6. design (construct prototype)
7. research (utilize prototype) – develop and conduct formative evaluation
8. revision .

The first five steps would be incorporated in the preparation stage of the ELEKTROKIMIA programme. The sixth stage would constitute the development stage, the seventh stage would be the evaluation of the programme while the last stage would be the revision of the programme. Thus, the development of the entire programme could be summarized as follows:

1. preparation of the ELEKTROKIMIA programme (step 1 to step 5)
2. development of the ELEKTROKIMIA programme (step 6)
3. formative evaluation of the ELEKTROKIMIA programme (step 7)
4. revision of the ELEKTROKIMIA programme (step 8).

Preparation of the ELEKTROMIKIA programme was basically to identify the instructional goals, specification of the content, writing the performance objectives, identifying the instructional strategy to be used in presenting the programme and selecting and identifying the resource materials and other instructional material.

Development of the ELEKTROKIMIA programme was made possible by a multi-disciplinary team of the subject matter expert, the instructional designer, the multimedia developer, the multimedia programmer, a computer graphic

artist and a computer animator. Experts in video production and audio production were also sought in this project.

Evaluation of the ELEKTROKIMIA programme was done twice, the pilot testing and the actual field test. The results of these formative evaluations formed the basis for the programme to be revised.

Preparation of ELEKTROKIMIA programme

The instructional goal identified in this programme was that every Form Four Science student at least identify the concepts in Electrochemistry. The content of the topic would be based on the Form Four Chemistry syllabus of the *KBSM*. The performance objectives of the programme written from the general goals to the specific objectives helped to guide the researcher in the development of the content.

The general performance objectives in this programme were that the Form Four Science students should be able to differentiate between the two concepts found in Electrochemistry; that is electrolysis and chemical or galvanic cells. For electrolysis, the students should be able to state the definition of electrolysis, electrolyte, electrode and state the Ionic Theory. They should also be able to recall the factors affecting electrolysis as well as the uses of electrolysis. For the chemical or galvanic cells, these students should be able to state the different types of chemical cells like simple cells, Daniell cells and the other chemical cells used in our daily lives. In

addition, students should be able to describe and explain the various electrochemical experiments found in this topic.

Next, the instructional strategies for the programme were identified. This ELEKTROKIMIA programme was meant to be used as a supplement and revision course to teaching and learning in schools after the topic has been taught. As such, the emphasis in the strategy was to highlight to the students what the important concepts that the students needed to know in this topic. This was done by adopting the widely recognized functions as *directing attention, informing the learner of the objective, presenting the stimulus material and providing feedback* (Gagne, Briggs and Wager, 1992).

The resource materials for the ELEKTROKIMIA programme were also identified. For the subject matter, resources included the *KBSM* Chemistry Textbook For Form Four and other reference books on Electrochemistry. The media to deliver the programme was decided to be in the form of a CD due to the very large amount of files that needed to be stored.

In developing a multimedia project, the multimedia elements like text, sound, graphics, images, video clips and animations have to be prepared separately. Once these elements have been prepared, the authoring tool is used to tie up all these elements together into a cohesive and continuous project.

All the multimedia elements were prepared by the researcher. This would include the text of the content, photographs, and the images to be used in the programme . The graphics and animations were developed by the computer graphic artist and computer animator respectively based on instructions by the researcher. The video clips

used in the programme were produced by a local production house based on a storyboard developed by the researcher while the audio used in the programme was recorded in a recording studio. All the multimedia elements were then brought to the multimedia programmer. The multimedia programmer, using the authoring tool *Authorware* and other related softwares then developed the actual content of the ELEKTROKIMIA programme.

To present an overview of the whole programme, a storyboard was written by the researcher for the multimedia pragrammer (see Appendix 6). The layout of the screen, the text content, attributes and fonts, style, responses, navigational choice, colour, shade, image, graphics and animations were described in detail for every screen in the programme. Hypertext to be incorporated within the programme were also identified.

Next, the thematic background for the screen had to be selected. An image of three different fruits each connected to an electric bulb, a calculator and a clock respectively was chosen as the thematic background of the screen. These images were selected because they represent how chemical energy can be converted to electrical energy. The images were then placed on the background design. The entire design of the screen was developed by the computer graphic artist.

