CHAPTER 4

METHODOLOGY

This chapter describes the research methodology employed in the study. First, the research design is described followed by an outline of the procedures used in selecting the subjects for the study. Next, the procedures for the design and administration of the template are outlined followed by a presentation of the procedures involved in data collection and data analysis.

Research Design

The study employed a one group pretest and posttest experimental design. In this design, the subjects are observed or measured twice on the dependent variable (Seliger & Shohamy, 1989, p. 139) which in this case, is the Webclen. The two advantage of using this research design is that incompatibilities between two or more groups of subjects can be eliminated and it controls for attrition or loss of subjects (Seliger & Shohamy, 1989, p. 139). In addition, the repeated measures design is useful because by using the same subjects in the treatment, results will be highly correlated, hence reducing the error term; and the same subjects can be tested for the different treatments (Ferguson and Takane, 1989). The disadvantages include the fact that there is no definite way of knowing if the changes before and after are caused by the treatment or if they are due to other reasons. Further, the pretest might sensitize the subjects to the performance indicators that are examined in the study. In order to overcome these shortcomings, theree measures were taken. First the treatment was implemented during the sBelinl holidays which time students would not be exposed to content input from another source. Secondly, the large

large number of performance indicators viz. higher-order thinking test, cognitive skills test and geoscience performamce would have eliminated the possibility of students reacting to the treatment in light of the test content. Third, at the end of each day of study, the remplate was deactivated, so that student access to the treatment was controlled.

Before the treatment, three different tests were administered namely the Thinking Skills Test, the Information Skills Test and the Geoscience Content Test. The treatment was then administered for a period of 4 weeks. A web-based template specifically designed for the study guided the treatment. Besides the tests, qualitative data were collected through observations, opinionnaires, questionnaires and teacher diary recordings. At the end of the treatment, the three tests were administered again.

Selection of Subjects

The sample was drawn from a primary sBelinl in Kuala Lumpur. The 36 students involved in the study were all Primary 4 students (10 year-olds) from the Taman Tun Dr. Ismail Primary SBelinl, Kuala Lumpur. The students were selected based on their Year 4 final examination results. To select the subjects, all 184 Primary 4 students' composite scores for six subjects were examined. It was determined that the high ability students would be those students whose percentage scores for six subjects ranged between 70% and 100%, the mid ability students would be those students whose percentage scores were between 50% and 70% and the low ability students were those students whose percentage scores stood between 30% and 50%.

A teacher from the sBelinl then selected 73 students based on the following criteria: at least 40% of students were to be from the high ability group, at least

20% were from the mid ability group, and at least 40% from the low ability groups. For purposes of the study, the selected sample were grouped into 4 groups of high ability (n = 31), 4 groups of low ability (n = 31) and 4 groups of mixed ability (n = 11). Furthermore it was ensured that there was an equal number of male and female students, and scores for the English Language was at least above 40%. The latter was to ensure that the groups had a minimum standard of English competency to surf and understand materials from the Internet.

These selected students were asked to seek approval from their parents to participate in the program to be held during the sBelinl holidays (Appendix A). Of these 73, only 36 students attended the first meeting during which time they were briefed about the geoscience project that would form the basis of the study. The 36 students were then grouped into 12 groups consisting of 4 groups of high ability students, 4 groups of mixed ability students and 4 groups of low ability students. Each of the 12 groups was given group names according to the solar system. Table 4.1 presents a profile of the students and their respective groups.

Table 4.1

Profile of Subjects Selected for the Study

Group number	Group name	Group members	Academic ability	Gender
High Ability				
6	Jupiter	Nazua	High	Boy
		Wong	High	Girl
		Aja	High	Girl
7	Neptune	Tazi	High	Boy
		Rurna	High	Girl
		Taisya	High	Girl
9	Uranus	Fila	High	Girl
		Adin	High	Girl
		Harul	High	Boy
11	Saturn	Nivek	High	Boy
		Ainel	High	Girl
		Nawaz	High	Girl
Mixed Ability				
2	Earth	Belin	Low	Girl
		Nizar	Mid	Boy
		Hafin	High	Girl
4	Mars	Kris	Low	Boy
		Anilna	Mid	Girl
		Kushur	High	Boy
10	Mercury	Tazat	Mid	Boy
		Hareef	Low	Girl
		April	High	Girl
12	Venus	Anand	Mid	Boy
		Mawar	Low	Girl
		Malin	High	Girl

(table continues)

Table 4.1 (continued)

Profile of Subjects Selected for the Study

Group number	Group name	Group members	Academic ability	Gender
Low Ability				
1	Asteroid	Hans	Low	Boy
		Lily	Low	Girl
		Don	Low	Boy
3	Comet	Hairil	Low	Boy
		Mary	Low	Girl
		Rasha	Low	Girl
5	Meteor	Akesha	Low	Boy
		John	Low	Boy
		Lisa	Low	Girl
8	Pluto	Lamik	Low	Boy
		Hajani	Low	Girl
		Rohaz	Low	Girl

Design of the Web-Based Constructivist Learning Environment

To design the learning environment, two procedures were followed namely the selection and restructuring of content and the creation of components of the template and other learning interactions such as experiments and use of courseware. These learning interactions were created based on the general systems theory (Banathy, 1980) as well as the researcher's tacit knowledge with regards to use of technology in the teaching and learning process. As stated by Gagne, Briggs and Wager (1992) a basic function of instructional design is to take into consideration the specific attributes of the delivery medium. In a more simple and well structured

learning environment such as the use of multimedia courseware or print-based materials, traditional instructional design models may be considered. However a web-based constructivist learning environment is more open, ill-structured and complex in nature, as such the design of learning should be guided but not strictly adhered to existing instructional design models.

Instructional design involves planning tasks and activities which eventually will lead to the achievement of predetermined learning objectives. In a web based constructivist environment, while instructional design ideals help the teacher or designer of instructional events to determine a variety of learning activities, this does not however entail that the learner will rigidly entrench himself in the pursuit of those activities. Given the flexibility and interactivity of such an environment, the learner decides on the activities that are most suitable to his needs and the depth and breadth of activities he would like to cover. In a web-based learning model, the instructional design is no longer the territory of the lone teacher, but is a combination of activities deemed crucial to learning as seen by the teacher as well as the learner. The instructional design must allow for features which will eventually lead to evolvement of learning activities as a result of teacher and student interactions with the Internet. In a sense we may call it an adaptive instructional design. The activities and learning interactions in the WebClen had been designed using such principles, however entrenched in a conceptual base of learning underlined by learning theories (see Figure 2.1).

(a) Selection and Restructing of Content

Geoscience was selected as the content area because teachers had suggested that some of the topics can be quite abstract and difficult to understand if no proper visual support was available. Also the web-based learning environment supported the teaching and learning of such content due to the suitability of material from the Internet. Four topics from the primary 4 to primary 6 geoscience syllabus were selected, namely the *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. Figure 4.1 shows the topics as they were presented in the syllabus prepared by the Ministry of Education and Figure 4.2 shows the restructured topics.

