PEDAGOGY OF A WEB-BASED CONSTRUCTIVIST LEARNING ENVIRONMENT (WEBCLEN) FOR MALAYSIAN LEARNERS

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Abstract

This paper presents a description for the design, development and implementation of a web-based constructivist learning environment (WebClen) for Malaysian school learners. A conceptual framework that guided the design of the learning environment will be presented. Pedagogically, the framework is based on a two-tiered model of instruction namely, active learning and support involving a combination of several learning strategies and tools such as cooperative and collaborative learning, rich learning resources, electronic workspaces and the teacher (as in Figure 1). In the development process the following elements were created, i.e. the web template, the activities, the classroom layout, and other support materials. The WebClen was implemented in a class of 36 year 4 Malaysian students (10 year olds) over a period of 4 weeks whereby students worked on each of the 4 geoscience topics of Earth, Moon and Sun; Physical Phenomena; Rotation and Revolution of the Earth and The Solar System. The implementation of the WebClen achieved gains in higher-order thinking skills and content acquisition.

Introduction

How are Malaysian school teachers using the web to create learning environments? Do they imitate existing familiar teaching situations or have they well thought out strategies to effect new ways of learning? There are few sources of literature that contain well-recorded anecdotes of teacher strategies in a web-based environment. To date, the WebQuest (Dodge, 1996) seem to be the most popular method employed by teachers. Dodge (1996) defines the WebQuest as a strategy that engages students in active learning. The building blocks of the WebQuest assembled by Dodge (1996) include: an introduction, a process, resources, evaluation, and a conclusion. To further enhance understanding of the kinds of activities that can be carried out on the web, Harris (1995) has proposed three different types of learning structures: interpersonal exchange, information collection and problem solving projects.

Whilst the WebQuest and activity structures has paved the way to many web-integration initiatives, there is still room for the evolution of a more concrete pedagogy of the web. The following section will describe one such attempt by first orienting the reader to constructivist principles, followed by the design, development and implementation of the WebClen.

Constructivism And Learning

Constructivism is a process of learning whereby the learner personally constructs and interprets a given set of information based on his or her experiences. Broadly, there are three specific characteristics of constructivism as it relates to learning (Grabingar & Dunlap, 1995). First, learning is an active and evolving process whereby the learner attempts to make sense of the world. Second, knowledge is developed in an authentic learning environment whereby context plays a significant role in the building of knowledge. Third, the social context in which learning happens is fundamental to conceptual development and is fostered by sharing and testing ideas with others. In other words, the pedagogy of constructivism includes learning by doing, learning through interaction, learning in rich environments, learning at higher order thinking levels, and learning in a teacher-supported environment.

Learning By Doing

Learning by doing is a principle advanced by John Dewey who realized that rote learning methods in education were inconsistent with findings in child psychology and a changing democratic social order. Dewey (1910) rejected authoritarian teaching methods, and viewed learning as a process of inquiry. His main contention was that children should learn by doing and not be idle, passive recipients of knowledge meted out by teachers. Similarly Bruner (1960) emphasized that learning is an active process in which learners construct new ideas or concepts based on their prior knowledge. In advocating discovery learning, Bruner emphasized that concepts are internalized in a more meaningful manner if the learner is more actively involved in his or her learning. The concept of learning by doing was further explored by Papert (1980) who was particularly interested in how children actively build their own intellectual structures. Papert was greatly influenced by Piaget's (1950) theory about developmental stages which says that a child's development from one stage to another takes place through a gradual process of interaction with the environment. While Piaget was more concerned about the biological development of cognition, Vygotsky (1978) proposed a perspective of learning based more on social interaction. Vygotsky proposed that a child's immediate potential for cognitive growth is bounded on the lower end by that which the child can accomplish on his own and on the upper end by that which the child can accomplish with the help of a more knowledgeable other, such as a peer, tutor or teacher.

