UNIVERSITI SAINS ISLAM MALAYSIA

# THE EFFECTIVENESS OF ANNOTATIONS IN COMPUTER ASSISTED INSTRUCTIONS (CAI) IN ENHANCING SCIENCE-BASED TEXT COMPREHENSION

## RESEARCH CODE: PPP (H) /2006



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# ACKNOWLEDGEMENT

In the name of ALLAH the Most Gracious The Most Merciful, it is our deepest gratitude for His Blessings in making this research a successful endeavor.

We are thankful that this research, which is *a collaboration between two faculties* in USIM namely, the **Faculty of Major Languages** and the **Faculty of Science and Technology**, has been able to produce a significant outcome in the effort of providing our students with meaningful learning context.

Our heartiest appreciation goes out to the Biotechnology students of FST that had given us their full cooperation in ensuring the success of this research

Finally, we would also like to thank our family for their love and support.

# ABSTRACT

The aim of this study is to investigate the effectiveness of annotations in multimedia on-screen texts using two presentational modes in enhancing learners comprehension level as well as vocabulary level. The subjects involved are 44 first year Biotechnology students of USIM. The methodology employed is experimental comparison of the performance of two groups of subjects under two different conditions: one using multimedia on-screen text with the annotations of 'text+animation' and the other using multimedia on-screen text with the annotations of 'voice+animation'. The instruments used in this study are the multimedia texts on "transgenesis method' which focuses on the processes involved in the "Protoplast Fusion' as well as the ''Agro bacterium mediated transfusion' and a Comprehension Test that assessed the subjects understanding of the reading texts assigned. The method of data analysis used is of descriptive statistics which uses the frequency count of the average (mean) value scores as well as the highest (max) and lowest score (min) in identifying the effectiveness of the multimedia annotations in facilitating the students comprehension level using the two presentational modes. Generally, the overall scores indicate that there is no significance difference in the use of annotations via the two presentational mode - 'text+animation' and 'voice+animation' as the difference that exist in the scores are small. However, the findings do indicate that the subjects are found to emphasise on the use of their visual sense of modality in facilitating their reading tasks. Subsequently, this has resulted the students that are exposed to the presentational mode of 'text+animation' to do fairly better than the latter group 'voice+animation'. Finally, it is important to highlight here that the annotations (animations) found in the multimedia on-screen text, do to a certain extent, facilitate the students in understanding a science based text due to its ability to build referential connections between the two mental representations in short term memory hence, resulting in better performance in the tasks assigned

# ABSTRAK

Tujuan kajian ini dijalankan adalah untuk mengenalpasti keberkesanan penggunaan anotasi melalui penggunaan dua kaedah penyampaian yang berbeza didalam teks multimedia terhadap pengaruh dan kadar kefahaman serta peningkatan penbendaharaan kata pelajar. Kajian ini telah melibatkan 44 orang pelajar Tahun Satu dari Fakulti Sains dan Teknologi (FST) USIM. Kaedah kajian yang digunakan adalah berbentuk perbandingan 'eksperimental' prestasi dua kumpulan pelajar yang diletakkan dibawah dua keadaan: satu kumpulan menggunakan teks multimedia berbentuk 'teks+animasi' dan satu lagi kumpulan menggunakan kaedah berbentuk 'suara+animasi". Di antara instumen atau bahan kajian yang digunakan adalah penggunaan teks multimedia bertajuk "transgenesis method" yang memfokuskan kepada dua proses utama iaitu "Protoplast Fusion" dan ''Agro bacterium mediated transfusion" serta satu set ujian kefahaman mengenai isi kandungan yang dibaca. Kaedah analisis data yang digunakan adalah berbentuk statistik yang deskriptif yang menggunakan jumlah markah purata selain daripada penialaian markah maksimum serta markah minimum yang dicapai bagi mengenalpasti keberkesanan anotasi multimedia didalam meningkatkan kefahaman pelajar menggunakan dua kaedah penyampaian yang berbeza itu. Secara amnya, dari jumlah skor kumulatif yang diperolehi, hasil kajian ini menunjukkan tiada sebarang perbezaan yang ketara wujud didalam kefahaman pelajar melalui penggunaan kedua-dua kaedah penyampaian multimedia – 'teks+animasi' dan 'suara+animasi'. Ini disebabkan hasil perbezaan yang diperolehi didapati sangat rendah. Hasil kajian ini juga mendapati bahawa kedua-dua kumpulan ini menumpukan perhatian mereka melalui penggunaan 'visual sense modality' (kaedah visual) didalam meningkatkan kefahaman pembacaan mereka terhadap sesuatu teks berasaskan multimedia. Oleh itu, hasil kajian ini tidak menolak bahawa pelajar-pelajar yang didedahkan kepada kaedah penyampaian secara 'teks+animasi' telah menunjukkan prestasi kefahaman yang lebih baik berbanding daripada kumpulan pelajar yang didedahkan kepada kaedah penyampaian 'suara+animasi". Secara amnya, adalah penting untuk dinyatakan disini bahawa penggunaan 'anotasi' di dalam teks multimedia merupakan satu kaedah yang dapat membantu para pelajar didalam meningkatkan kefahaman mereka terutamanya didalam pembacaan teks berlatarbelakangkan sains kerana kaedah ini dapat merangka 'referential connections' (kaitan rujukan) diantara dua bahagian pemikiran didalam memori jangka pendek, seterusnya menghasilkan keputusan prestasi yang lebih baik didalam pemahaman teks yang dibaca.