Other images used in the programme were selected from various sources to complement the text. Students' textbooks, reference books and other books on Electrochemistry were the main sources of the images selected. For example, the images of electrochemical cells and cross-sectional diagrams of the different types of batteries were selected and then scanned and edited by using the software Adobe *Photoshop*. In addition, images were also taken from a supply of *clipart* which included

image of Bunsen burner and beakers. Other images like electrodes, dry cell symbols, voltmeters, electric bulb symbols and connecting wires were adapted and edited from the supply of *clipart*.

To highlight the applications of Electrochemistry, still pictures of the different types of batteries were photographed, scanned and then edited. All the images selected were stored into the computer to be used later in the programme during the actual authoring. To present the concepts in this topic, questions on Electrochemistry were in the form of text as well as audio. For example, the first narrated question was *"Apakah yang dimaksudkan dengan elektrokimia?"* (What is meant by Electrochemistry?) (See Appendix 5 for other questions presented). The questions were in audio form to reinforce the important concepts that the students needed to know in this topic. The answers, which appeared at the end of each of these questions, were in text form only.

The narrated questions were recorded in a recording studio. There were altogether thirty questions on Electrochemistry that were prepared for the recording. Some of these questions were frequently asked in the public examinations. The recorded questions were then edited by a sound engineer after which it was digitized into the computer using the software *Soundforge*. These narrated questions were stored in the computer to be used during the actual authoring.

One of the ways to provide motivation and to remove monotony from answering all the evaluation questions was to provide music as a reward for every correct response to the questions. The music was selected from the current 'pop' hits in the country. Only certain sections of each of the music hits were selected for each

response. These music hits were programmed into the computer from the various music CD's. Editing of these music clips were again executed by using the software *Soundforge*. Each of the music hits which was then stored in the computer to be used later. There were eleven music hits chosen where one music hit was used after each correct response in the assessment questions.

Animations is a powerful tool to help students visualize what is happening in an electrochemical cell at the microscopic level. It is one of the concrete ways to depict most molecular events. There were altogether thirty-one animations used to represent the workings of the electrochemical cells and their connecting concepts. For each animation, a labelled still image has to be prepared to show the animated sequence within the diagram. The following are some examples of the animations that were used in the programme:

1. movement of electrons from the outermost orbital of an atom to form a positive ion and the movements of electrons into a positive ion to form an atom
2. movements of electron to the outermost orbital of an atom to form a negative ion and vice-versa
3. movement of positive and negative ions to the oppositely-charged electrodes during electrolysis
4. movement of electrons from the zinc electrode to the copper electrode in a Daniell cell along the wires in a chemical cell
5. movement of electrons into a copper ion at the carbon or copper cathode to form a copper atom during electrolysis of copper sulphate solution

6. movement of four electrons donated from four hydroxide ions at the anode to form two molecules of water and one molecule of oxygen gas during electrolysis of a dilute acid
7. movement of ions through the pores of a porous pot in a chemical cell
8. movement of two different metal electrodes being immersed into an electrolyte which resulted in the electric bulb being lighted up.

Care was needed to ensure the size and colour of the different atoms, ions, metals and solutions were correct. Other animation techniques were also utilized to show the inside workings of a battery, the production of sodium hydroxide and chlorine gas, the electroplating process, the hydration process of an ionic compound.

For each of the animations, five to six drawings of the 'cast' or the characters in the animation were drawn by the researcher. Directions and instructions for the colours, shapes and sizes of each of the cast were also prepared for the computer animator. Labelling of the cast and the accompanying text for each animation were also prepared by the researcher.

Apart from animation techniques, motion video provided another primary source of dynamic action in multimedia presentations. In this project, the services of a professional video production studio were acquired. Preparation of the video would include identifying the experiments in this topic , the apparatus and the chemicals needed for each experiment and the props that were needed for the introduction segment of ELEKTROKIMIA programme.