Restructuring of topics consisted of realigning and renaming certain sections of the content. To cite an example, in the syllabus provided by the Ministry of Education, Natural Phenomena, Day and Night and the Moon's Light are studied in Year 5 while a related sub-topic, Eclipses is studied in Year 6. In restructuring, these sub-topics were realigned and renamed. Thus, Day and Night, The Moon's Light (Phases of the Moon) and Eclipses were subordinated to the topic Rotation and Revolution of Earth and Moon while Earth Layers was subordinated to Natural Phenomena (see Figure 4.2).

(b) Components of the Template

Once the topics had been selected and restructured, the template named "The GeoScientist's World" was developed which constituted the following components: GeoCentre, GeoLink, GeoCreate, GeoMedia, GeoSpecialist and GeoQuiz (see Figure 4.3). To begin, the user activates a web browser. The

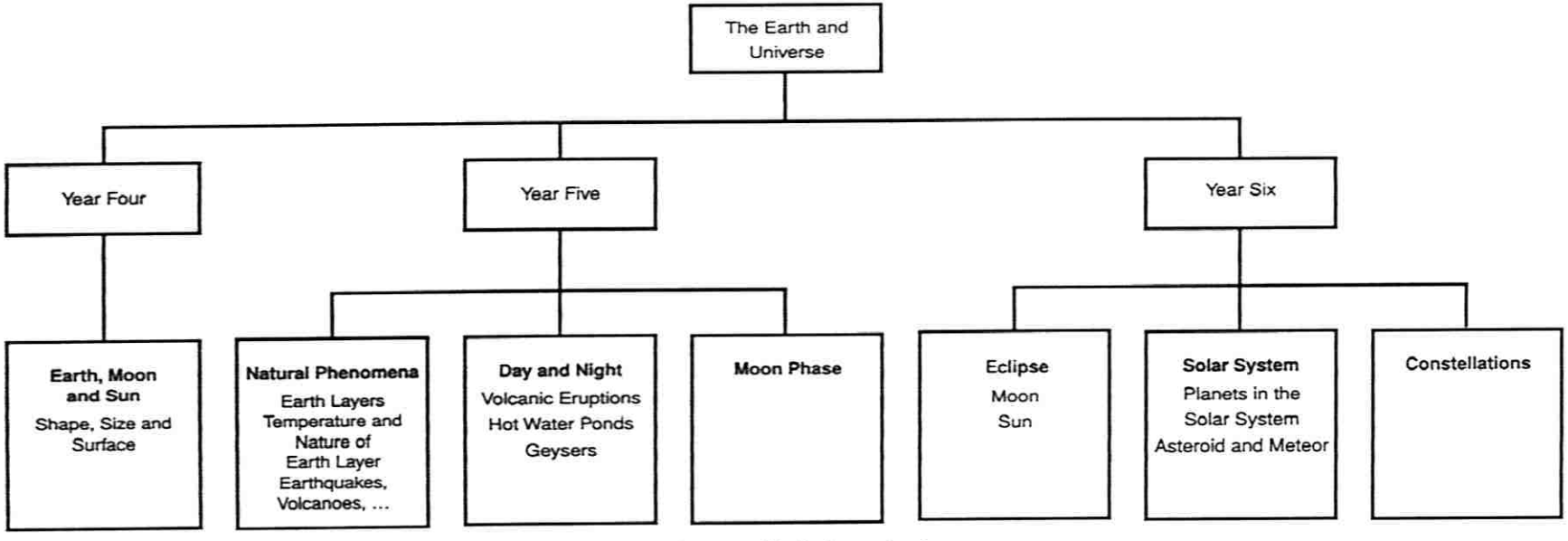

Figure 4.1. Year 4, 5 and 6 Geo-science topics from the primary sBelinl curriculum