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# CHAPTER 1

# INTRODUCTION

## 1.0 Background of the problem

Traditionally, textbooks have been the focal point for most of the instruction that students incur during class lectures or related educational activities. However, in any of the classroom activities or other related educational activities, most students either use their textbooks exclusively or copy diligently every word found in the book without having a complete understanding of the content found in the book. Often times, such lack of meaningful integration that teacher expects with textbooks can attribute to a students' lack of knowledge on how they can approach the texts found in the book when faced with a problem.

In an effort to reform science education, effective science teaching and learning need to be identified. For instance, initiatives have been made by the schools in the US to revise the current curriculum to reflect a more student-centred and meaningful approach to science instruction. This include developing a classroom atmosphere that will create

partnership between students, teachers, and technology that will build on students curiosity and creativity ; emphasize quality of understanding rather than quantity of information, as well as expose students to concepts in variety of contexts (Sydner-Gordon 1997).

Although many researchers believe that new technologies do not influence learning, the use of such technologies has often helped in increasing our knowledge of certain components of teaching and learning. A case in a point is the use of computer assisted instruction (CAI) in the learning process, has been found to enable researchers to identify the importance of integrating learners' affective characteristics into their cognitive learning models. Furthermore, CAI has also been found to enhance learners learning due to its merits of providing immediate access to the available annotated information in a program including textual, audio and visual annotations. As such, it provides learners with the desired meaning immediately and allows them to pursue reading without disturbing the reading process (Al-seghayer, 2001).

Moreover the value of value and effect of the multimedia presentations in facilitating the learning environments may also include having access to images. Hence, providing learners with visual information attached to a word in which may help them to confirm or reject hypotheses made about the meaning of the context read as well as an

opportunity to interact with the text, in which they become actively involved in their own reading and learning process (Chun and Plass, 1996)

Therefore, Computer assisted Instruction (CAI) is seen as an alternative for learning as information can be presented in various forms like texts combined with graphics, images and audiovisual content to enhance retention and learning.

On the other hand, there are several key considerations that need to be examined in implementing multimedia technology or Computer assisted Instruction (CAI) as an educational tool. Primarily, it is important for the teacher to determine the purpose or expected outcomes that are targeted to be achieved by using the multimedia. These include the flexibility offered by the multimedia by providing problems, scenarios and simulation in modifying and influencing the nature of the learning process which in turn allow the learners to progress along various levels of thought, manipulate the basic parameters of a situation or even to test out the alternatives found that may not be possible with other traditional teaching and learning methods.

As such, it is pertinent for educators to explore how learners and its users interact the content and processes as well as each other; the short and long term goals involved; the intended and unintended outcomes; the richness and depth it offers; and the multidimensional nature of the different forms of multimedia technology as well as

finally the potential offered in multidimensional nature of the different forms of multimedia technology (Carter, 1999).