Learning Through Interaction

Based on the earlier discussion, learning by doing appears to be crucial which may be scaffolded by the interactive nature of cooperative and collaborative learning strategies. Cooperative learning is a method of instruction espoused by Slavin (1982) and Johnson & Johnson (1984). Cooperative learning is a strategy, which involves students in established, sustained learning groups or teams whereby group work is an integral part of, not adjunct to, the achievement of the learning goals of the class. Collaborative learning on the other hand, happens when students interact with one or more collaborating partners to solve a problem or to access information. A student's collaborating partners could be the teachers, other students, researchers and subject-matter specialists.

Learning In Rich Environments

Whilst Slavin (1982), Johnson and Johnson (1984) and Bruffee (1998) were using cooperative learning and collaborative learning methods to have children reach their zone of proximal development, Brown, Collins and Duguid (1989) who were researching Vygotsky's ideas, became concerned about how to design rich learning environments. According to Brown, what students learn should not be separated from how they learned it. To counter the problem of inert knowledge, Brown et al. (1989) introduced the concept of cognitive apprenticeship which is a method of learning, against predetermined instructional sequences but instead employs the modeling, coaching and fading paradigm of traditional apprenticeship with an emphasis on cognitive, rather than physical skills. Thus in the classroom, the learner is seen as an apprentice who works with information to enhance his/her learning skills. In order that the learner is given the correct environment, Brown et al. (1989) suggested the concept of situated learning, i.e. incorporate situations from everyday life into the learning environment or be situated in real world contexts. Similarly, the Cognitive and Technology Group at Vanderbilt (CTGV, 1990) under the leadership of John Bransford felt that learning is enhanced when learners are placed within a real-life context. They proposed 'anchored instruction' a paradigm based upon a general model of problem solving.

Learning and Thinking

As the field of web-based leraning evolved, the need for educators to create relevant and experiential learning opportunities to enhance higher order thinking is imperative. Newmann (1991) defines higher-order thinking broadly as challenged and expanded use of the mind whereby a learner makes meaning of information by interpreting, analyzing and reorganizing it. He compares this to lower-order thinking which represents routine, mechanistic application and limited use of the mind. To enhance higher-order thinking skills in the classroom, some important considerations are: a) the need to select thinking skills for a particular content or grade level due to time constraints; b) The need to structure the learning environment, c) the need to integrate thinking into curriculum and d) the need to use different assessment techniques. The teacher may utilize these considerations of thinking to help organize activities that will enhance higher-order thinking skills.

Learning In A Teacher-Supported Environment

In a constructivist classroom, the teacher engineers the learning, delivers it, but mostly supports student inquiry. To engineer the learning, the teacher goes backstage and structures the learning environment.

The conceptual framework, the learning goals and the teacher's experience (especially in using technology) play an important role in determining the success of a web-based learning environment. To help structure the activities, a first level design may involve structuring the topics conceptually (Bruner, 1960).

Next, the teacher goes on stage and delivers. One important aspect of delivery is to ensure that students see the whole picture and are able to connect previously acquired concepts to present and future learning concepts or topics. To enable learners to do this, Ausubel (1963) proposed the use of advance organizers to invoke appropriate schemata.

Finally, the teacher goes down stage and supports student inquiry. Here the teacher is seen to play the various roles of a facilitator such as a motivator, whereby she/he motivates children to explore, and reach their inquiry through "learning on demand" (Galas, 1999). This may be done by encouraging them to create their own questions, a process which Galas terms as the "students curricula." The teacher also models inquiry and questioning by probing questions forwarded or created by learners. As a coach, the teacher provides structure and supports students' performances and reflections (Means & Olson, 1994). As a guide, the teacher provides student-centered educational adventures that make students passionate learners and arouse the natural curiosity of the learner. Apart from that, the teacher also acts as a resource and technology manager (Lee & Reigeluth, 1994, Robyler, Edwards, and Havriluk, 1997), whereby the teacher arranges for required resources such as books, guest lectures, demonstrations, lessons, discussions and the websites.

