

**A COGNITIVE PRINCIPLE BASED INSTRUCTIONAL DESIGN FOR
CONCEPTUALIZATION OF COMPUTER CONCEPTS**

BY

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ABSTRACT

The increasing development of computer technologies has made multimedia learning an important learning and instruction strategy. The multimedia design alone, however, does not necessarily result in significant positive learning performance therefore there is need to thoroughly address the critical issue of how to develop effective multimedia instructional content that leads to desirable learning performance, motivation and contentment. Instructional designs like electronic learning and computer training provide different ways of delivering content, promote technology-centered environments that motivate students and add variety to learning. Some researchers have highlighted the advantages of using multimedia components alone not stressing their combinations whilst others outlined the positive effects of each of all the cognitive principles, however, stimulation only without education does not always make for sound instructional design in multimedia delivery. The researcher designed Cognitive Principle Instructional Strategies (CPIS) fro conceptualization of computer concepts. CPIS include different types of multimedia lectures combined with selected cognitive principles to give out maximum conceptualization and understanding in learners. The lectures included different combinations of audio and video and text using principles such as modality and redundancy. Data was collected using random sampling and analyzed using a statistical package (Predictive Analytics Software. Results indicated that the use of CPIS benefited learners more compared to traditional instruction strategies. The research revealed that CPIS is a motivational, interesting and even easier way of delivering lectures. Most learners have recommended instruction using CPIS as they highlighted the issues of high motivation, concentration, stimulation and understanding. The main essence of this research does not only lie with the type of multimedia components used but their combinations with a given number of certain cognitive principles in order to achieve optimal conceptualization of computer concepts. This will result in a more positive and effective process of conceptualizing introductory computer concepts.

Key words: *multimedia, instruction, conceptualization, cognitive principles, computer*

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ABBREVIATIONS

AN-	Animation and Narration
ANT-	Animation, Narration and Text
AT-	Animation and Text
ANOVA-	Analysis of Variance
ACT-R-	Adaptive Control of Thought – Rational: pronounced act-ARE
BUSE-	Bindura University of Science Education
CPIS-	Cognitive Principle Instructional Strategies
CS001-	Computer Studies course using course code CS001
CTML-	Cognitive Theory of Multimedia Learning
CLT-	Cognitive Load Theory
RAM-	Random Access Memory

CHAPTER ONE: COGNITIVE PRINCIPLE INSTRUCTIONAL DESIGN FOR CONCEPTUALIZATION OF COMPUTER CONCEPTS

1.0 INTRODUCTION

Sciences can be grouped into two: - hard and soft sciences. Computer Science is classified under hard sciences as it is based on more facts and basically less opinions. And in the previous years research on this area has been increasing at a faster rate as the generations got the bottom line of how some of the things were done and how they worked or operated. This has also come with hard and tough competition as the world watched our technology boost to greater levels.

The education industry is also trying to maximize the use of technology to enhance students learning hence the drive for this research. The researcher's study is based on the cognitive principle instructional designs for conceptualization of introductory computer concepts. This is an endeavor to tackle the basic concepts which introduces conceptualization of introductory computer concepts in computer science. The study is to experiment cognitive principle instructional strategies if there could be a better way of designing electronic lectures to allow better understanding during a learning process.

Learners in the tertiary industry of developing countries have lagged behind in terms of technology compared to their colleagues in the developed world. They need to be exposed to a strong learning background consisting of current technology which should help them apply taught concepts in the industry. Therefore they need a quick and easy way of understanding these taught concepts. The researcher will try to expose the weaker points in this situation and find possible solutions in order to curb the alleged low pass rates.

1.1 BACKGROUND TO STUDY

The researcher was motivated to design the cognitive principle instructional design due to the increasingly alarming rate of failure on the first year students who are taking a computer studies course. Over the past years the number of students taking and failing this introductory university-wide offered has increased alarmingly. This was mainly due to the increase in enrollment when actually the infrastructure remained at a standstill. Apparently the student to computer ratio has acutely risen from 2005 to date in such a way that if the situation is not curbed then a high failure rate will cause a call for concern.

This is therefore a very serious issue which needs very serious attention in order to balance the effect of an increase in enrollment with the overall student's pass rate despite the fact that educational infrastructure being developed at a slower pace. The researcher also noted that even if a smaller number was involved, if instructional strategies are not improved the failure rate will not improve. The best way to effectively curb this continual decrease in pass rate has pushed the researcher to endeavor in this research.

One of the key characteristics of multimedia is the capability to integrate different media, such as text, picture, audio, animation and video to create a multimedia instructional material, promoting the reading interests and willingness of the learner per se (Vichuda, et al, 2001). However, some research has shown that the design of multimedia is costly (Dan, Feldman, & Serpanos, 1998) and multimedia does not have consistent effects on promoting learning performance.

For instance, multimedia instructional material does not necessarily produce significant effect on understanding instructional content, although it does attract learner's attention more (Bartscha & Cobern, 2003). According to some researchers like (Mayer 2001), some research shows that too much unnecessary multimedia elements in instructional material may distract learners and actually decrease learning performance.

This researcher has argued that the media lectures are not as important as the message itself, and therefore believes that the constructive effects of new media on learning performance shown in some researches are mainly caused by positive things that learners will be saying but not by the media.

Therefore, how to develop an effective multimedia instructional material according to the property of instructional content has been rising as an important issue of learning and it is based on the combinations of cognitive principles (Bartscha & Cobern, 2003). The researcher designed a number of cognitive principles with certain multimedia components in order to try and reduce the failure rate of students undertaking this particular course.

1.2 PROBLEM DEFINITION

The alarming rate of failure over the past years in those students undertaking the computer introductory course offered university wide has been mainly caused by the increase in enrollment. An increase in student`s enrollment is actually a positive move when it comes to university administration but the issue of infrastructure not being developed at the same increasing rate has made it difficult for the pass rate to remain afloat.

Apparently the student to computer ratio has risen from a mere 1: 1 in 2003 to a shocking 1: 60 per annum from the year 2005 to date. The quick development of computer and internet technologies has made multimedia learning become an important learning method. The multimedia design alone, however, does not however necessarily result in significant constructive learning performance; there are other factors to be considered.

Instructional designs like e-learning, computer-based training *et cetera* provide different ways of conveying content, promote technology-centered environments that stimulate students and add variety to learning. However, stimulation only without education does not always make for sound instructional design in multimedia delivery, and student`s pass rate is negatively affected.

Learners and students must be able to use technology efficiently and intelligently, rather than simply because it is available, seems flashy or exciting. There is a very thin line between cognitive science and multimedia since they are intertwined in such a way that it can be impossible to design the other without implementing the other. The researcher will try and find effective solutions upon this currently helpless situation.

1.3 AIM

The main aim of research is to investigate the effectiveness of the cognitive principles to be designed for instructional design in multimedia learning in relation to introductory computer concepts.

1.4 OBJECTIVES

1. Design cognitive principle instructional strategies (CPIS).
2. Implement CPIS to enhance students' conceptualization of computer concepts.
3. Use CPIS to determine students' interest, stimulation and motivation in the subject or course.
4. Determine differences of conceptualization in students exposed to either traditional strategy or CPIS or both.
5. Use CPIS to determine performance improvement and knowledge retention in learners.
6. Investigate students' perceptions and other aspects on CPIS then use them to find and understand their preferences.

1.5 RESEARCH QUESTIONS

1. Does the cognitive principle instructional strategy (CPIS) enhance students' conceptualization of computer concepts?
2. Does CPIS stimulate and or motivate student's interest in the subject?
3. Is there a difference in conceptualization of computer concepts among students exposed to either traditional strategy or CPIS or both?
4. Are there any students' perceptions and other aspects on the use of CPIS and if so what are they?
5. Is there a difference in performance between students who had prior computer knowledge or a certain previous level of education and those who did not have?
6. Is there a significant difference in student's performance between different age groups, programmes/area of study and sex/gender?

1.6 RESEARCH PROPOSITIONS / HYPOTHESIS

The researcher proposed to design a model which focuses only on introductory computer concepts. The overall hypothesis of this work will be answering the question of how to come up with certain combinations of cognitive principles that will result in optimal performance of university students studying introductory computer concepts thereof.

1.6.1 MAIN HYPOTHESIS

H0 (null): The desired combinations of cognitive principles results in the optimal performance of university students studying introductory computer concepts.

H1 (Alternative): The desired combinations of cognitive principles will not result in the optimal performance of university students studying introductory computer concepts.

There are other sub hypotheses according to the specified research questions and they are outlined below as follows:

1.6.2 SUB- HYPOTHESIS

1) **H0 (null):** The cognitive principle instructional strategy (CPIS) enhances students' conceptualization of computer concepts.

H1 (Alternative): The cognitive principle instructional strategy (CPIS) does not enhance students' conceptualization of computer concepts.

2) **H0 (null):** The cognitive principle instructional strategy (CPIS) stimulates and motivates student's interest in the subject.

H1 (Alternative): The cognitive principle instructional strategy (CPIS) does not stimulate and motivate student's interest in the subject.

3) **H0 (null):** There is a difference in conceptualization of computer concepts among students exposed to either traditional strategy or CPIS or both.

H1 (Alternative): There is no difference in conceptualization of computer concepts among students exposed to either traditional strategy or CPIS or both.

4) **H0 (null):** There are also students' perceptions and other aspects on the use of CPIS.

H1 (Alternative): There are no students' perceptions and other aspects on the use of CPIS.

5) **H0 (null):** There are performance differences between students who had prior computer knowledge or certain previous level of education than those who did not have.

H1 (Alternative): There are no performance differences between students who had prior computer knowledge or certain previous level of education than those who did not have.

6) **H0 (null):** There is a performance gap in students with different age groups, programmes/ area of study and sex/ gender.

H1 (Alternative): There is no performance gap in students with different age groups, programmes/ area of study and sex/ gender.