Subsequently, although the advent of such computer technology provided learners with new learning environment of immediate access to the required information, there exist a gap of a research-based theory of how the modes of effective learning in designing multimedia instruction using concurrent words, sound and pictures (animations) (Rieber 1990) are enhanced in relation to scientific texts. Therefore, it is the aim of this research to identify the modes of learning conditions that are effective in enhancing learner's comprehension in understanding the concepts learnt.

## 1.1 Statement of the Problem

In the effort of enhancing the learning environment in classrooms, computer assisted instruction (CAI) has been introduced due to its capability to integrate texts with annotations like graphics, images, audio visual content with a click of the mouse. However, as students learning strategies vary in comprehending texts; hence the way individual interact with multimedia technology and its assessment varies. The question now lies in determining the most effective learning mode that can not only enhance learners ability to comprehend multimedia texts but also their vocabulary retention in their reading process.

## 1.2 Research Questions

1. Will students who are exposed to the presentational mode of *(*text+animation*)* show any significant difference in comprehending the text in comparison to those exposed to *(*animation+sound*)*

2. How do the annotations found in the different instructional designs help learners in their comprehension level?

3. How do the annotations found in the different instructional designs help learners in acquiring and retaining the vocabulary learnt?

## 1.3 Research Hypothesis

There will be a significant difference in the level of comprehension as well as the acquisition of new vocabularies in the comprehension test scores of students who are exposed to (text+animation*) in* comparison to those exposed to (animation+sound*)*

## 1.4 Purpose of the Study

The purpose of the study is to find out whether the use of computer annotations in two different modes affects students' comprehension level as well as to identify which presentational mode is most effective in enhancing student's comprehension level of science-based texts.

This study is also undertaken to find out whether the use of annotations differ in helping students to understand the text apart from looking into how the annotations found in the different instructional designs aid the learners in acquiring and retaining the related vocabulary found in the texts.

## 1.5 Justification for Research

This research is a comparative and descriptive research that is performed to identify whether such meaningful connections between picture and text can be enhanced under two different conditions; (text+animation), and (animation+sound), employed in enhancing learners comprehension level in a scientific text. By doing so, it is hoped that it will provide a layout of how instructional design should be presented to maximize learning among the students. In addition, in the light of the developed instructional software that integrates text, sound as well as computer animation presented in a multimedia form to maximize its effectiveness, identification of such modes of presentation, will provide insights of the theoretical framework in multimedia learning as well as an alternative means for autonomous learning that suits the learners strategies and affective factors apart from the traditional paper printed-text.

# CHAPTER 2

# LITERATURE REVIEW

## 2.0 Introduction

Over the past there decades, computers have become progressively more important as instructional vehicles in schools. Each year, a little more learning occurs in front of computer screens and a little less in front of teachers or textbooks. This can be seen through wide arrays of educational soft wares currently available on the market covering a variety of topics, in which the implicit presumption is that computerised instruction is better than traditional instruction, like classroom lectures or self-paced workbooks.

Although traditionally, textbooks have been the primary source of classroom instructions, problems arise when there is no meaningful integration of the content learnt in the textbooks to the building of a rich context and background for understanding difficult concepts learnt. One related area of education that has seen a lot of attention over the past several decades is that of science and technology. As Carl Sagan asserts, (Sydner-Gordon 1997)

"*We have arranged a global civilisation in which most crucial elements profoundly depend on science and technology. We have also arranged things that almost no one understands science and technology*". As more and more discoveries are made in the world of science, the amount of information that students are required to learn grows at an almost unfathomable rate.

In addition, the predicament rises when students can read a textbook lesson that contains scientific explanation but yet not able to remember the explanation adequately or to use it to solve problems. As such, even though the textbooks provide an extensive treatment of the subject matter in building a rich context and background for understanding difficult concepts, meaningful integration between the content of the books to students background understanding seem to be lost

Hence, many educators are searching for unique ways of integrating diverse arrays of educational as well as instructional material into science classrooms. As recent developments in technology have given a way of improving students' attitudes, motivation, understanding transfer, equity and responsibility for their own learning, the avenue for implementing these instructional and educational ideas has been paved by advancement in multimedia technology.