To execute the filming of the video clip, a storyboard and a script was prepared by the researcher for both the introduction segment and for the actual demonstrations of the electrochemical experiments. Another important consideration of the video clip was the art direction of the video clip itself. The researcher had to decide how the video clip of the introduction segment and the experiments be presented. There were two different video clips that needed to be filmed. For the production of the video clips, the production house has used the *Betacam Hi-8* tape as the image acquisition format. The content was then transferred to Beta-SP tape for editing and mastering. This was because copies dubbed directly from Beta-SP differed little from the master in quality.

There were altogether ten experiments that were video-taped. Chemicals like sulphuric acid, hydrochloric acid, copper sulphate solutions each with a concentration of 2 moldm $^{-3}$ were prepared. Apparatus like glass beakers, carbon electrodes, metal electrodes, connecting wires, cell-holders, bulb menthols, voltmeters, millivoltmeters, Bunsen burners, tripod stand, crucible, pipe clay triangle were brought to the studio for the filming of the video clips.

Props used in the introduction segment of the video clip included the different types of batteries like lead accumulator, alkali batteries, dry cell batteries, lithium and nickel-cadmium batteries. These were brought to the studio together with electrical appliances like calculator, alarm clock, "Walkman"-type cassette recorders, mobile phone and wrist watches. In addition, silverware, gold-plated ornaments and gold-plated jewellery were also used to show the relevance of Electrochemistry in everyday life in the introductory segment.

The actual shoot of the video clip involved a cameraman, a film director and a studio director with the researcher acting as the main talent. In the introductory segment, the researcher welcomed the user to the ELEKTROKIMIA programme. A brief overview of the whole programme was presented with the applications of Electrochemistry being exhibited. The second video clip was the demonstrations of the experiments found in this topic.

The art direction of the video clip was discussed between the researcher and the film director as the shoot was progressing. For instance, decisions were made on whether a close-up shot or a wide-angled shot should be made, which sections of the scene required a zoom in or a zoom out and which part of the shoot sufficed with a standard shot. Editing of the entire video clip was done at the production house by a film editor. The video clip was then transferred to a normal VHS video tape and then digitized before being transferred into the computer using the software *MPEGator*. The actual length of the video clip was eleven minutes.

The ELEKTROKIMIA programme contained assessments questions at various sections within the programme. These questions were also prepared by the researcher. In addition, a short explanatory text were prepared for each of the correct response to the assessment questions.

Development of ELEKTROKIMIA programme

The authoring tool Macromedia's *Authorware 4.0 was* used in the

development and production of this programme. The authoring of the programme would entail that events, activities, decisions and user interactions being sequenced by placing icons on the flow line. Changing of the sequence, adding options and restructuring interactions could also be done by dragging and dropping these icons. In *Authorware*, each design icon denote a special function that is performed when the icon is encountered during interaction. The program could be tested at any time by clicking on the Start/ Stop Flag icon in the authoring mode. An example of the sequencing of icons for the Introduction section was shown in Appendix 7.

The design, colour scheme and naivgatoinal buttons were designed by the computer graphic artist using the software *Soundforge*. During the development of the programme, the navigational and user interface considerations were attended to by the computer programmer. This was to ensure that the user knows where he or she is in the programme, where he can go next, where he was before, whether he can go forward or backward or whether he can exit from the programme at any time. The programmer had to ensure that some aspects of the programme like ease of use, screen layout consistency, format of the text, amount of text per screen and the reading level of the text was suitable for the target audience (Tolhurst, 1992).

The sequencing of the icons to represent the placement of text, hypertext, images, animations, video clips, audio, buttons, hotspots, text of instructions, at the various levels of interactions were tested repeatedly to ensure that the programme could be run smoothly when used. The final product of the program was finally transferred to a compact disc (CD) which was an inexpensive way to store large files

required for visual information. As an example, the video clip (of eleven minutes) alone occupied a storage space of 105 MB.

Finally, for the completed multimedia project to be delivered to the users who will in turn install the project on to their computers, there was a need to prepare the run-time files so that they could be easily transferred from the media to the user's platform. This was done by providing a single programme that acted as an *installation routine*. This would help the end user to easily and automatically set up the project on their own computer. The preparation of the installation files was done by the multimedia developer expert . The important consideration to be made at this stage was to ensure that ELEKTROKIMIA programme be made compatible to as many different types of computers that the end-user might be using.

