SELINUS UNIVERSITY
OF SCIENCES AND LITERATURE

Integrated New Learning Management System with Reinforcement and Mastery Learning Process

I do hereby attest that I am the sole author of this Project / Thesis and that its contents are only the result of the readings and research I have done.

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TABLE OF CONTENTS

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Abstract

As e-learning or on-line learning materials continue to evolve and increase tremendously in educational setting, the design is based on many components and the adaptation of three LMS such as Moodle, Blackboard and Claroline.. In the area of assessment, twelve types of questionnaires adopted and stored in the Item Bank repository. The questionnaires are developed using the prestigious Bloom Taxonomy. Additionally, this research combined the concepts of reinforcement learning and mastery learning in the areas of artificial intelligence and educational psychology respectively to remediate learning difficulty and improve learning output.

There are many possible benefits of using the system if this is successfully implemented. It provides mastery and reinforcement learning as motivational factors and corrective measures and it can increase cognition and acquisition of knowledge. The prototype successfully demonstrated the reinforcement process. Reinforcement process refers to the overall learning activities that remediate learning difficulty after students fail the summative examination. This mechanism is immediately activated for student who will be given a chance to re-study the learning materials.

Based on the results, the implementation of the prototype that was incorporated, the result is a convincing 54% increase of the passing rate as revealed in the case study. There are many factors that contributed to the success of the study. The prototype employed several controlling mechanisms during formative examination, summative examination, and in the Bloom's cognitive examination not to mention the use of different media formats that encouraged and increased motivation. During formative examination,

students were able to review the question in multiple ways. This included, looking at explanation facilities, opening the link that points to specific part of the lesson, viewing the answers, and getting familiar with all the question types. During summative examination, students could view their different performance indicators while in the Bloom Cognitive examination, students could view and analyze their individual performance, thereby motivating them to continue learning. During reinforcement, it was proven that additional materials and corrective activities inevitably contributed to the overall results.

With these results, the implementation of this new prototype will greatly help in phasing out or gradually eliminating several academic problems faced by College of Saint John Paul II Arts and Sciences. With the help of the e-learning implementation, the increase of the number of student passing the course is guaranteed, thereby reducing the length of residency of the students in the University. It can also solve academic problems brought by geographic locations by allowing students study anywhere and whenever online learning is possible.

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DEDICATION

I dedicate this project / thesis to God Almighty my strong pillar, my creator, my savior, my foundation of encouragement, wisdom, knowledge, and understanding. He has been the basis of my fortress throughout this program and on His wings only have I glided high. I also bestow this work to my wife; Liberty Agustin who has cheered and motivated me all the way and whose encouragement have made sure that I give it all it takes to finish that which I have started. To my family and friends who have affected in every way possible by this journey, my source of inspiration and joy. Thank you. My love for you all is immeasurable. God Bless!

Chapter 1

INTRODUCTION

Education is one of the key fundamental natures of life and to take a hold of things quickly whilst applying it is perhaps more significant. Being educated provides individuals with a perspective that would serve as a motivating element in order to achieve a progressive success. However, being successful necessitates an extensive allotment of time and effort. Education and success, being associated with each other, therefore also shares the same requirements in order for positivity to prosper.

To be able to cope with the fast paced growth of technological innovation, aspects concerning the progression of education also undergo such improvement. The instigation of the LMS (Learning Management Systems) to such teaching approaches is one particular method which is widely implemented by an extensive number of institutions in order to hone the adaptation and deliberation of knowledge to their students and as well as their employees. Here in the Philippines, online education is starting to make its presence felt as it is now being put into practice by schools such as UST (University of Santo Tomas) and CJSP II AS (Our Lady of Fatima University), AMAOeD (AMA Online Education). Having utilized the online education process, these particular institutions are now most likely to be more adept in providing an easier and more comprehensible approach in teaching and as well as developing those people associated with it.

The implementation of E-Learning factors to the current program that certain colleges are using plays a considerable role in improving the academic, as well as the social aspects of those who are involved in its field. The progress of the online education scheme is of purposeful standards which had been the reason why certain tools are promulgated in order for its users to adapt to it with ease. Tools like Blackboard, MOODLE, and Claroline are the most suited examples for E-Learning development and platform. However, these tools are of lofty costs and to offer an alternative would definitely require a concentrated determining on how to diminish the cost while still providing the same level of quality. A vast number of LMS are available on the market today, which is why choosing what to use would be a difficult task, for there are a number of factors to be considered like user-interface, functionality, and the number of additional features available on the system.

There have been a number of studies which aimed to compare the features of the Blackboard, MOODLE, and Claroline to other E-Learning tools available on the market and very few actually has the capabilities which situates to either of the three. However, the learning effectiveness had not been considered significantly which makes this study result into providing a user experience as well. The researcher then seeks to develop a more effective but economical system which will provide the same effectiveness with combined features as the three E-Learning tools which are being discussed. The alternative e-learning management system will also adapt notable theories in pedagogical strategy and theory of computing such as mastery learning and reinforcement learning process.

1.1 Background of the Study

The proponent existing e-learning tool are the Moodle, Blackboard and Claroline, among the three (3) e-learning tools the proponent would like to combine the capabilities of the three by mapping their features and functionalities. The results of the mapping will then be used as one of the several factors to be considered in designing a new e-learning management system with the inclusion of mastery learning in educational psychology and reinforcement learning in computer science.

The proponent differentiate the three(3) e-learning tool to easily identify the details. The Claroline and Moodle are almost the same and can be access publicly, unlike the Blackboard, a private and not an open source. Aside from the benchmarking, the ADDIE model in e-learning development, mastery learning in education psychology and reinforcement learning in computer science will be incorporated in developing a new system.

The learning effectiveness had not been considered significantly which makes this study into providing the user experience as well. The weakness of the e-learning tool is that the users of the e-learning tool must have the training to handle the software accurately, smoothly and efficiently. As the proponent discussed and studied the e-learning tool, the proponent found it interesting and subsequently, makes the learning process challenging and exciting. So as the proponent push through this study there is no place to go but up 'cause they do believe that the technology and learning never stops.

There are many study in e-learning effectiveness and implementation however, several issues have emerged such as how to incorporate formative assessment (mastery learning in psychology) summative assessment that somehow identify and shows learning difficulties. Given a learning difficulties, the system should intelligently and proactively remediate such problems to help the student achieved the required level of competency.

Mastery learning (ML) is one notable area of educational technology that has attracted much attention in the past. The work of Bloom (1968) on mastery learning is regarded as the classic theoretical perspective with its comparison of two models of education: the traditional model and mastery model. The traditional model uses the same instruction for an entire class, regardless of aptitude. The instructor presents the required information to the students who are then tested to measure the information they have retained. Students are typically given only one chance to learn the material. The course then moves on to the next material. Once tested, students may learn what mistakes they made, but tests are never conducted again to find out whether they have learned from those mistakes. Consequently, the amount of learning in a classroom varies among students. Students with an aptitude to learn requisite materials quickly move forward while slower students fall behind and received lower grades. In contrast, the mastery model varies instructions according to aptitude which results to a higher level of learning for all students. If the students have not learned the material by the first test, they can repeat it until they can achieve the required level of competence. Then they proceed to the next module. As a result, the instructor who employs mastery learning model of education hypothetically achieves high level of learning benefits.

Mastery learning has been widely applied in tertiary and primary levels in a variety of subject matter such as music (Hruska, 2011), economics (Laney, 1999), mathematics (Ma, 2011), skill development and critical thinking (Anderson, 2000). Many meta-analytic studies have demonstrated consistent positive effects of reinforcement and mastery learning (Guskey, 2007; Kulik & Kulik, 2012). The students are helped to master each learning unit before proceeding to a more advanced learning task (Bloom, 1985) in contrast to conventional instruction. If such benefits will likewise be achieved in e-learning, a tremendous impact on the learning process is possible. However, during mastery learning in the form of formative and summative examination, errors, misconceptions and difficulty become inevitable. There is a need therefore to reinforce the learner to repeatedly read and understand the learning materials. The reinforcement should not be similar to the previous lesson, but similar concepts must be taught and applied to avoid boredom and discontinuation of the learning process. This issue should be taken into consideration in designing the e-learning module when a student does self-learning.

The idea of reinforcement learning (RL) is to motivate learners to continue by giving them rewards or points for their efforts or by enforcing penalties when students cannot pass the learning assessments. E-learning is characterized by giving corrective activities to remediate misconceptions or difficulty found during computer summative examination (CSE). It is a principal aid in planning the corrective measures to remedy learning difficulty. For instance, activities to correct these difficulties may involve alternative materials or resources such as videos, simulations, interactive tutorials, scenario-based learning, or any type of learning activity that allow motivational preferences. Reinforcement activities may also include problem-solving exercises, or any learning activities which are stimulating and rewarding to different types of learners. If reinforcement is successful in helping the students by remediating their learning difficulties, then most students will demonstrate readiness to take remedial examination. This can be used as a motivational device in situations where students are shown directly that they can improve their learning and become successful learners.

Reinforcement learning has become a methodology of choice for learning in a variety of domain. Reinforcement learning can be achieved well in games and simulations. The work of Qi (2001), Hu (1998) and O'Doherty (2012) applied reinforcement learning in multi-agent, game-playing environment, and students achieved a superior level of performance in learning complex task. The work of Mataric (1994) used RL to accelerate learning process by giving rewards functions to students. If these benefits can be transformed and then implemented in e-learning, then learning process can be guaranteed.

Educational strategists must develop an e-learning system that personalized learning sequence since learning is dynamic and students are heterogeneous. This e-learning system caters personalization, individualization or customization based on the learner's prior knowledge, prior performance, and study habits. If personalization of learning path and a certain level of competence are achieved, learning benefits such as skills acquisition, knowledge transfer, and increase cognition are also guaranteed.

1.2 Objective of the Study

The objective of the study is to develop an alternative E-learning management system that take advantage with three E-Learning management features, and incorporate mastery learning in the area of educational psychology and reinforcement learning process of computer science.

Specifically the following objectives have been sought to achieved:

1. To design and develop an e-learning system by comparing several e-learning tools and incorporating several concepts essential in e-learning development such as interactivity, content analysis, multimedia and others.
2. To design questionnaires for assessment in the proposed e-learning module by incorporating Bloom Taxonomy to support mastery learning.
3. To illustrate mastery learning and help the students learned and increased learning competency.
4. To incorporate reinforcement process to remediate learning difficulty of students using rewards and punishments rule based system.
5. To illustrate the benefits to students in using the proposed e-learning system.

1.3 Significance of the Study

It is the hope of this study to encourage an e-learning instructional strategist to implement an e-learning management system that can contribute mastery learning and reinforcement process. Particularly, this study hopes to contribute critically in the development and implementation of e-learning as educational entities become more and more aware and begin shifting their learning delivery if not full, initiated a blended learning.

i. *Provides mastery learning and reinforcement learning* - If the students could not learn the materials by the first test, they can repeat it until they achieve the required level of competence through reinforcement learning. During reinforcement, misconceived or difficult lessons will be re-learned by loading lessons and practice examinations not similar to the previous, but have the same concepts, to avoid boredom in the learning process. Then they can proceed to the next module. As a result, teachers who employ a mastery learning model of education are expected to hypothetically find high levels of achievement among all students.

ii. *Provides learning benefits* – There are many educational benefits of adapting the evolutionary techniques in e-learning implementation. It is hypothetically believed that it will improve or increase the cognitive ability of the students in different stages of cognitive development. Most frequently cited educational benefits include development of critical thinking, self-reflection, acquisition and construction of knowledge and personal confidence.

iii. *Provides pedagogical alternatives* – Since learning styles and pedagogical strategy effectively vary according to the learner, an alternative instructional deign for e-learning system and development is highly recommended. An educational strategist will employ strategy that lessens the learning time without sacrificing the quality of learning benefits, while allowing the students to study wherever, whenever possible. Students can re-learn, practice examination, and develop self-skills and self-learning.

iv. *Faculty De-loading* – Educational staff, mostly faculty are de-loaded with their work specifically checking manual exams. Time for academic reporting and generating reports will be lessened as the system automatically records and generates reports necessary for academic institutions.

v. *Bringing Prestige to the University* – Today, only few educational entities have shifted to fully e-learning implementation. Having an alternative learning materials for the course is well noted to the students since they will no longer required to come to the schools since it is already accessible and viewed online.

1.4 Scope and Delimitation

There are many courses for computer science but for the purpose of developing the prototype, the design and analysis of algorithms, one of the core computer courses that requires mathematical analysis and algorithmic program is taken as subject of the research. The topics included in the course Algorithm in e-learning module have been selected or driven by either the problem's practical importance or by some specific characteristic making the problem an interesting research subject. The following are the topics which are included in the module: algorithm analysis, time complexity, sorting techniques, searching algorithms, string processing, shortest path algorithms, graph problems, combinatorial problems, numerical problems and advance structures. The course is composed of 12 lessons with a passing mark of 75 as stipulated in the course syllabus and approved by the Quality Assurance Office or QAO.

During mastery learning, students are numerically rewarded or punished according to the difficulty matrix developed during summative examination. Student who passed are rewarded with numerical points; those who failed are punished by giving them extra course materials for reading, viewing solved problem exercises and practice examinations. The number of additional or alternative learning materials varies accordingly as defined by the rule-based punishment and reward system employed by the reinforcement learning mechanism.

The reinforcement process employed a 60-rule system, capable of selecting random learning reinforcements for each topic and sub-topic of a particular module. These 60 rules were ready to fire and match in the database to activate reinforcement files for particular student. The reinforcement files vary in each lesson depending on the available files stored in reinforcement table. Files or learning activities can be in the format of PowerPoint, document, gif, video, PDF, or solved problem files which were readily available for reinforcement process.

Many rigorous processes were undertaken to come up with e-learning system prototype. These included the content of the 12 lessons which had 65 subsections, twenty four (24) interactive MHTML files, seven (7) embedded videos, fourteen (14) simulations, twenty two (22) PowerPoint, forty five (45) PDF files, twenty two (22) word files, sixteen (16) executable files, sixteen (16) C++ source codes, two (2) simulated excel files, and 94 reference materials which were directly linked to the internet for additional reading. The design of 280 questions distributed among 12 question types, designed according to Bloom questions schema which were stored in the Item Bank database with different difficulty level. These were used for various assessments such as diagnostic, formative, and summative examinations. The content of the e-learning materials and the questionnaires in the Item Bank database was subjected to internal consistency and reliability test. This generally resulted to an acceptable level of Cronbach's alpha.

Chapter 2

THEORETICAL FRAMEWORK

This chapter presents a list of readings that supports the conceptual framework and highly noted theories of the study that served as the backbone in developing the conceptual framework. Theories ranging from existing e-learning model, content, learning delivery, assessment, interactivity, mastery learning in psychology and reinforcement in computer science will be discussed to support the new e-learning management system.

2.1 Review of Related Literature

This sections focus on the related concepts necessary to develop an e-learning system which includes e-learning design, assessment modules, content development and other related studies.

2.1.1 E-learning

According to Arimbuyutan (2010), e-learning in the Philippines is a good formula for Filipino preference that will open the opportunity for growth and benefit individuals who place high value on education and the desire to succeed. The e-learning is widely used to large organizations such as universities, big communities, large and medium sized businesses that can reduce their training costs and improved learning standards. The Philippines has been cited as one of the top 10 countries in the world in terms of high growth in “E-Learning” revenues in the next few years, according to a global report by

US-based market research firm Ambient Insight. The report, titled “The Asia Market for Self-paced ELearning Products and Services: 2011-2016 Forecast and Analysis,” finds that Asia has the highest growth rate for E-Learning worldwide at 17.3 percent yearly and the growth in some countries “is nothing short of remarkable.” In terms of growth rate in E-Learning, the study places the Philippines at seventh. Aside from Asia other countries like Azerbaijan, Thailand, Kenya, Slovakia and India with growth rates of 30 percent and 35 percent (Domingo, 2011).

According to Trinidad (2011), the initial assessment of the Philippines’ e-learning stature both depicts a glooming and changing scenario. Three crucial domains need further reinvigoration: technology and infrastructure, educational standards and literacy, and government-private sector teamwork. E-learning requires higher-order skills and analytical thinking. Raising the quality of training of teachers and students is a must to maximize the promises of Internet technology.

According to Reynato (2012), the prime advocates that spearhead the drive to incorporate e-Learning technologies into the Philippines school system are educators from prominent universities like the University of the Philippines which has established in 1995 the UP Open University (UPOU), as an alternative to traditional classroom. It has started offering fully accredited classes in 2001.The University of Sto. Tomas (UST) have added in their curriculum an e-learning course that provides learning materials on-line named as e-LeAP (e-Learning Access Program). Moreover, Ateneo de Manila University, the Dela Salle University and other major universities offer some form of online courses.

According to Thapan (2010), e-learning is cheaper than classroom teaching because organizations and institutions can save up to 32% in costs through e-learning in comparison to the classroom-based teachings, according to an internal study of IT education and training company Tata Infotech. As per the study, in case of e-learning, assuming that 25 days of training has to be bought so that it covers all the classroom based training courses. E-learning could save up to 35% of faculty cost excluding infrastructure and travel costs on a user base of 300.

According to Leaman (2010), the current eLearning solutions are not designed to provide this information easily. Learning in the classroom or online – is still treated as a one-time event, with little or no reinforcement after the fact to ensure the learning sticks for the long term. And often the only time we figure out that learning didn't happen is when something goes wrong. There are some new and exciting developments that can transform the eLearning landscape. There are many great ways that eLearning can be modified or augmented to deliver true capabilities and performance improvement to business.

According to Kalai (2011), the quality assurance is a key issue in the implementation of E-Learning as the number of non-accredited institutions offering degrees increases rapidly, damaging the reputation of online learning. A number of virtual programmes have thrown up quality concerns such that the quality E-Learning programmes must fight harder for recognition from employers and the wider society. The measurement of 'quality' is often qualitative rather than quantitative; it is possible that online students have to be more disciplined and work harder to achieve their goals.

However, online students lack sufficient immersion and interaction to develop qualitative characteristics such as interpersonal skills.

PADI (2011) "Professional Association of Diving Instructor" is a specialist eLearning education, training and research institute orientated to serving the needs of local and central government in the UK and other English language locations. Some of us at PAI eLearning are ex-public servants ourselves. Our ethos is the provision of online learning programmers that are highly focused and relevant to the central government and local authority sectors. PADI eLearning lets you complete the knowledge development sections of selected PADI courses online. Traditionally this section was completed in the classroom of the PADI Dive Shop before your course. With PADI eLearning you can complete these sections as long as you are online.

Thorns (2011) "The General Medical Council e-Learning for Healthcare" (GMC) guidance provides a framework to help doctors deal effectively with the clinic complexities and difficult ethical and legal questions enabling them to provide a high standard of care, and reduce the scope for disagreement. The guidance applies to children and adults. However, this session uses examples from adult end of life care to demonstrate decision making process and key principle from the guidance.

Griffin of NASA argued that learning in a virtual world CD presents a wealth of information and knowledge on the new eLearning field (2012). The DON is enthusiastically embracing eLearning as a natural extension of the DON and DOD long-term commitment to education and training. Education and training is one of the primary means to maintain our War fighting Effectiveness and readiness, as well as to help our people develop professionally and personally.