1.7 JUSTIFICATION / SIGNIFICANCE OF STUDY

It is cautious to structure instruction in such a way that efficiently maximizes learning. Whether instruction takes place in a classroom or on a computer screen is not most important but what is of importance is that the tested strategies for multimedia education are employed and they facilitate knowledge construction by the learner. The design of the cognitive principle instructional strategies (CPIS), will enable a great motivation is learners as far as understanding taught concepts is concerned.

The study will make learning easy as the way students learn enables stimulation and interest in the learners involved. As a science course, most social science learners find computers a bit challenging so this study will enable that easy conceptualization and appreciation of the course and this positively affect their end results.

As a result the department of computer science itself will produce better and improved results from its learners. If the pass rate is boosted then the university is positively marketed hence the increase enrolment will be justified. The university would produce trainers who deliver a good service resulting in brilliant students. And the student is highly motivated and content to be associated with high standards- hence the success of this research if that is achieved.

1.8 RESEARCH SCOPE

Research has restricted investigation- with a one kind of learning environment (multimedia learning environments), a one kind of knowledge (introductory computer concepts), and a one kind of outcome/ achievement test (problem solving test). The scope is mainly under educational e-learning or information systems dwelling on cognitive learning. Research uses a case study is based on first year students who are at Bindura University of Science Education (BUSE) and those who undertook a CS001- Introductory to Computer Science concepts course at the appointed time. Study is based on the problems that have been identified from the e-learning field.

1.9 ASSUMPTIONS, DELINEATIONS AND LIMITATIONS

The research has limited study- with one kind of learning environment, one kind of knowledge, and one kind of outcome/achievement test. All students who were exposed to CPIS were computer literate. All groups have approximately equal variance on the variables and the variables are normally distributed. The sample to be used for experiments and surveys is a true representative of the population. No interaction among students being experimented upon that is there was close monitoring by the lecturer and tutors. The main limitations that affected this research were that computers did not perform equally among participants in terms of speed – some machines performed faster than others. And also constant electricity power cuts were experienced due to load shedding.

In order for this research to remain valid and justified, there is need to minimise the impact of the afore-mentioned limitations. For uniformity, the researcher purchased Random Access Memory (RAM) for those machines that were performing slower so that the specifications equalled the other fast machines. As for constant power cuts a big generate was purchased in standby such that as soon as electricity is cut off it provides power to the required labs.

10.0 DEFINITION OF TERMS AS USED IN CURRENT STUDY

Instruction in this context refers to content (for example words and pictures) and how it is delivered instructional methods.

Cognitive as used in this study is seeking to understand mental processes such as perceiving, knowing, thinking, remembering, understanding language and learning.

Multimedia in this context is the combination of text and other media like audio, animations and or video.

Conceptualization is a unit of knowledge-understanding.

CHAPTER TWO: LITERATURE REVIEW

2.1 INTRODUCTION

The researcher will use this chapter to identify points of analysis articulated by different researchers by scrutinizing on the given relevant literature. There is need to find the conflicting points of view since they are the indicators of diverging theories surrounded by this area of study and an understanding of these differing theories and opinions behind these theories will help in the evaluation of this research.

This research addresses the issue of how to avoid unproductive multimedia instructional practices and employ more effective cognitive strategies. Baddeley's model of working memory (Baddeley, 1999) and Paivio's dual coding theory (Clark & Paivio, 2003) suggest that humans process information through dual channels, one auditory and the other visual.

If the aforementioned theories are combined with Sweller's Theory of Cognitive Load (Chandler & Sweller, 1991), (Sweller, 1994) and (Anderson, 1993) , Adaptive Control of Thought – Rational (ACT-R) cognitive architecture it provides a convincing argument for how humans learn. This leads to the question of how multimedia instruction can be designed to maximize learning.

Cognitive theory and frameworks provide empirical guidelines that may helps to design multimedia instruction more effectively. The researcher agree with (Mayer R.E , 2001) who argues that the best way to present multimedia instruction is through visual graphics and informal voice narration, which takes advantage of both verbal and visual working memories without overloading one or the other and this researcher have closely followed his work which has helped me map this research.

2.2 GENERAL ISSUES

Multimedia and its effects on learning is an area which has been exhausted by researchers and it is slowly being mocked out. The repartee, or investigation, is best endeavored from a well-grounded foundation, such as cognitive psychology. There are a lot of learning principles and approaches that have been developed in line with my research among which are the behavioral principles, cognitive principles and constructivist principles and theories. The researcher is going to focus on furthering research on some of the cognitive design principles in multimedia learning basing on human cognition, rather than mere technology capacity and features. The researcher`s main concern lies with the effects on students after a certain number of principles are combined with certain multimedia components which enhances conceptualization of introductory computer concepts.

2.3 COGNITIVE THEORY OF MULTIMEDIA LEARNING

Multimedia learning is defined as any electronic presentation involving words and pictures that are intended to foster learning; based on how the mind works, (R.E, Mayer, 2002). Mayer outlined three prominent approaches to the design of multimedia: the delivery media approach, the presentation mode approach, and the sensory modality view.

The delivery media approach focused on the technology and centers design around the technology, not the learner. Presentation mode spotlighted the quantity of material displayed to the learner in two or more modes. The sensory modality view revolved around the congruence of multimedia modality and cognitive structure.

Cognitive Theory of Multimedia is a mixture of the presentation and sensory modality approach. In reviewing computerized learning materials, (Mayer R. E, 2003) concluded that the majority were centered on technology, not learning. He suggested that this technology-centered approach was driven by the delivery of information, not in promoting, not in promoting learning.

(Mayer R.E, 2002) proposed a learner approach that used knowledge of human cognition to create materials that fostered learning. (Mayer R. E, 2003) argued that the goal of the information delivery method is different from knowledge construction since the former only promotes information acquisition.

2.4 COGNITIVE PRINCIPLES

Mayer`s cognitive theory of multimedia learning explains the following nine multimedia design principles and effects, (Mayer, 2002) and these are:

- **Modality principle:** When designing a multimedia explanation, present the words in spoken form.
- **Contiguity principle:** When designing multimedia explanation, present corresponding words and pictures at the same time.
- **Multimedia principle:** When designing a computer-based explanation, use both words and pictures.
- **Personalization principle:** When designing a multimedia explanation, present words in conversational style.
- **Coherence principle:** When designing a multimedia explanation, avoid extraneous video and audio.
- **Redundancy principle:** When designing a multimedia explanation involving animation and narration, do not add redundant on-line text.

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- **Pre-training principle:** When designing a multimedia explanation, begin the presentation with concise descriptions of the components.
- **Signaling principle:** When designing a multimedia explanation, provide signaling for the narration.
- **Pacing principle:** When designing a multimedia explanation, allow the learner to have control over the pace of presentation.

2.5 COGNITIVE EFFECTS

- **Modality effect:** Do students learn better from animation and narration than from animation and on-screen text.
- **Contiguity effect:** Do students learn better when corresponding narration and animation are presented simultaneously rather than successively.
- **Multimedia effect:** Do students learn better from animation and narration rather than narration alone.
- **Personalization effect:** Do students learn better when is in conversational style rather than formal style.
- **Coherence effect:** Do students learn better when irrelevant video, narration, and sounds are excluded rather than included.
- **Redundancy effect:** Do students learn better from animation and narration than form animation, narration and on-screen text.
- **Pre-training effect:** Do students learn better when training on components that precedes rather than that follows a narrated animation.

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- **Signaling effect:** Do students learn better when narrations are signaled rather than non-signaled.
- **Pacing effect:** Do students learn better when the pace of presentation is under learner control rather than program control.

Investigating the effects of multimedia on learning and performance requires a solid foundation in learning theory. A theoretically-grounded investigation of multimedia allows one to draw conclusions relative to the learner, rather than attempting the slippery slope of a media comparison, (Lockee, et al, 1999)

(Bishop and Gates, 2001) effectively synthesize information processing theory and communication theory as a foundation for the investigation of the use of sound in multimedia instruction.

(Mayer, 2002) has based the majority of his multimedia work on an integration of Sweller`s cognitive load theory (Chandler, P. and Sweller, J., 1991), Paivio`s dual-coding memory (Clark J.M and Paivio A., 2003), and Baddeley`s working memory model (Baddeley, A.D & Hitch G.J. in G.A Bower (Ed), 1990). Mayer focuses on the auditory/verbal channel and visual pictorial channels. Mayer bases his cognitive theory of multimedia learning on the following model.

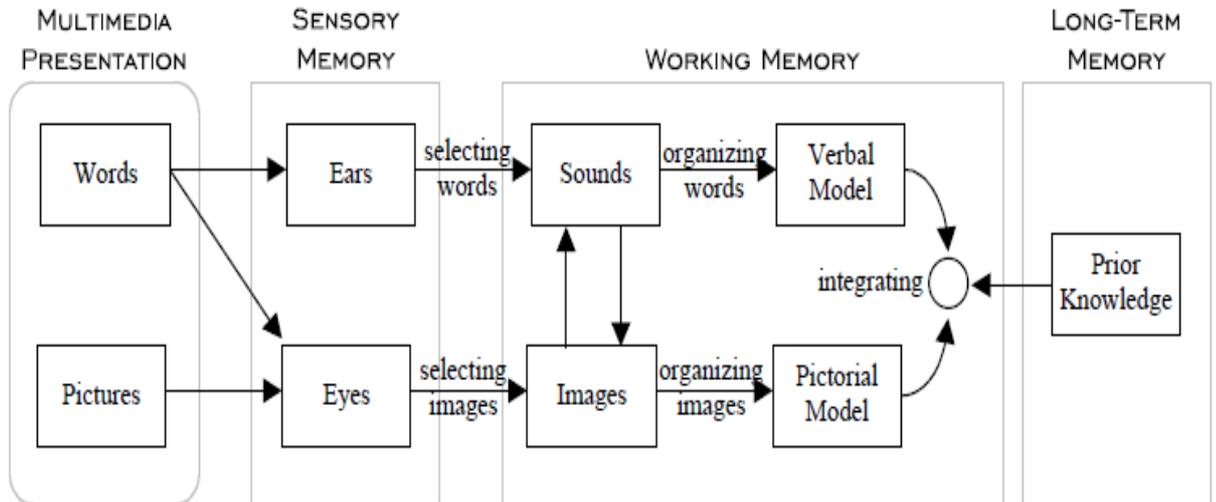


Figure 1. The Dual coding working memory model by (Clark J.M and Paivio A., 2003))

The above model is based upon three primary assumptions (Mayer R.E, 2002):

1. Visual and auditory experiences-information is processed through separate and distinct information processing `channels`.
2. The information processing channel is limited in its ability to process experience-information.
3. Processing experience- information in channels is an active cognitive process designed to construct coherent mental representations.