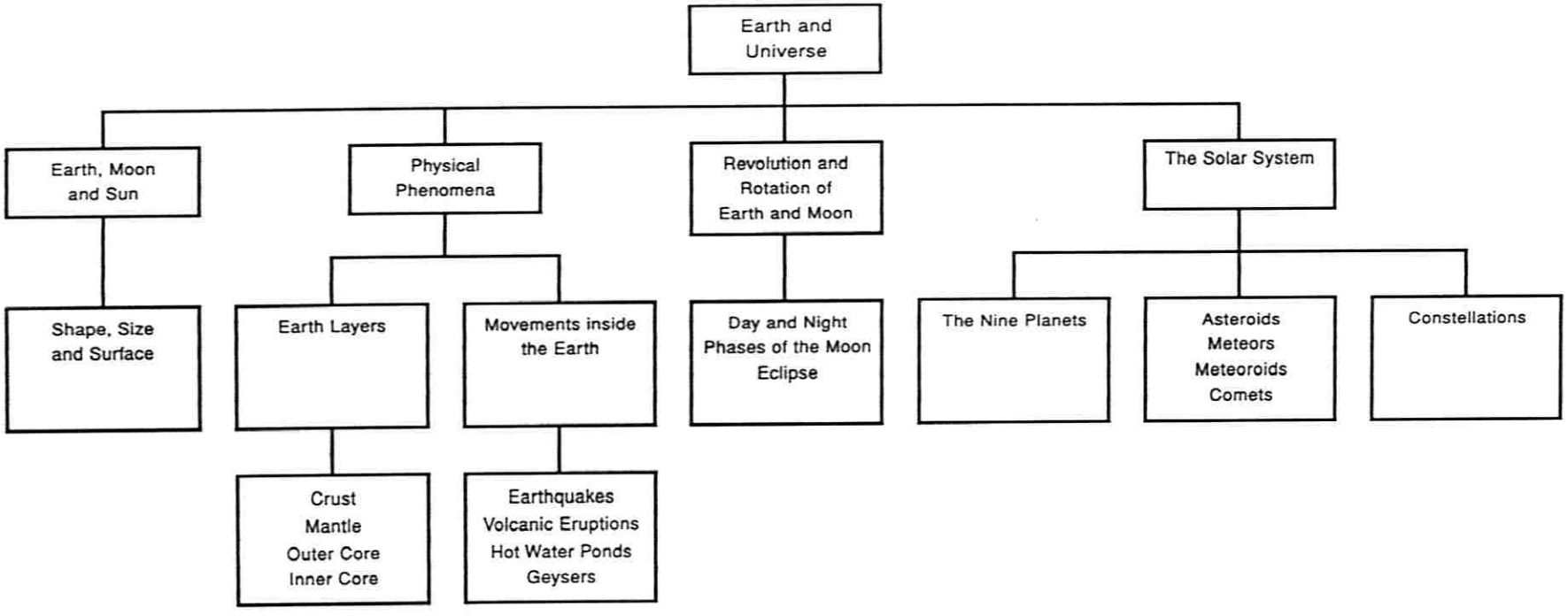

Figure 4.2. Years 4, 5 & 6 Geoscience Topics restructured for the study

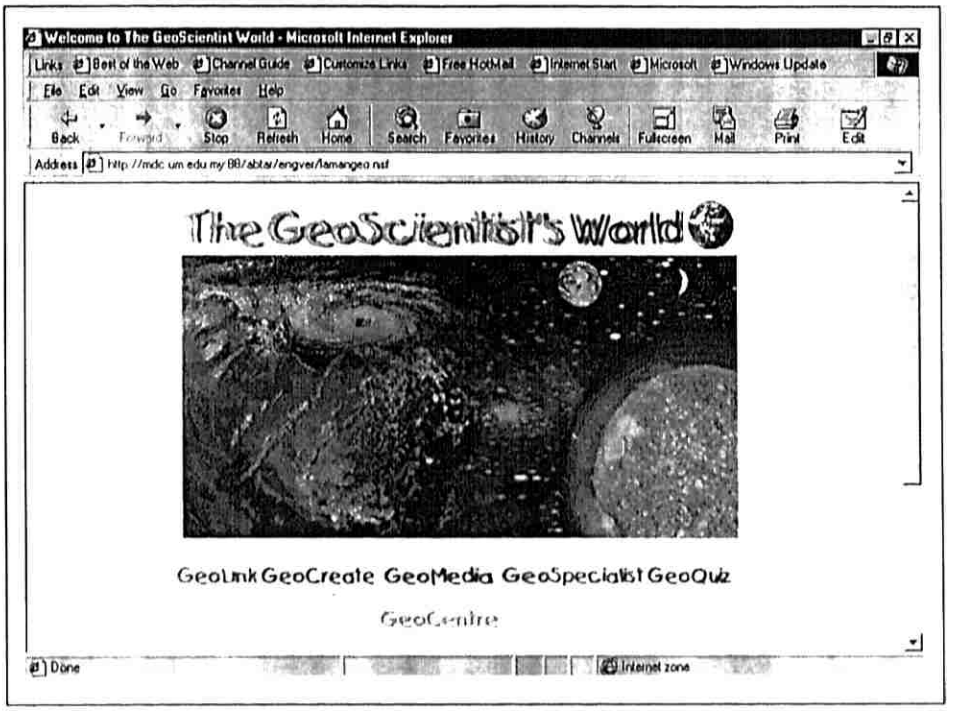

Figure 4.3. The main page of the GeoScientist's World

following URL is then keyed in: http://mdc.um.edu.my:88/abtar/engver/lamangeo.nsf. The student then types in the group username and password to activate the template.

Once the template opens up, the user is advised to click at the *GeoCentre* and then at *Student Modules* to read the tasks which are presented according to each of the four topics. The GeoCentre is a management center consisting of 3 sub-components namely the *Teacher Guide*, *Student Modules* and *Student Database* (Figure 4.4). *Teacher Guide* is a facility provided for the teacher to keep his/ her lesson plans and other support materials such as power-point slides, related websites and media-clips. *Student Modules* consist of student task sheets (see Appendix B for samples of task sheets related to Physical Phenomena topic) and worksheets (see Appendix C for samples of worksheets related to Physical Phenomena topic) which provided the students with the activities according to the four main topics of: *Earth,*

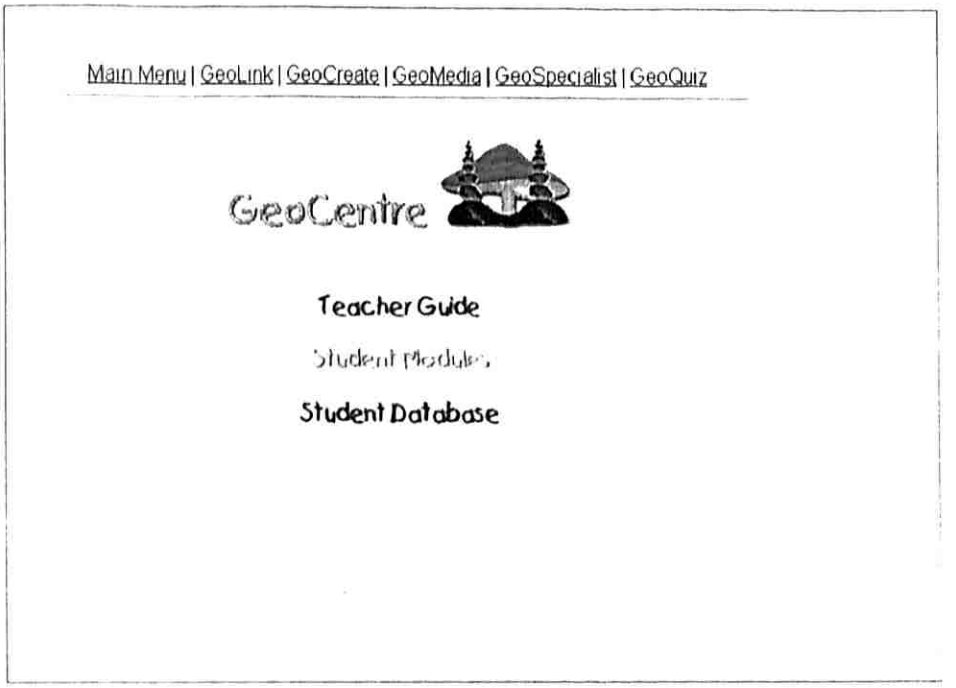

Figure 4.4. The GeoCentre component

Moon and Sun; *Physical Phenomena*; *Revolution and Rotation of Earth and Moon*; *and, The Solar System*. *Student Database* consist of information about the students such as a description of the group with a group photograph attached.

The *GeoLink* consisted of web-sites for each of the four topics. The websites provided learners with a rich collection of resources which were accessible wherever learners needed the information. The links were divided into two main categories that is 'Main Links' whereby the materials were presented in the Malay Language and 'Related Links' whereby the materials were presented in the English Language (see Figure 4.5). When there was a special link the teacher wanted the students to look at, it took the name of the activity as for example, 'Journal Link' whereby the learners had to click on to this link every time they wanted to do activities related to the journal. Further, each link or URL was provided with a short synopsis to help students identify the relevance of the web-site to their needs.