Shea (2013) “An Exploration of Massage Therapy Training Options” In the SUNY learning network, courses are designed based on principles of social constructivism where learning is seen as an outcome of socialization. Accordingly there is a strong focus on the use of discussion forums and student-teacher interaction. The authors believe that the level of interaction contributes to the development of “knowledge building communities”. Therapy programme has recently undergone the transition from a purely face-to-face delivery style to a blended delivery style. The programmer’s delivery style is making use of contemporary online applications such as wikis, blogs, collaborative document editing, voice-over-internet-protocols (such as MSN messenger and skype). This is new ground for massage therapy education and in many ways for education in general. The department feels that there is a need to monitor the student’s experience and achievement in this new context and to make changes to improve that experience over time.

E-learning began at just about the same time that a computer was developed that was practical for personal use. In fact, the concept and practice of distance learning predates the computer area by almost 100 years. In England, in 1840, shorthand classes were being offered by correspondence courses through the mail. The improvements to the postal service made this method of distance learning popular in the early part of the last century. This led to a large number of "through the mail" type of educational programs.

The computer only made distance learning easy and better. Television, video recorders, and even radio have all contributed to distance learning.

E-learning and distance learning are not quite the same thing. The basic thing that distinguishes distance education is the physical separation of the student from the instructor and the classroom. E-learning, however, became part of the classroom environment from the beginning. The early use of computers was geared to help the classroom instructor. Gradually, as more and more personal computers became available, the idea of online classes was explored by some pioneering Colleges and Universities. The early attempts at distance education were hampered by resistance from traditionalist within the education field.

Some invoked what they called the philosophy of education to demonstrate that the teacher was essential to the educational process. This resistance led to the early online degrees being considered inferior to traditionally obtained degrees. This prejudice extended to the personal departments of major employers. When choosing between two otherwise equally qualified applicants, preference was shown to the person holding the traditional degree. In recent years this has changed drastically. The improvements in E-learning technology and the ability to create virtual classrooms and a virtual learning environment (VLE) has gradually broken down the resistance. This process has been helped by the emergence of a new generation that was weaned on the computer. It would not be surprising if within another generation, the pendulum shifts completely, and the online degree is the one that is respected and coveted.

2.1.2 E-Learning Design

Designing the e-learning programs can be challenging, but important for effective learning. Learning must be able to motivate hence relevant, engages the users, and allows them to control learning to an appropriate extent. There are many considerations in designing the e-learning system and these include cognitive development, content management, media technology, learning delivery, instructional design and many other details. The following succeeding sub-topics discuss concepts that are adapted in creating e-learning system prototype.

A. Cognitive Learning in E-learning Design

The design will support the learning theories and will focus on three domains: the cognitive, affective, and psychomotor development of the students. Of the three domains, details on cognitive development and how it will be implemented in e-learning design will be exhaustively discussed. Many e-learning designs are available and worthy to be implemented but this study will focus on how cognitive development will be maximized by taking into account factors that involve cognitive activities and development (Clark & Mayer, 2003). The following components can contribute to the cognitive enhancements in e-learning materials; learning theories, interactivity and simulation, and the effect of multimedia learning materials such as video, graphics, animation, and assessment in the overall design of e-learning prototype (Juwah, 2013).

B. Learning Theories

According to Knud (2004) and Ormrod (2012) learning theories are conceptual frameworks that describe how information is absorbed, processed and retained during learning. Cognitive, emotional, and environmental influences, as well as prior experience, all play a part in how understanding, or a worldview, is acquired or changed, and knowledge and skills retained. There are many learning theories which vary accordingly to their implementation and concepts yet all of these are encompassed by four known learning theories in the field of educational technology; behaviourism, constructivism, transformative and cognitivism.

Behaviourism is coined by Watson (Cherry, 2013) in which learning is the acquisition of a new behaviour through conditioning, the operant and classical conditioning. Operant conditioning is the reinforcement of behavior by a reward or a punishment while the latter is a reflex response to stimulus. Behaviourism is found to be excellent in the area of competency-based learning, skill development and training. Educational approaches such as applied behaviour analysis, curriculum-based measurement, and direct instruction have also emerged from this model (Flippen, 2014 p.1; Keesee, 2014; Hiemstra, 2014) .

Constructivism on the other hand, provides context for the learner by placing the learner in a situation similar to the one in which he/she is going to apply the knowledge. Understanding is more important than memorizing facts. Through the construction of understanding and meaning, the learner interprets and acts upon the material being learned and thereby results to better understanding of the materials. The idea of Piaget and Bruner is to build learning based on new ideas or concepts of the current knowledge and past experience (Keesee, 2014).

Transformative learning theory seeks to explain how human revise and reinterpret meaning (Taylor, 2008). Transformative learning is the cognitive process of effecting change in a frame of reference that defines our view of the world. Emotions are often involved in which adults tend to reject any ideas that do not correspond to their particular values, associations, and concepts. There are three levels of transformation in transformative learning theory: psychological, which means changes in understanding of the self, convictional, which is revision of belief systems, and behavioral, which involves change in lifestyle (Mezirow, 1997; Knud, 2004).

The cognitive learning theory considers how human memory works to promote learning, and understands short term and long term memories. They view learning as an internal mental process including insight, information processing, memory and perception where the educator focuses on building intelligence and cognitive development. Meaningful information is easier to learn and remember. If a learner links a relatively meaningless information to a prior schema then this information will be easier to retain. It is easier to remember items from the beginning or end of a list rather than those in the middle, unless that item is distinctly different. Practicing or rehearsing improves retention especially when it is distributed practice. By distributing practices, the learner associates the material with many different contexts rather than one context afforded by mass practice. These are the effects of prior learning on learning new tasks or material. (Keesse, 2014).

These four learning theories can be combined interchangeably in the learning process. In e-learning for instance, behaviourism is effective in knowledge based, skill acquisition, and training while constructivism is excellent in situational-based learning. Transformative learning on the other hand, is good in proving knowledge, thereby, changing the learner's prior knowledge based on the evidence collected during the learning process, while cognitive is the mental effect of learning, the highest among the four learning theories. In combining these four learning theories, Bloom's Cognitive model can be utilized in the development of the system.

C. Bloom's Cognitive Model

There is more than one type of learning domain. A committee of colleges, led by Benjamin Bloom (1956), identified three domains of educational activities: cognitive, affective, and psychomotor. This taxonomy of learning behaviors can be thought of as "the goals of the learning process". That is, after learning an episode, the learner should have acquired new skills, knowledge, and/or attitudes. The cognitive domain of Bloom involves knowledge and the development of intellectual skills. This includes the recall or recognition of specific facts, procedural patterns, and concepts that serve in the development of intellectual abilities and skills.

There are six major categories, starting from simplest behavior to the most complex. The categories can be viewed as degrees of difficulties. That is, the first one must be mastered normally before the next one can take place. Figure 2.1 illustrates the Bloom Cognitive Taxonomy and which was revised by Anderson and Karthwohl (2001). The layers represent the levels of learning and each layer represents increasing complexity.

Presented with each layer are sample verbs that describe actions or creations at that level of cognitive development.

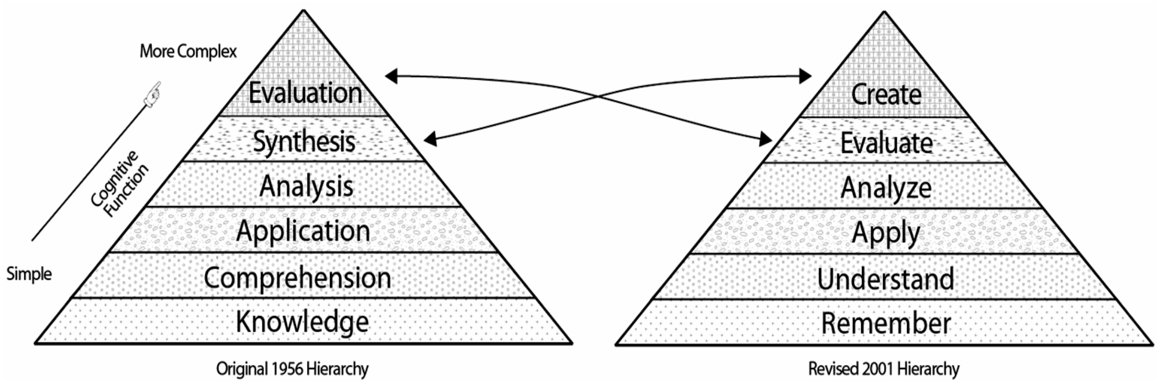

Figure 2.1: Revised Bloom Taxonomy (Anderson & Karthwohl, 2001)

Layer one is, “Remembering” where memory is used to produce definitions, facts charts, lists, or recitations. Layer two, “Understanding”, includes producing drawings or summaries to demonstrate understanding. “Applying” is layer three, where concepts are applied to new situations through products like models, presentations, interviews or simulations.” Analyzing” is layer four which includes “distinguishing” between the parts creating spreadsheets, surveys, charts, or diagrams. Critiques, recommendations, and reports are some of the products that can be created to demonstrate layer five which is “Evaluating”. Creating, which is the sixth and top layer, puts the parts together in a new way.

Figure 2.2 represents the cognitive levels in Bloom’s original taxonomy, arranged in ascending order. On each step is a list of suggested activities for the specific level. Below each step is a list of verbs that are commonly used to create learning objectives. Benjamin

Bloom never intended to generate instructional dogma but intended his work to be used in the assessment of expertise and to develop new ways in measuring what college students learned.

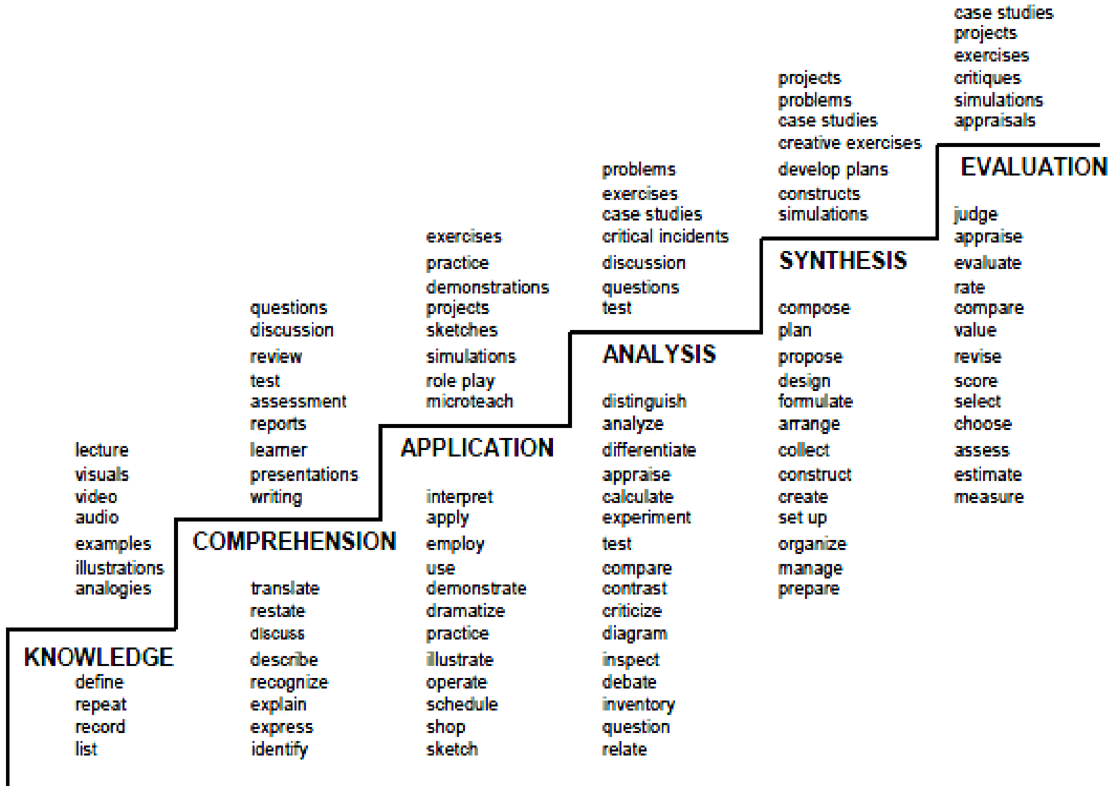

Figure 2.2: Bloom’s Taxonomy Staircase (Source: Churches, 2008)

At present, this model becomes a basis in developing e-learning; transforming its contents, instructional delivery and assessment. His work contributed greatly in shifting the focus of educators to learning from teaching. Andrew Churches (2008) updated Bloom’s work by introducing Bloom’s Digital Taxonomy. The intention was to capture Bloom’s cognitive levels to the 21st-century digital skills.

Figure 2.3: Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom’s Taxonomy of Educational Objectives
(Source: Anderson & Krathwol, 2001)

Figure 2.3 shows how the revised taxonomy arranges skills from the most basic to the most complex. The new version has two dimensions: the knowledge and cognitive processes and the sub-categories within each dimension are more extensive and specific. The cognitive process dimension represents a continuum of increasing cognitive complexity - from remembering to creating while knowledge dimension represents a range from concrete (factual) to abstract (meta-cognitive).

D. Interactivity and Simulations

Many educators believe that interactive e-learning courseware which allows "learning by doing" arouses interest and generates motivation; this provides a more engaging experience for the learner. Interactivity is seen as part of a system where learners are not passive recipients of information, but they are engaged with a material that is responsive to their actions. Interactivity results in deeper learning because students can hypothesize to test their understanding, learn by mistakes and make sense of the unexpected and enhance knowledge and performance (Rosenberg 2000, p. 28).

An e-learning that merely allows the learner to navigate content or take a test is often labelled as interactive. This does not meet the criteria for meaningful interactivity outlined above. This is not similar to a design that provides simulation where a student can actively explore a simulated system or process (Thomas, 2001). Simulations and modelling tools are the best examples of complex, meaningful interactivity. Such applications model or represents a real or theoretical system, allowing users to manipulate input variables, change the system's behavior and view the results. With such applications, learners can construct and test hypotheses and receive feedback as a result of their actions. Inclusion of interactive simulations in e-learning courses improves the quality and outcomes of e-learning. Simulations and visualization tools make it possible for students to bridge experience and abstraction which help to deepen understanding of ambiguous or challenging content. According to Clark and Craig (1992), interactivity is a factor that has the biggest impact on cognitive learning and is the most powerful model of instruction.

E. Multimedia Learning Effect

Studies have compared the effect of multimedia-based learning with traditional classroom-based learning. Allen (1998) discusses the effect of multimedia-based training. He claims that a good multimedia training is not only faster than classroom training, it is also better. People remember and retain longer in memory what they learn more accurately and use what they learn to improve their performance. Adams (1992) reviewed six studies that carefully compared multimedia training to classroom instruction: Learning gains were up to 56% greater while consistency of learning" (variance in learning across learners) was 50-60% better and content retention was 25-50% higher. Brett (1997) claims that multimedia-based learning is more motivating and exciting than the more traditional educational methods. It can also be claimed that using multimedia increases learning effectiveness and cognitive skills.

Clark and Craig (1992) present two assumptions that promote the use of multiple media. The first assumption is called additive assumption, or also called as instructional media. If used properly, this media can make valuable contributions to the learning and academic performance of students. Therefore, the instruction presented by several media increases learning benefits, because the benefit of each of the combined media are additive. The multiplicative assumption is that multimedia benefits are sometimes multiplicative, that is, greater than the sum of the benefits of individual media.

The use of multimedia such as graphics refer to variety of illustrations including line drawings, charts, photographs, motion graphics such as animation and video can indeed increase learning. Research shows that graphics improve learning through cognitive exercises, storing and retrieving ideas. Mayer (2003) found an average gain of 89% on transfer test from learner who studied lessons with text and graphics compared to learners whose lessons were limited to text alone. He also found that the integration of text near the visuals yielded an average improvement of 68%. Furthermore, explaining graphics with audios improve learning almost by 80%. According to Clark (2003), audio should be used in situations where overload is likely. For example, if a student is watching an animated demonstration of maybe five to six steps on how to use a software applications, the student needs to focus on his/her visual resources on the animation. If the student is reading the text and at the same time is watching the animation, then overload will likely to happen.

Learning is based on the engagement of the learner with the content of the instruction. According to Jones et al. (1997), in order to engage in learning, tasks need to be challenging, authentic, and multidisciplinary. Authentic in the sense that they correspond to the tasks in e-learning course and training and are seen useful for the future. Instruction actively engages the learner, and is generative. It involves experience and this makes the content more memorable than passive listening. Also, engaged learning fosters more holistic and creative solutions by using simulations, games, and workshops to experiment with new ideas. Moreover, engaged learning ignites commitment and motivates the participants closer to the goals.

F. Assessment

Assessment for learning is best described as a process by which assessment information is used by teachers and students to adjust their teaching strategies and learning strategies respectively. Assessment is a powerful process that can either optimise or inhibit learning, depending on how it is applied. This can be in a summative or formative form.

Summative assessment ("assessment of learning") is generally done at the end of a course. In an educational setting, summative assessments are typically used to assign students a course grade, and by using a scaled grading system, enables the teacher to differentiate students. Both the teacher and the students need to be updated on the students' abilities, progress, and overall development in the learning process. Summative assessment plays a critical role in this information gathering process. By conducting a variety of forms of summative assessment, the teacher will have a good understanding of where their students are in the learning process (Bilash, 2011). If the students have misconceptions or difficulty, it will redirect the student to perform corrective measures.

Formative assessment is a diagnostic testing procedures employed by teachers during the learning process. It provides information through qualitative feedback to modify teaching and learning activities to improve the student's performance (Black & William, 2009). When properly incorporated in e-learning practice, it provides the needed information to adjust the teaching and learning while these are happening simultaneously. Adjustments help to ensure students to achieve targeted standard-based learning goals within a set time frame. According Cauley and McMillan (2010), formative assessment is one of the most powerful ways to enhance student motivation and achievements through practice, guidance, and feedback. Formative assessments determine the next steps during the learning process as the instruction approaches the summative assessment of student learning. Some of the instructional strategies that can be used formatively includes the following: criteria and goal setting, self-assessments, constructive feedback and student record keeping, and questioning strategies (Garrison & Ehringhaus, 2007).

i. *Criteria and goal setting* – Defining criteria and stating goals engage students in instruction and the learning process by creating clear expectations. In order to be successful, students need to understand and know the learning target/goal and the criteria of reaching it.

ii. *Self-assessment* – Student who can reflect while engaged in meta-cognitive thinking are involved in their learning. Students will be allowed to modify inputs or change variables in the simulations to be engaged with the learning process. They also assess the output by using the “learning by doing” approach and assess readiness of the *to* summative examinations.

iii. *Constructive feedback* – Students who receive positive feedback, guidance or help provide learners to continue the learning process. For example, feedback should be constructive so as not to hinder the learning process. It must also consider sensitivity since assessment has an emotional impact. It also recommend ways on how to improve the learning process.

iv. *Student record keeping* – helps student better understand their own learning as evidenced by their work and effort in their learning process. This process of students keeping ongoing records will not only engage students, it also helps them to see beyond “grade” and to evaluate where they started and the progress they are making toward the learning goal.

v. *Questioning Strategies* - The question type currently dominating large-scale computer-based testing and many e-learning assessments is in the standard multiple-choice question, which generally includes a prompt followed by a small set of responses from which students are expected to select the best choice. This kind of task can be scored easily by a variety of electronic means. It also offers some attractive features for assessing the format. However, if e-learning developers adapt this sole format as the focus in this emerging field of learning, then much of the computer platform's potential for rich and embedded assessment can be sacrificed. If the design of e-learning materials uses multimedia and interactivity to increase cognitive development, the same idea should also be adapted in creating assessment to guarantee mental skills and development.