## 2.1 Multimedia Annotations

As defined in Webster's New World Dictionary of computer Terms (2000) annotation symbol is a symbol used to add messages or notes to other flowcharting symbols, as well as an explanatory note or comment inserted into a document like business report or even analytical worksheet. Moreover, with some applications this symbol can also be inserted as an icon. Hence, when clicked, it can open a separate window containing the note.

However, in relation to this study, the literature addressing multimedia annotations is referred to their presentation via printed text, as well as their presentation via the modes of audio delivery, dynamic video imagery or even pictorial imagery. (Al-Sagheyer : 2001) These include modes like the hyperlinks, glossing of words, text pop-ups, sounds, or navigation tool bars or even graphic presentations. For the purpose of this study however, the annotations that will be looked into are specifically that of animation that can b found in describing a scientific process.

The value of multimedia annotations provides additional merits to the educators in using multimedia annotations as it offers learners a means of developing reading and learning strategy. (Martinez-Lage: 1997) These include:

1. Offering immediate access to the available annotated information in a program including textual, audio and visual annotations. It provides readers with the desired meaning immediately and allows them to pursue reading without disturbing the reading process.
2. Giving access to images. For instance, visual information attached to a word enables readers "to confirm or reject hypotheses made about the meaning of a word".
3. Providing readers an opportunity to interact with the text, in which they become actively involved in their own reading process.

Moreover, according to Mayer and Simms (1994), with the use of multiple modes in multimedia learning environment, the aids for text comprehension could be presented in textual form, visual form or in any combination of these presentation modes. As such, the three types of aids that are involved in text comprehension include:

1. **Aids for selecting information** are mainly served as to focus the reader's attention on certain aspects of the target information on improving the chance for the information to be processed.
2. **Aids for building internal representation** are mainly designed to support he reader's building of internal connections among the units of

information presented that is in organising the presented information into a coherent structure of the logical idea units in the text.

3. **Aids for building external connections** are mainly aids designed to help the reader build the connections between the ideas in the text and the existing mental model.

As such, the presentation modes other that text can be based on these three aids for text comprehension. Thus, extending Mayer's proposed models of aids for text comprehension to multimedia aids; the multimedia information is seen as the best means to aid text comprehension. This is due to the fact that the multimedia environment can support the process of selecting information, of building internal representations as well as the building of external connections through the extension use of dual coding theory as well as the contiguous presentation of visual and verbal materials (Chun, 1997).

Finally, the usefulness of illustrations or annotations for instructional applications is further confirmed in several research studies reviewed by Eddy and Spaulding (1996) and Rieber (1994). Both have derived some general conclusions on the effects of illustration on text. Among the positive effects of illustrations or annotations suggested by Spaulding (Anglin et al., 1996). include

(1) Being effective interest-getting devices

(2) Helping the learner interpret and remember the content of the illustrated text

(3) Being more effective in realistic color than black-and-white

(4) Having the ability to draw more attention if they are large

(5) Conforming to eye movement tendencies.

In addition, Rieber (1994, p.141) identified the following positive effects of illustrations or annotations which include :

(1) Pictures are superior to words for memory tasks

(2) Adding pictures (external or internal) to prose learning facilitates learning, assuming that the pictures are congruent to the learning task