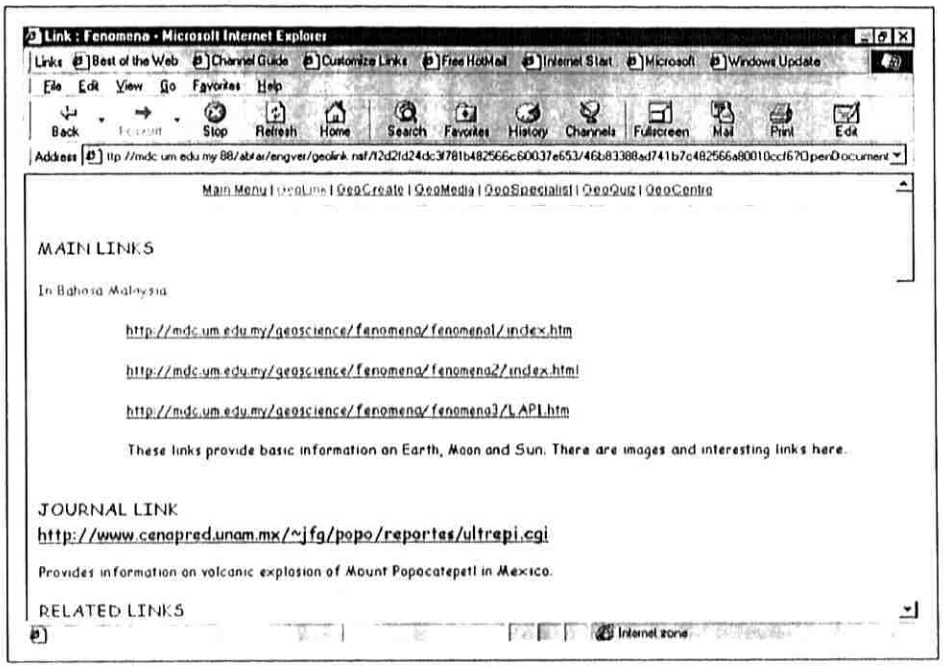

Figure 4.5. The GeoLinks component

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 creatively and reflect on what they have learned (Figure 4.6). 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. To write a report, students will click on 'New Report' which will open up a template consisting of rows and columns for students to classify the information required of the report. At the end of the report, students write a critical summary. Then they save their work by clicking on the 'save' button (see Appendix D). Information can be updated whenever there is a need to do so by clicking on the 'List of Report'.

To create frequently asked questions (FAQs), students will first click on the 'New FAQ' link under FAQ (Figure 4.6). Students then key in their frequently asked question as well as their answers to FAQs (see Appendix E). Students are

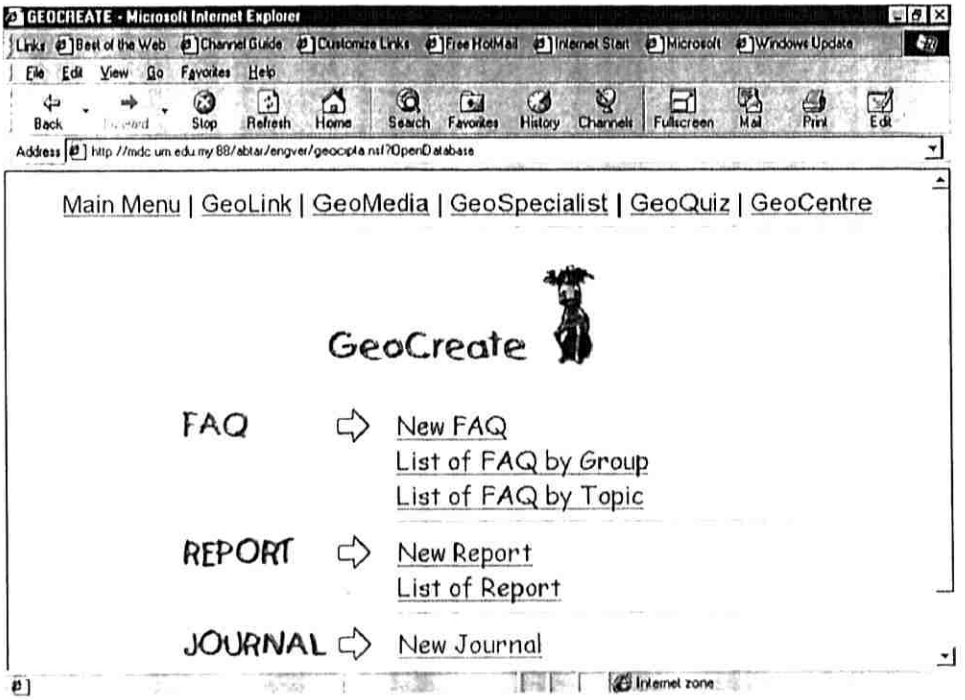

Figure 4.6. The GeoCreate component

allowed to attach images to their FAQ answers. To do this, they will click on the 'browse button'. The FAQ is then saved according to group name or by topic. Like the report, students can change or update the information in the FAQ. Students are also allowed to access and read answers to each other's FAQs and then grade them. To do that, they click on the 'Response' button, whereby a page will open up for them to select a letter grade and key in the reasons for the grade (see Appendix F for an example of an FAQ answer and grading procedure).

Keeping a journal allows students to keep a chronological record of events. For this activity, students kept an account of Mt. Popocatepetl in Mexico which was erupting at the time of the study. To do that, students will click on the 'New Journal' link (see Figure 4.6) and key in the summarized account of Mount Popocatepetl for the day (see Appendix G). To update information, students will click on 'List of Journals'.