In creating items in the assessment process, the development of questionnaires that guaranteed cognitive development and how it should be implemented was investigated. The classic work of Anderson (2001) adapted the concepts of Bloom's revised taxonomy and suggested questionnaires schema as shown in Table 2.1.a (lower hierarchy) and Table 2.1.b (higher hierarchy). This new taxonomy reflects a more active and accurate form of thinking (Pohl, 2000).

Table 2.1A: Bloom Questionnaire Schema

Category	Example and Key Words (verbs)	Level
Remembering: Recall previous learned information.	Examples: Recite a policy. Quote prices from memory to a customer. Knows the safety rules. Key Words: defines, describes, identifies, knows, labels, lists, matches, names, outlines, recalls, recognizes, reproduces, selects, states.	
Understanding: Comprehending the meaning, translation, interpolation, and interpretation of instructions and problems. State a problem in one's own words.	Examples: Rewrites the principles of test writing. Explain in one's own words the steps for performing a complex task. Translates an equation into a computer spreadsheet. Key Words: comprehends, converts, defends, distinguishes, estimates, explains, extends, generalizes, gives an example, infers, interprets, paraphrases, predicts, rewrites, summarizes, translates.	L O W E R
Applying: Use a concept in a new situation or unprompted use of an abstraction. Applies what was learned in the classroom into novel situations in the work place.	Examples: Use a manual to calculate an employee's vacation time. Apply laws of statistics to evaluate the reliability of a written test Key Words: applies, changes, computes, constructs, demonstrates, discovers, manipulates, modifies, operates, predicts, prepares, produces, relates, shows, solves, uses.	

There are many ways in which assessment items can be innovative and reinforce mental development when delivered by computer. The work of Parshall, Davey and Pashley (2000) studied one organizational scheme which describes the innovative features for computer-administered items, such as the technological enhancements of sound, graphics, animation, video or other new media incorporated into the item and the response. This work showed innovative formats where students can, for instance, click on graphics, drag or move objects, re-order a series of statements or pictures, or construct a graph or other representation. These innovations of assessment can hypothetically improve cognition and lead to higher academic outcomes.

Table 2.1B: Bloom Questionnaire Schema

Category	Example and Key Words (verbs)	Level
Analyzing: Separates material or concepts into component parts so that its organizational structure may be understood. Distinguishes between facts and inferences.	Examples: Troubleshoot a piece of equipment by using logical deduction. Recognize logical fallacies in reasoning. Gathers information from a department and selects the required tasks for training. Key Words: analyzes, breaks down, compares, contrasts, diagrams, deconstructs, differentiates, discriminates, distinguishes, identifies, illustrates, infers, outlines, relates, selects, separates.	H I G H E R
Evaluating: Make judgments about the value of ideas or materials.	Examples: Select the most effective solution. Hire the most qualified candidate. Explain and justify a new budget. Key Words: appraises, compares, concludes, contrasts, criticizes, critiques, defends, describes, discriminates, evaluates, explains, interprets, justifies, relates, summarizes, supports.	
Creating: Builds a structure or pattern from diverse elements. Put parts together to form a whole, with emphasis on creating a new meaning or structure.	Examples: Write a company operations or process manual. Design a machine to perform a specific task. Integrates training from several sources to solve a problem. Revises and process to improve the outcome. Key Words: categorizes, combines, compiles, composes, creates, devises, designs, explains, generates, modifies, organizes, plans, rearranges, reconstructs, relates, reorganizes, revises, rewrites, summarizes, tells, writes.	

The work of Scalise and Wilson (2006) introduced a taxonomy or categorization of 28 innovative item types that may be useful in computer-based assessment. This is organized along the degree of constraint on the respondent's options for answering or interacting with the assessment item or task. Table 2.2 describes a set of iconic item types termed "intermediate constraint". The 28 example types are based on 7 categories of ordering, which involves successively decreasing response constraints from fully selected to fully constructed. Each category of constraint includes four iconic examples. References for the Taxonomy were drawn from a review of 44 papers and book chapters on item types and item designs – many of them well-established references regarding particular item types. They intend to consolidate considerations of item constraint for use in e-learning assessment designs. If such mechanism can be adapted in the assessment design, an additional impact in cognitive learning can definitely be obtained.

Table 2.2: Assessment Schema for E-learning (Scalise & Wilson, 2006)

***Most* Constrained** → ***Least* Constrained**

	Fully Selected	*Intermediate Constraint Item Types*					*Fully Constructed*
***Less* Complex**	**1. Multiple Choice**	**2. Selection/ Identification**	**3. Reordering/ Rearrangement**	**4. Substitution/ Correction**	**5. Completion**	**6. Construction**	**7. Presentation/ Portfolio**
	1A. *True/False* (Haladyna, 1994c, p.54)	2A. *Multiple True/False* (Haladyna, 1994c, p.58)	3A. *Matching* (Osterlind, 1998, p.234; Haladyna, 1994c, p.50)	4A. *Interlinear* (Haladyna, 1994c, p.65)	5A. *Single Numerical Constructed* (Parshall et al, 2002, p. 87)	6A. *Open-Ended Multiple Choice* (Haladyna, 1994c, p.49)	7A. *Project* (Bennett, 1993, p.4)
	1B. *Alternate Choice* (Haladyna, 1994c, p.53)	2B. *Yes/No with Explanation* (McDonald, 2002, p.110)	3B. *Categorizing* (Bennett, 1993, p.44)	4B. *Sore-Finger* (Haladyna, 1994c, p.67)	5B. *Short-Answer & Sentence Completion* (Osterlind, 1998, p.237)	6B. *Figural Constructed Response* (Parshall et al, 2002, p.87)	7B. *Demonstration, Experiment, Performance* (Bennett, 1993, p.45)
	1C. *Conventional or Standard Multiple Choice* (Haladyna, 1994c, p.47)	2C. *Multiple Answer* (Parshall et al, 2002, p.2; Haladyna, 1994c, p.60)	3C. *Ranking & Sequencing* (Parshall et al, 2002, p.2)	4C. *Limited Figural Drawing* (Bennett, 1993, p.44)	5C. *Cloze-Procedure* (Osterlind, 1998, p.242)	6C. *Concept Map* (Shavelson, R. J., 2001; Chung & Baker, 1997)	7C. *Discussion, Interview* (Bennett, 1993, p.45)
***More* Complex**	1D. *Multiple Choice with New Media Distractors* (Parshall et al, 2002, p.87)	2D. *Complex Multiple Choice* (Haladyna, 1994c, p.57)	3D. *Assembling Proof* (Bennett, 1993, p.44)	4D. *Bug/Fault Correction* (Bennett, 1993, p.44)	5D. *Matrix Completion* (Embretson, S, 2002, p. 225)	6D. *Essay* (Page et al, 1995, 561-565) & *Automated Editing* (Breland et al, 2001, pp.1-64)	7D. *Diagnosis, Teaching* (Bennett, 1993, p.4)

2.2 Mastery Learning

Mastery learning is a theoretical perspective of education that has attracted much attention in the past. Mastery learning was coined by Benjamin Bloom (1968; 1971) and is widely regarded as the classic theoretical perspective in pedagogy. Bloom hypothesized that a classroom which focuses on mastery learning as opposed to the traditional form of instruction reduces the achievement gaps between varying groups of students (Guskey, 2007). In mastery learning, the students are helped to master each learning unit before proceeding to a more advanced learning task in contrast to the conventional instruction.

The concept of mastery learning can be attributed to the behaviourism principles of operant conditioning. Operant conditioning theory asserts that learning occurs when an association is formed between a stimulus and a response. In line with the behaviour theory, mastery learning focuses on an overt behaviours that can be observed and measured. The material that will be taught is broken down into small discrete lessons that follow a logical progression. In order to demonstrate mastery over each lesson, students must be able to overtly show evidence of understanding the material before moving to the next lesson (Anderson, 2000). It is based on the concept that all students can learn when provided with conditions appropriate to their situations. The students must reach a predetermined level of mastery in one unit before they are allowed to progress to the next. In mastery learning, students are given specific feedback about their learning progress at regular intervals throughout the instructional period. This feedback helps students identify what they have learned well and what they have not. Areas that are not learned well are allotted more time to achieve mastery learning. Only grades of “A” or “B” are given because these are the accepted standards of mastery. Students must demonstrate mastery in unit examinations, typically with a score of 75, before moving to the next learning materials (Davis & Sorrell, 1995).

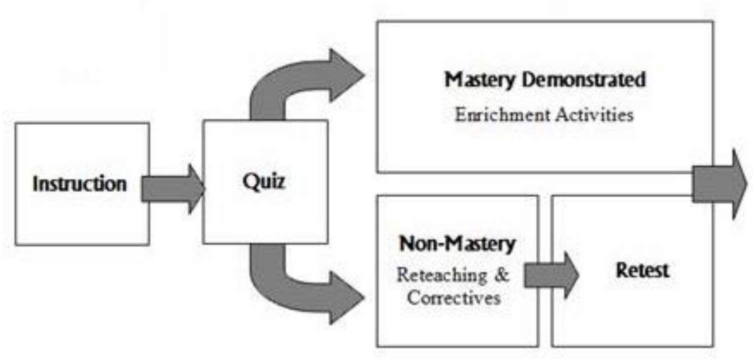

Figure 2.4: Learning Mastery Architecture (Source: Candler, 1996)

The major steps in implementing mastery learning are outlined in Figure 2.4. First, teachers must present instructional materials and determine the level of students who are ready to learn. Second, a quiz or a formative assessment which is basically a diagnostic instrument or process used by the teacher to determine difficulty and as basis for corrective activities to remediate learning errors is planned. Assessment in the mastery learning classroom is not used as a measure of accountability, but rather as a source of evidence to guide future instruction. A teacher using the mastery approach uses the evidence generated from their assessment to modify activities that best serve each student. In this sense, students do not compete against each other, but rather compete against themselves in order to achieve their personal best. Third, activities which correct and enrich may take a variety of forms and usually vary from one unit to the next. For instance, activities which correct may involve alternative materials or resources, peer tutoring, computer assisted lesson, interactive demos and simulations or any type of learning activity that are both stimulating and rewarding for fast learners at varying degree. Students will receive constructive feedback on their work and will be encouraged to revise and revisit their work until the objective is achieved. Finally, a second assessment is formed to determine mastery based on the corrective activities. It covers the same concepts and materials like the first assessment but ask questions in a slightly different way or format. If the corrective activity is successful in helping the students remedy their learning difficulties, then almost all students will demonstrate mastery in the second formative assessment. The second assessment or retest becomes a powerful motivational device in directly showing to the students that they can improve their learning and become successful learners (Bloom, 1971). In the process, the students can move on to the next unit of instruction.

Mastery learning has been widely applied in tertiary and primary education, adult learning, training, instructional learning models and in a variety of subject matters such as in the fields of mathematics (Gomez & Sangel, 2012), nursing (Bender, 2007; Roberts, Ingram & Flack, 2012), physics (Wambugo & Changeyiwo, 2008), and for skills such as reading (Crijnene Feehan & Kellan, 1998) and critical thinking (Anderson, 2000; Hmelo, 2009). Many meta-analytic studies have demonstrated consistent positive effects for mastery learning programs.

In general, studies have shown that mastery learning programs result to higher achievement in all students as compared to the more traditional forms of teaching (Anderson, 2000). Despite the empirical evidences, many mastery programs in schools have been replaced by more the traditional forms of instruction because of the level of commitment required from the teacher and the difficulty in managing the classroom especially when each student follows an individual course of learning. Despite the conclusive evidence that an appropriately instituted mastery approach to instruction yields improvement in students' achievement, criticisms such as time constraints as a flaw in the approach often surface. Educators who prefer breadth of knowledge rather than depth of knowledge may feel that it is more important to "cover" a lot of materials than to focus on details. They also focus their energy in ensuring that all students achieve learning goals. Many teachers are hesitant to institute a mastery learning approach in their classroom because of fear that they may not finish the lessons' coverage on time. Giving students extra time in completing their work is also viewed as unfair by some critics. They argue that differentiated instruction is inherently unfair because students who receive extra feedback and time are somehow given an advantage over students who achieve the objectives of the lesson. Most of these criticisms stem from a misunderstanding of Bloom's approach. In Bloom's ideal classroom, the institution of a mastery learning approach is postulated to eventually lead to a drastic decline in the variation of student achievement, as students who require more correctives initially and evidently gain personal benefits from the process. The students eventually come to employ these varying strategies and techniques on their own. On the other hand, students who receive less will make slower progress. As the gap in student achievement lessens, more time will be devoted to "enrichment activities" rather than corrective activities for all students (Guskey, 2007).

2.3 Reinforcement Learning

Reinforcement learning is a learning paradigm which aims to control a system so as to maximize the numerical performance measure that expresses a long-term objective. Reinforcement learning provides partial feedback and provides predictions when to implement the learner's corrective activities. It can be described as an intelligent technique in learning achieved by interacting with the environment (Sutton & Barto, 1998). In reinforcement learning technique, the agents map the states of the environment to appropriate actions in order to maximize rewards (Ayesh, 2004). Reinforcement learning is of great interest because of the large number of practical applications that can be used to address problems in artificial intelligence, in operations research or control engineering and in learning.

Advanced computer systems have become pivotal components for learning. However, there are still many challenges in e-learning environments when developing reliable tools to assist users and facilitate and enhance the learning process. For instance, the problem of creating an e-learning system that can be learned from interaction, learning the students' preferences, and increasing learning efficiency of individual users are still widely unsolved. Reinforcement learning (RL) is an intelligent technique that can be learned from trial and error mechanism and generally does not need any training data or a user model. At the beginning of the learning process, the RL does not have any knowledge about what actions it should take. After a while, the RL learns which actions need to be taken and which yield the reward. The ability of learning from interaction with a dynamic environment and using reward and punishment independent from any training data sets makes reinforcement suitable tool for e-learning situations where subjective user feedback can easily be translated into reinforcement signal.

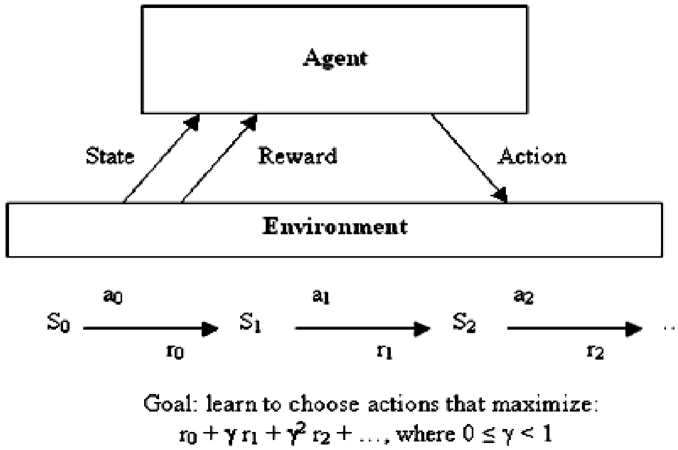

Figure 2.5: Standard Model of Reinforcement Learning (Chen, 2006)

Figure 2.5 models the agent in the environment and how it chooses an action a_i, obtains reward r_i, and switches from state s_i to state s_{i+1}. The goal is to maximize the long term reward, where γ is called the discounting factor. The RL has become the chosen methodology for learning in a variety of domains. RL is played well in games and simulation (O'Doherty, 2012). Educators apply reinforcement learning in multi-agent and game-playing environment to achieve a superior level of performance in learning complex tasks. It accelerates the learning process by giving the rewards functions (Mataric, 1994). The RL agent or the decision-maker takes the action by using a policy to influence the state of the environment. Reinforcement feedback provides knowledge on the actions which manifested through rewards or punishments. The agent learns to take the actions that are most rewarding in order to reach its goal.

Literatures that focus on user-machine interface and the complexity of a dynamic environment like the e-learning application reveal that it is based on reinforcement learning. In e-learning application, the user needs access to the most suitable sources of information. Reinforcement learning has the ability to autonomously lead search engines to adapt themselves by monitoring the user's queries, reaction to messages, and even actions that the user takes examination. As a consequence, an intelligent search engine can improve its behavior in order to personalize search tools, save the user's time and avoid confusion and fatigue by providing the shortest path to the optimal learning object. Some hybrid systems using reinforcement learning technique are provided by presenting the states and actions and defining the objective and subjective reward such as the area of image-based application. The high and low-level image processing techniques must be applied to extract features, patterns and clues from an image set or a single image (MacArthur & Bradley, 2000).

In the framework of e-learning, various research show the design of an artificial intelligent system to provide services for the learner through the web or other interfaces. Intelligent agent should act rationally in performing a task for the user and in reducing human error or fatigue. Reinforcement learning can be employed to design a personalized system to adapt to human intention, intuition, needs, and requests. To design an adaptive personalized mechanism, the artificial intelligent system must communicate with the user through the graphical user interface (GUI). Requests, responses, and reactions can be given by the users to the computer by using intelligent GUI. This yields the most efficient system that can perform challenging tasks, save the user's time and prevent user fatigue and confusion. The work of Tizhoosh, Shokri and Kamel (2005) accomplished this by linking AI and GUI in order to have a flexible interaction strategy that contributes in determining what is best suited for the most appropriate time for the learner.

2.4 Concepts of the Study

The general conceptual framework of the study is to combine the existing relevant related literature to improve the e-learning system implementation in multi-faceted ways such as the comparative features of three existing MLS model such as Moodle, Blackboard and Claroline. Various considerations have been implemented in the development of the LMS including the mastery learning of educational technology and reinforcement process in artificial intelligence of computer science.

Figure 2.5 describes how the new learning management system will be developed. At first, the proponents described and compared the three existing model to capture the possible features to be included in the new system including the admin module, content analysis and the incorporation of multimedia design. Several major concepts discussed in the related literature such as Bloom Taxonomy, Mastery learning, Reinforcement learning and ADDIE Model played a vital rule in the development of the proposed learning management system.