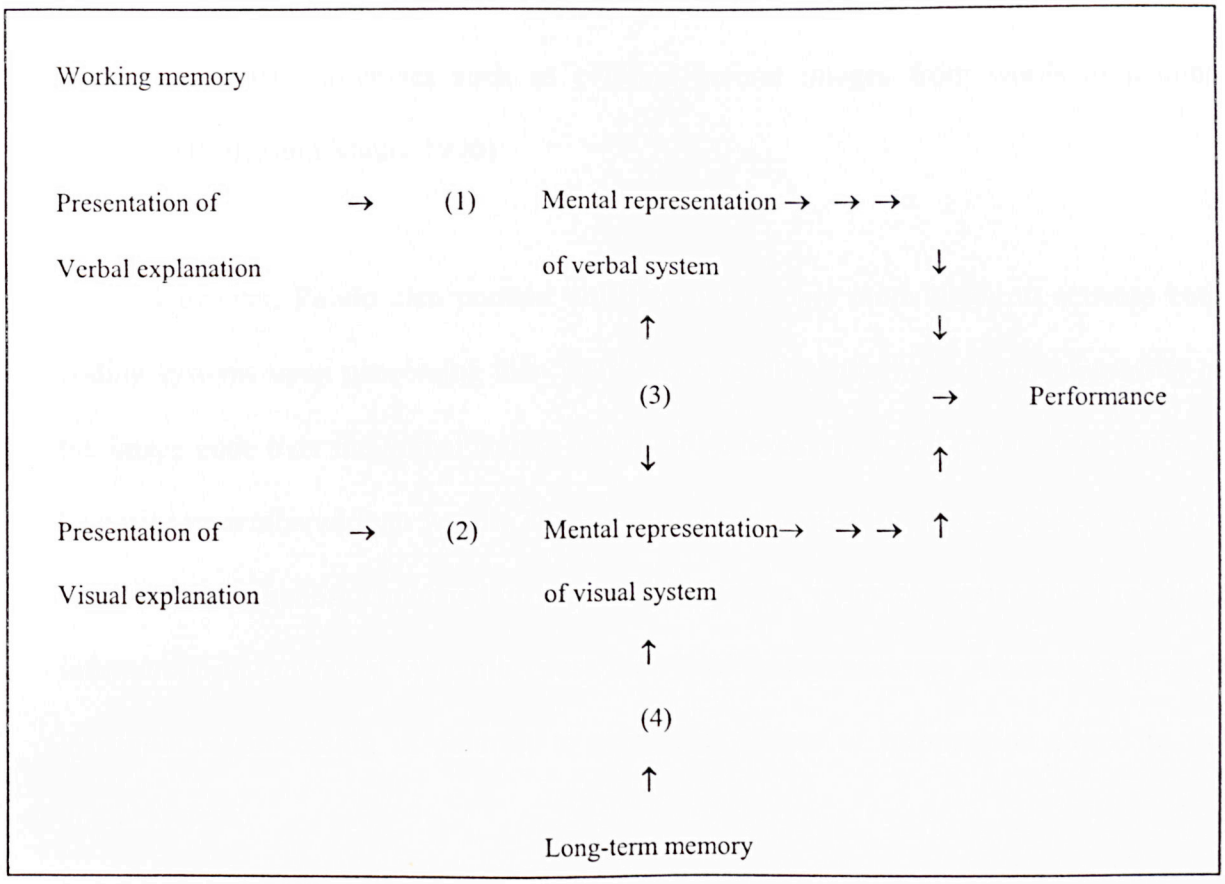
(3) Children up to about the age of 9 or 10 rely more heavily on externally provided pictures than do older children

(4) Children do not automatically or spontaneously form mental images when reading

## 2.2 Theoretical Framework - The Dual Coding theory

To assess many of the attributes of multimedia, educators need to explore how learners and its users interact with content and processes as well as each other; the richness, depth and multidimensional nature of the different forms of multimedia technology. Another consideration that educator need to understand before implementing multimedia is that the learning styles among students vary, hence the way in which individuals interact with multimedia technology and its associated assessment also differs. (Altschund 1995) The Dual Coding Theory for processing information focuses on two of these major learning styles that are present to learners. This has also been asserted by Mayer and Anderson (1992) in which such value and effect of the multimedia presentations in facilitating the learning environments is related to the generative theory of multimedia learning known as the 'contiguity principle' that is drawn from ***Paivio's dual coding theory*** (1990). The theory conceives that human possesses two distinct information-processing systems: one that represents *information verbally* and one that represents *information visually*.