Further, this model is activated through five steps:

- a. Selecting relevant words for processes in visual working memory,
- b. Selecting relevant images for processing in visual working memory,
- c. Organization of selected words into verbal mental model,
- d. Organizing selected images into a visual model, and
- e. Integrating visual and verbal representations as well as prior knowledge, (Mayer R.E in D.L Medin (Ed), 2002)).

(Mayer R. E, 2003) envisioned the following components of knowledge construction:

- a. Process structures- cause and effect chains; how some system works
- b. Comparison structures- compare two or more structures along several dimensions.
- c. Generalization structures- main ideas and subordinate ones (branching trees)
- d. Enumeration structures- list and consist of a collection of items
- e. Classification structures- hierarchical and contain sets and subsets

Mayer used these components to design retention and transfer tests associated with his multimedia learning materials. Inherent in knowledge construction were five steps to learning: selecting relevant words, selecting relevant images, organizing selected words, organizing selected images, and creating a coherent mental representation. (Mayer R.E. 2001) argued that the eventual goal of any multimedia learning lesson should be the integration of information into a coherent mental representation. Using this exemplar, (Mayer R. E. 2001) articulated practical guidelines for multimedia design.

2.6 DESCRIPTION OF MAYER'S EXPERIMENTAL MATERIALS

Based on his experiments, Mayer designed a set of process-based, brief texts such as; how lightning storms develop, how brakes function, and how pumps work. He created a multitude of multimedia combinations for all three and administered the texts and transfer tests experimentally: lightning, (Mayer R.E, et al, 2001) brakes (Mayer & Anderson 1998) (Anderson R, B and Mayer R,E, 1992) and pumps (Mayer R.E and Moreno , R., 1998).

(Mayer R.E, 2001) developed multimedia conditions using an animation authoring tool that is now antiquated for the Macintosh.

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In order to test the efficacy of multimedia combinations, (Mayer, R.E & Moreno, R, 2002) created three primary conditions: animation and written text; animation and auditory (narration) test the efficacy of multimedia combinations, (Mayer, R.E & Moreno , R, 2003) created three primary conditions: animation and written text; animation and auditory (narration); and animation, written text, and narration.

Hence, in the animation and written text condition, participants watched the same animation and read the descriptive text. In the third condition, participants were exposed to all three modalities: they listened to the narration, read the written transcription of the narration, and watched the associated animation. The animation was consistent across all conditions and the written and spoken texts are identical.

Upon completion of the multimedia lesson, participants completed either an achievement test. The retention test was an elemental measure of recall, asking the participant to recall the steps \in the lesson. The transfer test focused on measuring the learner`s deeper understanding of the materials, measuring the ability to extrapolate and apply the material. (Moreno, R & Mayer, R.E, 1999) noted that as an educator, he was primarily interested in the transfer test performance.

Cognitive (the process of knowing) psychology began to overtake the other principles as it now emphasized on unobservable constructs such as the human mind, memory, attitudes, motivation, thinking, reflection and other presumed internal processes. Based on computer science artificial intelligence has given out two theories of cognitive learning.

These principles have been designed in different categories which include semantic networks attempting to parallel how biologists view the connections of the human brain. According to this theory our knowledge consists of nodes connected in countless ways.

Remembering, thinking, acting, problem solving consist of information being activated via relationships or connections to other information that in turn activates other information. The spreading activation of billions of node via links accounts for cognitive activity.

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Another and perhaps most dominant theory is based on information- processing approach which attempts to describe how information in the world enters through our senses, becomes stored in memory that is retained or forgotten and is used.

Also include in this notion of an executive control, which coordinates the learner`s perception, memory, processing, and application of information. Underlying the information-processing approach is the assumption that the senses and the brain follow but very systematic laws and that we can facilitate learning to the extent we can determine those laws.

According to (Yekovich, 1993) in (Kozma, R.B, 1991) the areas of cognitive theory that are most important to multimedia design are those relating to perception, and attention, encoding of information, memory comprehension, active learn in g, motivation, loss of control, mental models , metacognition and individual differences.

Mentioned above are some concepts which the researcher is going to incorporate into her instructional design for multimedia learning like individual differences and motivation. A research in which more is closely related to the one the researcher is undertaking was done by (Stephen D., Sorden, 2004) who combined different types of cognitive approaches integrated them to come up with his perfect design of multimedia learning.

These include the theory of working memory (Baddeley, A D., 1999), dual Encoding Theory Paivio`s model, (Clark, J & Paivio, A, 1991), Cognitive Load Theory Sweller`s model (Sweller, J, 1999), ACT-R Production System theory Anderson`s model, (Anderson, J.R & Schunn, C.D, 2000) and the cognitive theory of multimedia learning Mayer`s model, (Mayer R.E , Boye W, & Bryman, A, 1996).

The current research will focus mainly on Mayer`s cognitive theory of multimedia learning (Mayer R.E & Gallini, J, 1990) frameworks combining with some concepts form only the first three of the four models mentioned earlier for my instructional design.

2.7 COGNITIVE LOAD THEORY

Cognitive Load Theory (Chandler, P & Sweller, J, 1994), or CLT, states that working memory is limited in its capacity to selectively attend to and process incoming sensory data. CLT is concerned with the way in which a learner's cognitive resources are focused and used during learning and problem solving, suggesting that for instruction to be effective, care must be taken to design instruction in a way as not to overload the mind's capacity for processing information.

The implication for multimedia is that if we only have a very limited amount of information processing capacity in working memory at any single moment, then instructional designers should not be seduced into filling up this limited capacity with unimportant but flashy `bells and whistles` in a multimedia unit.

An example of what this means for multimedia instructional design is that the layout should be visually appealing and intuitive, but that activities should remain focused on the concepts to be learned, rather than trying too much to entertain. This is especially true if entertainment is time consuming to construct and is complicated for the learner to master. Working memory can be overloaded by the entertainment or activity before the learner ever gets to the concept or skill to be learned.

2.7.1 GOAL- FREE EFFECT

The goal free-effect suggest that problems should not be given with an end-goal, because it cause the learner to have to maintain several conditions in working memory while they engage in problem solving. A goal- free problem reduces extraneous cognitive load and aids in schema construction. One example is that a conventional geometry problem will require the learner to find a value for a particular angle, while goal- free problems ask students to find the values of as many as they can.

2.7.2 WORKED EXAPMLE EFFECT

The worked example effect that provides with worked-out examples of problems to study can be just as or even more effective in building schemas and performance transfer than having them work out similar problems themselves. This means that if a multimedia instructional unit was appealing enough to hold the learners' attention and cause the learner to really study the process of a worked-out problem in detail, then it could likely be just as much or more effective than having them work the problem out themselves, at least initially. One strategy that encourages learners to process a worked example at a meaningful, deeper level is self-explaining.

2.7.3 COMPLETION PROBLEM EFFECT

The key to learn from worked examples, however, is that the examples must be carefully studied, which many learners do not do. Completion problems provide a goal state and a partial solution, and then require the learners to complete the partial solution. This type of problem combines the strong points of worked examples and conventional problems, because the learner must carefully study the partially-worked example and then applies what they have learned to actively solving the problem.'

2.7.4 SPLIT- ATTENTION EFFECT

Split- attention occurs when learners are presented with multiple sources of information that have to be integrated before they can be understood. This principle simply states that instruction should not be designed that causes the learner to have to divide attention between two tasks, such as searching for information to solve a problem or reading a manual while trying to practice a software application on a computer. In the computer example, it is better to have learners read the manual first and then sit s down at the computer to practice what they have read.

2.7.5 MODALITY EFFECT

This draws from theories such as (Baddeley, A.D & Andrade, J, 1994)`s theory of visual and auditory working memory sub-components. It asserts that effective working memory capacity can be increased by using auditory and visual working memory together rather than using one or the other alone. The information that is directed at each channel, however, should be such that it can't be understood in isolation, but needs to be integrated with information in the other channel in order to be fully understood. This of course, is one of the strong points of multimedia instruction, where it is easy to present information visually while also providing related or supporting information visually while also providing related or supporting information through narration, for example.

2.7.6 REDUNDANCY EFFECT

The redundancy effect occurs when information that can be fully understood in isolation, as either visual or auditory information, is presented to both channels as essentially the same information. Integrating redundant information in both working memories can actually increase cognitive load. What is actually happening when this occurs is a form of split-attention.

This strategy can vary, though, depending on the experience of the learner. It is suggested that a diagram with text may be beneficial for novice learners because they need the text to make sense of the diagram, while a similar instructional strategy may become redundant for a more experienced learner and the diagram alone would be more effective. Computer manuals that have minimal text and ample diagrams are another example of a good way to do this. The general message of the redundancy effect is that less is often more when it comes to learning so that cognitive capacity is overtaxed.

2.7.7 VARIABILITY EFFECT

This technique recommends variability of practice because it encourages the learner to develop schemas that aid in transfer of training to similar situations. The more variability in instruction in instruction, the more the learner will develop multiple schemas that allow them to recognize common components under different conditions and apply what they have learned to solve problems in other areas.

