

# EVALUATION OF LEARNER ACHIEVEMENT WITHIN ACTIVE MULTIMODAL PRESENTATION (AMP) AND STATIC E-LEARNING MODES

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## ABSTRACT

While current e-learning activities mainly focus on static mode, this paper proposed a simple Active Multimodal Presentation (AMP) application, and evaluated the student achievement in static and active modes. Of the various AMP acquisition and presentation tools, this paper addresses the use of active text as input and output interaction and animation with video for presenting some learning contents. Other gestural modalities such as iconic forms including pointing fingers, open, flat or cupped hand, etc., are left for coming experiments. For the purpose of this study, learning contents have been built in a form of static and active presentations within the proposed application. We formed two different equivalent student groups that are given the pre and post tests. In this paper we showed the evaluation procedure and some obtained results using our proposed AMP prototype. The result of the statistical analysis of student achievements showed no significant difference in the statistical mean between the experimental group and the control group with respect to the post test. Achievements of both selected groups, the control and experimental, where  $F(1,17)=0.521$  and the  $p\text{-value}=0.480$ . However, the student achievement comparison revealed an interesting result showing that experimental students using AMP e-learning module achieve more knowledge than those using the traditional static e-learning modules.

*Index Terms* – E-Learning, Static Learning, Active Multimodal Presentation, Usability Evaluation, Student Achievement.

## 1. INTRODUCTION

The concept of e-learning has grown exponentially during the very recent past. One of the main goals of e-learning is to promote and enhance the learning process through better use of computer and available technology. E-learning can take the form of e-courses as well as learning modules and smaller learning objects. E-learning may incorporate synchronous or asynchronous access that gets benefit of communication and networks. Different e-learning frameworks and models have been developed lately. One of the known and famous frameworks that provides best and meaningful flexible learning environments for learners worldwide is the "*Framework for E-Learning*" created by Badrul Khan, of the George Washington University [10].

Current information-oriented society shows an increasing exigency of different e-learning tools. In the recent past, a great number of e-learning platforms have been introduced with different properties and abilities. This drags the e-learning society to think about active multimodality in e-learning. In the recent past, researchers have introduced the guidelines of active multimodality e-learning.

Passed studies have shown that passive learning is still dominating many learning sectors especially in lower levels of high school education while there is a good shift towards active learning. Also, passive e-learning is still dominant in e-learning environment. Consequently, the development of active multimodal semantic structure for learning presentation aims to provide a sophisticated conceptual representation of the content and full engagement, which was not possible before [3]. This approach of Active Multimodal Presentation (AMP) encourages learners to take greater responsibility for their learning process [5] and therefore enhances the process of knowledge acquisition, retention of knowledge and acquisition of additional skills and knowledge [9].

The purpose of this study was to investigate how the development of Active Mutimodal e-learning material contributed to student achievement in a selected topic from Software Engineering course given to junior/senior students majoring in

information technology. The student achievement comparison revealed an interesting result concerning the gained scores in the posttests of both control and experimental groups.

In this experiment we organized two different student groups formed randomly with valid details. The groups are evenly divided into control and experimental groups. The achievement statistics are gathered depending on the results of pretest and posttest given to both groups who used the proposed application in the given mode. The pre and post test has been formed of a multiple choice questions used to measure the level of achievement of both groups.

The paper will briefly introduce the structure of the proposed AMP prototype used in this study. The application is named *Active Presentation Manager* (APM) to indicate the ability of managing instructor and student activities concerning the learning material.

## 2. APM PROTOTYPE

The main concern of this section is to propose an LMS software to work as Active Presentation Manager (**APM** prototype), that allows active multimodal interaction to some extent. APM is characterized by its functionality, usability and flexibility. It supports the common types of student-centric active interaction to enhance students' participation and encourage students to play an active role rather than stay listening only. These common interaction styles are: **Student-content** interaction and **student-instructor** interaction, with some functionalities to support student-student interaction to some extent. On the other side it supports **teacher-content** interaction which concentrates on constructing and managing the learning material.