Design Of The Conceptual Framework

Based on the above theoretical discussion of early and contemporary constructivists, two major principles were identified as the crux of the WebClen conceptual framework, namely, active learning and support (see Figure 1).

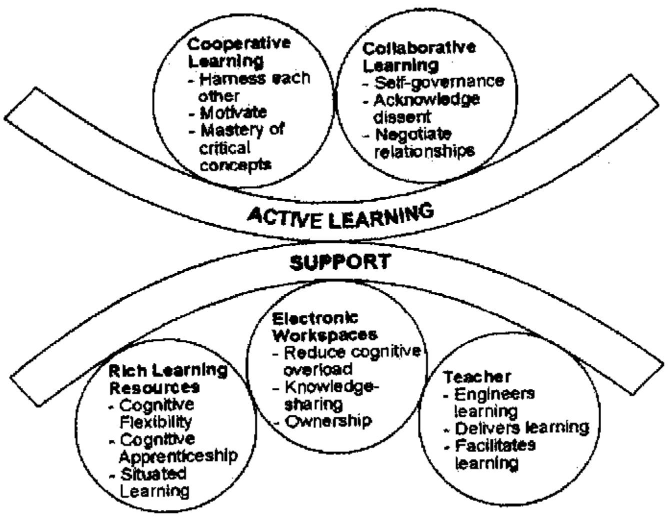

Figure 1: Conceptual Framework Of The Web-Based Constructivist Learning Environment (Webclen)

Active Learning

Active learning is based on principles of cooperative and collaborative learning. Thus, active learning in this context refers to the to the following: (a) students decide on some of the learning activities; (b) all students are actively involved in knowledge construction; (c) students discuss their ideas with their group members; (d) students seek for help when they face a problem; and (e) students self-check on their progress.

Thus while being in charge of his or her learning, the learner selects activities that have been carefully thought out by the teacher to achieve pre-determined learning goals. Apart from that, all learners are encouraged to do the report writing activity first. The purpose of this activity is two fold: first, to build students' prior knowledge for more social discourse to take place; and second, to build up the basic higher order thinking skills of classifying and critically analyzing information.

Active learning also means students seek for help when they are unable to reach a decision about some issue or solve a learning problem. In order for students to seek help readily, it is important that students are able to reach their peers teacher, or another expert.
Finally, students keep track of their learning performance by deciding on when they are ready to be assessed.

Support

Students need to be supported in their learning processes. In the WebClen, support is given in various ways, which includes the availability of rich learning resources, electronic work spaces and the teacher.

As an information apprentice, the learner should be provided with a wide range of resources. To provide learners with a wide range of resources, it is recommended that websites be created or alternatively selected from the world-wide web. The availability of rich resources in the WebClen will allow not only nonlinear interactions but also multiple representations of knowledge, explanations, and viewpoints. Rich learning resources can also be provided in the form of printed notes, textbooks, digital databases or printed encyclopedias.

To support student construction of knowledge, students need to be given the right "cognitive or mind tools" (Jonassen, 1997). For the WebClen, these are referred to as "electronic workspaces". The principles underlying electronic workspaces are that they should allow: (a) any one student in the group to key in the group's answer; (b) the information to be easily viewed by the learner, teacher, expert, parents and any other interested party; (c) for easy input of information in the form of text and multimedia images; and (d) the learner to make changes easily.

Teachers too need to be supported. The learning materials should be easily available and suitable to their teaching styles and their learners.

Development Of The WebClen

The conceptual framework guided the development of the WebClen. Many factors were considered such as the content and learning outcomes, design of the web template, and other support structures such as the use of printed materials, the role of the teacher, the design of the room and the number of computers in the classroom, and the use of supportive media such as CDROM courseware and VCD.