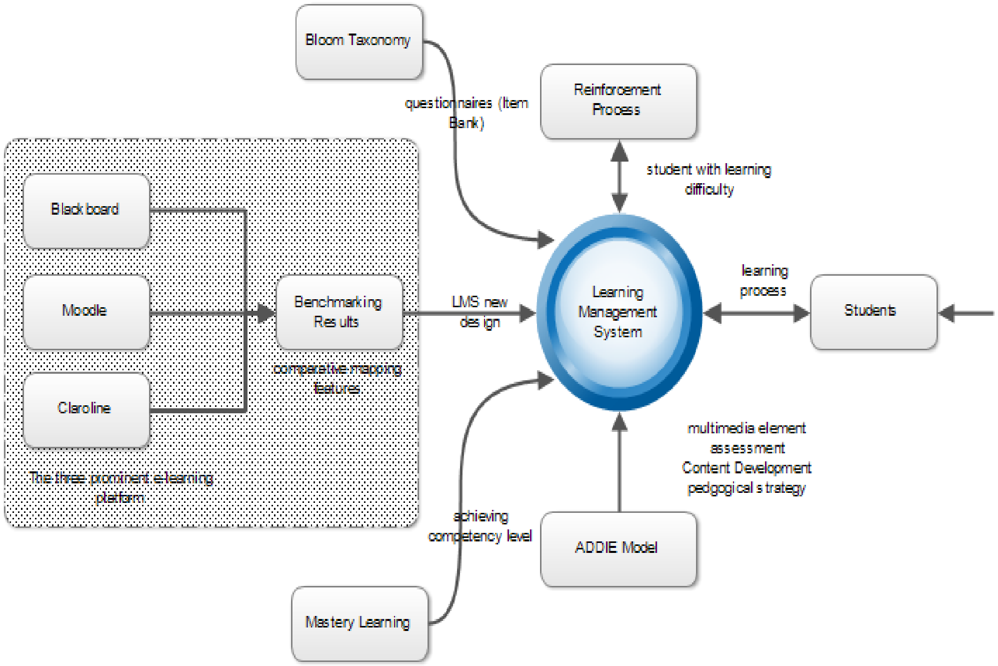

Figure 2.6. Research Paradigm of the New Learning Management System with Reinforcement and Mastery Learning Process

First, assessment plays a very vital role in developing the e-learning system. To enrich the assessment process, 12 very useful, innovative question types in computer-based assessment were developed and stored in the Item Bank database. Two hundred eighty (280) questions were designed based on the studies of Bloom Taxonomy Staircase by Churches (2008), Taxonomy for learning, teaching and assessing by Anderson and Krathwol, (2001) and Taxonomy and categorization by Scalise and Wilson (2006). The content and design on the other hand, underwent several processes to suit the objectives in creating the system as well as the background of the students at (name of the school). In developing the content and design of the prototype, several concepts such as the design and instructional methodology were considered.

Second, learning content and assessment includes the design of item bank in the database and the development of questionnaires to be used in different examinations or assessments following the ADDIE Model. In addition, it also involves the development of lessons and instructional materials presented in different media formats. Links and additional references for further reading are also included in this part of the system. To support the e-learning framework discussed in the previous section, an e-learning strategy must be developed. One important element of deciding and defining e-learning strategy is the use of instructional model. It is the practice of creating "instructional experiences" which makes the acquisition of knowledge and skill more efficient, effective, and appealing. ADDIE model composed of Analysis, Design, Development, Implementation and Evaluation. The model has been adapted based on its wide acceptability and use.

Third, mastery learning involves different correctives measures, explanation facilities, practice or formative examination, random summative examination, and hyperlinks of related topics. Fourth is the reinforcement process which is responsible in giving cumulative rewards to the students and the implementation of giving punishments governed by set of rules.

2.5 Operational Definition of Terms

The following terms were utilized in the discussions and analysis of the study. This is to provide meanings on the various essential terms cited in the study. All the terms mentioned were operationally defined to give the exact meaning of its usage in the study.

Blackboard :

It refers to a proprietary E-Learning tool that proponent' will use to be a basis to the proposed system to be develop.

Claroline :

It refers to an open source platform for collaborative e-learning which is helpful for the teachers.

E-Learning:

It refers to the use of electronic media and information and communication technologies (ICT) in education. E-learning is broadly inclusive of all forms of educational technology in learning and teaching.

Item Bank:

This refers to the database that stores the 12 questions types with 280 questions used for various assessments.

Lesson:

Refer to the list of chapters of the curriculum vector also know as chromosomes in the study or member of the populations.

Learning Management System (LMS):

It refers to a software application for the administration, documentation, tracking, reporting and delivery of e-learninge ducation courses or training programs.

Mastery Learning (ML):

Mastery learning is a learning model which varies instructions according to the aptitude of the students. This results to a higher level of learning by letting the students repeat the assessment until they can achieve the required level of competence (Bloom, 1971).

Moodle:

It refers to a popular open-source E-Learning tool that proponent' used to be a basis to the proposed system to develop.

Reinforcement Learning (RL):

It is a type of learning process which is used to motivate learners to continue the learning process by giving them rewards or points for their efforts or by enforcing punishments when the students cannot pass the learning assessments. (Mataric, 1994; Chen, 2006).

Chapter 3

OPERATIONAL FRAMEWORK

This chapter provides discussion on the operational framework of the study including the materials, software and hardware design. Moreover, research method, data gathering procedures, samples and sampling techniques used, instrumentation, procedures and statistical analysis of data.

3.1 Materials and Lessons

The study is organized within the context of Design and Analysis of Algorithms class which is taught at College of Saint Paul II Arts and Sciences. The entire data collection and training have duration of 18 weeks or one semester. All students are familiar with the use of electronic materials and have seen the implementation of the e-learning system and were given one week familiarization of the system flow and navigation. During the training, students were given examinations which were administered every three weeks to determine their knowledge level of the course.

Initially, the students were given the same module which would level the stage were the lessons were sequentially presented. To pass the course, the students were required to complete several assessment tasks during the study period, take a final examination and must have a minimum overall aggregate score of 75. If the student fails, a reinforcement process will be given to the students to remediate the learning difficulty.

Prior to implementation, students were informed about the research and the task involved. Students had time to navigate the e-learning system to familiarize and be directly involved in the learning process. Participation in the study was strictly voluntary and students who chose not to participate were permitted to work on course assignments and course handouts/lectures. Also, students were discouraged not to take down notes and directed to pay attention to the lesson at hand, but the students could review lessons in the course module several times. If some issues arouse during the learning process, the researcher provided necessary assistance in support for blended learning. At the end of the lesson, participants were directed to practice the module (formative assessment).

3.2 Software Requirements

To meet the recommended system requirements, for the features and functionalities of the e-learning prototype, the following were used:

3.2.1 XAMPP

XAMPP is a free package of web services developed by Apache Friends. The package is cross-platform, so it can work in Windows, Mac OS X, Solaris and Linux. It was originally designed as a development application, so that people could test their scripts, codes and websites on their own computers without the need of an external server using all the services needed. The package supports and includes the following:

+ Apache 2.2.11
+ MySQL 5.1.33 (Community Server)

+ PHP 5.2.9 + PEAR (Support for PHP 4 has been discontinued)
+ XAMPP Control Version 2.5 from www.nat32.com
+ XAMPP CLI Bundle 1.3 from Carsten Wiedmann
+ XAMPP Security 1.0
+ SQLite 2.8.15
+ OpenSSL 0.9.8i
+ phpMyAdmin 3.1.3.1
+ ADOdb 5.06a
+ Mercury Mail Transport System v4.62
+ FileZilla FTP Server 0.9.31
+ Webalizer 2.01-10
+ Zend Optimizer 3.3.0
+ eAccelerator 0.9.5.3 für PHP 5.2.9 (but not activated in the php.ini)

3.1.2 Personal Computer

+Microsoft Windows 7 or later
+Google Chrome 28
+64 bit Operating System

3.1.3 Redactor

Redactor is powerful, flexible, and easy to use tool. It provides great service without the clients spending expensive time on complex customization. Most features work out of the box (library package) and are customizable with literally a line of code. This was used primarily in the design of assessments that cater 12 question types. It customized the toolbars, used to drag and drop the images needed for the assessments, and linking explanation facilities to specific lessons.

3.3 Population and Sampling

Forty-one (41) students who were enrolled participated in the experimental study. A special arrangement or permission was granted by the Head and the Dean of the

Department of Computer Science so that students can participate in the said study. Out of the selected 41 students, 22 males and 19 females voluntarily opted to use the e-learning course. The students are third and fourth year undergraduate students.

Direct observations of every individual in the population cannot be made by the researchers. Instead, data from a subset of individuals – a sample – were collected and observations were made to make inferences about the entire population. Ideally, the sample corresponds to the larger population on the characteristic(s) of interest. In this case, the researcher's conclusions from the sample are applicable to the entire population. In establishing the overall acceptability of the software and critical even recall, a survey with purposive sampling was used. All students in the study participated in the survey.

Non-probability sampling was used to survey the computing software acceptability and internal consistency of the software and questionnaires. The composition of the professional staff is as follows: four in the managerial level (all PhD holders), six teaching staff (three PhD holders and three Masters degree holders) and two staff members from the University Technical Department which maintain the University portal. Population elements were selected on the basis of their availability or because of the researcher's personal judgment that they were representative of the entire population. One of the most common types of non-probability sample is called a convenience sample – not because such samples are necessarily easy to recruit, but because these individuals are readily available and therefore there is no need to select from the entire population.

3.4 Research Design

The central role of research design is to minimize the chance of drawing incorrect causal inferences from data. Design is a logical task undertaken to ensure that questions can be answered by the evidence collected or to test theories as clearly as possible. In this study, both descriptive and experimental designs were used.

3.4.1 Descriptive Design

This design also provides rich descriptive details about people, objects, and other phenomena. It often involves extensive observation and note-taking, as well as in-depth narrative. It does not lend itself to in-depth analysis or hypothesis testing. However, a descriptive research design can serve as a first step to identify important factors and laying a foundation for a more rigorous research.

3.4.1.1 Learning Content

The content of the e-learning materials has been used and is the product of five-year teaching. This has also been improved for the purpose of creating an e-learning prototype. There are 12 lessons with 65 subsections. The course contents were specifically designed for the students. Their backgrounds and communication problems were considered, making the content more focused in problem solving and application types of discussion. Aside from the lessons and discussion of the subsections, twenty four (24) interactive MHTML files, seven (7) embedded videos, fourteen (14) simulations, twenty two (22) PowerPoint, forty five (45) PDF files, twenty two (22) words files, sixteen

(16) executable files, sixteen (16) source codes and two (2) excel files were used. Figure 3.1 shows the components of the learning design. The overall design of the learning materials follows the concepts and implementation on the work of Ballera and Elssaedi (2013). Different principles were used in e-learning development such as the principles of using audios, sounds, and text presentation as discussed by Mayer and Clark (2003). This study made use of the modified Bloom cognitive taxonomy by Churches (2008).

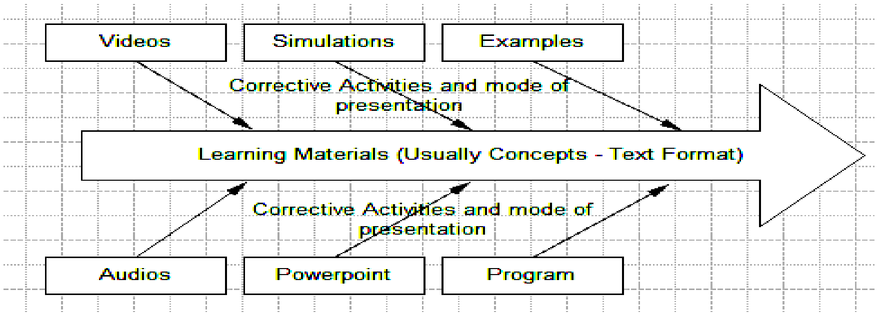

Figure 3.1: Component of Learning Materials

3.4.1.2 Syllabus

The syllabus content was approved by the University Quality Assurance Office (QA). Likewise, the content was approved by the Syllabus Committee of the Department of Computer Science. The original passing competency level is 50, but this was changed to 75 in consonance with the certification competency (CISCO, 2012). Activities and deliverables both for blended learning and online are specifically stipulated in the syllabus.

3.4.1.3 Item Bank and Assessment Design

The item bank is a repository of different question types with varying difficulty level. It contains 280 questions with explanation facilities divided among twelve (12) question types and are used to produce the Bloom Cognitive Taxonomy examination, the random formative examination, and the random summative examination. Questions were formulated and designed using the Bloom Cognitive Taxonomy Schema. The following were the designed question types stored in the Item Bank database: Complex Single Multiple Choice Questions (CSMA), Fill-in the Blanks and Enumeration Questions (FIBE), Matching and Categorization Questions (MTCQ), Matrix Completion Questions (MCOQ), Multiple Alternative Questions (MALT), Multiple Choice with Illustrative Diagrams (MCID), Multiple Choice and Multiple Answer Questions (MCMA), Multiple True or False Questions (MATF), Single Answer Multiple Choice Questions (SAMC), Single Numerical Construction Question(SNCQ), Situational Multiple Choice Question (SMCQ), and True or False Questions (TOFQ).

3.4.2 Experimental Design

Experimental designs are often touted as the most "rigorous" of all research designs or, as the "gold standard" which all other designs are judged. Experiment is the strongest design with respect to internal validity. In this study, it determines whether the prototype was able to personalize the learning sequence, and implement mastery and reinforcement learning which hypothetically could lead to higher learning benefits. To validate and answer the research questions, an e-learning prototype was developed and implemented which was capable of producing conclusive data about the Bloom Cognitive Taxonomy, dynamically populate performance matrices for student profiles, capable of recommending personalized learning sequence, and perform mastery and reinforcements. To recommend a personalized learning sequence, several formulas have been developed to formulate the fitness function. These formulas were developed and incorporated to the e-learning system.

3.4.2.1 Bloom Cognitive Taxonomy

The Bloom Cognitive Taxonomy measures the cognitive performance of the students. Sixty questions for Bloom was created using the Bloom Taxonomy Schema. These questions are readily available in the Item Bank in the database. The examinations were divided into six categories to facilitate six phases of Bloom Taxonomy and were taken four times throughout the study. The examination is activated to measure the improvement of students as the training neared its end. The e-learning prototype shows the graphs of both individual and overall class average performance.

3.4.2.2 Reinforcement Metrics

Based on the students' performance, the system dynamically activated and recommended the reinforcement process of students. The system suggested a number of files or activities based on the reinforcement rules fired in the system. The lower the fitness value was, the more files were activated. Reinforcement files were presented in various media formats. There were 60 rules coded in the program, with 78 reinforcement files.

3.4.2.3 Examination

Aside from the Bloom Cognitive diagnostic examination, two examinations were given namely the formative or practice and summative or final. During the formative examination, the system imposed several controlling mechanisms to guarantee learning of the materials, while the summative examination varied according to the time spent by the students in reading the materials. No two students could have the same set of questions. The summative examination varied according to the level of reinforcements. The higher the reinforcement, the smaller the number of questions was generated for the summative examination. The Bloom Taxonomy is a sixty item (60) question, equally divided among six categories. Initially, the summative examination is composed of sixty items, proportional to the time allotted in reading the materials then varies accordingly as the reinforcement process increased.

3.5 Data Collection Methods

In this study, primary data were collected in two ways. The first is the experimental collection where various tables were populated dynamically, manipulated, and extracted to generate several reports. Examination results, graphs, frequency of the practice, and reinforcement process were recorded in the system. The second was the survey which collected after the training. Two surveys were conducted in the study. The first survey was used to collect the evaluation of the features and functionality of the system and its internal consistency by the academic staff and IT professional. The survey was conducted prior to implementation to reflect on the students views, comments or suggestions. The second survey was used to collect demography, overall acceptability in terms of e-learning prototype's features and functionality, and theme extraction of students who experienced and used the system. The data were collected after the training. All the questions in the survey were checked and revised accordingly.

According to Kumar (2013), surveys are concerned with describing, analyzing, recording, and interpreting conditions that exist or existed. Surveys are only concerned with conditions or relationships that exist, opinions that are held, processes that are going on, effects that are evident or trends that are developing. They are primarily concerned with present but at times do consider past events and influences as they relate to current conditions.

3.6 Statistical Treatment and Theme Analysis

To determine the learning benefits and outcomes of the study, several statistical treatment and data analysis were employed.

3.6.1 Z-Test

A z-test is a statistical test used to determine whether two population means are different when the variances are known and the sample size is large. The reason the *z*-test works is that the sum of normally distributed random variables is also normally distributed. Z-tests are performed in cases where the underlying population is not normal and if n is large (above 30) and the population variance is known (Messy & Miller, 2013).

Equation 3.1: Population Variance is the formula in computing the sample variance where x_i corresponds to each observation in the sample, and x,¯ the mean of the sample.

$$s^2 = \frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n-1}$$

Equation 3.2: Z-Test**,** is used to test a hypothesis with given significance level α, the critical value of *z* is calculated and checked whether it is in the critical region. Most often, the tests involve α = *:*05.

$$z = \frac{x-\mu}{s^2 / \sqrt{n}}$$

During the survey, reliability and acceptability (staff survey) of the system were using Likert Scale of 1 to 5 while the same formula (Equation 3.2) was used to evaluate features and functionality of the students (Trochim, 2006). To test if the results were statistically significant the following hypotheses were:

***H_1: μ* < 4** (student average agree with the system features)

***H_0: μ* ≥ 4** (student average does not agree with the system)

In one tailed, the null hypothesis is rejected if $z \geq z_\alpha$ (if the hypothesis is right-handed) or if $z \leq z_\alpha$ (if the hypothesis is left-handed). The most common *z*-values use is $z_{:05}$ = 1*:*645. The hypothesis μ=4 was tested whether all respondents agree with the features, functionality, level of acceptability and reliability of the system according to the Likert scale.

3.6.2 Cronbach's Alpha

Cronbach's alpha provides a useful lower bound on reliability and measures internal consistency. It generally increases when the correlations between the items increase. Alpha coefficient measures the internal consistency of the system. Its maximum value is 1, and usually its minimum value is 0. A commonly-accepted rule of thumb is that an alpha of 0.6 indicates acceptable reliability and 0.7 or higher indicates good reliability. (George & Mallery, 2003; Vehkalahti, Puntanen & Tarkhonen, 2006; Tavakol & Dennick, 2011).

Equation 3.3: Crobach's Alpha is used to measure the internal consistency and acceptability of all the system questionnaires stored in the Item Bank, the content and features of the e-learning prototype. In particular, it was used for testing with a score between 0 and 1. The formula is given by Equation 3.3.

$$\alpha = \frac{k}{k-1}(1 - \frac{\sum_{j=1}^{k} \mathrm{var}(\mathrm{x}_j)}{\mathrm{var}(x_0)})$$

3.6.3 Theme Analysis: Sentiment and Theme Extraction

To correlate the results of the Bloom's cognitive examination, theme extraction using a special software called Semantria was used to analyze the digital transcripts of the students. The students were requested to write a report in one or two sentences about their experiences and perceptions in using the system and the new learning delivery. In particular, the respondents did the following: gave simple summary of actions they had done as part of their participation, proposed and discussed some strategies that could be applied in a situation, stated the topics for which they got assistance, examples and topics that were products of their work, and finally provided their personal reflection and experiences in participating in the exploratory study.

Semantria software extracts themes using the digital transcript of the students taken from the survey to determine and follow trends that appear over a period of time. Themes are noun phrases extracted from text and are the primary means of identifying the main ideas within the digital transcript. In addition, Semantria assigns a sentiment score to each extracted theme to understand the tone behind the themes.