**Figure 2.1: A dual coding model of multimedia learning.**




**Number 1 refers to building verbal representational connections; 2 refers to building visual representational connections; 3 refers to building referential connections; 4 refers to retrieval from long-term memory. (Mayer & Anderson, 1992)**

The two aspect of this theory involve the verbal subsystems which specialises in representing and processing information and the imagery subsystems related to non-verbal objects and events. The verbal and the imagery (visual) systems can be activated independently. Hence, although different entities, these verbal and imagery subsystems

can operate in cooperation with one another. Activity in one system can trigger activity in another. Links between these two subsystems are referred to as referential connections and can facilitate processes such as evoking mental images from words to naming pictures. (Butler and Mautz 1996)

However, Paivio also pointed out that pictures are more likely to activate both coding systems upon processing than words As a result of the 'mnemonic superiority of the image code over the verbal codes" (1991, 265), he asserted that pictures are found to be easier remembered than words. This has also been posited by Rieber (1994) in which recalling information contained in the visual system is much easier than recalling information in the verbal system because the visual system accesses information through synchronous processing in contrast to sequential access of information stored in the verbal system.

Thus, in relation to the effectiveness of the multimedia annotations, learners learn to construct referential connections between the two forms of mental representation systems (the verbal and the visual representation system) using three basic connections:

1. Building **representational connection** between **verbal information** presented and that of **learner's verbal representation of that information**

2. Building **representational connection** between **pictorial information** that is presented and the **learner's visual representation of that information**
3. Building **referential connections** between corresponding elements in the **learner's verbal and visual representations**.

As such, in line with the contiguity principle, learners may more easily construct referential connections when words/texts and pictures/animations are presented contiguously rather successively.

In short, the Dual Coding Theory proposes that information is much easier to retain and retrieve when dual coded because of the availability of two mental representations instead of one.

## 2.3 Past Research

The development of computer-based curricula has been taking placed before the existence of microcomputers in the late 1970s. The first well-known study to develop the programs to enhance learning was the Stanford Computer Instructed Project. This ongoing study was developed to create programs capable of individualized reading instruction for kindergarten through third grade. The two counter-projects, TICCIT and

PLATO then, began to develop computer based strategies for learning to read (Sighal, 1999). Although it was gradually terminated, the initial goal of the project was to develop a complete curriculum for all grade levels.

In essence, many of the studies conducted in the seventies were research projects that focus on issues that were related to students' achievement with Computer Assisted Instruction (CAI). However, attempts to enhance learning through computers were extended to research projects that examined the use of computers in relation to reading as well as how such specific computer programs affected students reading ability. One of the earlier studies includes a study by Fletcher and Atkinson in 1972 regarding the effects of receiving a computer based instruction on students. The outcome of this study was positive as results on the post test scores showed that students receiving CAI performed better than those who did not (Al-Segheyer, 2001).

In relatively short period of time, computer technology has increasingly changed the method used in classroom instruction and learning process. In the light of the newly developed instructional software that integrates text, sound as well as computer animation presented in a multimedia form that maximize its effectiveness, many of the researches in the eighties and nineties, focus on these multimodal instructional materials to study the process of reading and text comprehension on a second language environment.

In relation to the research on the Dual coding theory, one prominent study that was carried out was by Mayer and Anderson (1992) on investigating whether the contiguity principle (words and pictures presented contagiously) along with the use of instructive animation improve students understanding of a concept learnt. The study, which was derived from the dual coding model (verbal and visual processing systems) involved two experiments in which students were asked to study an animation depicting the operation of a bicycle tire pump or an automobile braking system, along with concurrent oral narration of the steps in the process (concurrent group), successive presentation of animation an narration, animation alone, narration alone or no instruction (control group). The results from this study were found to be in consistent with the contiguity principle in multimedia learning in which students learn best when the words and pictures of an explanation are presented contiguously in time or space. This is due to the fact that contiguity of words and pictures during instructions are found to help the students to build connections between their verbal and visual representation of the incoming information, which in turns support problem solving transfer that was reflected from the answers provided in the creative problem solving performances of the learners.