Selection and Restructuring of Content

The content was carefully analyzed to ensure suitability in terms of flow. Geoscience was selected as the content area and the four topics were *Earth, Moon and Sun*; *Natural Phenomena*; *Revolution and Rotation of Earth and Moon*; and, *The Solar System*. The topics were restructured so that commonly occurring phenomena were studied together. To cite an example, in the syllabus provided by the Ministry of Education, *Natural Phenomena*, *Day and Night*, *The Moon's Light* and *Eclipses* each existed as separate topics studied in different years. In restructuring, these sub-topics were realigned and renamed. Thus, *Day and Night*, *The Moon's Light* (renamed *Phases of the Moon*) and *Eclipses* were subordinated to the topic *Rotation and Revolution of Earth and Moon.*

Design of Template

The conceptual framework, the content and the learning outcomes guided the design of the template. The resulting output was named the GeoScientist's World which consisted of the following components: GeoCentre, GeoLinks, GeoCretae, GeoMedia, GeoSpecialist and GeoQuiz (Figure 2).

The *GeoCentre* acted as the management center consisting of 3 sub-components namely the *Teacher Guide*, *Student Modules* and *Student Database*.

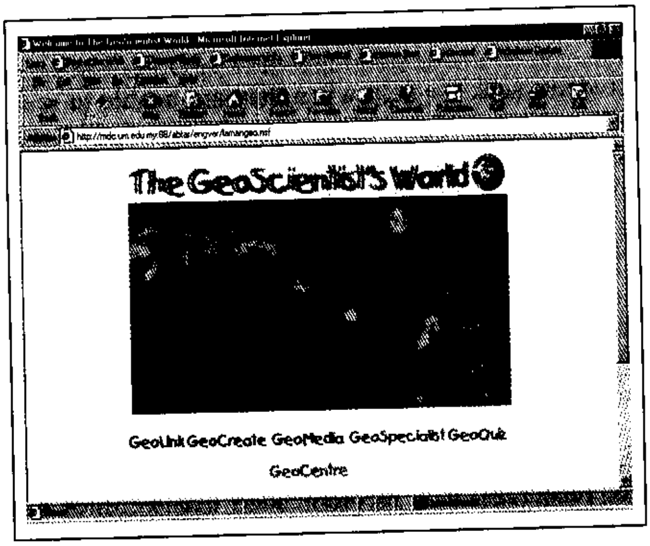

Figure 2: The Main Page of the GeoScientist's World

The *GeoLink* consisted of web-sites for each of the four topics so as to provide learners with a rich collection of resources stored in a dedicated database which allowed learners to access information when needed. The links were divided into two main categories that is 'Main Links' whereby the materials were presented in the Malay (Native) Language and 'Related Links' whereby the materials were presented in the English Language

The third component is the *GeoCreate* which is an online working space where students do their work. This component is aimed at allowing students to write critically and creatively and reflect on what they have learned. The *GeoCreate* component consists of three sub-components namely, a facility for writing a report, a facility for answering frequently asked questions (FAQs) and a facility for keeping a journal.

The fourth component is the *GeoMedia*, which is a database of images relevant to the four topics under study. Visual images form an important part of learning geo-science and students were required to analyze and describe the images. The images consisted of still graphics, time-based images (for example, websites that provide graphical images of day and night based on day and time onsite) animations and video-clips.

Another component is the *GeoSpecialist* which allows students to communicate with a geo-science expert in the area under study. Students were given the option to either communicate with the expert locally if they posed a question in the Malay Language or internationally if they posed a question in the English Language.

Finally in the *GeoQuiz* component, students were provided with practice test items to keep track of their own learning. Online quizzes could be taken any number of times and feedback and test scores were given immediately upon completion of the test. Scores to the same test done on previous accounts were recorded.

The following are a repertoire of activities students engaged themselves in: *main activities*, which consist of 2 sections, namely: writing a report and creating and finding answers to FAQ's; *extra activities* which consist of analyzing images such as graphics, animations and video clips relevant to the subject matter; *activities throughout the topic* which include reading FAQ's of other groups and responding to them; *reflection activities* whereby students discuss about what and how they have succeeded in learning something; *end of topic activities*, which is a multiple-choice quiz that allows students to get immediate feedback to their answers and after class activities which will get students ready for the next day's lesson.