After the digital transcript was sent to Semantria, the engine identified the basic parts of speech called POS tags. Figure 3.2 demonstrates how two simultaneous steps occur:

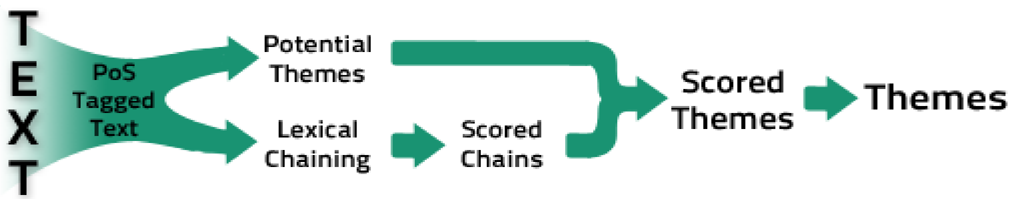

Figure 3.2: Theme Extraction (Semantria, 2014)

i. Potential themes are extracted from POS tags and kept for scoring. A process called <u>Lexical Chaining</u> occurs, which involves linking sentences through nouns that are synonyms or otherwise related to each other. In this way, Semantria is able to establish a conceptual chain in the content.

ii. Once the Lexical Chaining and Potential Theme Extraction steps are finished, each theme is scored based on Semantria's algorithms. Potential themes that belong to the highest Lexical Chain are assigned the highest score. The algorithm also takes context and noun-phrase placement into account when scoring themes. If there are fewer than four chains in the given text, the algorithm reverts to scoring purely based on count.

Chapter 4

RESULTS AND DISCUSSION

This chapter presents the discussion of the results and presented according to the sequence of the objectives stated in Chapter 1. The study was conducted at College of Saint Paul II College of Arts and Science, particularly the 3rd student of Bachelor of Science in Computer Science. At first, this chapter discusses the summary of the demographic profiles of the students, the pre-survey results using Cronbach's alpha, the post survey acceptability of the prototype system's features and functionality, and the various experimental results which were derived from e-learning prototype. This also includes the discussion of the Bloom Cognitive assessment and its correlation to theme extraction using a special software called Semantria.

Some of the results presented in this section are structured and customized for discussion which can be verified in the appendices of this thesis or in the e-learning prototype. The extracted data in the different tables of the database were obtained dynamically during the learning process. In-depth analyses of the results are included to reflect the researcher's views, opinions and observations with which were strengthened and justified from the various scientific output and scholarly published materials. The discussion and analyses of the results are presented in accordance to the sequence of statement of objectives.

4.1 Respondents

Out of the 41 students surveyed, 38 returned the post survey questionnaires; six were males and 32 were females. There were twenty- eight fourth year students and 10 were in third year. These 10 students passed already the course prerequisite. The average age of the respondents was 19.2 years old with a standard deviation of 1.6. All the respondent owned electronic devices at home and had access to the Internet. Twenty (20) had personal computer, laptops and computer tabs while 10 had personal computers only, and eight had used laptop. Thirty-eight (38) respondents out of 41 returned the survey forms, and they were asked about their internet connectivity in the preliminary questions. Results show that 100% of the respondents have access to the internet via different mediums. The students were able to access the learning modules anywhere, anytime at their own convenience and time disposal.

4.2 E-learning Framework

Numerous models for curriculum changes in technology education have been implemented. This easily leads to a situation of constructive phase, followed immediately by the planning phase. This does not give enough time for conceptualization, ideation, and the evaluation of ideas. Good design and planning are very crucial to classroom-based learning program, and even more in e-learning design. In traditional learning, the most important factor to consider is the delivery of learning, whereas in e-learning, the instructional design and development of structured material can be used several times and be shared by multiple learners using varied technology.

The e-learning framework of the study is shown in Figure 4.1. It shows that technology is the central driving force of the framework. Without it, e-learning will not exist. The framework is divided into three modules: the instructional module, the social context module, and the assessment module. The instructional content module includes integration of multiple components such as content analysis and sequencing, personalization support mechanism, and the use of digital media. The social module supports the use of social network media and collaboration while the assessment module includes test and practice module, performance parameters, and profiling.

In the content module, different tools can be used to produce e-learning content, depending on which file formats will be used and how the end product will look like. Static documents such as PowerPoint and Microsoft documents can be used as simple learning resources and can be interactive if added with more sophisticated tools such as animation, videos, graphics, and simulations. Applying available courseware authoring tools and the use of graphics, text, and other media not only entice learning, but also provide a framework to organize pages and lessons for reliable navigation.

In social content module of the framework, e-learning activities can be realized by using range of communication tools – both synchronous and asynchronous. In asynchronous, tools such as e-mail, discussion forum, blogs and wikis are more appropriate tools. In the prototype, Skype, Yahoo Messenger, Windows Live Messenger, FaceBook, DropBox and TeamViewer are readily available. The concept of collaboration and team building and the use of social media is not part of the present study but worthy to mention for future use and analysis.

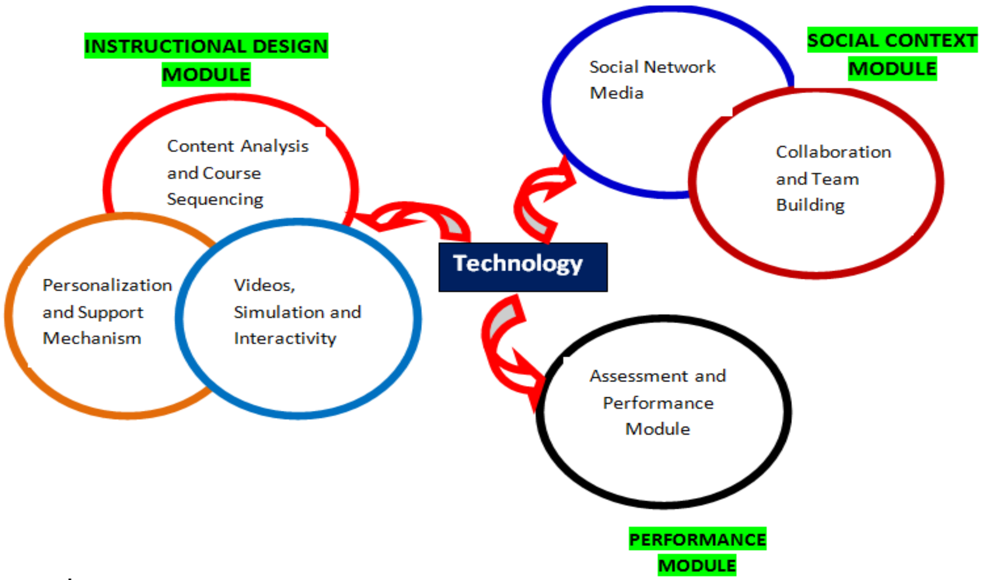

Figure 4.1: E-learning Framework of Tertiary Curriculum
(Source: Ballera & Elssaedi, 2013)

The performance module consists of assessment and various records of performance indicators. There were three examinations used in the study: the Bloom cognitive examination, the formative examination, and the summative examination. Mechanisms on how it dynamically populates different tables to generate reports are the main concern of this module. The assessment module can help to monitor the performance of the students and can be further used for profiling and personalizing the e-learning system.

4.3 E-learning Strategy

To support the e-learning framework discussed in the previous section, an e-learning strategy must be developed. One important element of deciding and defining e-learning strategy is the use of instructional model. It is the practice of creating "instructional experiences" which makes the acquisition of knowledge and skill more efficient, effective, and appealing.

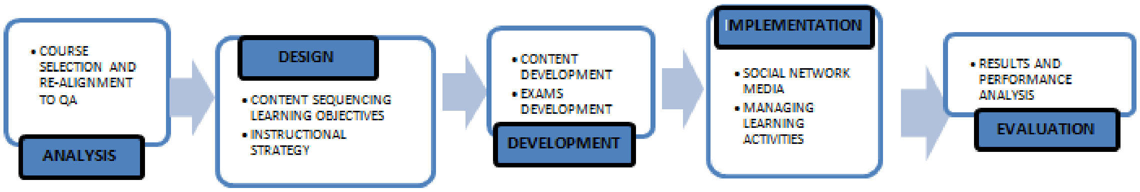

Figure 4.2: The ADDIE Model for College of Saint Paul College of Arts and Sciences
(Source: Ballera & Elssaedi, 2013)

Figure 4.2 shows the ADDIE model composed of Analysis, Design, Development, Implementation and Evaluation. The model has been adapted based on its wide acceptability and use. The model has eight strategies, and these are distributed among the five phases of the ADDIE model.

i. *Course selection and Re-alignment from QA* – The course Design and Analysis of Algorithm was personally chosen by the researcher because of his 10-year experience in teaching the course. The QA approved the implementation.

ii. *Content Sequencing and Learning Objectives* – The content sequence of the course was approved by the QA in consultation with IT Staff. The identified contents together with corresponding objectives were debated upon and discussed by the cluster members. The contents were identified according to necessity, time constraints, pre-requisites, overlapping issues, and incremental learning. Content analysis shows specific learning objectives and curriculum outline based on the set requirements from the quality assurance group. This can be done by applying two methods: topic analysis and objective analysis. Topic analysis was used to identify and classify the course content while the objective analysis shows what and how the learner should learn. It also shows what and how are skills going to be developed or improved from each topic.

iii. *Instructional Strategy* **–** In designing the instructional strategy of the e-learning prototype, three strategies were considered; expository, application, and collaborative. The expository methods were in the form of static content such as documents and PowerPoint and interactive lessons. Proven examples with theory and illustrations of how a task can be performed using videos with a step-by-step demonstrated procedure were also considered. Application method allows learners to practice the demonstrated procedure by either modifying the inputs, doing the same procedure, and allowing the learners to take control with the application. Situational case-based exercises improve critical thinking skills by asking learners to apply knowledge and principles to the problem at hand. The collaborative method, on other hand, allows learners to have different kinds of activities such as discussion of online assignments and one-on-one tutoring. In the prototype, collaborative method is not included in the analysis although this is already considered as features of the system. This part can be analyzed for future works.

iv. *Content Development* **–** After reviewing the course syllabus, topics, and objectives, content development was considered. The primary focus of this strategy is the development of learning materials. A major challenge which providers of e-learning face is the provision of meaningful courseware that is responsive to learners and which allows them to actively participate in the learning process. It is believed by many educational strategists that a system that allows “learning by doing” arouses interest, generates motivation and provides more engaging experience for the learners. It deepens learning because students can hypothesize to test their understanding, learn by mistakes and make sense of the unexpected.

v. *Examination Development* **–** Questionnaires are developed using the Bloom Cognitive Schema found in Appendix C. These questionnaires were subjected to Cronbach’s alpha analysis for its internal consistency. There were 280 questions stored in the Item Bank database that can be readily accessed for the three examinations: Bloom, formative, and summative examination.

vi. *Social Network Media* **-** The rapid diffusion of social media enables users to connect with people than ever before. Students use social media at school for various purposes such as communicating, exchanging information, sharing personal experiences, and collaborating with each another. The use of social media provides a strong social component that allows the learners to work together and collaborate. However, in the prototype, these features have no bearing with the results of the study but were only added as features intended for future research works.

vii. *Managing Learning Contents* – Various mechanism in managing the contents were incorporated in the prototype to avoid navigational lost, cascading window problem, and concept overloading. Student were not allowed to open another examination if they did not pass the previous examination. They could not load examination without reviewing since the system compelled the students to study. They could not load another lesson while another lesson was open. The system also provides feedback and explanations, activated and deactivated, and of course managed the personalization and reinforcement process.

viii. *Results and Performance Analysis* – The prototype was capable of generating several reports that showed class and individual performance. The graph for cognitive development for both individual and class standing was just a mouse click away and easily generated. The final results before and after were stored in the database for generating the students' performance analysis. Trials, formative or practice results were all stored in the database. Personalized learning sequence, reinforcement files, and reinforcement level for all students could be viewed for further analysis.

4.4 Assessment Design

With dynamic visuals, sound, and user interactivity as well as adaptivity to individual test-takers and near real-time score reporting, this computer-based assessment vastly expands the testing possibilities beyond the limitations of traditional paper-and-pen tests. Through these and other technological innovations, an e-learning-based platform offers the potential for high quality formative assessment that can closely match instructional activities and goals, makes meaningful contributions to the educational delivery, and perhaps offer instructive comparisons with large scale or summative tests (Hanna & Dettmer, 2004). With the digital revolutions, it seems that technology is poised to take advantage of these new frontiers for innovation in assessment. It brings forward rich new assessment tasks and potentially powerful scoring, reporting, and real-time feedback mechanisms which can be used by the teachers and students.

One potential limitation in maximizing the benefits of computer-based assessment is the designing of questions and tasks with which computers can effectively interact, including scoring and score reporting. The question type task that is currently dominating large-scale computer-based testing and many e-learning assessments is the standard multiple-choice question, which generally includes a prompt, followed by a small set of responses from which students are expected to select the best choice. According to some researchers, ubiquitous multiple-choice testing sometimes encourages “poor attitudes toward learning and incorrect inferences about its purposes. For example, it gives the idea that there is only one right answer, and that the right answer rests solely on the teacher or test maker, and that the job of the student is to get the answer by “guessing” (Bennett, 1993, p. 24). Some cognitive theorists argue that the multiple-choice format presumes, often without sufficient basis, that complex skills can be decomposed. Moreover, some critics maintain that in practice, this format over-relies on well-structured problems with algorithmic solutions and that in theory, it builds on a view of learning that knowledge is additive rather than integrative of developing knowledge structures. This kind of task is readily scorable and offers some attractive features as an assessment format. However, if e-learning developers adopt this format as the lone focus of assessment formats in this emerging field, much of the computer platform’s potential for rich and embedded assessment can be sacrificed.

Table 4.1 shows the 12 question types which were developed to enhance assessment. There were 280 questions stored in the Item Bank database ready for various assessments and grouped according to question types. Questions were formulated according to the questionnaire schema of Bloom Cogntive Taxonomy. In the Item Bank, questions were coded according to question types and question number, e.g. CSMA1 is a Complex Single Multiple Choice Question type question number 1.

Table 4.1: Twelve Question Types in the Item Bank

Code	Description
CSMA	Complex Single Multiple Choice Questions
FIBE	Fill-in the Blanks and Enumeration Question
MTCQ	Matching and Categorization Question
MCOQ	Matrix Completion Question
MALT	Multiple Aletrantive Question
MCID	Multiple Choice with Illustrative Diagram
MCMA	Multiple Choice and Multiple Answer Question
MATF	Multiple True or False Question
SAMC	Single Answer Multiple Question
SNCQ	Single Numerical Construction Question
SMCQ	Situational Multiple Choice Question
TOFQ	True or False Question

4.4.1 True or False Questions

Items that required an examinee to choose an answer from a small set of response options fall into the first column of the Taxonomy table, which was the multiple choice category.

TOFQ7. A function $t\,(n)$ is said to be in $O(g(n))$, denoted $t\,(n) \in O(g(n))$, if $t\,(n)$ is bounded below by some constant multiple of $g(n)$ for all large n, i.e., if there exist some positive constant c and some nonnegative integer n_0.

[ ] True
[√] False

Figure 4.3: True or False Example

These include the simplest selected response item types that offered only two choices, such as simple true/false items. Example as shown in Figure 4.3, respondents were asked whether a function t(n) was bounded, given a condition true or false. The correct answer in this case was *False*. Making a selection between "*yes or true*" and "*no or false*" for a given statement is one of the simplest and most constrained selected choice formats.

4.4.2 Alternative Choice Questions

Alternate choice items are similar to true/false items; however, rather than asking whether a single statement is correct or not, alternate choice offers two statements and asks the respondent to select the better option. Choices are often scenarios or cases, as shown Figure 4.4. In this type, students were shown two possible algorithmic models for computing their running time complexity and must choose the most accurate response option. In this case, the correct answer was the second option due to its simplicity.

MALT2. Evaluate the 2 codes below and determine which one is better? Used 99, 6, 0, 89, 30 as test data.

ALGORITHM 1

```
for i ← 1 to n − 1 do
    v ← A[i]
    j ← i − 1
    while j ≥ 0 and A[j] > v do
        A[j + 1] ← A[j]
        j ← j − 1
    A[j + 1] ← v
```

ALGORITHM 2

```
for i ← 1 to n − 1 do
    j ← i − 1
    while j ≥ 0 and A[j] > A[j + 1] do
        swap(A[j], A[j + 1])
        j ← j − 1
```

[ ] Algorithm 1 runs at $O(n^2)$ with 7 lines, the criteria of analyzing algorithm in this case uses simplicity and readability. Tracing back using the test data is straightforward however line 3 and line 6 repeatedly executed.

[ ] Algorithm 2 runs at $O(n^2)$ with 5 lines. It eliminates redundancy and straight forward mechanism. Thus it is better to implement and simple.

Figure 4.4: Alternate Choice Example

4.4.3 Single Answer Multiple Choice Questions

In a question type where the available choices from which to select answers increase beyond two, Type 1C items are generated, which are the conventional or standard multiple choice questions with usually four or five distractors and a single correct option.

SAMC7. What is the equivalent of $\lceil \log (n + 1) \rceil$?

a. $\lfloor \log n \rfloor + 1$
b. $\lfloor \log n \rfloor - 1$
c. $\lfloor \log n \rfloor * 1$
d. $\lceil \log n \rceil + 1$

Figure 4.5: Single Answer Multiple Choice Example

The example presented in Figure 4.5 shows a list of logarithmic functions that is likely equivalent to ceiling function of log (n + 1). The answer required understanding of logarithmic law and simplifications thus the answer was *Option A*.

4.4.4 Multiple Choice with Illustrative Diagrams

Innovations in the multiple-choice category for online settings can include new response actions not common in paper-and-pen settings, such as clicking on an area of a graphical image. It can also include new media, such as sound clips which can be considered as destructors. Such new media innovations are represented in Multiple Choice with Illustrative Diagrams. An example is given in Figure 4.6.

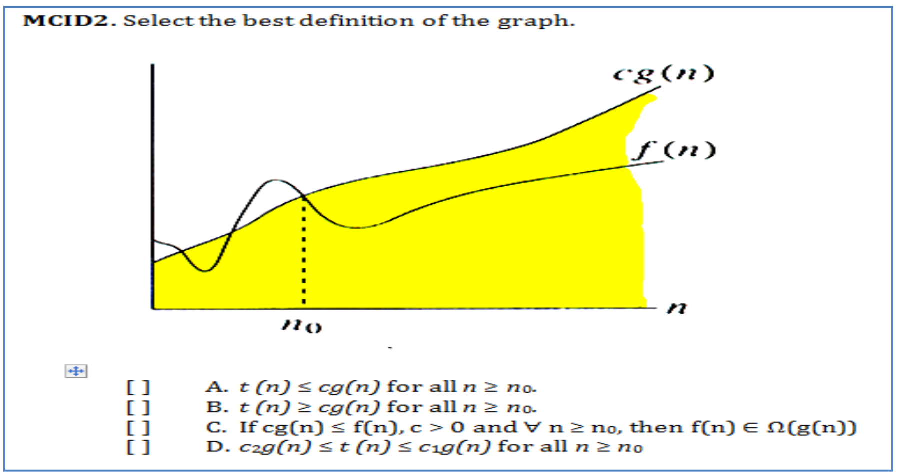

Figure 4.6: Multiple Choice with Illustrative Diagrams Example

In this example, respondents must select one of the four choices that corresponded to the meaning of the graph. There were four choices to choose from. This is analogous to the standard multiple choice question with four possible responses and one correct choice, but with the mode of response involving analysis.