### 2.1. Proposed Structure of APM prototype

It is required for active multimodal presentation, as the name indicates, to have multimodal technology as part of the learning process as well as active content. The

active environment is not limited on learner and content only, rather it is wide enough to include any entity or role enhance active learning. APM is generally structured to two main parts:

- Course Builder
- Course Presenter

The course builder aims at providing a framework environment to enable the instructor to construct the learning content to be presented in an active mode as well as static mode. Moreover, it facilitates building the mastery exam to given to the student at the end of learning module. On the hand, the presenter provides the suitable environment for the learner to access and view the content in both modes, the static and active modes. Consequently, the student will access the mastery exam as been built by the instructor. Figure 1 shows the general structure of the APM, with no illustration of dependability or the flow of processes.

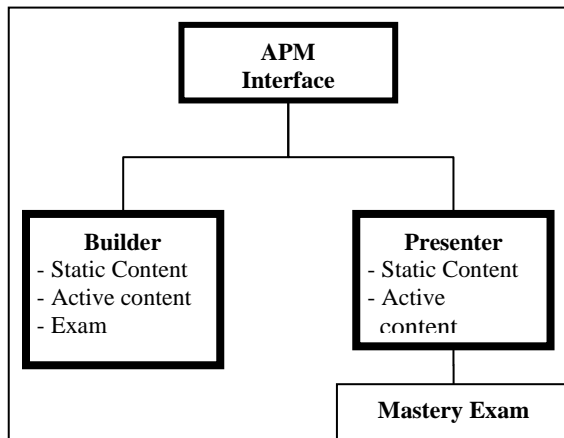


Figure 1: General Structure of APM prototype

According to the statement of the problem, the solution could be conducted using separate static modules to be executed radically as selected manually by the student. This solution is characterized as traditional e-learning irrespective to its ability of interaction. The second solution is to build one module based on active multimodal presentation and hence selected to be used mainly in the case. Figure 2 is the structure model of the proposed APM prototype which identifies the two main parts or interfaces; instructor part

as a presentation builder and the learner part as a content presenter. Active interaction is clearly depicted throughout the learner interaction with the content. Consequently, the learner is able to direct content delivery based on the progress and the active level of interaction. The prototype provides access to three data stores; registration, content and exam stores.