Formative Evaluation of the ELEKTROKIMIA programme

In this study, formative evaluation was executed on the programme that was developed. The evaluation of the programme was done at two levels; the pilot testing and the field testing. The pilot testing was conducted by former students while the field testing of the progarmme was done by two groups; students and teachers. Students who evaluated the programme were again divided into two groups, the low-ability students and the medium and high-ability students. Although both groups of students were required to answer the questionnaire in the students' instrument, only the low ability students were observed and interviewed. In addition, these low-ability

students were asked to perform the achievement test which was in the ELEKTROKIMIA programme itself. The results of all these evaluations would serve as the basis for this programme to be revised.

Pilot testing

The draft version of the material or prototype was first tested with representative learners to gauge the effectiveness of the material. Three former students who are currently undergoing their General Certificate of Education (G.C.E.) Advanced levels (A-levels) tested the IMM programme for presentation of text, ease of use, interface, language and navigation. These evaluations constituted developmental pilot testing.

Students' evaluation

The edited prototype was then tested on thirty-five students from several schools in Subang Jaya and Petaling Jaya. Those students (25) who had computers at home were allowed to bring back the ELEKTROKIMIA programme to evaluate. They were asked to respond to the questionnaire found in the Evaluation Form Of A Multimedia Programme For Students (Appendix 1) at the end of the programme. These students had scored more than 50% in their school's Chemistry semester test and were considered average and above average.

Observation and interview of students

Of the thirty–five students who tested the IMM programme, the remaining ten students selected for observation during the use of the programme and interviewed after using the programme, had scored less than 50% in their School's Chemistry semester test. They had no experience with computers and they were from the low income families (monthly income of less than RM1000). These students were referred to as low-ability students. All the of them stayed in a hostel which housed students who came from the rural areas throughout Malaysia but studying in a various schools in the district of Petaling Jaya.

The rural areas referred to settlements in the interior parts of the country where an area of land was developed for the purpose of planting rubber trees and oil palms. Children from these settlements were selected to attend schools in the bigger cities like Kuala Lumpur, Johor Bahru and Petaling Jaya where hostels were provided to accommodate them.

Each of the ten students were informed beforehand that they were selected to evaluate a Compact Disc (CD) on Electrochemistry. The students were also informed that they would be observed by the researcher during the evaluation which was held at the hostel library. The library was equipped with one multimedia computer. The students were then individually observed during the programme and then interviewed at the end of the programme. They were also asked to respond to the questionnaire in the Evaluation Form of a Multimedia Programme for Students (see Appendix 1). It took three hours to go through the entire ELEKTROKIMIA programme. The students were

given a twenty minute break after going through the programme for one and a half hours. Refreshments were provided to the students during the break.

The students were observed individually on how they used the ELEKTROKIMIA programme, which section of the programme they went to first, whether they had problems using the programme and whether they were "lost" while navigating the programme. The interview questions (see Appendix 3) were phrased in an open and neutral way where the students were encouraged to reveal more information and elaborate on their answers. All the responses to the questions were recorded by the researcher.

Achievement test of low-ability students

The same low-ability students were also asked to do an achievement test which was in the ELEKETROKIMIA programme itself. The achievement test referred to the 40 multiple-choice questions in the TEST section of the programme (see Appendix 4). To do the test the students had to click on the answers for every question in the programme. The score of the test was presented in the programme at the end of the 40 questions.

Before going through the other sections of the ELEKTROKIMIA programme, the students were asked to answer the multiple-choice questions in the TEST section of the programme first. The score presented at the end of this section constituted the pre-test score. The student was then allowed to go through the rest of the programme before repeating the same questions in the TEST section. The new score presented at the end

of the 40 questions constituted the post-test score. The results of these pre-test and post-test would indicate the effectiveness of the programme.

Teachers' evaluation

Apart from the students, six senior Chemistry teachers were also allowed to bring home the ELEKTROKIMIA programme for evaluation after which they were asked to respond to the questionnaire in the Evaluation Form of a Multimedia Programme for Teachers (see Appendix 2). One of the teachers is currently attached as a Science Officer in the Curriculum Development Centre while another is now in Petrosains, a science centre in a national petroleum company while the other four are practising teachers. In addition, the content and general features of ELEKTROKIMIA were also evaluated by an expert in Chemical education and an expert in Electrochemistry from a local university.

