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ISO 9001:2000 No Sijil :0500132

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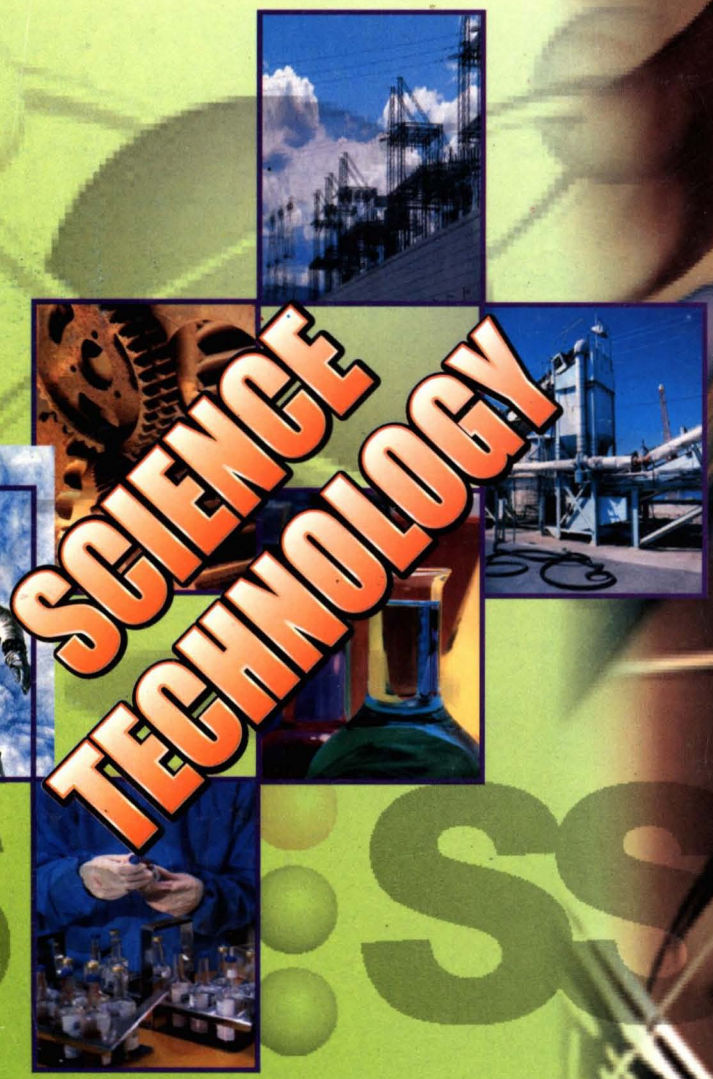

NATIONAL SEMINAR ON SCIENCE TECHNOLOGY & SOCIAL SCIENCES 2006

30-31 May 2006

Swiss Garden Resort & Spa

Kuantan, Pahang

Development of Web-Based Material on Bioinformatics

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ABSTRACT

This development of a web-based material on Bioinformatics aim is to design a learning package via Internet. The gaining popularity and the wide use of Internet have realized the importance of WWW as an educational medium. Basically, there are five main pages that have been interconnected which are the Home Page, FAQ Page, Information Page, Tutorial Page and Links Page. Home Page is the page that will be seen first, it acts as the main menu of the website. The FAQ Page would showcase all the basic questions the user might have, and it will give definitions in an easy to understand method. This page would also gather all the doubts that the user might have, where they could send it to the Webmaster for reply in the future. Information page is where one can get all the information needed to have a deeper understanding about the topic. There is also a test on Bioinformatics available here. At the Tutorial Page, the user can get examples on Sequence Analysis, which provides a chance to get hands-on experience in using advanced programs in the same way as modern biologists frequently do. It shows how the optimal alignment of two proteins stored in a database can be performed over the Internet. This example also demonstrates how fast and relatively easy existing databases can be searched. The biggest advantage of these databases is of course, that they are accessible over the Internet using the World Wide Web as graphical user interface. All the programs for user search are usable over the Internet. The advantage of having this website is it gives a high level understanding to students anywhere as long as there is an internet connection available. In future, it is expected that the use of WWW will surpass the standard that is being used today. Furthermore, universities and schools of the future might only exist in virtual reality where classes will be conducted through WWW with the use of web-based material.