In addition to understanding working memory and cognitive load for designing multimedia instruction, it is helpful to be familiar with production system theory, which seeks to provide a model and explanation for how information is transferred from working memory to long term memory and the retrieved at a later time when it is needed. Some of the production system concepts that we will consider include declarative and procedural knowledge self- explaining behaviors, and transfer of learning.

2.8 A PRODUCTION SYSTEM THEORY OF KNOWLEDGE AND LEARNING

Production system theory further expands the understanding of human working memory and how it interacts with long-term memory to identify goals needed to solve a problem or construct new knowledge. A production system is a model that is based on a set of condition-action pairs (if- then statements) known as production rules that form the basis of cognitive skills, (Moreno, R & and Mayer, R.E, 2000).

For a production to become active or `fire`, it will test incoming information against a predetermined condition. The stronger the production and the more the incoming data meet the condition; the easier it is to trigger the production, which causes a chain reaction, also known as spread activation, which results in a cognitive action of some sort. According to production system theory, learning and automation is actually the process of strengthening these production paths.

One production system that is increasingly being used as a guide for the development of computer- based training (or more specifically, intelligent tutoring systems) is Adaptive Control of Thought – Rational (ACT-R), which was originally developed by John Anderson in (Anderson, J.R & Gluck, K, A in D.Klahr & S. M. Carver (Eds), 2001) for stimulating human cognition and understanding how people organize knowledge and produce intelligent behaviour.

ACT-R makes several assumptions about how knowledge is represented. The first is that knowledge is stored in two long-term memory structures known as procedural memory and declarative memory. The second is that a chunk represents the basic unit of knowledge in declarative memory, and the third is that productions (production rules) form the basic unit of knowledge in procedural memory (Anderson, J.R & Gluck, K, A in D.Klahr & S. M. Carver (Eds), 2001).

One of the most important concepts in ACT-R is this distinction between declarative and procedural knowledge and how the two work together to form human cognition, and that memory and behavior is often a result of some combination or interaction between the two (Anderson, J.R & Gluck, K, A in D.Klahr & S. M. Carver (Eds), 2001). These factors contribute to the acquisition and construction of knowledge.

2.9 PRINCIPLES FOR EFFECTIVE LEARNING CONTENT DEVELOPMENT

(Clark R. C, & Mayer R.E, 2003) provide strong research evidence supporting certain forms of e-learning content delivery; the primary principles pertaining to my findings include the *modality principle* and *the personalization principle*. These two principles specifically address areas for improvement for Kronos e-learning content.

This media project will present a broader set of six key principles presented by (Clark R. C, & Mayer R.E, 2003) for pedagogically sound e-learning. The work of (Alessi & Trollip, 2001) provides extensive resources on the extensive delivery modes of delivery available to an e-learning content developer. In discussing different delivery modes, Alessi and Trollip not only describe the mode but they provide solid foundations for implementing and effectively delivering the mode.

(Bonk and Zhang, 2008) provide a simple model they have titled “R2D2,” which represents a four-component model to “Read, Reflect, Display, and Do” when developing elearning. This is not a method; rather it is a model that is intended to reach learners through multiple learning styles and through multiple intelligence dimensions. By reaching learners through multiple modalities and styles, one or more of these methods is more likely to stick with the learner.

2.10 ROLE OF INDIVIDUAL DIFFERENCES

The search for isolation of the cognitive primitive has long been a theme for many experimental psychologists. One group argued that processing speed is the primitive that predicts cognitive task performance and can be delineated by age differences (Salthouse, Hartman, Hasher, Kane & Stoltzfus, 2000). Another group contended that a primary inhibitory mechanism, that allows that suppression of irrelevant stimulus and information, is the cognitive primitive (Hartman M, Hasher L, Stoltzfus, Zacks and Rypma, 2000).

A final research group, inspired by (Baddeley A.D & Hitch G. J, 1999), differentiated working memory capacity from short term memory capacity, as espoused by (Miller, G.A, 2000) in (Mayer R.E, 2001) and his `magical` number seven capacity estimation and conception for short-term memory. According to (Mayer R.E, 2001) this group of researchers contended that working memory capacity is the cognitive primitive (Jurden, 1995; Miyake, Just & Carpenter, 1994; Bredart & Beerten, 1998).

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(Baddeley A.D & Hitch G. J, 1999) proposed a dramatically different conception of memory compared to traditional unitary systems that encode, maintain and retrieve. They proffered a continuous model of working memory with a central executive component managing two primary slave systems: phonological loop (verbal information processing) and the visiospatial scratchpad (visual/spatial information processing).

Although research is proliferating; the specific details of central executive functioning and storage are still under investigation (Kintsch, Patel, & Ericsson, 1999). (Baddeley , A, 1996) delineated four approaches to studying the central executive; dual task performance assessment: random number generation; selective attention manipulation; and long term memory activation measurement. Regardless of research approach, the debate continues regarding storage and processing aspects of the central executive component of working memory.

(Baddeley , A, 1996) maintained his position that the central executive includes both processing and storage features. (Norman and Shallice, 1995) conceived a supervisory attentional system, largely responsible for processing and control, while (Dempster, F, 1981) found that traditional notions of capacity did not predict memory span. In addition to research on the central executive, numerous investigations have studied the phonological loop such as (Baddeley & Andrade ,1994), (Jones & Macken, 1995), (LeCompte, 1994), (Longoni, Richardson, & Aiello, 1993) and (Saito, 1994) and the visiospatial sketchpad such as (Hitch , Brandimonte & Walker, 1995), (Salway & Logie, 1995), (Smyth & Scholey, 1994) and (Toms, et al, 1994).

An individual difference can influence the relationship between multimedia condition and test performance in two fundamental manners; as a mediator or as a moderator. There is a specific criterion for shaping whether a variable intercede the relationship between two other variables. For example, the predictive relationship between the cognitive multimedia principles and performance on retention and transfer tests may hold for certain conditions of a third variable, but not for all conditions.

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For example, the predictive relationship between the cognitive multimedia principles and performance on retention and transfer tests may hold for certain conditions of a third variable, but not for all conditions. Typically the moderated variable has been dichotomized into low and high groups, but finer categories can be used describe group membership as well.

Another way to distinguish mediating variables is that, “moderator variables specify when certain effects will hold; mediators speak to how or why such effects occur” (Baron and Kenny, 2000).

In terms of the discussion of individual differences and their impact on the relationship between multimedia condition and transfer test score, cognitive individual differences are temporarily prior; a measured variable that fundamentally impacts, either completely or partially, the relationship.

In hierarchical regression analyses, temporally prior variables are entered first in order to extract the variance known to be associated with the dependent variable. Once that “nuisance” variance is removed, one can explore the main effects and interactions in the analysis (Tabachnick & Fidell, 2001). Mayer’s work has been completely absent statistical examination of the interaction between several key cognitive variables and the modality and redundancy effect on transfer test performance.

Rather, Mayer and colleagues, (Mayer R.E, Moreno, R,Boire M & Vagge, S., 1999) focused on media manipulations, without exploring the reason that certain manipulations have an effect. In essence, they focused almost exclusively on the symptom, without consideration for temporally prior cognitive individual difference causes.

In order to evaluate the superiority of animation and narration that Mayer espouses, the predictive validity and possible interaction of elemental individual differences with multimedia condition must be considered in order to scientifically evaluate the authenticity of Mayer`s modality and redundancy principles.

2.11 PRESCRIPTIVE PRINCIPLES FOR INSTRUCTIONAL DESIGN

2.11.1 FIRST PRINCIPLES OF INSTRUCTION

(Merrill , D.M, 2006a.b,2006a.b,2007,2008) reviewed a number of instructional design theories and models (Dijkstra, et al ,1997), (Marzano, et al, 2001) in an attempt to identify underlying prescriptive principles common to all or most of these approaches. He concluded that they do share common principles and that they do not incorporate fundamentally different principles. These first principles are:

Task-centered approach

Learning is promoted when learners are engaged in a task-centered approach which includes demonstration and application of component skills. A task-centered approach is enhanced when learners undertake a progression of whole tasks.

Activation principle

Learning is promoted when learners activate relevant cognitive structures by being directed to recall, describe, or demonstrate relevant prior knowledge or experience. Activation is enhanced when learners recall or acquire a structure for organizing the new knowledge.

Demonstration principle

Learning is promoted when learners observe a demonstration of the skills to be learned that is consistent with the type of content being taught. Demonstrations are enhanced when learners receive guidance that relates instances to generalities. Demonstrations are enhanced when learners observe media relevant to the content.

Application principle

Learning is promoted when learners engage in the application of their newly acquired knowledge or skill that is consistent with the type of content being taught. Application is effective only when learners receive intrinsic or corrective feedback. Application is enhanced when learners are coached and when this coaching is gradually withdrawn for each subsequent task.

Integration principle

Learning is promoted when learners integrate their new knowledge into their everyday life by being directed to reflect on, discuss, or defend their new knowledge or skill. Integration is enhanced when learners create, invent, or extrapolate personal ways to use their new knowledge or skill to situations in their world. Integration is enhanced when learners quickly demonstrate their new knowledge or skill. In this chapter, even though these principles seem to have been available for some time they are not often used in instructional materials.

Four- Phase Cycle of instruction

(Merrill , D.M, 2006a.b,2006a.b,2007,2008) goes on to say the identification of the first principles does more than merely collect a set of prescriptive principles that might be used to select or design effective instruction. These principles are interrelated to one another. The four- phase cycle of instruction consists of activation, demonstration, application and integration. Effective instruction involves all four of these activities as required for different problems or whole tasks.

A similar four-phase cycle of instruction consisting of meaning (activation), conceptualizing (demonstration), operationalizing (application), and renewing (integration) was described by (McCathy, 1996).