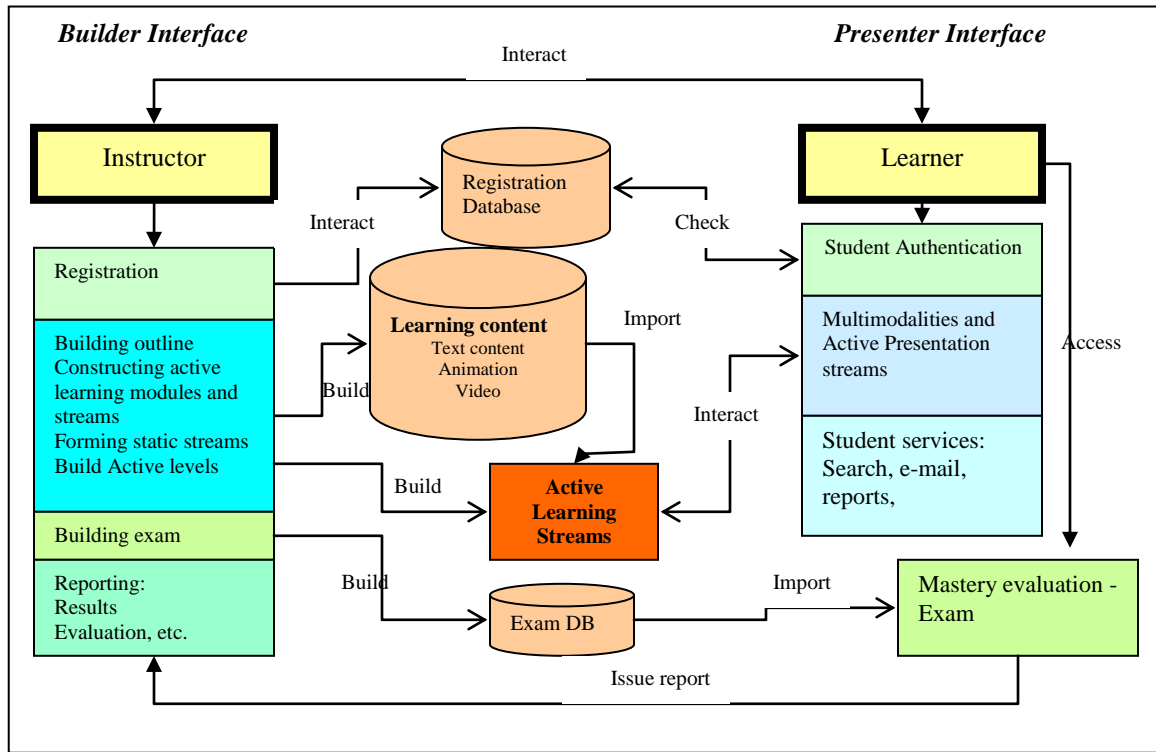


Figure 2: The Architecture of APM Model

APM prototype is based on the 3-Tier version. This methodology defines three discrete layers of abstraction, which are optimized for web-based application development. These tiers are the Data Tier which includes SQL database and actual learning contents, the Application Tier and the Client Tier as clarified in figure 3.

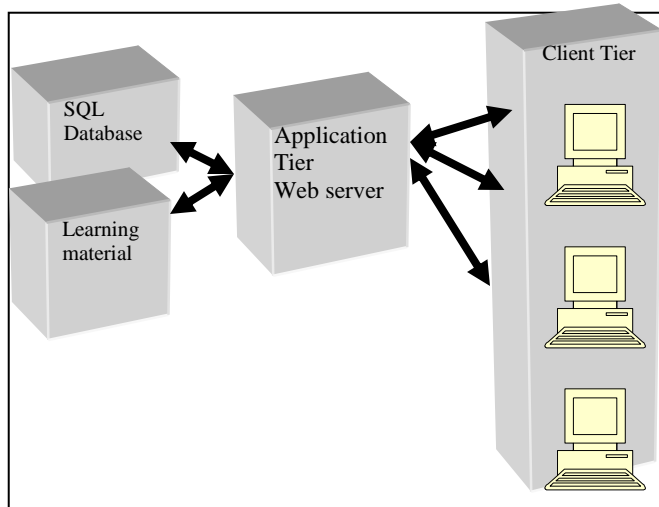


Figure 3: Physical Structure of APM Prototype

## 2.2. Objective of AMP prototype

This prototype mainly focuses on defining and testing the ability of building and updating e-learning module with AMP specification and enabling students to use this AMP module along with the level of understanding. The prototype provides a mastery test at the end of the module which is also characterized by AMP specifications. The objective of the mastery test is to transform the student achievements into some numbers that can be used and measured in studies such as comparative study with outcomes of static modes. The main functions of the prototype is to allow the instructor to build the static and active learning material, and to allow the student to brows the active or the static learning material interactively

So, based on the introductory section of this study, the main question is “do active multimodal e-learning presentations positively affect the learner achievement?” This question is to be answered depending on the proposed APM prototype that deals with active and static modes. The following model depicts the research question:

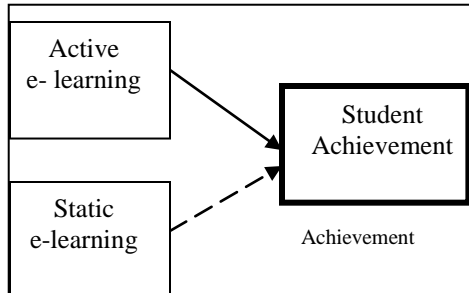


Figure 4: Research Question

### 3. EVALUATION OF THE AMP PROTOTYPE

#### 3.1. Usability Evaluation of the Proposed Prototype

As of the objective of the study, the research prototype is designed to evaluate the use of active multimodality in e-learning presentations. Usability is the degree to which something—software, hardware or anything else, is easy to use and good fit for people who use it. Using usability heuristics, or rules of thumbs, is enough to evaluate prototypes. For example, meaningful error messages, consistent colours, and logically grouping of navigation items [4].

Usability inspection is a generic name for several methods to enable evaluators inspect or examine usability-related aspects of a given user interface. Of the various inspection methods, heuristic evaluation is one of the formal methods enabling specialists check and inspect aspects of a given interface conform against usability principles. Ssemugabi [19] demonstrated that heuristic evaluation web-based e-learning is an appropriate, effective and sufficient usability evaluation method, as well as relatively easy to conduct. It identified a high percentage of usability problems.

Since Usability Principles (Heuristics) range and differs based on special characteristics of each prototype, the following list is proposed by Levi and Conrad [11] as usability principles:

1. Speak the users' familiar language.
2. Consistency in terminology, interface and graphics.
3. Minimize the users' memory load.
4. Flexibility and efficiency of use.