4.4.5 Multiple True or False Questions

Multiple true-false (MATF) is really an item set, or item bundle, that offers the advantage of administering many items in a short period of time. But this type has a single score over many items so that guessing is controlled within the item group. It is unlikely for a respondent to randomly guess a consistently correct over a set of items.

MATF6. Which of the following statements are True or False about criteria asymptotic notations. Select all that apply.

True	False	
[ ]	[ ]	A. Big-Oh(O) notation, $t(n) \leq cg(n)$ for all $n \geq n_0$
[ ]	[ ]	B. $O(x^4) \approx 6x^4 - 2x^3 + 5$
[ ]	[ ]	C. Omega (Ω) notation, $t(n) \geq cg(n)$ for all $n \leq n_0$
[ ]	[ ]	D. $\Omega(n)$ could be n, log n, n/1000
[ ]	[ ]	E. Thetha (Θ) notation , $c_2 g(n) \leq t(n) \leq c_1 g(n)$ for all $n \geq n_0$

Figure 4.7: Multiple True or False Example

The example given in Figure 4.7 lists the possible criteria of asymptotic notations. In this example, the key to a successful answer was understanding asymptotic notations of computer codes. Thus, for each choice, it was necessary to examine whether it conformed to one of the rules in computing time complexity. This ruled out answers A, B and E, as the true statements to select while C and D were the false statements.

4.4.6 Multiple Choice and Multiple Answer Questions

Selection/identification category is the multiple answer or format, which includes, for example, an examination item that prompts examinees to select all of the elements listed that are factual statements about the greatest common divisor (GCD). The example shown in Figure 4.8 involves options 1, 2 and 3 as the correct answers.

MCMA1. Which of the facts about greatest common divisor algorithm are true. Select all that apply by using checkbox.

- [√] Euclid algorithm stop at m=0 which guarantees that the second integer gets smaller with each iteration and cannot become negative
- [√] The integer checking algorithm for GCD will not work if one of its input is 0
- [√] The Sieve of Erathosthenes is adapted to find the prime factors of n and m in Middle School algorithm
- [x] The integer checking algorithm allow negative number for n and m
- [x] Middle School Algorithm allow 1 as a prime number for special case.

Figure 4.8: Multiple Choice and Multiple Answer Example

4.4.7 Complex Single Multiple Choice Questions

The final type shown in this category Selection/Identification is the complex multiple choice, in which combinations of correct answers are offered as distracters.

CSMA1. The following are important problem types in analysis of algorithm except:

A. Searching, string processing, graphs problems, numerical problems
B. Searching, graph problems, numerical problems, combinatorial problems
C. Combinatorial problems, numerical problems, geometric, sorting problems
D. Mathematical problems, numerical problems, geometric, sorting problems

.

Figure 4.9: Complex Single Multiple Example

The example shown in Figure 4.9 involves different problem types where almost all of the choices are similar, thus involving analysis. Examinees with better test-taking skills think of one option as absolutely correct or incorrect to eliminate distracters and improve their guessing ability.

4.4.8 Matching and Categorization Questions

Given the richness of media inclusion and possible new response actions in computer environments, sequencing and ranking have become popular in courseware activities in computer environments.

MTCQ2. Match the asymptotic notations from the left given the following summation rule and enter to the input box provided

[ ] $\sum_{i=1}^{n} 1$	A. linear
[ ] $\sum_{i=1}^{n} n$	B. Quadratic
[ ] $\sum_{i=1}^{n} i^2$	A. n^4
[ ] $\sum_{i=1}^{n} i^3$	B. cubic

Figure 4.10: Matching and Categorization Example

Figure 4.10, involves simple pair matching of item stems on the left of the screen with a set of possible responses on the right. This matching item type is a popular format in classroom-based assessment but rare in large-scale testing programs. Choices on the left should be simplified before determining which statement on the right corresponds to correct answers, thus it involves analysis and computation. This lessens guessing and can increase the performance and problem solving skill. It is recommended that such items be continuously used as a variation of conventional multiple-choice since they are easy to construct and administer. They lend themselves to testing associations, definitions and examples. They are efficient in space, have options which do not have to be repeated. Limitations for this matching type come with item-writing traps that are easy to fall into, including non-homogeneous options, such as mixing sets of things, people and places. This type of matching type also provides equal numbers of items and options, both of which make guessing easier and can bring test-taking skills into play as a nuisance, or unwanted dimension of performance.

4.4.9 Single Numerical Construction Questions

The completion category asked respondents to finish an incomplete stimulus like what is shown in Figure 4.11. Item types include single numerical constructed items, short-answer and sentence completion. Type 5A is the single numerical constructed item type, which asked examinees to calculate/simulate and supply a desired number.

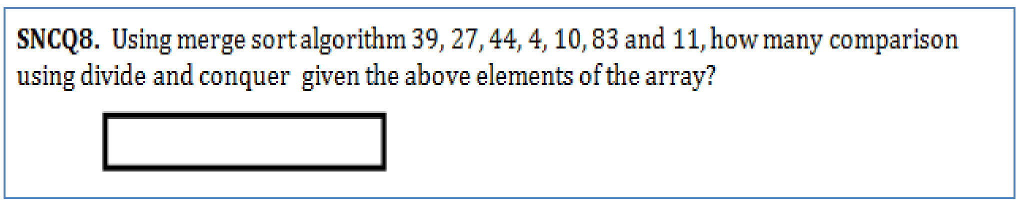
SNCQ8. Using merge sort algorithm 39, 27, 44, 4, 10, 83 and 11, how many comparison using divide and conquer given the above elements of the array?

Figure 4.11: Single Numerical Short Answer Example

This item format was once assumed to be best for low task complexity but this seems perhaps an unnecessary limitation as items demanding complex problem-solving, strategy selection and solution construction can result into a single, well-defined numerical answers. This is how the item type is often used in the classroom, although often with the specification that students show their work so that the problem-solving process is more clearly elucidated for partial credit scoring and learning intervention. This is also to discourage guessing without problem solving.

4.4.10 Fill-in the Blanks and Enumeration Questions

Short-answer and sentence completion is sometimes called the fill-in-the-blank format. In this example, as given in Figure 4.12, students were asked to name what criteria in algorithm analysis maximizes visits of different cities. The correct answer is “optimization.” The format mainly tests factual recall, as the respondent is only allowed to supply a word or short phrase. However, it seems reasonable that computer-based approaches can perhaps allow for more scoring options. In other words, an expanded outcome space, since an extensive databank of acceptable responses can be built to allows for richer use of the item.

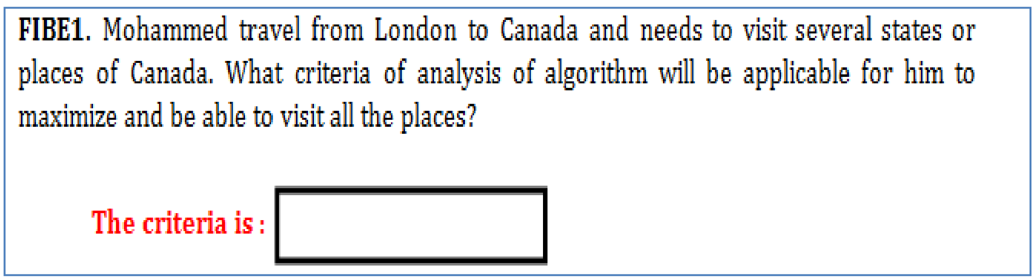

Figure 4.12: Fill-in the Blanks and Enumeration Example

Short answer items are presumed to reduce guessing, but there is little research to support this point. Item writing can be a big challenge in this type. Not only can the outcome space be too narrowly constructed, so as to allow for high guessing rates, but it also can be too widely conceived so that the student’s answer is correct but remains quite off the topic from what is expected, or what is being measured. This is where computer-based approaches that attempt to capture and categorize or analyze a range of empirical responses may make the item type more valuable.

4.4.11 Matrix Completion Questions

Type 5D, the matrix completion format, presents a matrix of patterns with one or more cells left blank. Respondents were asked to fill the empty cells from a set of supplied answers. Matrix completion has an extensive history in intelligence measurement and has been used in various tests of pattern recognition, correspondence, and generation (Embretson, 2002).

MCOQ1. The Tower of Hanoi is a mathematical game or puzzle. It consists of three rods, and a number of disks of different sizes which can slide onto any rod. The puzzle starts with the disks in a neat stack in ascending order of size on one rod, the smallest at the top, thus making a conical shape. The objective of the puzzle is to move the entire stack to another rod, obeying the following simple rules:

a. Only one disk may be moved at a time.
b. Each move consists of taking the upper disk from one of the stacks and placing it on top of another stack.
c. No disk may be placed on top of a smaller disk.

Complete the table from given n = 7?

n	1	2	3	4	5	6	7
M(n)	1	3	7	15	31	63	

127

Figure 4.13: Matrix Completion Example

The matrix is a table or spreadsheet of correct patterns, which can be in the form of graphics, words or numbers, as well as sound clips, film clips, and animations. These are dragged to the appropriate empty cells. The item type allows for a great deal of flexibility in the task assignment, openness of response and media inclusion, and is readily computer-scorable, making it potentially powerful item type in computer environments. It can be seen that depending on what is called for in matrix completion, the matrix type can fall into a number of categories. These are reordering, substitution and construction, as well as simple completion. Thus, this type blurs the lines of the constraint-based item taxonomy. Domain-specific matrix completion tasks may be among the families of innovation most ripe for computer based applications such as shown in Figure 4.13.

4.4.12 Situational Multiple Choice Questions

The first item type listed in the construction category of the item Taxonomy is the situational multiple choice similar to a typical multiple choice, only this time with some level of complexity.

SMCQ7. How is factorial problem similar to Tower of Hanoi, given that Factorial, $F(n) = F(n-1)\ (n)$ *for* $n > 0$ and Tower of Hanoi, $M(n) = 2M(n-1) + 1$ *for* $n > 1$.

[ ] A. The time of factorial is linear while Tower of Hanoi is 2^n-1
[ ] B. They both used backward substitution to solve recurrences and mathematical induction.
[ ] C. The time of factorial is linear while Tower of Hanoi is exponential
[ ] D. Factorial is recursive while Tower of Hanoi is not a recursive problem

Figure 4.14: Situational Multiple Choice Example

The scenarios or situational problems were given to provide in- depth analysis. Rather than having students originate and provide some portion of the answer to the question, selection choices were provided. Students were required to analyze a situation before choosing an appropriate answer. An example of this type is shown in Figure 4.14.

4.5 Bloom Taxonomy and Degree of Difficulty

The 12 question types presented in section 4.4 were categorized according to the Cognitive Bloom Taxonomy. Table 4.2 shows the question types description and the degree of difficulty *df*, for each type in different assessment formats. In formative assessment, the *df* is 1 for reviewing purposes and practice at the end of each lesson. The *df* of Bloom Cognitive examination on the other hand is also 1, to measure the cognitive improvements of the learner which is usually administered every three weeks of the training.

Table 4.2: Questions Types and their Degree of Difficulty (df)

Bloom Taxonomy *(Category)*	Question Types	Description	Formative Assessment (*df*)	Summative Assessment (*df*)	Bloom (*df*)
REMEMBER	MATF	Multiple True or False Questions	1	1	1
	MTCQ	Matching and Categorization Questions	1	1	1
	TOFQ	True or False Questions	1	1	1
UNDERSTAND	MCMA	Multiple Choice and Multiple Answer Questions	1	1.5	1
	MCID	Multiple Choice with Illustrative Diagrams	1	1.5	1
APPLICATION	CSMA	Complex Single Multiple Choice Questions	1	1.5	1
	SNCQ	Single Numerical Construction Questions	1	1.5	1
ANALYZE	SMCQ	Situational Multiple Choice Questions	1	1.5	1
	SAMC	Single Answer Multiple Choice Questions	1	1.5	1
EVALUATE	MCOQ	Matrix Completion Questions	1	2	1
	MALT	Multiple Alternative Questions	1	2	1
CREATE	FIBE	Fill-in the Blanks and Enumeration Questions	1	2	1

The *df* of summative assessment differs accordingly since it is the most important performance matrix. As the Bloom category goes down in the table, the more difficult the question is and deeper cognitive development. Each question has a level of difficulty, which is also used in updating student performance matrix. Correctly answering a harder question demonstrates a higher ability than correctly answering an easier question. *Remember* category has *df* 1 while *Understand*, *Application*, and *Analyze* category has a *df* of 1.5 while *Evaluate* and *Create* has *df* of 2.

4.6 Mastery Learning

During mastery learning, students were loaded with random questions for their individual formative examination. Students did not have the same set of questions due to random selection of items in the Item Bank database. At the end of the formative examination, the scores are prompted. The students could review their answers and directly access the link to the lesson where they could relate the questions. If needed, the students could view the explanation facilities, review answers and reload another set of examination. These helped the students to identify what they have learned well and what they needed to learn more. The specific corrective activities for students to use in correcting their learning difficulties or misconceptions were paired with each formative assessment. Most educational strategists match these correctives to every item or set of prompts within the assessment. Through this, the students were given help in identifying those concepts or skills, which were not yet mastered. The concepts or skills which are not learned would be the focus for the students to work on.

With the feedback and corrective information gained from the formative assessment, prescription of what more needs to be done to master the concepts or skill from the unit is detailed. This "just in time" correction prevented minor learning difficulties from accumulating and becoming major problems. It also gave the educational strategists practical means to vary and differentiate their instruction to better meet the students' individual learning needs.

In describing mastery learning, reducing variations in students' achievement did not imply making all students do the same. Even in those favorable learning conditions, some students undoubtedly would learn more than others, especially those involved in enrichment activities. But this is recognizing relevant, individual differences among students and then altering instruction to better meet their diverse learning needs. In e-learning implementation, mastery learning plays a very important role in molding the knowledge of the student by allowing corrective measures, random exercises and diagnostic examination. However, if its blended with reinforcement learning, it could hypothetically lead to higher learning gain.

One form of mastery learning is formative examination. The formative examination serves as practice module that prepares the student into graded summative assessment. It provides information at a classroom level and to makes instructional adjustments and interventions during the learning process (Garrison & Ehringhaus, 2014). Effective teachers use formative assessment during instruction to identify specific student misunderstandings, provide feedback to students to help them correct their errors, and identify and implement instructional correctives (Cauley & McMillan, 2014).

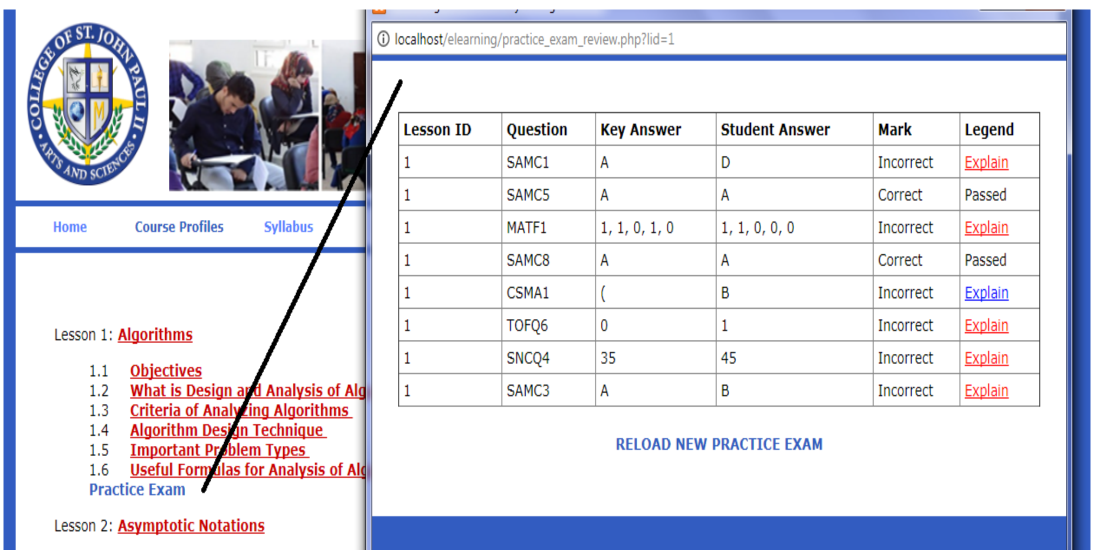

Figure 4.15: Practice Examination Module

Figure 5.15 is a live screen shot of the formative examination taken from the prototype. For each lesson, eight random questions were dynamically selected or extracted from the Item Bank at the end of each chapter. To guarantee that students would review the learning materials, several control mechanism were incorporated. Students, for example, could not proceed to succeeding lesson without passing the previous lesson. A student must accumulate a 75 or better grade to pass the formative examination. A student needed to review all the questions until all “Explain” buttons turned from red to blue. It could not load another without reviewing the failed questions and each question was linked to explanation facilities*;* and to a specific part of the lesson. Students could try as many times as they wanted to review the examination by reloading eight random questions repeatedly from the Item Bank.

Table 4.3 is a chunk of a live data taken from the prototype of the practice results. As shown in the table, a minimum of 6 out of 8 scores were recorded which was equivalent to 75 percent*.* The table did not record the results which were less than 75 percent. This compelled the students to review until a passing mark was achieved. The formative or practice was reloaded for the n^{th} time as long as the students wanted to review the learning materials. Although the student could practice multiple times, only the first passing score was recorded. A negative one score was recorded if the student did not take the examination within the activated time frame. P_1 field refers to the result of formative for lesson one L_1, P_2 for lesson 2 or L_2 until P_{12} for lesson 12 and so on*.*

Table 4.3: Practice Examination Module

Stud_ID	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	Ave_Prac
111111	-2	-2	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1.00
502315	6	7	6	8	6	7	7	7	6	8	8	8	7.00
702452	7	8	7	6	8	7	6	6	8	6	8	7	7.00
802092	-1	7	6	7	7	7	6	6	7	8	7	7	6.75
802098	8	8	7	7	7	7	7	7	8	6	8	7	7.25
802137	7	6	7	7	7	8	7	8	7	8	8	8	7.33
802144	7	8	8	7	8	7	8	7	8	8	8	7	7.58
802151	6	8	6	6	7	7	7	8	7	6	7	8	6.92
802178	6	7	6	8	6	8	6	6	8	6	7	7	6.75
802197	6	-1	6	7	7	7	6	7	6	6	7	6	6.42
802236	6	7	6	7	7	7	8	6	6	7	7	6	6.67
802237	8	7	6	8	8	6	7	7	7	8	8	6	7.17
802491	8	8	7	8	7	8	6	7	6	6	6	6	6.92
802513	7	7	7	6	6	6	7	6	7	6	7	7	6.58

Table 4.4 is a report of live chunk of trials generated from the prototype. This table records how many times students took formative assessment until they achieved certain competency level. This mechanism served as motivational perspective since the number of trial represented the level of understanding and comprehension in reading the e-learning module. T_1 refers to the number of trials in taking lesson one, T_2 for lesson and so on until T_{12}.

