service, students can either browse a hierarchically organized list of questions modeled after the geography syllabus or perform fielded searches on the metadata database. As students interact with these modules, access to each question is logged into the question statistics database which keeps track of overall usage patterns much like Web server access logs. This database also

maintains distribution data for individual topic areas. Both sets of data are used by the trends analysis tool to display question distribution statistics as well as aggregate access statistics.
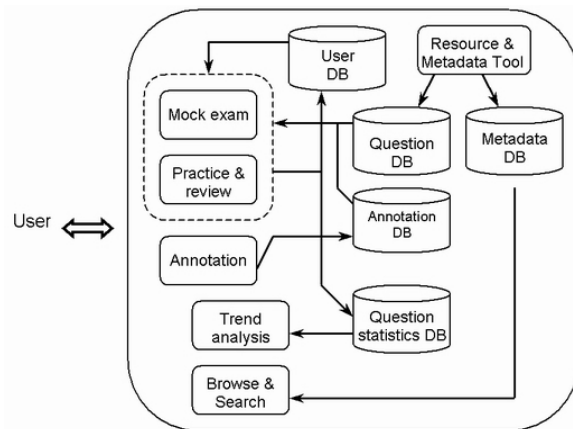

Fig. 8. GeogDL's architecture.

The annotation tool allows registered users to contribute discussion topics to the digital library. This module facilitates communication between students and their peers, and between students and teachers, and in the process, provides a means for sharing knowledge about topics in geography and the examination itself. Discussion topics are saved in the annotation database and are displayed by the practice and review module when associated examination questions are accessed. Finally, the resource and metadata tool allows authorized users such as teachers to add and modify content in the digital library. As each resource must be associated with appropriate metadata, the tool also provides support for metadata entry and validation. Together, these tools comprise the contributions module.

4   Conclusion

GeogDL offers a range of digital library services ranging from traditional search and browse to dynamic ones that manipulate and augment existing content. Using the practice and review module, students are able to interact with individual resources such as attempting an examination question, viewing its associated answer and exploring related supplementary content. The mock exam module adds a further level of interactivity over the digital library resources by assembling individual questions to create a simulated version of the geography examination. The trends analysis tool provides different views of the digital library collection to help students make informed decisions while studying for the geography examination. Finally, the

contributions module allows students and teachers to create and share knowledge through discussion topics and new content, thus adding dynamism to the content of the digital library.

While GeogDL shares the same education philosophy of active learning as existing education-oriented geography digital libraries, its design and implementation approach differs due to the importance of examinations in the Singapore education system. For example, the Alexandria Digital Earth Prototype System [8] provides students with "learning spaces" [3], personalized collections of geospatial resources relevant to one or more concepts or hypotheses. Through the process of exploring, manipulating and interacting with the resources in these learning spaces, students' scientific reasoning skills in geography may be cultivated. These skills can then be applied to solve real-word problems as well as examination questions. In contrast, GeogDL adopts a "bottom-up" approach in which students are first assisted with examination preparation. As students explore examination questions and solutions, GeogDL provides related higher-level concepts for them to investigate, allowing them to draw associations between various geographical issues and developing their reasoning skills. Since requirements for the geography examination are broad, solutions and their associated supplementary resources are developed in cooperation with experienced geography teachers who know how much depth and breadth to provide for each question.

In addition, while the mock exam module shares similarities with existing online tools such as QUIZIT [11] and PILOT [1] in that all provide a Web-based environment for testing and grading, our approach differs in that the mock exam is integrated with GeogDL's other tools thus offering various interrelated avenues for revision. For example, because the mock exam operates in conjunction with the trends analysis tool, students are not only able to ascertain their areas of weaknesses through their scores but also receive recommendations of important topic areas and hence, examination questions, that should be explored further.

The current implementation of GeogDL was developed in response to a user study involving secondary-level students. We anticipate that this richer interactive experience offered by GeogDL will better fulfill our goal of developing a digital library that meets the educational needs of students.

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