5. Aesthetic and minimalist design.
6. Chunking.
7. Progressive levels of detail. Organize information hierarchically.
8. Navigational feedback.

According to ISO 9241-11[14], usability is defined to be the extent to which the product (or software) can be used by a specified user to accomplish the specified goal with effectiveness, efficiency and satisfaction. Usability is also defined as a quality attribute that determines to some extent how easy the user interfaces are to be used and so it is measured by five quality components [22], [1] and [7]:

- Efficiency to indicate how quickly the use perform tasks
- Learnability which indicates how easy it is for users to accomplish basic tasks during the first use.
- Memorability to help user reestablishes proficiency
- Few and Noncatastrophic Errors
- Satisfaction which means how pleasant is using the design

Ryu and Smith-Jackson in [16] used effectiveness, learnability, flexibility, attitude, efficiency, satisfaction, errors, understandability, operability, attractiveness, pleasureability, memory load and attractiveness as usability dimensions for developing Reliability and Validity of the Mobile Phone Usability Questionnaire.

In addition, the following Ben Shneiderman's criteria clarify and guide usability [7]: Images, readability, use of color, navigation, iinteractivity, learning styles, system capabilities, general and overall reactions, and accessibility. In fact, there are several ISO usability standards namely ISO/TR 16982:2002, that provide information on human-centered usability methods which can be used to guide and help design and evaluation. These standards are directed for project managers and specialists to address technical human factors and ergonomics issues.

Based on the usability evaluation method for e-learning applications conducted by



Zaharias [24], the following factors are assembled: Interactive content, Instructional Feedback & Assessment, Navigation, Visual Design, Learner Guidance & Support, Learning Strategies Design, Accessibility, Learnability

In this study the development of a questionnaire, which based on usability evaluation method for e-learning applications, is described. The method extends the current practice by focusing not only on cognitive but also affective considerations that may influence e-learning usability. This method was developed based on HCI guidelines for applications combining web and instructional design parameters. The methodology is proposed as a new usability measure that is considered confident and more appropriate to evaluate e-learning designs [24]. It concludes the following questionnaire criteria with the measures strongly disagree, disagree, neutral, agree, strongly agree and NA.

**The list of usability criteria concludes:**

- **Content** such as vocabulary and terminology
- **Learning and Support** such as glossary and help
- **Visual Design** such as fonts and colors
- **Navigation** such as movement between topics
- **Accessibility** such as free of hyperlink errors and programming errors
- **Interactivity** such as simulation, animation and input/output interaction
- **Self-Assessment & Learnability** such as register, take exam
- **Motivation to learn** such as varied learning activities, enjoyable and interesting module.

The main focus of the work is to evaluate student achievement within the environment of active multimodal technologies. Therefore, researchers attempted not to deeply evaluate e-learning applications rather concentrated on the effect of active multimodality on student achievement. Since usability dimensions vary and differ based on special application characteristics and working environment, researchers decided to take into consideration Zaharias' usability criteria [24] and the Jakob Nielsen's framework which concludes the above usability factors as a checklist having in mind that

Zaharias' is more comprehensive.

The application is evaluated by four experts in a formal focus session held on Tuesday June 27<sup>th</sup>, 2008 at 11:00AM in the seminar room at the College of Administrative Science and Informatics, Palestine Polytechnic University. The proposed prototype is presented, tested and discussed in the session. The overall evaluation is satisfactory including usability evaluation checklist as shown in table 1:

<b>Rank</b> <b>Usability criteria</b>	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	NA
<b>Content</b> such as vocabulary and terminology	1	3				
<b>Learning and Support</b> such as glossary and help		2	2			
<b>Visual Design</b> such as fonts and colors	3	1				
<b>Navigation</b> such as movement between topics	4					
<b>Accessibility</b> such as free of hyperlink errors and programming errors	1	3				
<b>Interactivity</b> such as simulation, animation and input/output interaction	2	1	1			
<b>Self-Assessment &amp; Learnability</b> such as register, take exam	2	2				
<b>Motivation to learn</b> such as varied learning activities, enjoyable and interesting module		3	1			

Table 1: Usability Evaluation

[Source](http://www.dmst.gr/en2/diafora2/phd_thesis/Zaharias.pdf) of the usability criteria : Zaharias P. (2007 ). Developing a Usability Evaluation Method for E-learning Applications: From Functional Usability to Motivation to Learn. Retrieved April 17, 2008 from [www.dmst.gr/en2/diafora2/phd\\_thesis/Zaharias.pdf](http://www.dmst.gr/en2/diafora2/phd_thesis/Zaharias.pdf) .