The Vanderbilt group described a learning cycle consisting of a set of challenges (task or problem), the generation of ideas (activation), multiple perspectives (demonstration), research and revision (demonstration/ application), testing your mettle (application), going public (integration) and looking ahead and reflecting back- integration (Schwartz, 1999).

Problem- Centered Instruction

Merrill D .M,Matthew B, Andrew van Schaak, 2008) discovered that perhaps the most important notion of the first principles is that engaging instruction is problem centered; that is, individual instructional components are most effectively taught in the context of a progression of real- world problems where the student is shown a problem, then taught the components, and then show how the components are used to solve the problem or do the whole task.

Van Merriënboer's 4C/ID model for training complex learning tasks makes a very strong research-based argument for centering instruction in whole real-world tasks and then teaching component knowledge and skill in the context of these tasks (van Merrienboer 1997 and Kirschner, 2007; van Merrienboer in Merrill D.M, 1997).

The first principles and 4C//ID identify a task-centered approach that combines the solving of problems with more direct instruction of problem components as contrasted with problem-based approaches in which students are placed in collaborative groups, given resources and a problem, and left to construct their own solution for the problem. Research supports this guided instruction approach over more pure learner-centered approaches with less guidance.

(Khlar and Nigam, 2004) compared guided direct instruction with a discovery learning approach for children learning about confounding variables in scientific experiments. The children were actively involved in performing experiments. The direct instruction group observed demonstration experiments (demonstration- guidance), whereas the discovery group did their own experiments.

(Khlar and Nigam, 2004) demonstrated that “many more children learned from direct instruction than from discovery learning” and that children in the direct instruction group made broader and richer scientific judgments about science-fair posters than those in the discovery group. Two important research reviews have argued that instruction involving minimal guidance including problem-based teaching does not work, whereas task-centered approaches involving guidance and coaching are more effective an (Kirschner and Mayer R, 2006, 2004).

Levels of Instructional Strategies

Previous papers (Merrill D, 2006a.b) in (Merrill D .M, et al, 2008) emphasized that the first principles promote enhanced performance on complex tasks. To assess the effects of the first principles, it is necessary to assess learners` scaled performance on these complex tasks. Some methods for determining level of performance include:

- 1) The number of tasks completed in a progression of subsequently more difficult tasks,
- 2) The amount of coaching required for satisfactory performance on difficult tasks, and
- 3) The number of stages performed satisfactory in a nested complex task

(Merrill D, 2000a) further suggests scaled instructional strategies based on the first principles. He labeled information-only as a level 0 instructional strategy and suggested a series of yet-to-be- tested hypothesis for scaled strategies:

- 1) A level 1 instructional strategy that adds consistent demonstration to a level 0 information-only strategy promotes a higher performance level on scaled complex tasks (Merrill D, 2000a).
- 2) A level 2 instructional strategy that adds consistent application with corrective feedback to a level 1 instructional strategy consisting of information plus demonstration promotes an additional level of performance on complex real-world tasks (Merrill D, 2000a).
- 3) A level 3 instructional strategy that consists of a task-centered instructional strategy that includes consistent demonstration and consistent application with corrective feedback promotes an additional increment in the level of performance on complex tasks (Merrill D, 2000a).
- 4) Providing or recalling relevant experience promotes an additional increment in learning efficiency, effectiveness, and engagement when added to a level1, level 2, or level 3 instructional strategies (Merrill D, 2000a).

- 5) Providing activation-structure promotes an additional increment in learning efficiency, effectiveness, and engagement when added to a level 1, level 2, or level 3 instructional strategies (Merrill D, 2000a).
- 6) Adding reflection-integration to any of the above instructional strategies promotes an additional increment in learning efficiency, effectiveness, and engagement (Merrill D, 2000a).
- 7) Adding create-integrate to any of the above instructional strategies promotes transfer of the newly acquired knowledge and skill to performance on similar tasks in the real world beyond the instructional situation (Merrill D, 2000a).

2.12 OTHER INSTRUCTIONAL DESIGN PRINCIPLES

Some recent prescriptive books on designing effective instruction have stated prescriptive principles for instructional design (Merrill D. M, et al, 2008). (Merrill D, 2007) in (Merrill D .M,et al, 2008) presented a synthesis of some of these sources as they relate to the first principles of instruction.

The following summarizes some of the principles identified by other authors and attempts to relate them to the first principles of instructional design.

Clark and Mayer's Principles for e-Learning Aligned with Merrill's First Principles

E-Learning Principles (Clark and Mayer, 2003)	First Principles (Merrill, 2002)
Interactions should mirror the job (p. 153).	Task-centered
Critical tasks require more [distributed] practice (p. 159).	Task-centered-progression
Use job contexts to teach problem-solving processes (p. 251).	Task-centered
Incorporate job-specific problem-solving processes (p. 264).	Task-centered
Use job-realistic or varied worked examples (p. 186).	Task-centered
Replace some practice problems with worked examples (p. 177).	Demonstration
Apply the media elements principles to examples (p. 179).	Demonstration-guidance
Apply the media elements principles to practice exercises (p. 164).	Demonstration-media
Train learners to self-question during receptive e-lessons (p. 166).	Application
Teach learners to self-explain examples (p. 190).	Integration-reflect
Make learners aware of their problem-solving processes (p. 260).	Integration-reflect

Table 1. Clark and Mayer's Principles for e-learning aligned with Merrill's First principles in (M. David Merrill et al, 2008).

Principles for Multimedia Learning

(Merrill D .M,et al, 2008) researched that, based on extensive research; (Clark R. C, & Mayer R.E, 2003) have identified principles for multimedia learning. These principles elaborate the demonstration principle for relevant media (Mayer, R.E & Moreno, R, 2002).

Principles for e-Learning

In addition to the multimedia principles (Clark R. C, & Mayer R.E, 2003) recommended the additional instructional principles (Table 1). Correspondence to the first principles is indicated in the right column for each of these principles. It should be evident to the reader that some of these principles have a close correspondence, some of these principles provide more elaboration than the first principles, and some are not included in the first principles (Merrill D .M,et al, 2008).

Minimalist Principles

(Van der Meij ,H., 1998) in (Merrill D .M,et al, 2008) identified heuristics for designing minimalist instruction (Table 2). The task-centered orientation of these heuristics is apparent. Some of these demonstration, application, guidance, and coaching heuristics provide more specific prescriptions than the first principles.

Minimalist Instruction and Merrill's First Principles

Minimalist Principles (van Meij, 1998)

- Provide an immediate opportunity to act (p. 22).
- Select or design instructional activities that are real tasks (p. 29).
- Be sure the components of the task reflect the task structure (p. 31).
- Prevent mistakes whenever possible (p. 35).
- Provide error information that supports detection, diagnosis, and recovery (p. 38).
- Be brief; do not spell out everything (p. 43).
- Provide closure for chapters (p. 44).
- Respect the integrity of the user's activity (p. 25).
- Provide on-the-spot error information (p. 41).
- Provide error information when actions are error prone or when correction is difficult (p. 37).
- Encourage and support exploration and innovation (p. 23).

First Principles (Merrill, 2002)

- Task-centered
- Task-centered
- Task-centered-components
- Demonstration-guidance
- Demonstration-guidance
- Demonstration
- Guidance and coaching
- Application
- Application-coaching
- Application-coaching
- Integration-reflect, extrapolate

Table 2. Minimalist Instruction and Merrill's First Principles, (Merrill D .M,et al, 2008).

Cognitive Training Model

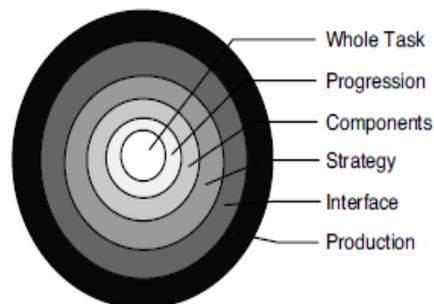
(Foshay, 2003) in (Merrill D .M, et al, 2008) presented a cognitive model that identifies five tasks learners have to complete when learning:

- 1) Select the information to attend to,
- 2) Link the information with existing knowledge,
- 3) Organize the information,
- 4) Assimilate the new knowledge into existing, and
- 5) Strengthen the new knowledge in memory. In association with these, they identify 17 elements (prescriptive principles for design) of a training lesson.

DESIGNING TASK-CENTERED INSTRUCTION

Figure 2 illustrates a Pebble-in- the Pond approach to instructional development that assists designers to systematically incorporate the first principles into their instructional design (Merril M. D, 2002b) in (Merrill D .M,Matthew B, Andrew van Schaak, 2008). The steps in this approach are to:

- 1) Specify a whole task,
- 2) Specify a progression of whole tasks,
- 3) Specify the component knowledge and skills required for each task,
- 4) Specify an instructional strategy,
- 5) Specify the user interface, and
- 6) Produce the course.



Pebble-in-the-Pond Instructional Design

Figure 2. The Pebble-in-the-Pond approach to instruction to (Merrill perform improve, 41(7), 39-44, 2002) in (M. David Merrill et al, 2008).

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(Merrill D .M,Matthew B, Andrew van Schaak, 2008), explains Figure 2 below which illustrates a typical topic-centered instructional strategy. In this strategy, each topic is taken in turn. Information is presented and demonstrated. Periodic is administered to assess the information that is presented.

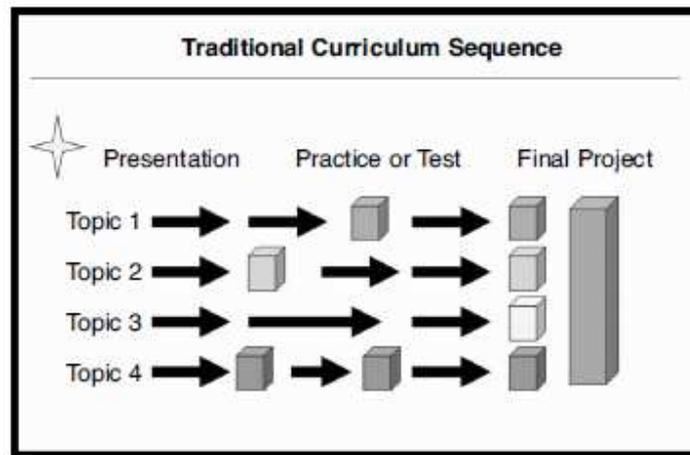


Figure 3. Topic –centered instructional sequencing. (Mendenhall et al., 2006) in (M. David Merrill et al, 2008).