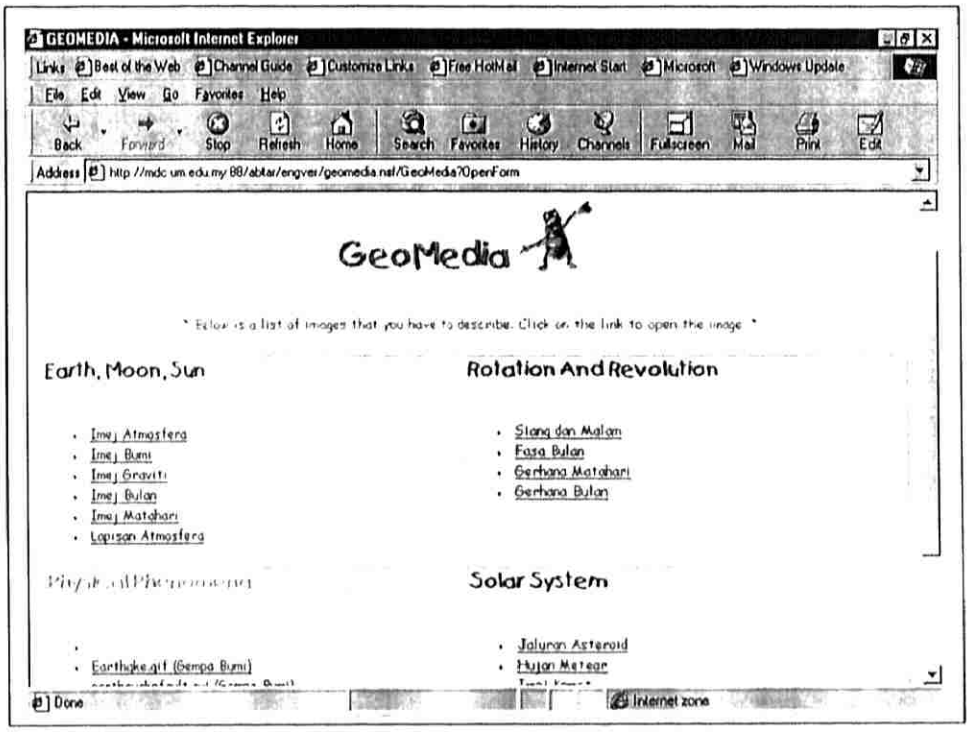

Figure 4.7. The GeoMedia component

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 geoscience and students were required to analyze and describe the images. The images consisted of still graphics, time-based images from the Internet animations and video-clips (Figure 4.7). There were a total of 13 still images sourced from the Internet, scanned from printed sources and downloaded from CD-ROMS. Time-based images are images that provide visual information over time and they exist in the form of websites. One website that was used in the study showed images of day and night of major cities around the world. Students could click on any city in the world and see an image of the city portraying the concept of day and night. If it was day, the image will be bright and if it was night the image would be dark. Students were also presented with 8 animations and video-clips,

taken from the Internet or CD-ROMS. To view the images students will click on the active links of the images, for example Earthqke.gif in the Physical Phenomena topic (Figure 4.7). A template will open up whereby the learners first view the image and then they click on the 'Description and Comments' button to key in the information (see Appendix H). This information is saved and can be edited whenever the student Belinses to do so.

Another component is the *GeoSpecialist* which allows students to communicate with a geoscience expert in the area under study. The expert could either be a teacher or a university lecturer, from a local or foreign institution. Students are encouraged to pose questions to the expert only after they have exhausted all avenues in search of an answer, such as their group mates, the teacher and the available learning resources. Students are given the option to either communicate with the local expert if they posed a question in the Malay Language or foreign expert if they posed a question in the English Language. To do that, students need to first click on the *GeoSpecialist* link which will link them to another document whereby they will Belinse 'Question' to send a question to the geoscience expert (see Figure 4.8). Next, another document opens up for the students to first Belinse the topic and the language before they key in their question and hit the 'Submit' button (see Figure 4.9). The geo-expert receives the question in his/her email in the form of a hyperlink. The geo-expert then clicks on the hyperlink, provides the answer and sends it. The learners view their answers by clicking on 'Answer' (Figure 4.8). Another document will open up where students can view the answer (see Appendix I for an example of geoexperts answer).

Finally in the *GeoQuiz* component, students are provided with practice test items to keep track of their learning (see Figure 4.10). Online quizzes could be