In fact, the Zaharias' criteria are all applied in the proposed application especially interactivity, motivation, and visual design. The application is free of catastrophic errors and provides efficient operations. The main lofty characteristic is active multimodal interaction that is considered as the pivot of the work.

### 3.2. Student Achievement and Measurements

Student achievement has been defined as what the person studied within a limited time, and can be measured based on the grade obtained in achievement test. Specifically, it is the mean of all grades obtained by students of sample groups with respect to all topics under research [6].

Learner achievement and satisfaction will ultimately, be important to the long term success of educational programs [14]. Recent research involving electronic education has shifted from a focus on technology itself to its effects on learners and their achievement with special concern of distance education. These studies have handled electronic media and the effect of streaming technology on improvement of student achievement and satisfaction. In fact, streaming technology improves student achievement and satisfaction. Hence, streaming media is the simultaneous move of digital media, such as voice, video and data, to be received in continuous and real-time delivery [15].

Previous researches showed that student achievement is the result of a plenty of factors ranging from clearly definable and collectable factors to intangible factors to motivate performance [20]. In fact, each study involves some criteria that make these studies diverse. Researchers have handled many types of concurrent learning trends. For example, Murphy [14] has evaluated distance education course design and found that the measures of individual differences in achievement among learners were confined to demographic variables and gender with no clear evidence of the effect of variables such as location/delivery and academic outstanding.

Researches related to distance education argues that the final academic performance grades of students enrolled in some e-learning courses such as in distance education programs are higher than those enrolled in traditional face to face programs especially when pretests are conducted. Still, there is a large debate on the influence from various media on student achievement [8].

It is also noteworthy that some previous studies argued that distance education did not bring any significant impact on improving education, while some, especially concurrent research, favored distance education. These studies have undoubtedly helped to promote distance instruction as a viable form of education with the same quality as its face-to-face counterpart [25][17]. The reason that some studies found distance education students had better achievement and satisfaction than their counterparts in traditional classrooms and some found the opposite, is that each individual study has its own characteristics. Moreover, the Meta analysis conducted by Liao [12] resulted in a suggestion that CAI/CAL is more effective than traditional instruction learning with

mean ES of 0.552 which indicates that CAI/CAL was slightly better than traditional instruction learning. And so, it is obvious that CAI/CAL modules are more effective concerning student achievement and satisfaction [17]. In fact, e-learning is not absolute alternative of traditional and not secondary; rather it is a new educational methodology that is having its own properties [6].

Murphy [14], in the evaluation of a distance education course design with respect to both educational effectiveness and learner satisfaction, has used variables such as: method/location, gender, academic standing in which researcher found that academic outstanding difference was not found to be statistically significant.

Sumerson and Farley [21] studied and examined the contributions of motivation, personality, learning strategies, and scholastic aptitude to academic achievement in college students. To have clear answer to above issue, a standard multiple regression analysis, including all variables, was performed with the student GPA as the dependent variable. When personality, motivation, learning strategies, and scholastic aptitude are considered, they together lead to a multiple R of .542 ( $p < .001$ ) and contributed of 25 percent of the total variance in academic achievement. Overall, these results indicated that only type T personality who are risk taker, openness to experience, and Scholastic Aptitude Test (SAT) were significant predictors of GPA.

As a recent practice of such work, researchers have applied an achievement test to test the effect of Electronic Learning Techniques on the achievement of two groups of students equivalent in some variables that may affect the achievement such as (age, academic level, general examination grades in high schools, and education level of student families) [6]. The researcher assumed that students have no significant differences and so used the design of equivalent groups with post test as the suitable experimental design for the research. The researcher has found that the group which used internet has gained higher score than the one used computer programs where the latter gained a better achievement than the one used data show technology in the classes, while the least achieving one is the one used CD-ROMs video in learning.