Table 4.4: Number of Trials Before Passing the Practice Examination

Stud_ID	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12
502315	3	4	4	4	1	6	6	6	5	4	4	5
702452	2	5	1	2	2	5	4	2	2	5	1	6
802092	5	5	4	5	3	5	1	3	5	2	5	1
802098	4	4	5	3	4	4	2	3	3	3	3	3
802137	2	2	1	5	5	5	2	5	4	4	4	5
802144	2	2	3	2	6	2	5	4	6	2	5	4
802151	5	2	4	2	4	5	3	4	5	5	3	2
802178	3	2	3	4	5	5	2	5	5	5	3	6
802197	5	4	1	4	1	2	4	6	6	3	3	4
802236	5	1	3	3	3	5	3	3	2	3	2	5
802237	5	5	2	4	1	6	4	5	4	6	5	5
802491	4	3	2	4	4	3	4	1	5	4	1	5
802513	4	5	3	2	2	2	2	5	5	4	5	6
902139	2	4	5	3	2	2	2	5	4	2	6	3
902242	3	5	4	2	5	5	4	2	4	1	4	5
1002043	2	6	3	2	5	6	4	5	2	4	2	6

4.7 Reinforcement Learning

The basic idea of reinforcement theory (RL), is to reinforce behaviors and remediate problems during learning process in the form of rewards and punishments. For example, students realizes that if they do well on assignments, then they get rewards. However, students who realize that if they do not submit assignments on time, then demerits will be given as punishments. This is similar to the "Coach Dilemma or Coach Problem" in sports like football wherein players are punished by the coach if they are not on time. What does a coach do? The standard answer is extra exercise. At the end of the session, the coach identifies the tardy players and make them run extra laps or do push-ups.

Table 4.5: Rule-Based Reinforcement System

Lesson 1:
if($weights < 100) $nItems = 1;
if($weights < 80) $nItems = 2;
if($weights < 70) $nItems = 3;
if($weights < 60) $nItems = 4;
if($weights < 50) $nItems = 5;
	Lesson 7:
	if($weights < 100) $nItems = 1;
	if($weights < 80) $nItems = 2;
	if($weights < 70) $nItems = 3;
	if($weights < 60) $nItems = 4;
	if($weights < 50) $nItems = 6;

Lesson 2:
if($weights < 100) $nItems = 1;
if($weights < 80) $nItems = 2;
if($weights < 70) $nItems = 3;
if($weights < 60) $nItems = 5;
if($weights < 50) $nItems = 7;
	Lesson 8:
	if($weights < 100) $nItems = 1;
	if($weights < 80) $nItems = 2;
	if($weights < 70) $nItems = 3;
	if($weights < 60) $nItems = 4;
	if($weights < 50) $nItems = 6;

Lesson 3:
if($weights < 100) $nItems = 1;
if($weights < 80) $nItems = 2;
if($weights < 70) $nItems = 3;
if($weights < 60) $nItems = 4;
if($weights < 50) $nItems = 5;
	Lesson 9:
	if($weights < 100) $nItems = 1;
	if($weights < 80) $nItems = 2;
	if($weights < 70) $nItems = 4;
	if($weights < 60) $nItems = 6;
	if($weights < 50) $nItems = 9;

Lesson 4:	Lesson 10:

if($weights < 100) $nItems = 1;
if($weights < 80) $nItems = 2;
if($weights < 70) $nItems = 3;
if($weights < 60) $nItems = 4;
if($weights < 50) $nItems = 5;
	if($weights < 100) $nItems = 1;
	if($weights < 80) $nItems = 2;
	if($weights < 70) $nItems = 3;
	if($weights < 60) $nItems = 5;
	if($weights < 50) $nItems = 8;

Lesson 5:
if($weights < 100) $nItems = 1;
if($weights < 80) $nItems = 2;
if($weights < 70) $nItems = 3;
if($weights < 60) $nItems = 5;
if($weights < 50) $nItems = 8;
	Lesson 11:
	if($weights < 100) $nItems = 1;
	if($weights < 80) $nItems = 2;
	if($weights < 70) $nItems = 3;
	if($weights < 60) $nItems = 5;
	if($weights < 50) $nItems = 8;

Lesson 6:
if($weights < 100) $nItems = 1;
if($weights < 80) $nItems = 2;
if($weights < 70) $nItems = 4;
if($weights < 60) $nItems = 6;
if($weights < 50) $nItems = 8;
	Lesson 12:
	if($weights < 100) $nItems = 1;
	if($weights < 80) $nItems = 2;
	if($weights < 70) $nItems = 3;
	if($weights < 60) $nItems = 4;
	if($weights < 50) $nItems = 5;

There were 60 rules ready to fire and match in the database to activate reinforcement files for particular student. The reinforcement files vary in each lesson depending on the available files stored in reinforcement table in the database as shown in Table 4.5 . Files or learning activities can be in the format of PowerPoint, document, gif, video, PDF, or solved problem files which were readily available for reinforcement process. Table 4.5 shows the rules of the twelve lessons. If the weight are less than the summative results in each lesson, a number of reinforcement activities were loaded to the student. For example, if the weight of Lesson 1 were less than 60, 4 *nItems* were randomly selected in the reinforcement table to be loaded on the student.

The use of random numbers during the implementation of the reversed roulette wheel selection gave the possibility that even lesson with weight higher than the passing threshold would be selected. If the student gets a perfect score for a particular lesson, all reinforcement files would be deactivated while lessons with less than 100 but greater than 80 weights would receive one reinforcement. During reinforcement, the students were required to open each blue colored links until all turns red, which indicated that the students read the reinforcement files. In case the students opened another link, the system would automatically block it to avoid the opening of several windows at the same time. This mechanism was used to avoid cascading window overloading and navigational problem. After reinforcement, the student undergoes formative to practice or check if comprehension and understanding about a particular lesson has been achieved.

Figure 4.16 shows the combined architecture of reinforcement and mastery learning to help the students in their learning process. During reinforcement process, the number of punishment was governed by the reinforcement rules as discussed in Table 4.5. The rules determined how much number of additional learning materials should be given to the students by randomly selecting from files in the reinforcement table that were stored in the database. In this model, the system chose an action a_i, (read more materials) which obtained reward r_i, (study and review matrix) and switched from state s_i to state s_{i+1} (rules). The cumulative reward r_i, was added to the average results of the summative examination.

During mastery learning, students were loaded with random questions for their individual formative examination. Students did not have the same set of questions due to random selection of items in the Item Bank database. At the end of the formative examination, the scores are prompted. The students could review their answers and directly access the link to the lesson where they could relate the questions. If needed, the students could view the explanation facilities, review answers and reload another set of examination. These helped the students to identify what they have learned well and what they needed to learn more. The specific corrective activities for students to use in correcting their learning difficulties or misconceptions were paired with each formative assessment. Most educational strategists match these correctives to every item or set of prompts within the assessment. Through this, the students were given help in identifying those concepts or skills, which were not yet mastered. The concepts or skills which are not learned would be the focus for the students to work on.

With the feedback and corrective information gained from the formative assessment, prescription of what more needs to be done to master the concepts or skill from the unit is detailed. This “just in time” correction prevented minor learning difficulties from accumulating and becoming major problems. It also gave the educational strategists practical means to vary and differentiate their instruction to better meet the students’ individual learning needs.

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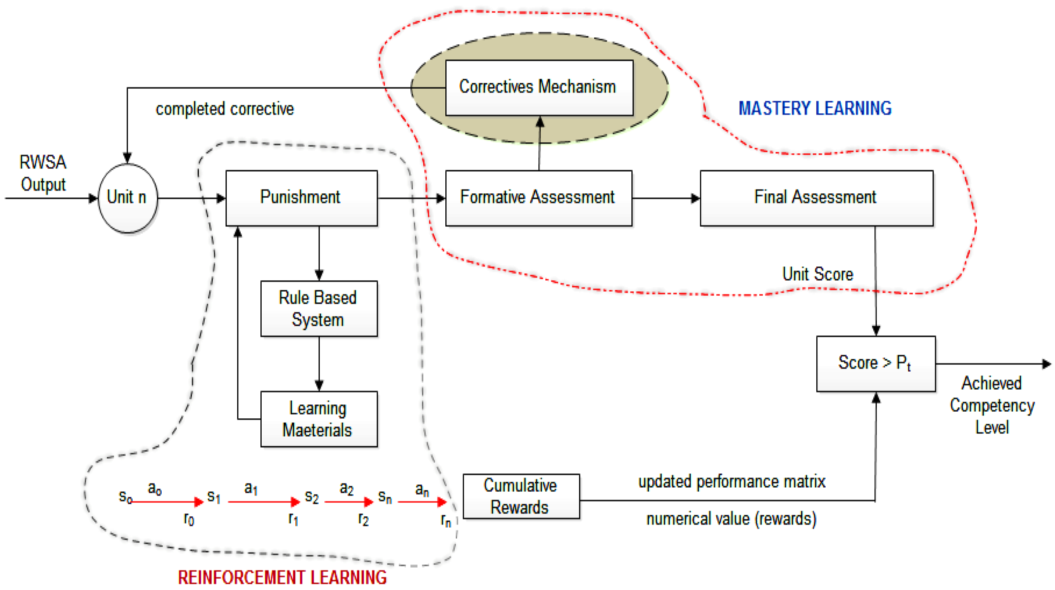


Figure 4.16: Reinforcement and Mastery Learning Model

4.7.1 Reinforcement Process Module

Reinforcement process is giving additional learning activities as a penalty for not passing the summative examination. However, this process aims to help students pass the course. Learning materials are presented in various media formats such as PDF, documents files, codes, executable files, videos, gif, and animations. The number of activities for reinforcement varies accordingly to different students due to the reinforcement rule-based mechanism incorporated in the system. Usually, reinforcement learning is activated by the teacher for all students who wants to undergo additional learning and be given a chance to pass the course. The number of reinforcement if the score is 80 is one or zero.

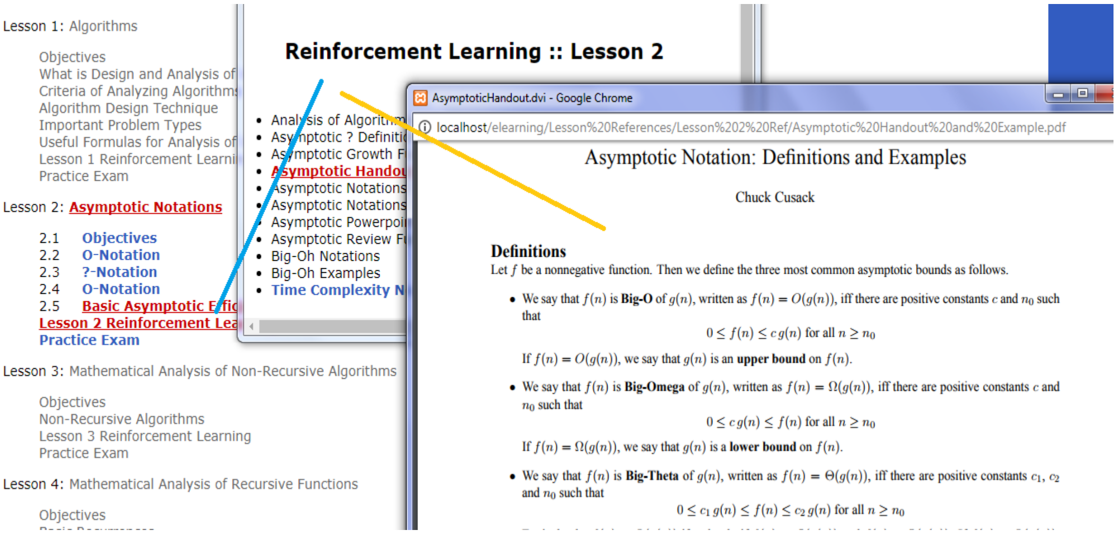


Figure 4.17: Reinforcement Process

Figure 4.17 is a live chunk of the reinforcement process. As shown in the figure, L_1 was activated while L_2 was deactivated. Clicking the reinforcement learning link at the bottom of the lesson outline activated the reinforcement process. Blue colored links indicated the reinforcement files randomly selected for additional reading.

Students were not allowed to do summative examination without reading the materials since the system would record and monitor the reinforcement files. As shown on Figure 4.17, the total number of reinforcement files is five as reflected in the rule-based system based on the overall score or percentage of Lesson 1. To indicate that the student read the files, the system window of the reinforcement file could be closed unless all links which were originally in blue would turn red. This was necessary to enforce reading the materials.

Table 4.6 is a chunk of the final results of students generated and stored in the prototype database. This live data was extracted from the database that summarized vital information including the average score of formative results, study performance, review performance, cumulative rewards, teacher evaluation, the three scores of the summative examination, and the final marks. In this table, the administrator or the teacher of the class could view and analyze individually and in details all related performances of the student. The action column or Edit icon allowed the instructor to inputs additional mark to deserving students. This mechanism was a request from staff members of the faculty during initial testing and pre-survey. The F1 column shows the results of first set of examination while F2 and F3 shows the columns that stores the results of the second and the third sets respectively after reinforcement.

Table 4.6: Final Grade Module with Cumulative Rewards

Stud_ID	Ave_P	Study	Review	Rewards	T_Eval	F1	F2	F3	Final Mark	Remarks	View	Action
502315	7.00	4.60	0.83	5.43	0	75.01	0.00	0.00	75.01	Passed	ANALYZE	EDIT
702452	7.00	4.40	2.04	6.44	0	78.44	0.00	0.00	78.44	Passed	ANALYZE	EDIT
802092	6.75	3.15	1.63	4.78	0	65.81	75.20	0.00	75.20	Passed	ANALYZE	EDIT
802098	7.25	3.15	0.88	4.03	0	67.11	78.25	0.00	78.25	Passed	ANALYZE	EDIT
802137	7.33	3.90	1.08	4.98	0	74.73	63.46	59.86	59.86	Failed	ANALYZE	EDIT
802144	7.58	4.60	2.46	7.06	0	79.65	0.00	0.00	79.65	Passed	ANALYZE	EDIT
802151	6.92	5.00	1.42	6.42	7	74.93	72.60	70.63	77.63	Passed	ANALYZE	EDIT
802178	6.75	4.25	1.13	5.38	0	69.46	67.15	82.35	82.35	Passed	ANALYZE	EDIT
802197	6.42	2.55	2.33	4.88	1	73.92	73.71	74.88	75.88	Passed	ANALYZE	EDIT
802236	6.67	2.55	1.08	3.63	6	63.86	70.00	69.19	75.19	Passed	ANALYZE	EDIT
802237	7.17	4.25	0.92	5.17	0	77.14	0.00	0.00	77.14	Passed	ANALYZE	EDIT
802491	6.92	3.60	1.42	5.02	6	73.68	73.47	69.67	75.67	Passed	ANALYZE	EDIT
802513	6.58	4.00	1.38	5.38	0	66.06	72.56	80.36	80.36	Passed	ANALYZE	EDIT
902139	7.33	3.45	0.71	4.16	0	78.13	0.00	0.00	78.13	Passed	ANALYZE	EDIT
902242	7.17	3.10	1.25	4.35	0	76.66	0.00	0.00	76.66	Passed	ANALYZE	EDIT
1002043	6.92	4.50	1.13	5.63	0	66.98	85.39	0.00	85.39	Passed	ANALYZE	EDIT
1002045	7.17	3.95	1.08	5.03	6	70.49	63.48	62.99	68.99	Failed	ANALYZE	EDIT

6.4.2 Bloom Taxonomy Assessment

The Bloom Cognitive Taxonomy is a special assessment that measures the cognitive development of the student while taking the e-learning course. This 60-items assessment was specifically designed based on the Cognitive Schema and readily extracted from the Item Bank database. The assessment was taken every four weeks during the experimental sessions. The assessment was equally divided to six categories specified in the Bloom Cognitive Taxonomy.

REMEMBER				UNDERSTAND				APPLICATION			
R1	R2	R3	R4	U1	U2	U3	U4	A1	A2	A3	A4
2.5	4.12	6.17	8.6	2.83	3.55	5.12	8.29	2.1	4.2	5.5	7.9

E1	E2	E3	E4	N1	N2	N3	N4	C1	C2	C3	C4
1.88	2.74	3.33	4.12	1.74	3.64	5.64	7.45	1.62	3.52	4.81	6.67
EVALUATE				ANALYZE				CREATE			

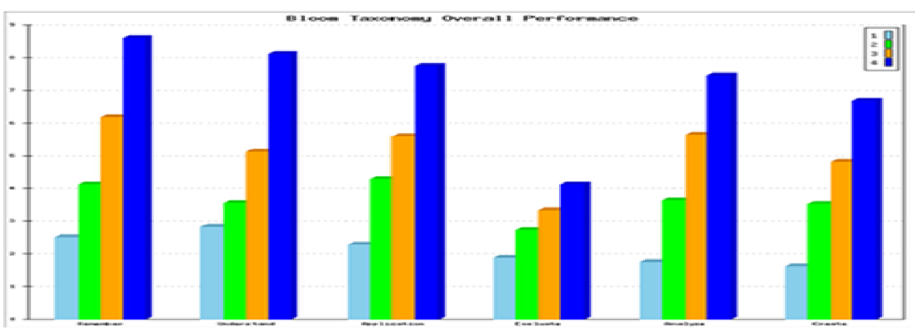


Figure 6.4: Average Cognitive Graph Output

For a Bloom Cognitive Taxonomy to become effective, the examination must be entirely based on the use of all six levels. For a student to evaluate his/her cognitive development he/she needs to *Remember* the basic facts. But beyond that, the student has to *Understand* the significance of those facts, and their interrelatedness, *Apply* them to solve real life problems, *Analyze* everything from all possible alternatives and study the results. After which the student has to *Evaluate* several alternatives or solutions and which of these is most reliable. He/She has to decide which of the several alternative answers is most appropriate in a particular case. Lastly, the student has to *Create* knowledge and experience from multiple sources into a high-order schema which will equip him/her to deal with the domain more effectively.

The graph in Figure 6.4 shows the overall class average of the cognitive development of students taken every four weeks during the training. It must be noted that the cognitive level of the six categories increased. The *Remember* category, for example, had an initial average of 2.5 for R1, 4.12 for R2, 6.17 for R3 and 8.6 for R4. These initial scores clearly represent 25% of the R1 followed by an increase of 16% for R2, an increase of 20% for R3 and an increase*d* of 24.3% for R4. Similarly, as the other learning process or training neared its end, the individual average score increased. As further shown in the graph, the category with highest gain is *Remember* since it is the easiest among the six categories while *Evaluate* has the lowest learning gain. The purpose of this was to determine whether students would improve their learning by recalling lessons that they had read and understood as they went through the sessions. As a general observation and as shown in the graph, students increase*s* their cognitive domain at different levels. However, these results cannot be interpreted as truly cognitive gain due to the absence of a single domain during testing. The questions were defined and extracted from various topics. To compensate for this gap, the study examined the cognitive development and its relationship to the experiences and perceptions of the students in using the prototype. The study employed Semantria, a special software that can compute and determine whether the coded transcripts of the student is positive, negative or neutral. During the post survey, the students were asked to write briefly their reactions, perceptions and experiences in using the system to correlate the results of the cognitive development. Out of the 38 students, 35 wrote their reactions, perceptions or experiences in the survey form. Their responses were coded and transformed into digital transcripts for further analysis.