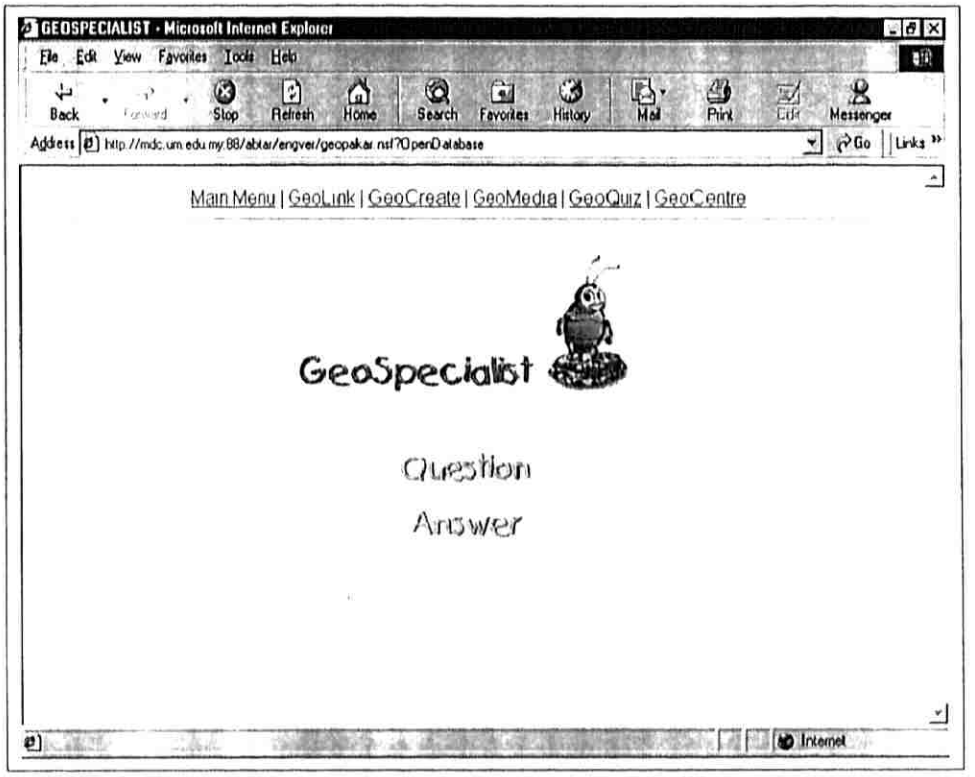

Figure 4.8. The GeoSpecialist question and answer component

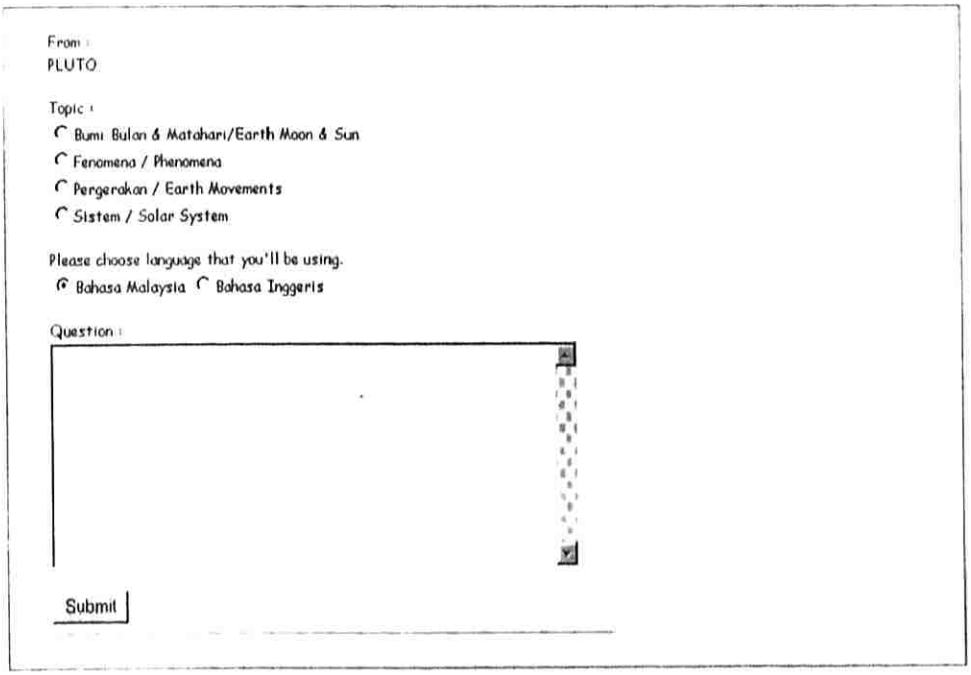

Figure 4.9. The GeoSpecialist component

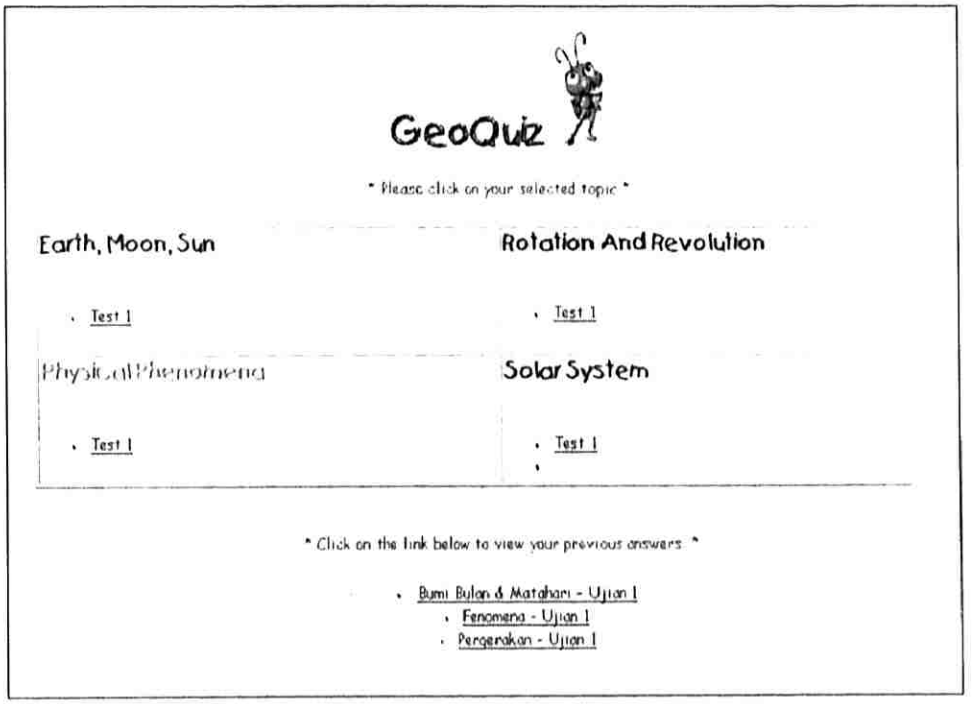

Figure 4.10. The GeoQuiz component

taken any number of times and feedback and test scores were given immediately upon completion of the test. In Figure 4.10, four tests were provided for the four topics. Scores to the same test done on previous accounts are recorded at the bottom (see Figure 4.10). An instruction "click on the links below to view your previous answers" is given for this purpose.

Administration of the Web-based Constructivist Learning Environment (WebClen)

In administering the WebClen, the researcher was the teacher and the study was conducted over a period of 4 weeks. The teaching sessions were conducted 3 times a week with 3 hours of instruction time per session. Printed materials such as encylopedia and magazines related to the topics were selected and placed in the 'Resource Corner' of the classroom (Figure 4.11). Each student was also provided with a file-folder that consisted of task sheets, worksheets and reading materials.