### **3.3 Design of Static Learning Module in LMS**

Based on the aim of the study, the first phase to be conducted is to experience the learning module in a static (not active) mode. This experimentation could be conducted using the proposed AMP prototype which named in this study as APM e-learning and also can be conducted using one of the current LMSs. The selection of a specific LMS was based on the fact that they are offered under the General Public License to be used as free and open source, reliable, share common system requirements, SCORM-compliant learning content (e-tutor 2006), and in addition to above properties, they offer ARABIC language packages when needed.

However, researchers used the proposed prototype to provide the static environment for the student. This way supports putting control and experimental homogeneous groups under the same environment to share the same effecting variables.

## **4. EXPERIMENT AND OPERATION**

The main focus of the work is to study the effect of active multimodality of e-learning on student achievement. Previous sections discussed e-learning with respect to traditional learning theories and the contemporary e-learning models and platforms. The consequent statement of the past work is that e-learning is a new learning branch with positive effect on achievement and satisfaction, while some debates concerning e-learning effects are still going on. Based on the previous review and discussion concerning evaluation, this paper focuses on conducting the achievement test with some overviews concerning methodology and research instruments required for this study. This paper ends up with some description of used statistical methods.

### **4.1. Research Instruments: Research Population and Sample Groups' Selection**

The researchers rely on static and active e-learning environment with no arguments concerns traditional learning. Hence, this research does not concern of evaluating the e-learning modules or their effects on student achievement, rather it aims at testing whether or not the active multimodal techniques have any impact on student achievement with respect to research limitations.

Therefore, and having the previous researches findings and assumptions in account, researchers have designed two equivalent student groups as experimental and control groups for the research. The research population has been determined within third and senior information technology student at College of Administrative Science and Informatics at Palestine Polytechnic University through summer term 2007/2008. The number of students is 20, all them are selected as research sample and to be divided into two groups of 10 students in each group. The two groups are selected to be equivalent in some variables that affect validity of experimental design of the research. These variables include (age, academic level, student general examination grades in high schools, education level of student families)

Specifically, researchers tended to test the student groups having in account gender, age, method of delivery (static, active) and the dependent variable which is the student achievement while ignoring other variables such as academic standing, course section, etc. Researchers assumed that all students groups are having the same situations and conditions.

#### **4.2. Applied Instrumentation**

The study will employ an achievement test in selected software engineering topics made up of closed-ended questions such as multiple choice and true/false items. Both selected groups will take the pre and post test. It is worth mentioning that the selected topic is just a case to be used in the instrumentation activities of the research. Consequently, the prototype is independent platform of the learning topic to be taught.

#### **4.2.1. Learning Material**

For the sake of the study, researchers have selected topics from software engineering, specifically UML, for the following reasons:

1. UML is currently being taught in most universities for junior and/or senior students majoring in computer related majors.
2. UML can easily be divided in small learning modules to be taught in a stream.
3. It is wealthy of graphical representation models that can clarify the text.
4. Normally, students lack of previous knowledge concerning UML. This makes the achievement figures accurate.

#### **4.2.2. Achievement Mastery Test**

The proposed test is a part of the case used in the active multimodal presentation prototype – Active Presentation Manager (APM). To experiment the prototype, researchers designed a test with set of questions having in account the basics of the successful test to be applied within the proposed prototype (e-test) or conducted separately on paper.

Researchers have conducted an achievement test of multiple choice type formed of 60 questions. The test was administered to both selected groups during summer semester 2008 to measure the theoretical information gained by the end of the learning module. The test have been formed carefully and been reviewed by specialists from the department of education at Quds Open University to determine its validity and reliability. The test have been applied on a random sample independent from research sample groups and found that the test has met the validity factors and hence we successfully built the experimental achievement test.

#### **4.2.3. What does the test measure?**

The questions of the mastery test aims at evaluating the levels of basic knowledge

and skills of the student achieved in the selected e-learning module via exploring the student's abilities to gain knowledge, analyze, understand, and apply information, ideas and different figures related to the learning module. While the study does not test each specific knowledge level, the test is formed based on Bloom's Taxonomy and Anderson's revised taxonomy, with the following are to be applied: Remembering, Understanding, Applying, Analyzing and Evaluating [18][13][2][23]. Researchers have consulted experts in education and human interaction with special emphasis on scaling and evaluation in designing the test. Experts helped in assuring that the test is reliable and built upon the knowledge taxonomy.