Keywords: *Internet, web-based, bioinformatics, database, sequence analysis*

Introduction

Bioinformatics is the development and use of computational and mathematical methods for acquiring, storing, analysing and interpreting biological data to solve biological questions. Today's biological research generates a huge quantity of data. This is growing exponentially with a shift in emphasis from individual biomolecules, to analysis of how they interact in complex networks which control the developmental and physiological processes of whole biological systems, and research into how this relates to human health. This transition has increased the importance of bioinformatics and raises key challenges which make it imperative that computer scientists work closely with biologists to refine existing bioinformatics tools and develop new ones using scientific method.

Science works because those conducting science search for answers to unknown questions through the scientific method. The scientific method combines the investigator's prior knowledge and experience with observation and experimentation to falsify incorrect hypotheses. Laboratory exercises and other "hands-on" lessons allow students in college and university science courses to experience the process of science first-hand. These experiences allow students to actively participate in their own learning, an important condition for the act of constructing meaning (APA 1992). However, in many lower division classes, large class size and constraints on time and resources limit the implementation of such exercises. Professors and instructors often fall back on lecture-style delivery of information, perhaps augmenting lectures with multimedia aids. While this approach is an efficient way to deliver content, traditional lectures may not effectively challenge the preconceptions that students bring to class. Unless the students' existing understandings are explicitly drawn out, misconceptions will persist (Bransford et al. 2000). In addition, students learn faster and retain information longer when new concepts are connected to their prior knowledge and experience (Caine and Caine 1994). These connections can be achieved by engaging the student's curiosity, challenging his or her misconceptions, and providing opportunities to explore ideas and construct new meaning (Carin and Bass 2001).

While technology may not necessarily provide a panacea for the challenges of teaching large classes, educators have increasingly turned to Internet-based exercises to improve interaction and enhance learning. Moreover, as universities, colleges, and private companies launch more and more websites, students are able to use search engines to quickly reach sites where the webpage creator has provided a concise summary of the concept under study. Many of these web pages are, in essence, short lectures that impart knowledge through facts and clear-cut examples, rather than resources that allow students to learn through active investigation of multiple examples with alternative outcomes.

We have developed a website that allows students to go beyond simply searching for factual information, which is based on a constructivist approach to learning. Using an inexpensive web-authoring package (Sausage Software 6.5) and Internet resources that are free to educators (http://school.discovery.com), we created the website, a site that allows students to investigate multiple real-world examples on Sequence Analysis, which provides a chance to get hands-on experience in using advanced programs in the same way as modern biologists frequently do. It shows how the optimal alignment of two proteins stored in a database can be performed over the Internet. This example also demonstrates how fast and relatively easy existing databases can be searched. The biggest advantage of these databases is of course, that they are accessible over the Internet using the World Wide Web as graphical user interface. All the programs for user search are usable over the Internet.
The website has several important structural features that make it a useful model for teaching other biology concepts. This paper will discuss the design of the website and indicate how the website has been successfully tested in our classes.

The Design of the Website

We believe that the design features of the website allow users to explore ideas, test hypotheses, and learn efficiently. Websites of similar design could be created to deliver many types of biology concepts. The design was adapted from the Lynch and Horton principles (1999). The web-based material consists of the following components:

i. Home Page - Home Page is the page that will be seen first, it acts as the main menu of the website.
ii. FAQ Page - The FAQ Page would showcase all the basic questions the user might have, and it will give definitions in an easy to understand method. This page would also gather all the doubts that the user might have, where they could send it to the Webmaster for reply in the future.
iii. Information Page - Information page is where you can get all the information needed to have a deeper understanding about the topic. There is also a test on Bioinformatics available here.
iv. Tutorial Page - At the Tutorial Page, the user can get examples on Sequence Analysis, which provides a chance to get hands-on experience in using advanced programs in the same way as modern biologists frequently do. It shows how the optimal alignment of two proteins stored in a database can be performed over the Internet. This example also demonstrates how fast and relatively easy existing databases can be searched. The biggest advantage of these databases is of course, that they are accessible over the Internet using the World Wide Web as graphical user interface.
v. Links Page - resource links on all aspects of bioinformatics.