In another similar experiment, (Mayer et al ; 1996), 3 different series of experiments were carried out to college students exposed to summary reading containing sequence of short captions with simple illustrations depicting the main steps of lightning

process and were asked to recall and solve transfer problems in comparison to students exposed to full text along with summary or even those exposed to full text alone. Findings of this study indicate that taking away the illustrations or captions would eliminate the effectiveness of the summary, while adding text to the summary would reduce its effectiveness. As such, it could be concluded that 'multimedia summaries (summaries based on both text and illustrations) works best when the multimedia summary consists of a combination of both visual and verbal formats in comparison to verbal summary alone. Other findings of this study also include that any effective multimedia summary must be constructed on the basis of three criteria that are with only few illustrations and sentences presented; coherence – in which the images and sentences were presented in the cause and effect sequence; and finally coordination in which the images were presented contiguously with the corresponding sentences (i.e. each illustration had a verbal caption).

Apart from facilitating reading comprehension, Mayer and Gallini (1990), also found that coordinated presentation of verbal and visual explanations improved problem-solving transfer, and indicated that the effectiveness depended on the experience level of the learner (Mayer and Simms, 1994). As such, they argued that "when a useful visual model is *not* presented along with a verbally presented explanation, high-knowledge students are more able than are low-knowledge students to retrieve a source model from

long-term memory and to use it to help interpret the incoming verbal explanation" (Mayer and Simms, 1994, p.391) As such, students who viewed an animation depicting the formation of lightning while also listening to the corresponding narration were found to generate 50% more useful solutions on a subsequent problem-solving transfer test that those who viewed the same animation with corresponding on-screen text consisting of the same words and narration.

# CHAPTER 3

# METHODOLOGY

## 3.0 Introduction

This chapter outlines the procedures used in eliciting the data for this study. The objective of this research is to identify whether such meaningful connections between picture and text can be enhanced under two different conditions; (text+animation), and (animation+sound), employed in enhancing learners comprehension level in a scientific text. The procedures include a detailed description of the research sample, the research instrument, the research procedures as well as the method for analyzing the data.

## 3.1. Research Sample

The subjects selected for this study are 44 Biotechnology students of USIM. They consists of first year students of the Faculty of Science and Technology, who has undergone the English proficiency courses found in USIM. The subjects, who are selected randomly for both groups, obtained the minimum of Grade of B for their English

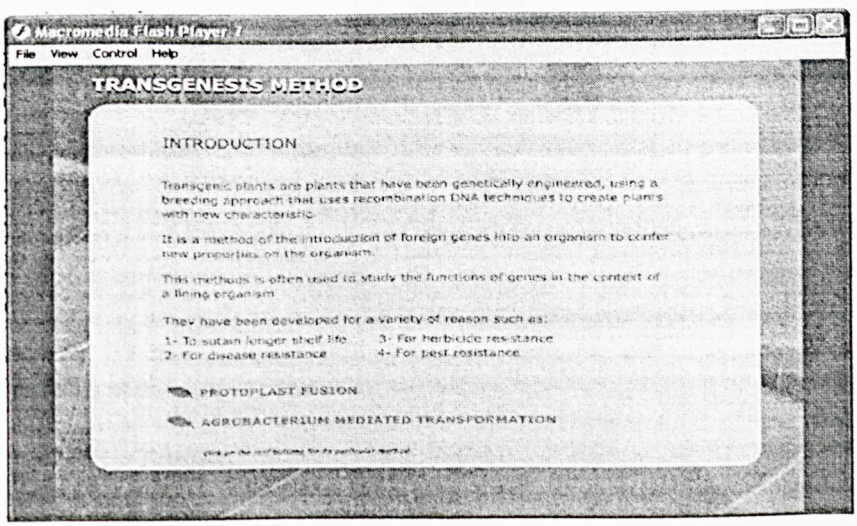
Proficiency courses and have sat for their MUET (Malaysian University English Test) during their Matriculation years and have obtained the minimum Band of 3. .