(Merrill, D.M, 2006c) elaborated the analysis required to specify the component knowledge and skill for each task in terms of portrays of specific artifacts and information for component concepts (kinds of) and component procedures- how to- (Merrill D.M, 1997). This component analysis (Figure 3) consists of the following steps:

- 1) Find a portrayal of the artifact that is a consequence of completing the whole task (kind of);
- 2) Identify a series of subtasks (information) leading to the desired consequence (how to);
- 3) For each subtask, find a portrayal of the artifact that is a consequence of completing this subtask (kind of);
- 4) Identify the defining properties of each artifact (kind of);
- 5) Identify the ordering properties of each artifact (kind of);
- 6) Identify the procedure for creating or selecting the artifact (how to); and
- 7) Identify a portrayal of a scenario illustrating this procedure (Merrill, 2006c).

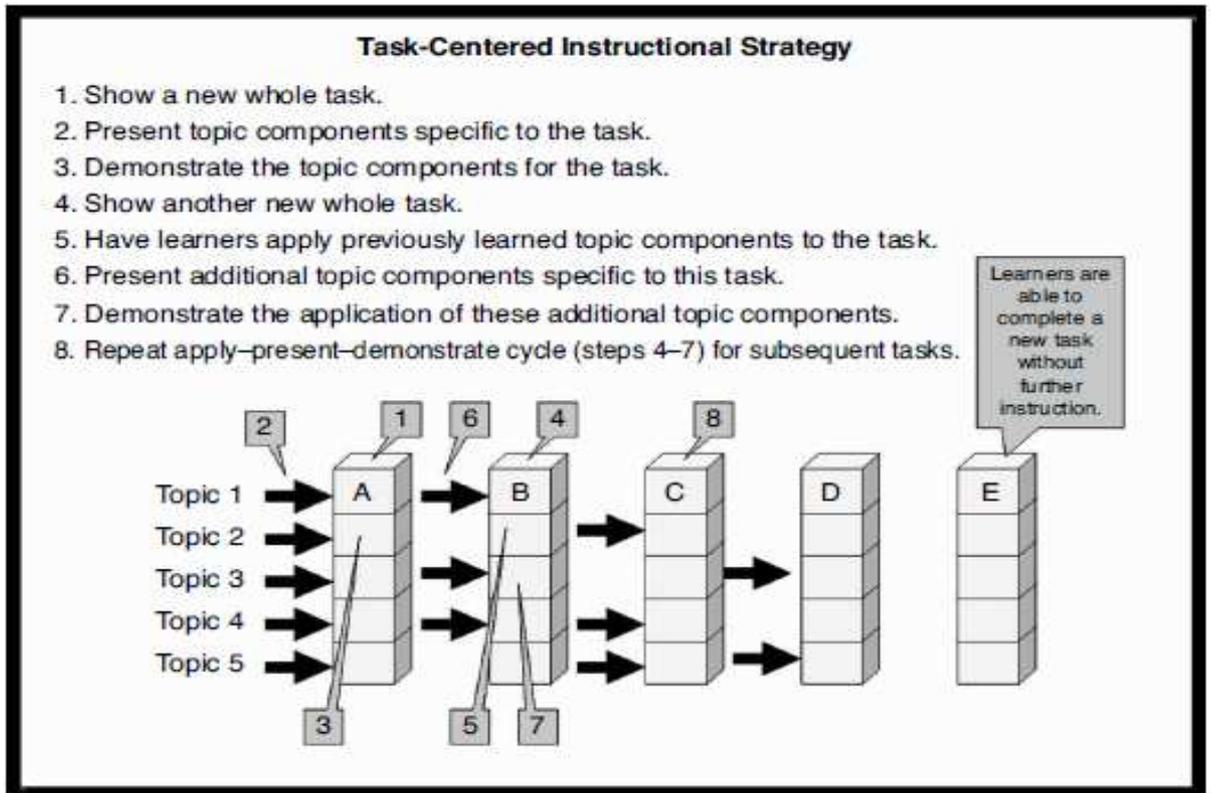


Figure 4. A task-centered instructional sequencing. (Mendenhall, et al., 2006; Merrill, *J. Res. Technol, Educ.in*, press).

Figure 4 in (Merrill D .M, et al, 2008) illustrates a task-centered instructional strategy consistent with the first principles of instruction and the Pebble in-the pond approach to instructional design. In this strategy, a whole task is demonstrated; some level of each of the relevant topics is presented and then demonstrated in the first task. A second whole task is then presented.

The learner is asked to apply those topics that were presented to the new task. An expanded version of the relevant to the second task is presented and demonstrated for the second task. This strategy is repeated for several more tasks until all the topics have been expanded as much as required by the final tasks and the student is able to apply the topics to a new task unaided.

A new book to help designers to use the 4 C/ID adapts the Pebble-in-the-Pond model of content – first instructional development as a recommended application of the ten steps to designing instruction for complex skills (van Merriënboer J.J.G & Kirschner , P.A, 2007). Table 14.6 compares the ten development steps of van Merriënboer and Kirschner to the ripples in the Pebble-in-the-Pond model for instructional design.

Pebble-in-the-Pond and Ten Steps to Complex Learning

Pebble-in-the-Pond

- Identify a whole task or problem.
- Specify a progression of whole tasks.
- Analyze the component skills for each task.
- Specify an instructional strategy.^a
- Determine user interface.^b
- Produce the course.

Ten Steps to Complex Learning

- Design learning tasks.
- Sequence task classes.
- Set performance objectives.^c
- Design supportive information.
- Analyze cognitive strategies.
- Analyze mental models.
- Design procedural information.
- Analyze cognitive rules.
- Analyze prerequisite information.
- Design part-task practice.

^a van Merriënboer and Kirschner (2007) combine analysis and strategy as they discuss component skills; Pebble-in-the-Pond separates these two design functions.

^b Ten Steps has only a minimal discussion on interface, delivery, and production; their emphasis is on the design aspects of instructional development.

^c Pebble-in-the-Pond does not specify assessment criteria for the tasks. This is an area where the model should be improved.

Table 3. van Merriënboer, J.J.G and Kirschner, P. A, *Ten steps to Complex Learning*, Lawrence Erlbaum Associates, Mahwah, 2007) in (MD Merrill et al, 2008).

(Merrill D .M,Matthew B, Andrew van Schaak, 2008)concludes that considerable agreement exists with regard to the prescriptive instructional design principles that are fundamental to effective, effective, and engaging instruction, and the first principles of instructional appear to have a fair amount of agreement.

The limited data available indicate that, when these principles are implemented in instructional products and environments, the instructional quality increases however, far too much instruction seems to ignore these fundamental principles.

2.13 COGNITIVE BEHAVIOURAL THEORY

(Shannon Birk, 2010) discovered that the main concept of Cognitive Behavioural Therapy (CBT) is that changing one`s thinking can transform emotions and behaviour. The theory postulates that people have the will and drive towards self-actualization, but their thought processes can stand in the way of achieving their goals.

The theory focuses on helping the client identify, evaluate, and modify dysfunctional thinking (Selingman, L, 2001). It is thought that if people have realistic thoughts about their strengths and weaknesses and take pride in their accomplishments, they will feel happier and have more stability in their lives. Hence, CBT teaches people to assess their thoughts and behaviour, not themselves (Selingman, L, 2001) in (Shannon Birk, 2010).

Furthermore the theory postulates that childhood traumas and difficulties may also contribute to dysfunctional thinking. Therefore, it is a combination of biological origin and life experiences that lead one to think about the self in a detrimental manner (Thompson C.L,et al., 2004) in Shannon Birk, MA CCC, 2010. Therapy uses the presenting emotions to help identify irrational beliefs that client holds. It is thought that disappointments are particularly useful to determine self-destructive emotions. (Shannon Birk, 2010).

Making these irrational beliefs conscious and actively disputing them is thought to reduce emotional disturbances (Culhune, S.E & Watson P.J, 2003) in (Shannon Birk, 2010). Therefore, it is the goal of CBT to help clients move beyond feeling by transforming their irrational beliefs into consciously articulated ideas that can be challenged in therapy.

2.14 SOCIAL LEARNING THEORY

(Thomas McClean, 2005) lectured that social learning theory (also known as Social Cognitive Theory) is the idea that people learn by watching what others do that human thought processes are central to understanding personality. Social learning theory stemmed out of work by (Miller, N.E & Dollard, J, 1990).

Their proposition posits that if humans were motivated to learn a particular behavior that particular behavior would be learned through clear observations. By imitating these observed actions the individual observer would solidify that learned action and would be rewarded with positive reinforcement (Miller, N.E & Dollard, J, 1990). The proposition of social learning was expanded upon and theorized by Albert (Bandura, A. , 1990) to the present. (Thomas McClean, 2005) said that in the book “Educational Psychology: Developing Learners”, author Jeanne Ellis Ormrod (2003) lists the main principles of social learning theory:

- People learn by observing others.
- Learning is an internal process that may or may not change behavior
- People behave in certain ways to reach goals.
- Behavior is self-directed (as opposed to the behaviorist thought that behavior is determined by environment).
- Reinforcement and punishment have unpredictable and indirect effects on both behavior and learning.