The web site can be accessed through the following URL addresses:

i. http://www3.uitm.edu.my/faculties/fsg/bioinformatics
ii. http://www.tmsk.uitm.edu.my/bioinformatics

Methodology

The sample in the present study consisted of the first year undergraduate biology and education students. Fifty students (15% women and 85% men) out of the 61 registered for the course responded to the evaluation study. Since the focus of the evaluation study was not to make a comparison between the traditional lecture-based teaching modes with the enriched one, there was no division of students into focus groups. All students that participated in the course were subjects to this study regardless if they used the ICTs for learning. They were asked to justify their choices and their criticism on the enriched mode. The majority of the subjects had previous experience in using computers but none of them had ever used ICT for learning. In terms of the time spent working with the computers, 48% spent less than one hour per week, 38% spent 1-2 hours per week and 14% spent 3-4 hours per week.

The aim of the evaluation study was to examine the learning effectiveness of the enriched instructional delivery mode, the factors that affect the effectiveness, as well as overall criticism on the delivery mode. For the purpose of this study, two instruments integrated into one questionnaire for data collection were developed: the first instrument was based on a number of standardized questions, reflecting the previously stated theoretical framework, whereas the second one on a number of open-ended questions, reflecting likes and dislikes, problems identified, suggestions, etc. Univariate and multivariate data analysis was performed for the quantitative part of the study and content analysis for the qualitative part (Makrakis et al., 1998). The criteria for the selection of items composing the variable "learning effectiveness" (Chambers 1995) were:

- *Criterion of appropriateness*: the course and its delivery mode were appropriate to the student body for which it was intended (preparedness for study, expectations, aims and objectives, etc.)

- *Criterion of engagement* (the student found the course and the course delivery interesting, challenging, flexible, etc.)
- *Criterion of students' performance* (students increased their knowledge, skills, developed new habits, etc.)

Results and Discussion

The average score of the learning effectiveness measurement was 3.25 on the five point Likert scale, where 5 was coded as the highest subjective effectiveness perceptions and 1 as the lowest. On the one hand, considering that the developed web-based courseware was at its first version, this score is relatively high. On the other hand, the effectiveness of the enriched instructional delivery mode reached only a moderate level. This is explained largely by the attachment of students to more human-centred modes of instruction. Most of the students admitted that they prefer to communicate and collaborate face-to-face than via ICTs. However, they mentioned that the ICTs allowed them to work on the course at their own pace and be informed about the course without constraints in time and place.

Secondarily, the preference of the students towards the traditional lecture based teaching mode was explained by problems related to the design of the web-based courseware as well as the development and administration of the computer system. The students expressed the need for more examples in the web-based courseware and especially in the online course notes, which were criticized as lacking interactivity with the learning material. The students either preferred to read the printed textbook or to select some parts of the online course notes and print them.

The analysis of the qualitative data also showed that students found the enriched instructional delivery mode easy and intuitive to follow. The case study was far more useful than the online course notes because it gave the students a hands-on experience with the development and documentation of a relatively large project.

It was also consistently evidenced that, due to the potential for periodic revision, extension and update of the web-based courseware, this instructional mode would provide greater flexibility for meeting the identified educational needs and a variety of learning styles in the future. Respondents rated highly the need for the integration into the delivery mode of electronic seminars as a form of computer-mediated collaborative learning method as well as the development of an online library of Internet sites and online journals, in which they would find relevant learning material. Other comments more specific to the course material were gathered and analyzed in order to make revisions and develop a more effective instructional mode.

Conclusion

The Internet offers the opportunity to create classroom and laboratory experiences that encourage students to think critically, and enjoy self-paced exploratory learning. Although a growing number of online exercises exist, design limitations constrain their easy adoption across a broad curriculum. Among these limits are differences in site design that prevent ready integration with existing course materials, difficulty in assessment, and lack of clear educational goals. As such, these limits often result in a view that online exercises or educational websites offer little for most biology classrooms. This website involves the students in a learning atmosphere where they are the investigators. In addition to the results of the pre- and post-tests, students were asked about their experience. Use of this website resulted in high student enthusiasm, an almost doubling of knowledge from pre-test to post-tests, and a desire from students to have more exercises of this type. This approach to web-based exercises encourages critical thinking and provides a mechanism for students to experience the multi-disciplinary nature of biology. Moreover, by allowing students to explore the topic, they learn to think like scientists and experience the joys of intellectual inquiry.

Acknowledgements

The development of this web site was supported by IRDC grant (600-IRDC/ST 5/3/951) of University of Technology Mara We appreciate suggestions for improvement from Assoc. Prof. Dr. Mohamad Bin Ibrahim on an earlier version of this manuscript.

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