### 3.2. Research Instruments

As the goal of this study is to promote learners understanding of scientific explanations, the instructional techniques for such meaningful learning to occur will be investigated. This will help to determine the mental connections required to build effective learning through improved scientific illustrations using the mode of multimedia. The research instruments included texts taken from Theiman & Palladino (2004) in this research are:

**I – Main Text**

**Figure 3.1 : Main text – "Methods use in plant transgenesis"**

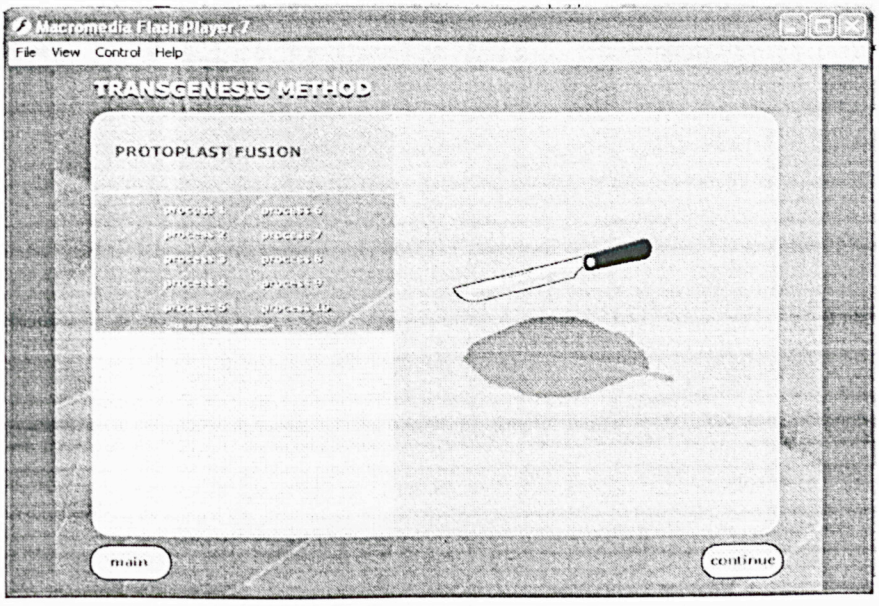


The topics covered are in relation to:

a. **"Protoplast fusion'.**

A method of creating a cell that grows into a hybrid plant by fusing protoplast with another from a different species.

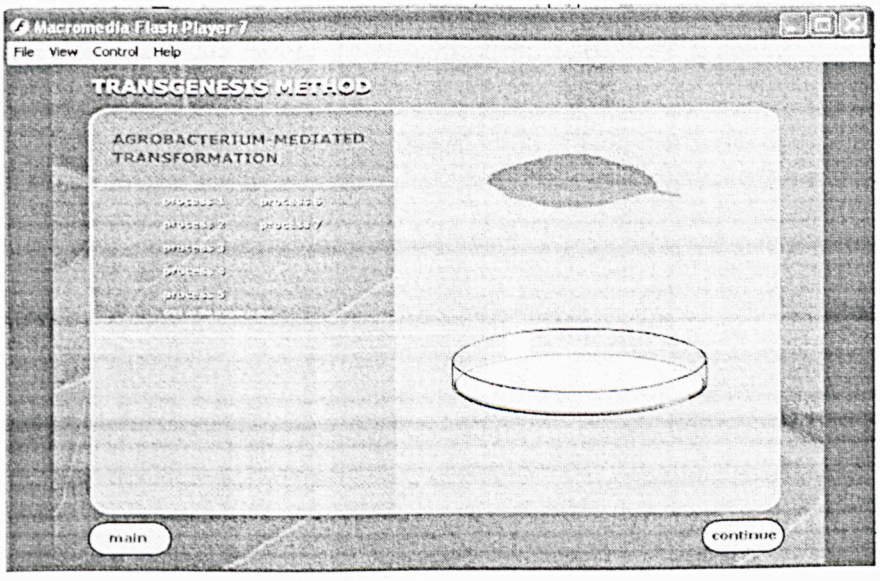
**Figure 3.2: Processes of Protoplast Fusion**



b. **'Agro bacterium mediated transfusion'**

A method of exploiting features of a soil bacterium *"Agrobacterium Tumefaciens"*, which infects many kinds of wounded plants.

**Figure 3.3: Processes of 'Agro bacterium mediated transfusion'**




The topic of the text is selected based on its content that is found to be relevant to the Biotechnology Science study. In this case, the content of the text provides the foundation knowledge regarding the process of cloning in plants. In addition, the topics of the text are selected also mainly because it provides a text that illustrates a given

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