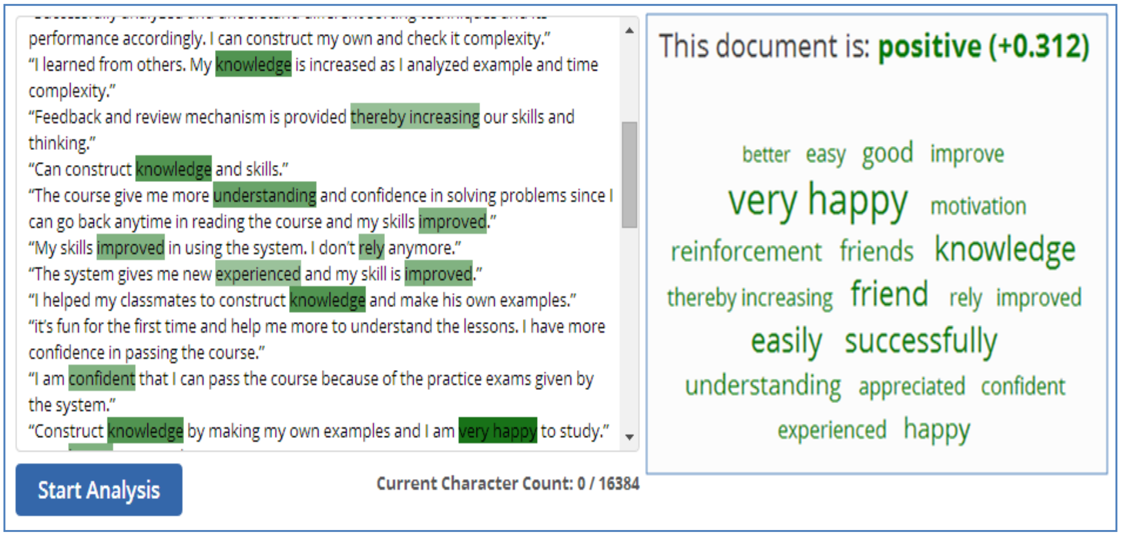
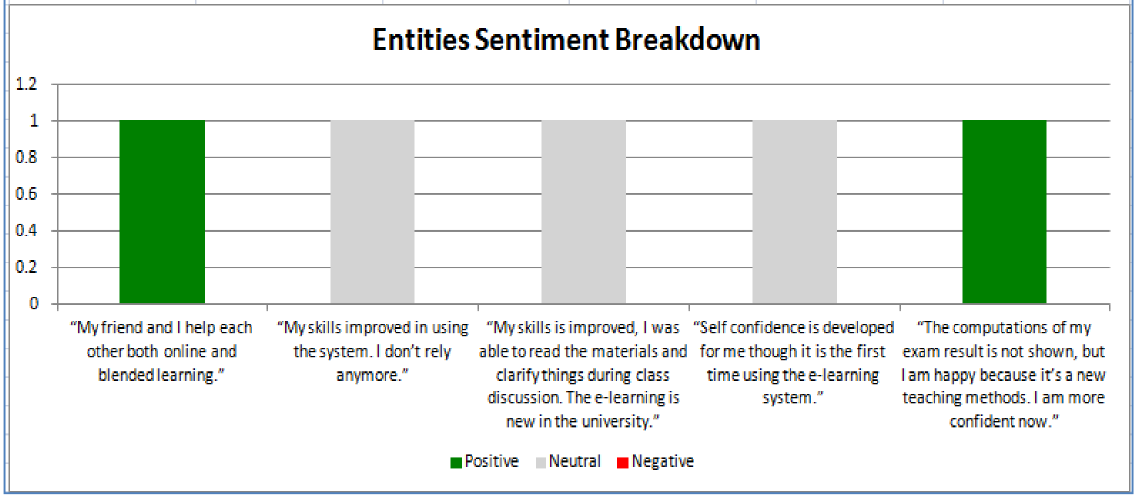


Figure 6.5: Semantria Analysis of the Digital Transcript

Figure 6.5 shows the output of the Semantria and revealed that the digital transcripts are positive with a score of +.321. Several positive words revealed the following words: *very happy, friends, motivate, improve, understanding, knowledge, and good.* According to Scheve (2014), students who have high cognitive benefits and self esteem will likewise reflect these in life or in their reactions to objects or surroundings. Being happy and positive increases the overall self-esteem and partly results to good school performance (Baumeister, Campbell, Krueger & Vohs, 2003). Thus, it can be concluded that the results coincide with the findings of Franken (1994) that being happy results to "making reasonable progress towards the realization of a goal".

Table 6.4: Entity Sentiment Breakdown of the Digital Transcripts

Entity	Entities Count	Entity Type	Positive Entities	Neutral Entities	Negative Entities
"My friend and I help	1	Quote	1	0	0
"My skills improved in	1	Quote	0	1	0
"My skills is improved,	1	Quote	0	1	0
"Self confidence is	1	Quote	0	1	0
"The computations of	1	Quote	1	0	0

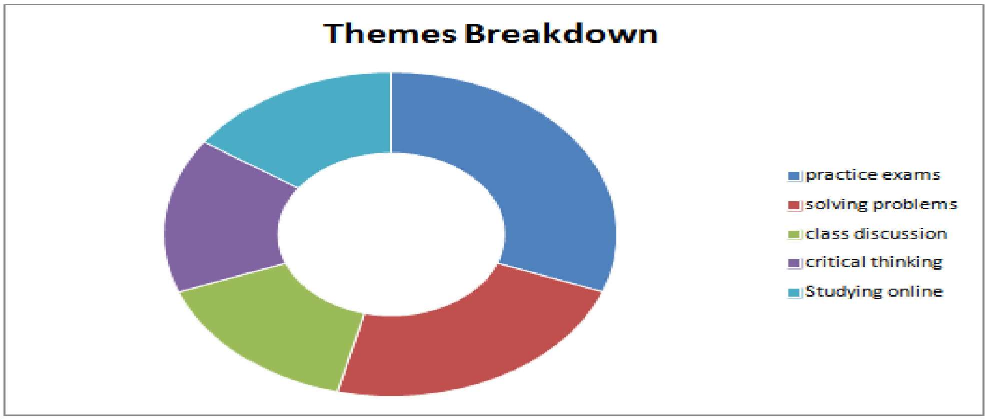


To further strengthen the findings, Semantria extracted five entities from digital transcripts and identified two positive sentiments and 3 neutral leading to positive. These results can be seen in Table 6.4. No negative feedback is received from the 35 coded entities. Sentiment analysis is the process of detecting positive, negative, or neutral feelings in a piece of writing (Pang & Lee, 2002). Semantria software is an information-gathering behavior that discovers what other people think (Turney, 2002).

Table 6.5 shows the five themes extracted from the digital transcript. They are *practice examinations, solving problems, class discussion, critical thinking,* and *study online* with their respective themes count of 4, 3, 2, 2, 2. The theme sentiment score is between – 1 and +1 is considered neutral. The overall theme sentiment polarity is neutral. However, according to Koppel and Schler (2006), neutral improves the overall accuracy and should not be considered as a state between positive and negative but as a separate class that denotes the lack of sentiment. The sentence “The weather is hot” for example, cannot be considered negative or positive.

Table 6.5: Themes Extracted from the Digital Transcript

Theme	Themes Count	Theme Sentiment Score	Theme Sentiment Polarity
practice exams	4	-0.00590241	neutral
solving problems	3	0.064992435	neutral
class discussion	2	0.313600004	neutral
critical thinking	2	0	neutral
Studying online	2	-0.057878751	neutral



6.4.3 Reinforcement Analysis

Reinforcement process refers to the overall learning activities that remediate learning difficulty after failing the summative examination. This mechanism is immediately activated for a student who will be given a chance to re-study the learning materials. The lesser the fitness value, the lower the reinforcement process as recommended by the rule-based reinforcement mechanism incorporated in the system.

Table 6.7: Summary of Reinforcement Process

Stud_ID	Number of Reinforcements	Reinforcement Level	Correctives Item	No. of Trials	Average Score	Rewards
802092	32	1	64	10	6.75	4.78
802137	16	2	64	8	7.33	4.98
802151	8	2	64	8	6.92	6.42
802197	11	2	88	11	6.42	4.88
802236	25	2	128	16	7.17	3.63
802491	9	2	56	7	6.92	5.02
802513	7	2	56	7	6.58	5.38
1002043	21	1	32	4	6.92	5.63
1002045	13	2	72	9	7.17	5.03
602164	30	1	72	9	6.67	3.56
8020920	14	2	88	11	7.58	5.18
802141	13	1	32	4	7.08	4.21
802245	7	2	48	6	6.83	5.31
802487	12	2	80	10	7.17	5.43
802592	12	2	88	11	7.00	5.89
902158	13	2	88	11	7.08	5.22
1102180	17	2	80	10	7.17	5.43
1102182	1	1	40	5	7.17	4.59

Table 6.7 shows the various reinforcement statistics accumulated by the students before passing the course. Thirty (30) additional files with different formats were given to student 602164. The student was also administered reinforcement level 1, 72 corrective activities, with 9 formative assessment or trials with an average of 6.67 and with a total

rewards of 3.56. On the other hand, student 1102180, received 17 number of files, reinforcement level 2, 80 corrective activities, 10 number of trials for formative assessment and has an average of 7.17 and with a total reward points of 5.43.

Reinforcement is among the many psychological tools that are used for teaching students. The two main kinds of reinforcement include, negative and positive reinforcement. Negative reinforcement attempts to enhance the learning process by eliminating or remediating learning difficulty (employing corrective measures). Positive reinforcement on the other hand, works by rewarding students based on their effort. Positive reinforcement is used for motivating students. Giving rewards to students who attain certain competency level will motivate them to study better, and increase their participation and effectiveness. Student who are acknowledged for their good work in their studies are more likely to succeed (Pink, 2011).

6.5 Learning Gains

The results based on the implementation of the prototype that incorporated the RL are considered successful. Table 6.8 shows that among the 41 students surveyed, 14 or 34% passed the course without reinforcement process. This means that 66% of the students failed the course. Out of the 27 students, 10 or 25% passed the course after reinforcement level 1 while 17 or 41% underwent reinforcement level 2. Out of these 17 students, five or 12% failed the course. After all the reinforcements were administered, 22 student passed the course which is 54% of the total number of students studied. This achievement can be attributed to practice examination, personalized learning sequence and reinforcement process.

Table 6.8: Overall Benefits of Reinforcement Learning

<table>
<tr><td></td><td colspan="3">Reinforcement</td><td>Failed After Reinforcements</td></tr>
<tr><td></td><td>Level 0</td><td>Level 1</td><td>Level 2</td><td>Level 1 and Level 2</td></tr>
<tr><td>Students</td><td>14</td><td>10</td><td>12</td><td>5</td></tr>
<tr><td rowspan="2">Percentage</td><td rowspan="3">34% (14)</td><td>25%</td><td>29%</td><td rowspan="4">12% (5)</td></tr>
<tr><td colspan="2" rowspan="2">54% (22)</td></tr>
<tr><td>Passed After Reinforcemnts</td></tr>
<tr><td>Total Student Passed</td><td colspan="3">88% (36)</td></tr>
</table>

From 14 students or 34% of the total number who passed the course without reinforcement, an additional 22 students or 54% passed the course after reinforcement. This is a total of 36 students or 88% who achieved competency level. The remaining five students or 12% of the total number discontinued the learning process for various and personal reasons. The results of the study can greatly help improve the teaching environment of the University. With the implementation, the rate of students passing the course will increase and this increase will be guaranteed in the years to come. This will lead to an increase in the number of graduates of the University, decrease in the number of years of residency of the students and reduction of financial support by the government to the University.

Chapter 5

SUMMARY, CONCLUSION, AND RECOMMENDATION

Summary

As e-learning or on-line learning materials continue to evolve and increase tremendously in educational setting, it is inevitable that instructional strategies improve the learning materials and need to manage effectively in extracting reports and individually help the students. There are many factors needed to consider such as the instructional design and different elements in designing the content of the learning module. In summary, the design of the e-learning materials is based on many components as suggested by scientific study, successful models, existing instructional models, assessments model and theory of computing. In the development of the learning management system or LMS, three existing model such as Moodle, Blackboard and Claroline have been studied for benchmarking to identify features of the LMS are adopt and consider in the study. In the area of assessment, several models of questionnaire development as noted in the related literature have been considered in the design of the questionnaires. There are twelve types of questionnaires adopted and stored in the Item Bank repository. The questionnaires are developed using the prestigious Bloom Taxonomy. Additionally, this research combined the concepts of reinforcement learning and mastery learning in the areas of artificial intelligence and educational psychology respectively to remediate learning difficulty and improve learning output. The process reinforcement learning and how these concepts work and improve the learning process was demonstrated using an actual working prototype.

Many rigorous processes were undertaken to come up with e-learning system prototype. These included the content of the 12 lessons which had 65 subsections, twenty four (24) interactive MHTML files, seven (7) embedded videos, fourteen (14) simulations, twenty two (22) PowerPoint, forty five (45) PDF files, twenty two (22) word files, sixteen (16) executable files, sixteen (16) C++ source codes, two (2) simulated excel files, and 94 reference materials which were directly linked to the internet for additional reading. The design of 280 questions distributed among 12 question types, designed according to Bloom questions schema which were stored in the Item Bank database with different difficulty level. These were used for various assessments such as diagnostic, formative, and summative examinations. The content of the e-learning materials and the questionnaires in the Item Bank database was subjected to internal consistency and reliability test. This generally resulted to an acceptable level of Cronbach's alpha. Likewise, the overall features of the system in different measurable scale are generally significant at all levels.

There are many possible benefits of using the system if this is successfully implemented. It presents a personalized learning process to lessen the learning procedure. It also provides mastery and reinforcement learning as motivational factors and corrective measures and it can increase cognition and acquisition of knowledge. The system also provides pedagogical alternatives

In this study, two major contributions were successfully demonstrated and implemented in the field of e-learning. These are the development of the improved learning management system by providing learning materials with interactivity, level of learning improvements and having a mastery learning used in educational psychology and reinforcement learning process using rule-based approach in artificial intelligence to remediate the learning difficulty of students. Lessons with lower probability compared to cumulative value, indicated a presence of learning difficulty, misconceptions or low competency, level and therefore needed to undergo reinforcement process.

The prototype successfully demonstrated the reinforcement process. Reinforcement process refers to the overall learning activities that remediate learning difficulty after students fail the summative examination. This mechanism is immediately activated for student who will be given a chance to re-study the learning materials. The lesser the fitness value, the lower the reinforcement process is recommended by the rule-based reinforcement mechanism incorporated in the system. The system employed 60 rules to govern the reinforcement process and allowed two reinforcement levels. Additional files or corrective activities were dynamically and randomly selected based on the summative score. The maximum rewards were 10 points and were readily extracted from the study and review performance tables in the database.

Based on the results, the implementation of the prototype that was incorporated, the result is a convincing 54% increase of the passing rate as revealed in the case study. There are many factors that contributed to the success of the study. The prototype employed several controlling mechanisms during formative examination, summative examination, and in the Bloom's cognitive examination not to mention the use of different media formats that encouraged and increased motivation. During formative examination, students were able to review the question in multiple ways. This included, looking at explanation facilities, opening the link that points to specific part of the lesson, viewing the answers, and getting familiar with all the question types. During summative examination, students could view their different performance indicators while in the Bloom Cognitive examination, students could view and analyze their individual performance, thereby motivating them to continue learning. During reinforcement, it was proven that additional materials and corrective activities inevitably contributed to the overall results.

Another novel and convincing result is the correlation of the feedback of students and their academic performance. Individual response of student in the survey which reflected their perceptions and experiences in using the system is coded to produce digital transcripts. The digital transcripts were subjected to document content and theme extraction analyses. The overall analysis of the digital transcripts or documents is positive. The positive document score, document sentiment analysis and the theme extraction process correlated with the increase rate of student performance.

With these results, the implementation of this new prototype will greatly help in phasing out or gradually eliminating several academic problems faced by College of Saint John Paul II Arts and Sciences. With the help of the e-learning implementation, the increase of the number of student passing the course is guaranteed, thereby reducing the length of residency of the students in the University. It can also solve academic problems brought by geographic locations by allowing students study anywhere and whenever online learning is possible.

Conclusion

In lieu with the summary and the findings shown and discussed in the previous section and chapter, the researcher was able to achieve the following:

1. An e-learning prototype has been developed and tested among students using course content of Design and Analysis of Algorithm with 202 lectures. The contend were develop according to ADDIE model and benchmarking using the three e-learning platform.
2. There are 280 questionnaires distributed and develop according to the Bloom Taxonomy with different difficulty level. The e-learning supports formative and summative assessment to help the students and understand and comprehend the learning materials. The bloom taxonomy in the system viewed the cognitive development of each students by providing graph of each students.
3. The mastery learning was successfully implemented as shown by the numbers of trials the students will take until a comprehension level or competency has been achieved. Through practice exams, student were able to familiarize the assessment and increased their learning competency.
4. The incorporation of the reinforcement process has been proven that it is effective in remediating learning difficulty given an ample time that a student will learn and

study the lesson. The rule base approach is dynamic defending on the number of alternative material in each topic provided in the prototype.

5. Fifty four percent of the students pass the course after reinforcement. The benefits of mastery and formative assessment are never an issue as it helps a lot in increasing the student's competency level.

Recommendation

The study is conducted for one semester using Algorithm Design course. The learning gains presented and the results does not provide a generalized learning benefits, therefore, a more experimental test and study should be conducted. For example, there is a need to have a control and experimental group to validate and compare the group's academic performance and learning gains. There is a need to implement this in a wider scale to demonstrate and encourage the stakeholders to realize the benefits of employing e-learning system in the university. Another future of the study is to implement in multi-university level to grasp the learning need of students in multi-sectoral level. Based on designing the questionnaires using the Bloom Cognitive Taxonomy, it must be implemented both specific-domain and scattered-domain to measure the cognitive development of the students in a deeper sense of cognitive learning. In terms of the performance matrix and data collection of students' prior knowledge, more variable is needed to address students' heterogeneity, and a need more intelligent profiling system to enhance learning delivery and increase learning benefits. Another study to be implemented is the use of a socially oriented e-learning to support online collaboration, online blended learning, group knowledge sharing, and knowledge construction which hypothetically improves the learning process and eventually lead to a very high academic performance.

It is also recommended that a more advance technique in the area of artificial intelligence be implemented to support and promote independent learning and addressed pedagogical strategy for diverse learning.