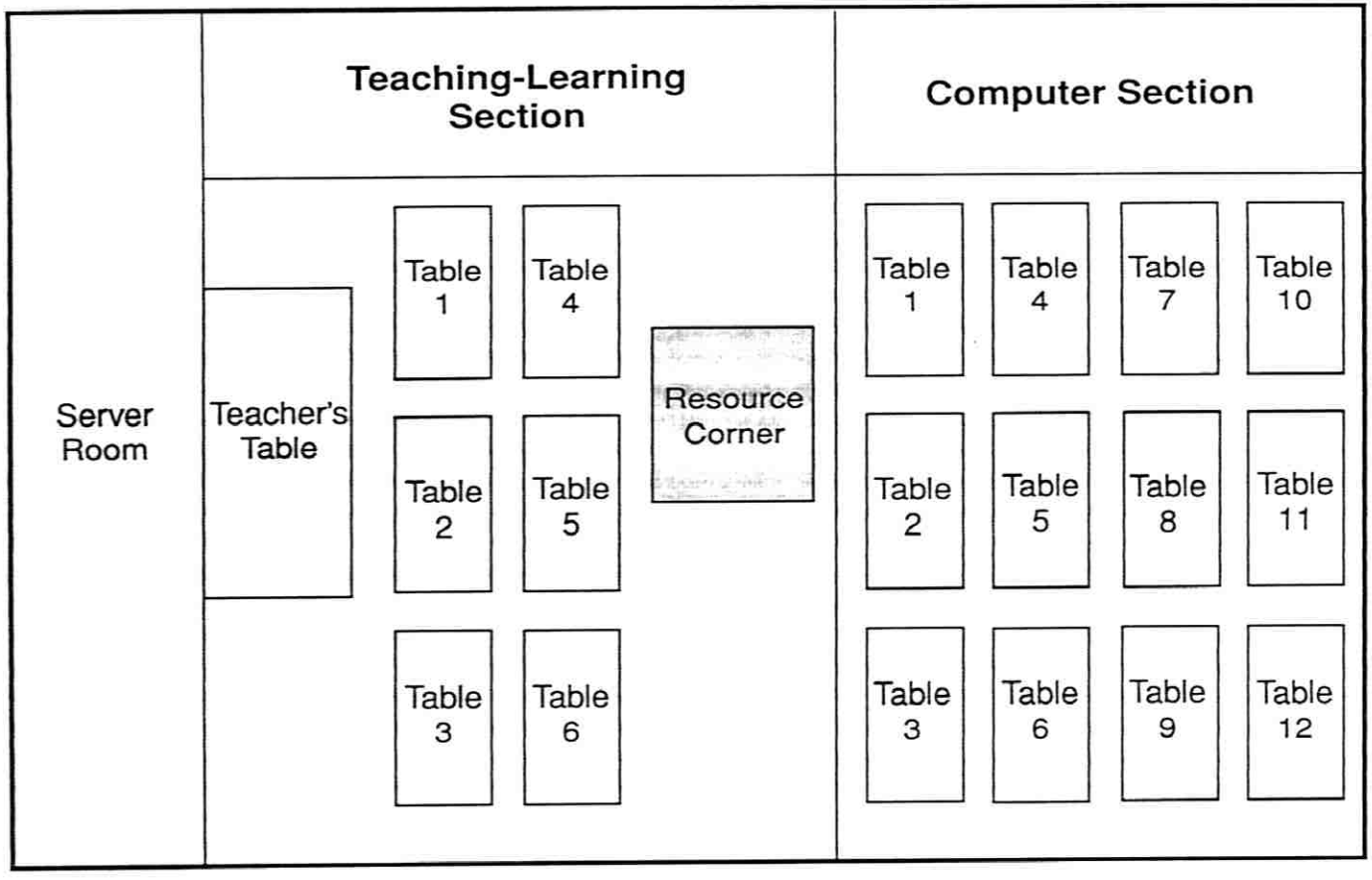

Figure 4.11. The classroom layout

The room was divided into two sections, a section where students sat at tables and held discussions or listened to the teacher when there was a formal teaching lesson and a section where 12 computers were arranged for students to do their online activities. All the computers were connected to a modem hooked to a server (see Figure 4.11).

Each day began with the teacher meeting students in the teaching-learning section. After recording class attendance, the teacher gave either an overview of a new topic or discussed with students areas of concern, for example, discussing their previous day's 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 given to students using a conceptual map (Figure 4.2). 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 followed by asking students to work on the activities and it was during this time that the students moved to the computer section whereby they work on the tasks given. During this time the teacher helped students with their work by moving from group to group or when the students raised 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 this purpose, student work is used and is normally projected onto a screen for discussion.

Data Collection Techniques

The study employed several quantitative and qualitative data collection techniques, which included paper and pencil tests, observations, survey questionnaires and analysis of student output. The various techniques listed below were used to obtain data about the product and the processes of learning in a web-based constructivist learning environment.

(a) Thinking Skills Test

A 35 item test developed for primary Malaysian students called the Thinking Skills Test (TST) was used to obtain information on 5 types of skills: classification, analogical reasoning, deductive reasoning, spatial thinking and mechanical reasoning skills of learners (see Appendix J for sample of items). Each of the skills was measured with 7 questions, each of which had 5 choices of answers. The internal consistency reliability for the test was 0.78 and had been previously established (Phillips, 1996).

(b) Information Skills Test

The Information Skills Test (IST) was developed by the researcher to test 3 types of skills: main idea extraction, inferencing and the ability to distinguish between fact and opinion. The test was based on short paragraphs of between 30-50 words per paragraph. After every few paragraphs, students were asked to answer multiple choice questions on the information presented. The total number of test items was 30 with 10 items testing identification and extraction of main ideas, 10 items testing inferencing skills and 10 items on distinguishing fact from

opinion. The test was piloted earlier with 30 students and the reliability coefficient was .61 for inferencing skills, .52 for main idea extraction and .44 for fact and opinion. For the section on identification and extraction of main ideas, students were asked a question and were given five choices. For the section on inferencing skills, students were given a statement and three choices that is 'yes',' no' and 'cannot be ascertained', while for the section on distinguishing fact from opinion, students were given a statement and two choices (see Appendix K for a sample of the questions).

(c) Geoscience Performance Test

This test was constructed by the researcher and consisted of 40 multiple-choice questions (see Appendix L) and had an internal consistency of 0.77. Each question had four choices of answers and the breakdown of the categories is as follows: *Earth, Moon* and *Sun* (14 questions); *Physical Phenomena* (9 questions); *Rotation and Revolution of Earth and Moon* (9 questions) and *The Solar System* (8 questions).

(d) Opinionaire on Group Work

An opinionaire (Appendix M) was administered after each topic had been completed and it consisted of two sections. In Section I, students were asked to discuss in groups with regards to what was done well in their group and what could be done better by the group the next time. In Section II, students were asked to answer individually five structured questions regarding group dynamics. For each question, they had the choice of "yes", "no" and "not sure".

(e) Questionnaire on Perceptions of the WebClen

This questionnaire was administered at the end of the study and consisted of two sections (see Appendix N). Section A consisted of 27 items on students' perceptions regarding their experiences with the WebClen. Students answered 'agree' or 'disagree' to the 27 items. In Section B, students were given two open-ended items, that is, what they liked 'most' about the Geoscience program and, what they liked 'least' about the Geoscience program.

(f) Observation Methods

In using observation methods, data were gathered using the following techniques: video, audio, and hand-written notes. Both the participant observer and non-participant observer techniques were used. The participant as observer was the teacher-researcher. The non-participant observers were three teachers and a videographer, assigned to record student interactions. A total of 3 independent observers were employed to keep track of student learning once a week for 4 weeks. Each independent observer was in charge of one set of ability learning group. Student interactions were captured using a video-recorder once a week for 4 weeks.

Observers recorded group interactions without any predetermined categories at hand so as to give a rich and holistic view of the interactions sought for. According to Coolican, "It is more important to record events observed such that the social meaning of actions is preserved for analysis. This may mean recording as much as possible of the social context in which actions occurred" (1994, p. 100). The data were first analyzed for illuminative insights and then quantified according to structures.

The teacher-researcher also kept a dairy of observed classroom processes so as to provide a source of rich and genuine information recorded in natural surroundings wherein observed subjects are completely relaxed. The teacher-researcher also made audio recordings of conversations held with students on various issues in the classroom.

(g) Evaluation of Student Online Data

Finally, data were also collected by evaluating student online data. There were eight sources of online data, which included reports, student generated FAQs, peer review of FAQ answers, answers to teacher generated FAQ, journal accounts, descriptions of images, interactions with geo-experts and online quizzes. The online data were evaluated based on rubrics generated for each of the data sources.

Data Analysis

Since a variety of data collection methods were adopted in the study, the techniques of data analysis were also varied. The scores for the 3 tests (Thinking Skills Test, the Information Skills Test and the Geoscience Content Test) administered at the beginning and at the end of the study were analyzed using the General-Linear Model (GLM) repeated measures procedure. The GLM-repeated measures method was used to ascertain if there were significant differences in the pre and posttest scores of the Thinking Skills Test, the Information Skills Test and the Geoscience Content Test. Scores were analyzed according to between subject ability differences, within subject differences and differences according to the subtests. The test of significance was set at $p \leq 0.05$.

Scores from the Opinionaire on Group Work and Questionnaire on Perceptions of the WebClen were analyzed to obtain frequency counts and percentages were computed.

With regards to analysis of data collected using observation methods, namely video recordings, audio recordings and hand written recordings, Seliger & Shohamy (1989) suggest two main approaches for analysis. The first approach is where a set of categories is derived from the data itself, a perspective termed as the inductive approach. The categories that emerge are then applied to the data again to discover comLisalties and patterns. This approach is essentially descriptive and exploratory in nature.