Other Support Materials

Each student was given a file folder that contained a set of concise notes for the 4 topics, task-sheets and worksheets. Apart from that, the students were also provided with other handouts such as recent reports about planets, asteroids and volcanic eruptions sourced from the newspapers. To enhance student understanding of difficult concepts, experiments and demonstrations were carried out. VCDs were mainly used by the teacher to motivate, elaborate and show students the impact of certain phenomena and the two VCDs used were Armaggedon & Deep Impact.

Implementation Of The WebClen

In implementing the WebClen, the teaching sessions were conducted 3 times a week with 3 hours of instruction time per session. Each day began with the teacher meeting students in the teaching-learning area whereby the teacher either gave an overview of a new topic or discussed with students areas of concern, for example, discussing their previous days work or sharing a website of interest with them. For this purpose, the teacher used a computer with Internet connection and an LCD projector. When a new topic was discussed the direct teaching approach was used whereby power-point slides and video-clips were used to introduce and enhance understanding of the concepts. A new topic began with an overview to students using a conceptual map. Key terms were explained with the aid of graphics, animations or video-clips. Each teaching session lasted for about 30 minutes, and it was during this time that students were encouraged to ask questions or clarify concepts that they did not understand.

This session was normally followed by having students move to the computer area so that they could work on the activities designed for them. The students were free to select any activity to work on and they were encouraged to work according to their pace. However, students were given approximately a week to work on one topic. To begin work on the computer, the student activates a web browser whereby the following URL is keyed in: http://mdc.um.edu.my:88/abtar/engver/lamangeo.nsf. followed by the group username and password to activate the template (to see example, please key in *pluto* for username and password) Once the template opens up, the student clicks on the *GeoCentre* and then at *Student Guide* to read the task in the student modules which are presented according to each of the four topics. Alternatively, the student refers to the file-folder which contains the task-sheets.

During this time the teacher also helped students with their work by moving from group to group or when the students raise their hands for the teacher's attention. After an hour, the students are given a half-hour break. They come back normally to the teaching-learning area. Here the teacher will highlight some concerns which have been observed during the interaction with students. For example, student work is projected onto a screen for discussion related to the activities carried out by students. Sometimes, the teacher interrupts the students while they are working at their computers, to discuss some important issues, such as if students are found to be attaching very heavy video-clips onto their workspaces. This is to impress upon them the load that the server will have to handle and how it will slow down their work processes.

Conclusion

The pedagogy of the WebClen was reflected by the conceptual framework which addressed the kinds of learning and the support for the learning. As a result, activities and tools that will support such a framework evolved. The resulting environment supported the constructivist view that learners are able to take charge of their learning. It also supports the constructivist view that the teacher plays a major role of the facilitator.

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Appendix A

Student Module: Physical Phenomena

Introduction

Your teacher has introduced the topic on physical phenomena to you. You can now do the following activities to understand the topic better.

Main Activity 1: Preparing a Report

1. You are a Geoscientist. You have been asked to prepare a report on physical phenomena.

2. In your report, show the differences and similarities between:
(a) the 3 earth layers
(b) volcanic eruptions, earthquakes, geysers and hot water lakes.

3. To prepare your report, your can refer to the notes in your file folder or read from the links provided in the Geoscientist's homepage.

4. To read from the Geoscientist's homepage,
(a) Open Netscape Communicator by clicking on the icon.
(b) Type the following address in the address space: http://mdc.um.edu.my:88/abtar/engver/lamangeo.nsf
(c) Enter your Username and Password.
(d) Click on Geolink
(e) Click on Physical Phenomena
(f) Refer to the main links. Read and write down the important notes in worksheet 1 and Worksheet 2.

5. After that, type your answers into Report. To type your answers, do the following:
(a) Click on Geocreate
(b) At the Report section, click on New Report.
(c) Click on Physical Phenomena.
(d) Type your answers in the spaces provided.
(e) Scroll to the bottom of the page, save your work by clicking on the SAVE button.