#### **4.2.4. Objectives of "UML" learning module**

UML is an Object Oriented System Design and Development learning material to be taught in one of the software engineering courses for sophomore and/or senior students in information technology or related majors. Objectives of UML learning material include:

- Enabling students to understand the basics of object oriented design methodology
- Understand concurrent object oriented UML methodology
- Enabling students to transform project requirements to object oriented models

#### **4.2.5. Detailed objectives of UML learning material**

In attempting to come up with usable learning material, it is worth considering the guidance of the experts from the department of education to formulate the test questions. Each learning section is divided into set of objectives that reflect the criteria of Bloom's knowledge levels. Then each objective is then assigned the time weight required in learning. Afterwards, the following specifications which are listed in table 2 are formed up to show the distribution of objectives among the learning sections having in consideration the type of each objective in terms of Bloom's taxonomy.

				Objectives
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Unit	Time (hours)	Time weight %	Number of objectives	Knowledge	Comprehension	Application	analysis	Synthesis
Introduction	1	0.085	5	4	1			
Use Case	1	0.085	5	2	1	2		
CRC	1	0.085	3	2	1			
Class diagram	2	0.16	6	4	2			
Object diagram	1	0.085	3	1	1	1		
Sequence diagram	1	0.085	4	1	1	1		1
Collaboration diagram	1	0.085	4	1		1	1	1
State diagram	1	0.085	2	1	1			
Activity diagram	1	0.085	2	1	1			
Implementation models	2	0.16	9	4	4			1
Total hours	12		43	21	13	5	1	3
Percentage			%100	%49	30%	% 11.5	%2.5	%7

Table 2:Specification Table of Distribution of Objectives Among Units

To obtain meaningful test, the questions are distributed among units based on the weight of each unit and the weight of objectives as calculated in table 3.

*Number of questions:* 60 questions distributed among units based on the objectives.

*Number of questions for each unit*  $Q = TQ * UW * OW$

***TQ:*** Total number of proposed questions

***UW:*** Unit weight

***OW:*** Objective percentage

Weight of objectives		Weights of Units										Questions
		1	2	3	4	5	6	7	8	9	10	
		.085	.085	.085	.16	.085	.085	.085	.085	.085	.16	
Knowledge	%49	3	3	3	4	3	3	3	3	3	4	32/60 =53%
Comprehension	%30	2	2	2	3	2	2		2	2	3	20/60 =33%
Application	%12		1			1	1	1				4/60 =7%
Analysis	%2							1				1/60 =2%
Synthesis	%7						1	1			1	3/60 =5%
Total	%100											100%
Number of questions in each unit		5	6	5	7	6	7	6	5	5	8	

Table 3: Distribution of Questions Among Units

## 5. RESULTS

This section presents the overall evaluation results. Despite the main research assumption, there was no significant difference between grades achieved by the experimental group using the proposed application and the control group using the static mode, researchers were satisfied with statistical findings. To know that whether or not there exist differences between grades achieved by both groups, researchers have built a table showing the statistical means and standard deviations for pretest and post test grades for both groups as shown in the table 4:

Group		Pre Test	Post Test
Control Group	N	10	10
	Mean	21.20	36.40
	Std.	3.645	6.867
	Deviation		
Experimental Group	N	10	10
	Mean	20.30	38.60
	Std.	4.398	5.910
	Deviation		
Total	N	20	20
	Mean	20.75	37.50
	Std.	3.959	6.337
	Deviation		

Table 4: Statistical Means Report

The following graphs (5 and 6) depict the above findings showing the statistical means of both groups, the control and experimental.