The teachers were requested to review the various aspects of the programme which include the user interface, programme overview, the programme design and the overall quality of the programme. Feedback from the formative evaluations of students and teachers provided the basis for the revision of the programme.

Revision of the ELEKTROKIMIA programme

The final version of the ELEKTROKIMIA programme was developed

based on the feedback from students, teachers and expert reviewers from both the pilot testing and the field testing of the ELEKTROKIMIA programme. Students' feedback from the interview and from the researcher's observation were also considered and amendments were made accordingly.

Mode of Presentation

The final programme was basically divided into four main sections. The first section was the introductory segment in video clip. The researcher introduced the programme by briefing the user about the topic to be learnt. The video clip showed the various application of electrochemistry in everyday life.

The second section introduced the user to the main concepts found in Electrochemistry, that is electrolysis and chemical or galvanic cells. In electrolysis, the user might want to find out more about the meaning of electrolysis, the factors that influence electrolysis and the applications of electrolysis. The user might also want to find out more about the different kinds of chemical or galvanic cells. Hypertext and hyperlinks, images and animations were interspersed in between each text for further clarification of the text.

The third section is a video clip of the demonstrated experiments found in the topic. The experiments were basically divided into the electrolytic experiments and the chemical or galvanic cell experiments. The video clips showed the actual experiment being demonstrated. Questions were asked on the various aspects of each

of the experiments during the demonstrations. At the end of each experiment, further questions in text form were prepared. Answers to these questions were given in text form within ten seconds.

The fourth section was the evaluation section. This was divided into two parts, the *LATIHAN* (EXERCISE) section and the *UJIAN* (TEST) sections. Each section consisted of forty questions in a multiple-choice format. For each correct response, the user was rewarded with a short music hit. When an incorrect response is entered, the user was shown the incorrect sign . The final score was given at the end of each section. The test questions were similar to the actual public examination questions. The user could only attempt each question once.

Each section in the programme proceeded with an objective page. The objective statement provided the user with some guideline on what would be learned in each section. At the end of each section, assessment questions were provided to evaluate the students on their understanding of the concepts presented. These included some objective-type of questions as well as fill in the blanks-type of questions.

The MAIN MENU provided the students a standard way to move to other sections. Within each section there was another sub-menu where the user could click and begin at any point in the sub-section. Navigation icons allowed the user to navigate within the section back to the main menu or to other sub-sections.

Instrumentation

A checklist developed locally at the University Malaya (Abtar Kaur,1995) and the *Borang Penilaian Kursus Untuk Pelajar* (Zoraini, 1993) were initially used to evaluate the programme during pilot testing .This checklist was given to the three former students. A new instrument was developed by the researcher by adapting and combining the above mentioned checklist and the *Borang Penilaian Kursus Untuk Pelajar* to form the new Evaluation Form Of A Multimedia Programme for Students or the *Borang Penilaian Program Multimedia Untuk Pelajar* (see Appendix 1).

Another evaluation form was developed for the teachers. This evaluation form was partly adapted from the *Borang Penilaian Kursus Untuk Guru* (Zoraini,1993) and constituted the Evaluation Form of a Multimedia Programme for Teachers or the *Borang Penilaian Program Multimedia Untuk Guru* (See Appendix 2).

The evaluation as a whole, was mainly concerned with the quality of the programme itself. In addition, direct observation and one-to-one interview of the students on the use of the program were conducted on each of the ten low-ability students selected.

Instrument for students

The instrument for students consisted of two parts. The first part of the instrument contained items to gather information about the students themselves. The four items

were concerned with student's family income, computer skills, attitude towards computers and students' score in their school's first semester test in chemistry.

The second part of the instrument had fifteen items and was designed to probe student's perception of the programme. Items 1,4,5 and 8 required the students to indicate whether they found the programme easy to use, whether they knew what to do in the programme and whether there were enough instructions in the programme. Items 2,9 and 15 extracted students' motivational level towards the programme. Item 3 covered information about students' views on the effects of multimedia towards their understanding of the concepts in Electrochemistry.