Main Activity 2: Seeking Answers to FAQ's

1. In your groups, think about a question that is related to Physical Phenomena that you would want to discover.

2. Write the question into Worksheet 3.

3. Find the answers to that question. To find the answer, you can do the following:
(a) Read the links provided.
(b) Search by using a search engine.

4. To read the links, click on Geolink, then click on Physical Phenomena.

5. To search by using a search engine, you can do the following:
(a) Click on this symbol [-] on the upper right side of the computer screen.
(b) You will see an Internet Explorer icon. Click on it.
(c) Type the following address : http://www.metacrawler.com
(d) Write the main words into the "Search" space. For example if you are interested to find out about this question: "Is there water on the moon?", Write Water on the Moon in the space provided.
(e) You will get many links.
(f) Read the link that will answer your question.
(g) Copy the information into Worksheet 3.

6. Now, enter your information into the FAQ section. To do that do the following:
(a) Click on Geocreate.
(b) Click on New FAQ.
(c) Click on Physical Phenomena
(d) Type your question in the question's space.
(e) Type your answers in the answer's space.
(f) Scroll to the bottom of the page, save your work by clicking on the SAVE button.

7. If you cannot find the answer to your question, you may send the question to the Geospecialist. To do that:
(a) Click on Geospecialist.
(b) Click on question.
(c) Click on Physical Phenomena and choose whether to use Bahasa Malaysia or English.
(d) Type your question.
(e) Scroll to the bottom of the page, and click "Submit"

**Reminder
While waiting for a response from the Geospecialist, you may carry on with the rest of the activities.

More Activities 1: Analyzing Images

1. You are an expert geoscientist. You have been asked to describe the following images and provide an explaination:
    i. Earthqke.gif
    ii. Earthquakefault.avi
    iii. Geiser.avi
    iv. Lapisan.gif
    v. Volca.avi
    vi. Voleruption.avi
    vii. Volfogo.mov
    viii. Volisland.avi

2. To view the images, click on Geomedia, then click on the image (for eg. Volca.avi).

3. Write a description of the image into Worksheet 4(a) or Worksheet 4(b).

4. Then key in the answer into the computer. To key in the answer, do the following:
(a) Click on "Description and Comments" at the bottom of the image on the screen.
(b) Type in your descriptions.
(c) Save by clicking on the save button.

More Activities 2: Keeping a Journal

1. Keep a journal of the eruption of Mount Popocatepetl in Mexico.
2. To do that, click on Geolink.
3. Check for the following link: http://www.cenapred.unam.mx/~jfg/popo/reportes/ultrepi.cgi
4. Click on the link and read the latest information.
5. Write the information into Worksheet 5.
6. Key in the information into the computer. To do that click on Geocreate.
7. Click on New Journal.
8. Key in the information.
9. Keep updating your journal for the next three days.

Activity Along the Topic: Read FAQ/Report of Other Groups

1. Read a few FAQ/Report of other groups and give your comments.

2. To read FAQ/Report, Click on GeoCreate.
3. Click on List of FAQs by Group or List of Reports.
4. Click on the FAQ or Report of your choice. You may use the Previous Page/Next Page to browse the FAQ/Reports.
5. Read and understand.
6. Click on Response.
7. Give a grade for this topic.
8. State reasons for the grade.
9. Click on the SAVE button.

End of Session Activity: Reflection

1. Refer to Worksheet 6 and discuss with your group members about your learning today.
2. Refer to Worksheet 7 and give your personal learning experience for today.

After Class Activity: Filling in a Chart

1. Refer to Worksheet 6 of Earth, Moon and Sun Topic and fill in the given chart.

End of Topic Activity: Quiz

1. You may check your understanding of the Physical Phenomena Topic by doing a quiz.
2. To do the quiz, click on GeoQuiz.
3. Click on Test 1 for Physical Phenomena.
4. Click on "Answer Question".
5. You may answer the question in a group or individually.
6. After the last question (Q. 15), read the instructions and then click on "Done" to see your marks.

End of Activities