The steps for analysis of qualitative data using this approach are as follows:

1. Transcribing of data from all data sources such as videotapes, observers' notes, teacher-researcher's dairy and audiotapes.
2. Grouping of similar information and chronological organization of the information.
3. Analysis for patterns and selection of suitable words to represent the categories.
4. Application of the categories to the data again.

The following is an example for steps 2 to 4, whereby the data were read and analysed to identify words, phrases, patterns of behavior and themes that may be developed. When the entire pool of data had been coded, the categories that were related to the same theme were collapsed and renamed. For example the categories related to teacher role were initially the following: (1) providing technology support; (2) providing motivational support; (3) providing content support; (4) providing instructional support; (5) supporting student interactions; (6) listening to students; (7) promoting cooperation; (8) supporting writing skills; (9) probing; (10) organizing groups; (11) providing advice; (12) supporting students in

transferring ideas from paper to computer; and (13) monitoring student progress. Further analysis revealed that the categories were found to overlap and the list was reduced to the following: (1) providing technology support; (2) motivating students; (3) providing content support; (4) promoting cooperative skills; (5) bilingual language support; and (6) monitoring student progress.

The second approach was more deductive in nature (Seliger & Shohamy, 1989) whereby a set of rubrics were established at the beginning, which were then applied to the data. This approach is essentially confirmatory. This approach was applied to eight sources of online data, which included reports, student generated FAQs, peer review of FAQ answers, answers to teacher generated FAQ, journal accounts, descriptions of images, interactions with geo-experts, and online quizzes. The following sections describe the generation and application of the rubrics to the eight sources of online data.

Reports

The reports were printed out and grouped according to the report number. Each report was assessed for the group ability to gather the correct content from the various web-sites and to critically evaluate the information that was gathered. The following rubrics were used to assess the reports:

a) Accuracy: geoscience information is accurately recorded;

b) Completeness: responses are comprehensive, no important or pertinent information is left out;

c) Conciseness: most important ideas are recorded; ability to extract main and subordinate ideas; and,

d) Critical evaluation: ability to compare and contrast and draw conclusions.

A maximum score of 12 was assigned for accuracy, completeness and conciseness indicating the ability of the student to understand content. A maximum score of 4 was given for the ability to critically evaluate information which was indicative of students' higher order thinking.

Frequently Asked Questions (FAQs)

The FAQs were first printed out and then categorized according to the topics and group names. The questions were then evaluated using the Wilen (1991) and Pearson and Johnson (1978) taxonomies. These taxonomies were seen as appropriate to evaluate student FAQs because of the following reasons. Firstly, the taxonomies allowed the teacher to classify the cognitive complexity of the question generated. Secondly, it could be ascertained, whether the question was directly connected to the syllabus or if it was connected to material accessed by surfing the Internet. Thirdly, the taxonomy facilitated categorizing the question as convergent (recall) or divergent in nature. To achieve inter-rater reliability, a teacher was selected to score the FAQs according to the Wilen (1991) and Pearson and Johnson (1978) taxonomies. The rater was given: (a) a set of criteria to categorize the questions (Appendix O) and (b) the questions that had been generated by each group (Appendix P). Concensus was reached for over 80% of the scores while disagreements were resolved through a discussion. The scores were then tabulated according to the 8 divisions found in the Wilen (1991) and Pearson and Johnson (1978) taxonomy and according to the high, mixed and low ability groups.

Student Answer to Teacher FAQ

In order to allow students to apply the knowledge learnt in the classroom to a real world situation, the teacher posed the following question to the students:

"*Will the Asteroid XF11 crash into Earth in the year 2028?*" In determining whether students had exercised their reasoning and thinking skills, each of the answers was evaluated according to students' ability to: (a) take a position; (b) support position taken with information; (c) provide additional relevant information; and (d) refer to authoritative sources for information.

Peer Evaluation of FAQs

Students were asked to evaluate peer answers found in the FAQ section. Students were required to read the FAQ answers, grade them and give reasons for the grade given. For each group, the total number of evaluations, grade given and reasons for the grade given were recorded. Next, the evaluations were assessed based on the following rubrics: (a) students were given one point if feedback given was not substantiated, for example, if the feedback given was "good", "excellent" or "clever" and (b) students were given two points if the feedback given was substantiated for example "good, the answer contains important information".

Student Journal

Each group was required to keep an account of the volcanic activity of Mount Popocatepetl. They had to log-on to the given website, read the volcanic report for the day, paraphrase and write a summary of the account. To assess students' journals, student answers were compared to the original message and graded according to students' ability to extract main ideas and write clearly. Each journal was first printed out to determine the number of days each group had kept track of the volcanic activity. Student summaries were then graded based on the following criteria: students were given 1 point if they copied everything from the

website; students were given 2 points if they partially used their own words to paraphrase; and, students were given 3 points if they paraphrased by using their own words to substantiate main and subordinate ideas.

Interpretation of Visual Information

Students' ability to describe still images, animations, video-clips and time-based images was judged. For each of the topics: *Earth*, *Moon* and *Sun*, *Physical Phenomena*, *Rotation and Revolution of the Earth and Moon* and *The Solar System*, a total of three to four images were provided. To carry out the activity, the students clicked on the hyperlink in the Geomedia section to obtain an image and then wrote a short description on paper. Later, the students keyed in the information into an online template. Student output was judged on their ability to describe what they saw and the quality of the description. The following criteria were used to assess student output: students were given 1 point if the description was not directly related to the visual, 2 points if the description was related to the visual but was mixed with irrelevant information, 3 points if the description was related but brief and 4 points if the description was related and written in detail.

Student Interactions with the Expert

Students were provided with an online 'ask-an-expert' facility under the hyperlink 'GeoSpecialist.' A total of three experts were enlisted to respond to student queries: two of the experts were from the University of Malaya and one expert from the United States of America. Three sets of data were collected under this section : frequency of GeoSpecialist use, cognitive complexity of questions asked and assimilation of experts' responses into student answers in FAQs.

Percentages were used to analyze the frequency of GeoSpecialist use, the Wiley (1991) & Pearson and Johnson (1978) taxonomy was used to analyze the cognitive complexity of questions asked and student answers to FAQs were checked to determine the assimilation of expert responses.

Online Quizzes

Students were provided with 4 online quizzes. Each online quiz had between 15-20 multiple-choice questions. Each question was accorded 2 marks. To answer the online quiz questions, students click on the GeoQuiz button. They will then be presented with the 4 different tests. Students click on the test they were ready to answer and at the end of the test, scores were automatically generated for the students.

Conclusion

The study employed a one group pretest and posttest experimental design where both quantitative and qualitative data were collected over a period of 4 weeks involving 36 primary four students. A web-based learning template was designed to serve as the basis of student learning. A classroom was specially designed whereby one section was used as the teaching-learning area and another section contained 12 computers which were connected to the Internet via a dial-up modem.