Item 7 concerned the level of language used in the programme. The whole instrument was in the national language, Bahasa Malaysia . It was important to know whether the level of language used was suitable and comprehensible to students. Items 6,12 and 13 indicated students' opinion about the content of the programme, whether they found the content to be logically sequenced, the presentation of concepts clear and effective and whether all the concepts of Electrochemistry have been presented.

In item 10, the students indicated whether the assessment questions were suitable and sufficient. Item 11 allowed students to express whether they could control the rate of the programme while item 14 indicated whether the students needed to think while doing the programme. All the items were provided with some space at the side of the page to allow students to comment or elaborate on the programme where necessary (see Appendix 1). The last two items were open-ended questions asking students to explain why they liked or disliked the ELEKTROKIMIA programme.

All items had three responses. Response A was total agreement with the statement of the items while response C was disagreement with the statement of the item. Response B was partial agreement with the statement given in the particular item.

Instrument for teachers

The instrument for teachers was more comprehensive and was made up of two parts. The first part of the instrument was divided into six sections. The first section contained eight items inquiring about the teachers' opinion about the educational value of the programme. In this section, the teachers opinion about the importance of the topic Electrochemistry was sought, whether the learning strategies used were varied as well as suitable, whether students needed to think while doing the programme, whether the presentation in the program was orderly, and whether the assessment was sufficient and suitable.

The second section to the instrument contained twelve items on the content of the programme. The teachers were required to consider whether the introduction of the programme was satisfactory and interesting and whether there was sufficient information which was accurate and suitable. Was the language used suitable and free from grammatical mistakes? Teachers' opinion about the presentation of concepts were also sought. This section also seeked to find out whether the level of difficulty of the content was suitable or whether there were any misconceptions in the programme. Teachers were also able to express whether the program fulfills the needs of the Malaysian curriculum, whether the programme could increase student' s

motivation and whether the teachers agreed that the feedback given in the programme were accurate and suitable.

Ten items were found in the third section to gauge teachers' view about the presentation of the programme. Was the text easy to read, what were the teachers' views about the screen design and the color used in the programme. The use of graphics and animations was a special feature in this program. Did the teachers find them interesting and suitable? Was the visual effect used interesting? Were the video clips clear and suitable? Finally the researcher also wanted to know whether the questions on the electrochemical experiments were suitable.

In the fourth section of the instrument, nine items were designed to probe teachers' opinion about the usage of the programme, whether it was easy to use, whether there were any technical problems with the programme, whether there were enough instructions and whether there were plenty of interactions in the programme. Could students control the rate of the programme? Could they do the programme unaided? Could they exit the programme anytime? Was there sufficient time to do all the activities in the programme? The responses to these items would determine whether the programme designed was user-friendly. The documentation of the programme had five items which seeked to know whether teachers agreed that the information was complete, orderly and , easy to understand.

The last section contained four items to extract information about teachers' overall view of the programme. How do teachers rate the programme when compared to other teaching and learning aids? Do teachers feel that the programme met the objectives of learning and can a multimedia programme like this help to

motivate students in their learning? The teachers' responses would indicate that the promises of multimedia in education, specifically in Electrochemistry had been substantiated.

All the above items were provided with four Likert-scale scores (1= total agreement, 2= agreement, 3= partial agreement and 4= disagreement).The second part of the instrument for teachers consisted of open-ended questions about the programme. Open-ended questions will allow the teachers to bring up issues not anticipated by the researcher. Teachers' opinion and comment were sought on which feature of the programme they found interesting or otherwise. Finally, at the end of the instrument, teachers were also required to rate the programme from a value of 1 to 10 (1= very poor quality, 10= excellent).

Development and Validation of the Instruments

The instrument used for teachers were partly adapted from the *Borang Penilaian Perisisan Kursus untuk Guru* (Zoraini,1993) but later more items were added to the instrument to ensure other aspects and features of the programme were evaluated. The final instrument constituted the Evaluation Form of a Multimedia Programme for Teachers (Appendix 2). The instrument was tested by two senior Science teachers and a lecturer in Computer Science studies. Based on their feedback, some items were amended, others deleted, and those items which were vague had to be rephrased and made simpler. The instrument was then returned to the teachers and lecturer for their comments.