Observation of Models

Social learning theory revolves around the process of knowledge acquisition or learning directly correlated to the observation of models. The models can be those of an interpersonal imitation or media sources. Effective modeling teaches general rules and strategies for dealing with different situations (Bandura, A, 1990) in (Thomas McClean, 2005).

As a result of the observations the individual observer can be affected in two separate ways. The inhibitory effect, a positive punishment action, occurs when an observer sees the action of another involved in a social situation being punished for that action. A disinhibitory effect, a positive reinforcement action, is when an individual is praised for a \action and the observer learns form and that action (Miller, Katherine , 2005).

Vicarious reinforcement explains that the observer does not expect actual rewards or punishment but anticipates similar outcomes to his/her imitated behaviors and allows for these effects to work. This portion of social learning theory relies heavily on outcome expectancies.

In education, teachers as well as other learners, can model the desired behavior/ concepts. Teachers and learners should be dedicated to building of high self-efficacy levels in the other learners by recognized their contributions, (Thomas McClean, 2005).

Identification and Self-Efficacy

(Thomas McClean, 2005 lectured that further development in social learning theory posits that learning will most likely occur if there is a close identification between the observer and the model and if the observer also has a good deal of self- efficacy. Self-efficacy beliefs function as an important set of proximal determinants of human motivation, affect and action [which] operate on action through motivational, cognitive, and affective intervening processes (Bandura, A. , 1990).

Identification allows the observer to feel a one-to-one connection with the individual being imitated and will be more likely to achieve those imitations if the observer feels that they have the ability to follow through with the imitated action (Bandura, A. , 1990) in (Wells G, 2007).

2.15 THEORIES OF LEARNING

Behaviorism

Methodological behaviorism began as a reaction against the introspective psychology that dominated the late 19th and early 20th centuries. Introspective psychologists such as Wilhelm Wundt (1999) maintained that the study of consciousness was the primary object of psychology.

Their methodology was primarily introspective, relying heavily on first-person reports of sensations and the constituents of immediate experiences. Some behaviorists, like (deJong, T., 2010) rejected introspectionist methods as being subjective and unquantifiable. Instead, they focused on objectively observable, quantifiable events and behavior.

The behaviorists argued that since it is not possible to observe objectively or to quantify what occurs in the mind, scientific theories should take into account only observable indicators such as stimulus-response sequences. According to Skinner in (Theodora Polito, 2005), the mentalistic problem can be avoided by going directly to the prior physical cause while bypassing intermediate feelings or states of mind.

The quickest way to do this is to consider only those facts which can be objectively observed in the behavior of one person in its relation to his prior environment history. Radical behaviorists such as Skinner also made the ontological claim that facts about mental states are reducible to facts about behavioral dispositions, (Theodora Polito, 2005).

Cognitive Constructivism

(Theodora Polito, 2005), taught that dissatisfaction with behaviorism's strict focus on observable behavior led educational psychologists such as (Perry W.G, 1999) to demand an approach to learning theory that paid more attention to what went on "inside the learner's head". They developed a cognitive approach that focused on mental processes rather than observable behavior.

Common to most cognitivist approaches is the idea that knowledge comprises symbolic mental representations, such as propositions and images, together with a mechanism that operates on those representations. Knowledge is seen as something that is actively constructed by learners based on their existing cognitive structures. Therefore, it is relative to their stage of cognitive development; understanding the learner's existing intellectual framework is central to understanding the learning process, (Lois Holtzman, 2010).

Social Constructivism

Social Constructivism is a variety of cognitive constructivism that emphasizes the collaborative nature of much learning, (Illeris, Knud, 2004). Social constructivism was developed by post-revolutionary Soviet psychologist, Lev Vygotsky. (Vygotsky, L, 1998) was a cognitivist, but rejected the assumption made by cognitivists such as Piaget and Perry in Wink, J. 2005, that it was possible to separate learning from its social context.

He argued that all cognitive functions originate in, and must therefore be explained as products of social interactions and that learning was not simply the assimilation and accommodation of new knowledge by learners; it was the process by which learners were integrated into a knowledge community.

According to (Vygotsky, L, 1998) in (Wolf, P, 2010) every function in the child's cultural development appears twice; first, on the social level and later on, on the individual level; first, between people (interpsychological) and then inside the child (intrapsychological). This applies equally to voluntary attention, to logical memory, and to the information of concepts.

All the higher functions originate as actual relationships between individuals. (Vygotsky, L, 1998)'s theory of social learning has been expanded upon by contemporary psychologists such as (Miller, N.E & Dollard, J, 1990), and (Bandura, A, 1990) in (Brown, B & Ryoo, K, 2008).

2.16 AN OVERVIEW OF SOME PREVIOUS RESULTS

A Doctor of philosophy student (Katherine ann Austin Stalcup, 2005) replicated (Mayer R.E, 2001)'s aforementioned research and her experiment: animation and narration multimedia materials yield higher scores compared to animation and text or animation, text and narration. Additionally, AT and ANT conditions were not significantly different in terms of transfer performance. Table 4 displays the means and standard deviations for the following three multimedia conditions whist Figure 5 further below illustrates the relationship among the means.

Table 4. Descriptive statistics for multimedia conditions (Katherine ann Austin Stalcup, 2005)

Condition	N	Mean	Standard Deviation
Animation & Text (AT)	25	1.68	.69
Animation, Narration, & Text (ANT)	25	1.92	.81
Animation & Narration (AN)	25	2.92	1.41

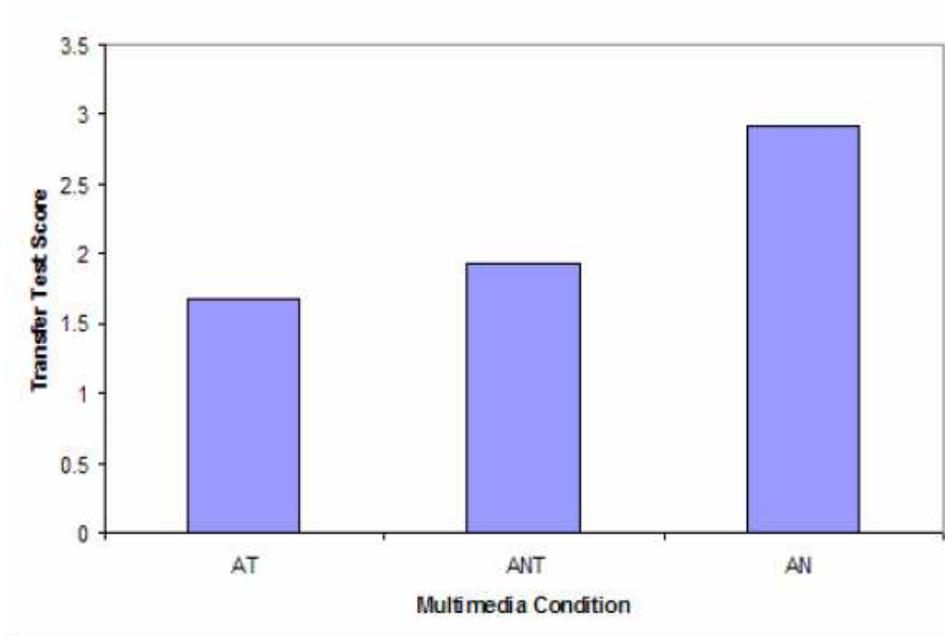


Figure 5. Relationship of group means for different multimedia conditions (Katherine ann Austin Stalcup, 2005)

An analysis of variance indicated group differences beyond the chance probability occurrence $p < 0.001$. Two-tailed t-test analyses between the animation and text (AT) group and the animation and narration (AN) group revealed that AN scores were higher than AT scores $t(48)=3.95, p < 0.001$.

In terms of Mayer's (2001) redundancy principle, two-tailed t-test analyses between the animation, narration, and text (ANT) and the AN group revealed that AN scores were higher than ANT scores $t(48) = 3.07, p=0.001$. Levene's test for equal variance indicated that the homogeneity assumption was valid for the two group comparisons.

However Mayer and Katherine did not discuss the relationship between ANT and AT, or with the other conditions with Narration and also the relationships comparing with the traditional group or blended whichever way neither they replicate the multimedia cognitive principle with the modality and or redundancy principles and this is taken care of by the current research.

2.17 SUMMARY

This chapter was highlighting different kinds of work related to the research being undertaken henceforth. All the theories, arguments from various authors and experts will help shape this research into a more tangible product basing on the given empirical evidence.

The chapter is mainly revolves around the cognitive theory of multimedia learning (Mayer, R.E & Moreno , R, 2003) mentioning and explaining the cognitive principles and their respective effects. The researcher went on to describe how Mayer conducted his experiments which is a greater guideline to the present research.

The cognitive Load Theory also plays a big role in mapping the current research where there is the production system theory of knowledge and learning. Principles of effective learning and content development were also described stating the role of individual differences that is even though there are theories involved in the whole learning process the fact that people were born differently means that they are unique and therefore can never perform equally.

An overview of the results by other researchers was also outlined in this chapter so that they can be used for useful comparison by the present researcher. Cognitive science provides several empirical theories that provide useful models to suggest ways in which knowledge is constructed and placed in memory. Basing on these theories and other factors taken into consideration this research could be conducted.

The Cognitive Load Theory builds on Baddeley`s model of working memory to propose that since the brain can only attend to and process a limited amount of incoming sensory information, it is important to structure instruction in such a way that working memory is not overloaded. Production system theories further explain how working memory interact with prior knowledge to construct new knowledge.

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Mayer`s Cognitive Theory of Multimedia learning (CTML), (Mayer R.E, 2001) based his own research on these theoretical foundations to develop a framework that serves to guide the development of effective multimedia instruction.

Since new developments in multimedia technology increasingly have the potential to overwhelm the apparently limited resources of the brain, it is important that we seriously consider cognitive research and look for ways to apply it more effectively.

The exponential growth in computer-based training will precipitate increasing demand for affective, learning design in multimedia instruction. Rather than relying on flashy special effects, the researcher begins to work within an empirical framework of cognitive principles, that are driven by the learner, rather than technology.