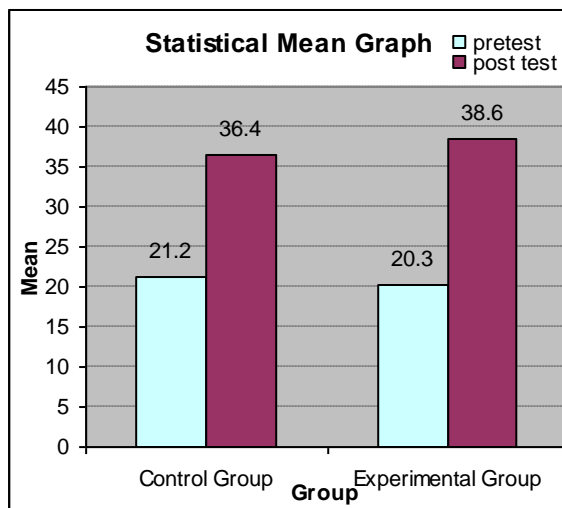


Figure 5: Graph of the statistical means of both groups

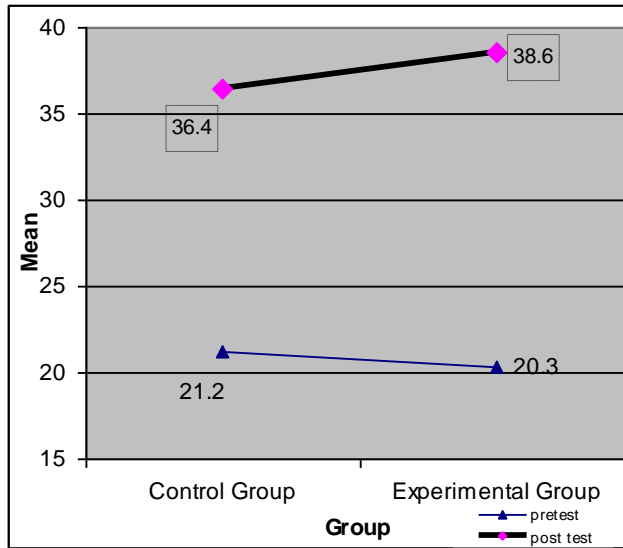


Figure 6: Graph of the statistical means achieved by each group

To check the statistical differences between both groups, we have used Analysis of variance (ANCOVA) procedure. Specifically, the analysis of covariance is conducted to test the differences between the two groups where the *Post test* is the response variable, the *Group* of study (Control & Experimental) is the independent variable, and the third variable used is the covariate *Pre test* to indicate the scores of the pre test. Following table 5 summarizes the *Univariate Analysis of Variance* showing the results of the statistical analysis.

Dependant Variable: Post Test

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Pretest	1.308	1	1.308	.030	.864
Group	22.585	1	22.585	.521	.480
Error	737.492	17	43.382		
Total	28888.000	20			
Corrected Total	763.000				

Table 5: Tests of Between-Subjects Effects

### 5.1. Analysis of findings

The above results show that the test is not statistically significant, where  $F(1,17)=0.521$  and the  $p\text{-value}=0.480$ . Hence, there are no significant differences were found in the mean between the experimental group and control group with respect to the

post test scores. In general, the above figures show clearly the achievement of each group. It is obvious that experimental group has achieved scores in the post test slightly more than what achieved by control group. Control group starts with an average score of 21.2 points and ends up with an average of 36.4 points. This means that control group gained a total of 152 more points equivalent to +71% of pretest score. On the other hand, experimental group starts with an average score of 20.3 points and ends up with 38.6 points. This means that experimental group gained a total of 183 more points equivalent to +90% of pretest score as shown in figure 7 below:

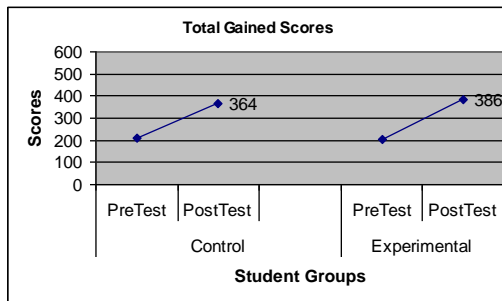


Figure 7: Final Gained Scores Achieved by Student Groups

Overall, above figures clarify that experimental students enrolled in software engineering course using AMP e-learning module achieve no less knowledge than those using the traditional static e-learning modules. Specifically, the modest finding numbers shown above indicate that experimental students gained slightly more scores than control students did. Moreover, we can say that the more active modalities used in e-learning modules, the more scores the student can achieve.

## 6. RECOMMENDATIONS AND FURTHER WORK

In general the results indicate the relevance of applying multimodalities in AMP prototype and can be used in e-learning modules. However, in order to accurately evaluate the AMP e-learning modules, it is important to apply more modalities and pay more attention to what proper modalities are to be used in the selected learning material for the student groups. Following are the main recommended further work preferred by researchers:

- Develop a comprehensive list of multimodal activities and technologies constitute

- a well designed AMP module with detailed evaluation.
- Study and experiment the effect of more user input modes, such as speech, pen, gaze, manual gestures, and movement of body parts such as head and hand.
- Expand the environment of experiment using more courses and larger population.

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