The instrument for students was developed partly from the *Borang Perisian Kursus untuk Pelajar* (Zoraini, 1993) and partly from a checklist of a multimedia programme developed at the University of Malaya (Abtar Kaur, 1995). The final instrument was the Evaluation Form of a Multimedia Programme For Students (Appendix 1). This instrument was checked by a senior teacher in the national language, Bahasa Malaysia, and also by four students aged between thirteen and sixteen on the clarity of language used in the items. The instrument was then given to five Form Four students to see whether there were any vague sentences or phrases in the questionnaire. There were no amendments to the Evaluation Form for Students as feedback from the teacher and the five students indicated that they could understand the questions and statements in the Evaluation Form.

Expert Review

The six senior chemistry teachers who evaluated and reviewed the contents, graphics, video and technical aspects of the multimedia courseware constituted the expert review. In addition, an expert in Chemical education and in Electrochemistry, both from a local university evaluated the programme for accuracy in content and concepts as well as giving feedback on the overall programme.

Each of these experts were given a copy of the CD and a set of the questionnaire. They were given a week to evaluate the programme. One week after they have received the programme, the researcher went to collect the material as well

as to get their feedback . The entire content and general features of the programme were discussed at length. Input and feedback from the experts concerning the content, instructional strategy and the presentation format of the programme was obtained.

Summary

The methodology of this study consisted of four stages. It involved the preparation, the development, the formative evaluation and finally the revision of the ELEKTROKIMIA programme. The preparation of the ELEKTROKIMIA programme was to identify the instructional goals and the content of the programe including the selection of instructional strategies and resource materials to be used. The development stage of the ELEKTROKIMIA programme involved the actual authoring of the programme using the Macromedia's *Authorware 4.0* and other supporting softwares. The evaluation of the ELEKTROKIMIA programme was conducted on the prototype developed.

There were three types of evaluation; evaluation by students based on the questionnaire in the Evaluation Form of a Multimedia Programme for students, evaluation by teachers based on the questionnaire in the Evaluation Form of a Multimedia Programme for Teachers and evaluation based from observation and interview of the low-ability students who were considered computer-illiterate. In addition, the low-ability students were also asked to do an achievement test based on the multiple-choice questions in the ELEKTROKIMIA programme to see the effectiveness of the programme.

The achievement test was based on the results from a pretest and a posttest . This was conducted only on the ten low-ability students. They were asked to do the test in the ELEKTROKIMIA programme first before attempting to go through the other section. The score of this test constituted the pretest. At the end of the programme, the students were required to do the test again and their score would constitute the posttest. The reason why only the low ability students were asked to do a pretest and a posttest was because if the achievement of these low students showed a significant increase, then the programme can be considered to be effective.

Direct observation method and one-to-one interviews were also used to evaluate the ELEKTROKIMIA programme. A wider range of usability issues could be elicited in the observational study whereas with interviews, more detailed information could be gained. The results of the evaluation formed the basis for the programme to be revised.

The methods used for data collection were survey by questionnaire (two instruments were used, one for students and the other for the expert reviewers), direct observation and interview. The source of data was the subjects selected- students and the experts in Expert Review.

The subjects involved were thirty-eight students; three 'A' level students who evaluated the programme in the pilot testing and thirty-five students who evaluated the programme in the field test. All of them were schooling in the district of Petaling Jaya. Ten of them were selected from a hostel which housed students who come from rural areas throughout Malaysia but studying in schools around Petaling Jaya. These ten low ability students scored less than 50% in their schools; semester chemistry test

and had no experience with any educational CDs before. They were also selected because they came from the rural areas. These students were observed and interviewed individually on the use of the programme.

Two survey instruments, *Borang Penilaian Program Multimedia untuk Pelajar* (Appendix 1) and *Borang Penilaian Program Multimedia Untuk Guru* (Appendix 2) were developed by the researcher to elicit response from the subject of research for the formative evaluation of the multimedia programme. The instruments was tested by four students, two science teachers and one lecturer in computer science before being administered.