Cognitive science provides a research-based foundation of theories that serve as a grounded starting point for this instruction, as well as further research. Creating multimedia instruction, is gradually becoming easier, but there is still quite a bit to master if it is to be done well. The combination of this with the rapidly changing field cognitive science, it becomes a moving target, and trying to stay current in new technology and cognitive theory presents a formidable challenge.

For this reason, the researcher moves to an empirical set of guidelines for the creation of our tutorials basing on the previous framework. That is, designing tutorials in a cognitively sound manner, while still producing effective and appealing tutorials for students.

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 INTRODUCTION

This chapter gives a description on how this research study was carried out. It is dedicated to the discussion of the research design and the various methodologies used in this research in this research study. Furthermore a great deal of discussion will center on how to do the research in order to collect data for the research questions as well as the overall objectives of this research study.

The researcher used a case study of part one students doing computer studies- CS001 at one of Zimbabwean colleges called Bindura University of Science Education. The researcher tested the rate or process at which students understood or conceptualized with taught computer concepts. A lot of factors affected the learner's pass rate but the researcher has dwelt on how instruction could be delivered using multimedia components defined in this context as video, audio and text, and combining these with some cognitive principles.

This entails defining the sampling techniques, sample size, the different types of data, introducing and discussing development of instruments and how data will be processed, analyzed and presented. Research is conducted through thorough experiments which are trying to answer the given research questions and also fulfilling the objectives and aim of research.

The researcher has adopted most of Katherine Ann Austin Stalcup, 2005's model of research where she also adopted most of Richard Mayer's work. These two have used cognitive principles basing on simple or soft science material whilst the current research is based on conceptualization of computer concepts. The above models have been greatly appreciated as they helped the researcher to map her own study.

3.2 RESEARCH METHODOLOGY AND DESIGNS

The lectures are designed using different combinations of audio, video and text using principles such as modality and redundancy. Tests, questioners and oral interviews are going to be held to see the student's perceptions on whether they benefit most from the use of Cognitive Principle Instructional Strategies as compared to traditional instructional strategies.

3.21 GROUP CHARACTERISTICS, POPULATION AND SAMPLE

The researcher used experimental design due to the fact that the course being examined and tested is scientific and science is mostly about experiments other than social calls.

Experimental design was advantageous because the researcher is a scientist who can base results from current experiments and deduce a reasonable meaning and there is a greater chance of conducting successful experimental designs to give satisfactory results. It can only be a disadvantage if the experiments are too complex and or there is no adequate experimental material in which case other designs can be opted for.

In the design, the research group consisted of students who were doing an Introductory to Computer Science course at Bindura University of Science Education (BUSE). The target population was **386** first year students in their second semester of February 2011. According to literature, a sample to be used should not be less than 15% of the overall population.

The researcher had to use 75 students out of the 386 students and it is justified as the sample is 19.4 %. The students used as the sample from the target population were therefore numbering **75** (N_T), and the students were grouped randomly by their respective faculties into five groups of equal size (15 apiece). The equality was created in order to minimize variances.

Using random sampling on N_T ;

$N_T = N_1 + N_2 + N_3 + N_4 + N_5$; thus,

75=15 + 15 + 15 + 15 + 15 where,

N_1 represents Pure Sciences, (15)

N_2 represents Social Sciences, (15)

N_3 represents Accounting, (15)

N_4 represents Business studies and (15)

N_5 represents Arts/Humanities (15).

The first year students are not restricted only to computer science students but also extend to all the other faculties. From each of the five faculties only an equal sample is picked randomly including males and females for the purposes of uniformity throughout the study. From each of the five groups consisting 15 students each, three students were then randomly taken from the 15 and randomly placed in the five different lecture groups which have the traditional group as the control group and four other groups as experimental groups.

The experimental groups were combinations of the modality, redundancy and multimedia cognitive principles which were Animation and Narration (**AN**), Animation, Narration and Text (**ANT**) Animation and Text (**AT**) and Narration (**N**). The age groups ranged from 19 to 32 years with the majority being on the 19-23 range.

Of the 75 students, 42 were male and 33 were female and they were grouped as follows:

- Group 1 - **Traditional learning** had 8 male and 7 female,

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- Group 2 that used **AN** had 9 male and 6 female,
- Group 3 that used **ANT** had 10 male and 5 female,
- Group 4 that used **AT** had 8 male and 7 female and
- Group 5 that used **N** had 7 male and 8 female.

Each group was introduced to an introductory computer concepts lecture with a topic of Computer Hardware. The researcher has given lectures comprising three different examples of lecture groups identifying particular hardware components and their functions that is Example a. using **ANT**, Example b. using **AN** only and Example c. using **AT** only.

The same concepts covered by all the experimental groups were also covered by the students who used the textbooks and lecture based method (traditional). The student to computer ratio was at average 1:1 and student to textbook ratio 1:2 which further enhanced collaboration between students and their lectures. Group monitoring was done by the observing lectures from the initial phase to the final phase of the learning sections.

3.3 DATA COLLECTION APPROACHES

There are a number of variables that affect the use and application of cognitive lectures. The variables were divided into two sets: dependent and independent/background variables which were taken from the grouped questions in the questionnaire. The independent variables were age, gender/sex, and prior knowledge, previous level of education and programme/area of study.

The dependent variables were namely achievement test, students ability to remember concepts, student rate of understanding taught concepts, amount of work done reading lecture material and textbooks, amount of effort put in by student`s learning, prior knowledge help students to learn and organize material better and finally whether learning methods stimulate interest in the subject.

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A questionnaire was designed by the researcher using both the independent and dependent variables. Questions were accompanied by a five point Likert scale, **1** denoting strongly disagree and **5** denoting strongly agree (Appendix A). The questionnaire was given at the end of each lecture in order to determine the impact, usage and satisfaction of using both strategies i.e. traditional and CPIS.

The performances of the students were finally measured also using a uniform achievement test which was marked out of 30 for the sections covered and this was done across all groups (Appendix B). All students begin and finish each lecture at same times with close monitoring from lecturer and teaching assistants (TA).

Each group was placed in a different venue with their monitor as follows:

- Lecture room 1 has the traditional group with lecturer
- Laboratory 1 has the AN with TA 1
- Laboratory 2 has the AT with TA 2
- Laboratory 3 has the N with TA 3
- Laboratory 4 has the ANT with TA 4

Each lecture lasted one hour after which the questionnaires were administered and done in the following **30** minutes. The questionnaires were monitored by the available lecturer and TAs. The achievement test was written in the following **30** minutes that is after the questionnaire. At the beginning of each lecture, students were provided with orientation on how to participate during the lectures and they were informed about what was expected from them during the lecture.

Each machine was tested for proper functioning before resumption. Compact Discs were used to place the recorded lectures on desktops of all the machines. Regardless of the multimedia lecture, all the students wore headsets and were told that presentation/lecture may or may not include audio, text and animation information before performance was measured. All the headsets are tested before lectures resume ensuring that they are functioning properly.

Statistical analysis was done for all the groups to determine the use multimedia cognitive lectures in improving students learning and satisfaction as well as the rate of impact of a cognitive principle based instructional design for conceptualization of computer concepts.

3.4 SUMMARY

Some researchers have highlighted a lot of advantages pertaining to the use of multimedia components alone not really stressing the use of different specific suitable combinations whilst others outlined the positive effects of each of all the cognitive principles. This research highlighted the issue of cognitive differences whereas the main essence of this research is not only limited to the type of multimedia components but their combinations with certain cognitive principles in order to achieve optimal conceptualization in this case using a sample of chosen introductory computer concepts.

CHAPTER FOUR: RESULTS ANALYSIS AND FINDINGS

4.1 INTRODUCTION

This chapter explains and analyses the results and findings that has come out of the research. These will help to clearly see the extent to which the research has affected the learning industry and helped the learners during the process. A statistical package has greatly helped discover the hidden logic so that it could be easily interpreted and understood.

The reliability of the tool with the set of seven dependent variables (Appendix C) encompassing the questionnaire was measured using Cronobach`s alpha at 0.820 and showed that five variables had Alpha closer to or greater than 0.7 to show that most of the variables were reliable. This is depicted by table 2 below.

Table 5. Reliability tool analysis scale

Variable Name	Reliability Analysis Scale
Students ability to remember concepts	<i>0.484</i>
Students rate of understanding of taught concepts	0.632
Combining different cognitive principles improves students learning.	0.761
Amount of work done when reading lecture material and textbooks.	<i>0.551</i>
Amount of effort put in by students to study and understand	0.732
Learning methods motivate and stimulate interest in the subject.	0.851
Prior knowledge helps students to learn and organize material better	0.754

4.2 ANALYSIS OF THE VARIABLES BETWEEN AND WITHIN GROUPS

The results for the independent variables on the four CPIS groups were collected and analyzed.

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Cross tabulation between age and the groups showed no significant difference on mean scores in all cases although this was not the case with gender on the groups which showed a significant difference. The age clustered into one common age group of between 18 to 25 years because the students were mainly coming from high school (Advanced level) and with much common experience and background. Also there were no gender disparities within the groups mainly because they shared because they shared different characteristics and dimensions to learning even though there were more males who enrolled than females.

Results showed that the programme /area of study had a significance effect to the learning ability of all group setups. Those from the faculty of pure sciences had major impact on the multimedia lectures with no significant difference compared to the social sciences, business studies, accounting and arts. This is mainly because they are able to carry some logic reasoning and understanding due to more exposure to multimedia materials. However, students who were exposed to multimedia lectures from the other faculties highlighted positive impact to their learning even though they are less exposed to multimedia lecture materials.

Group type and combination also has a significance difference to the student rate of understanding of taught concepts and amount of effort put in by students and understand. Those that had prior computer knowledge that is who did some certificate and or diploma studies were performing better than students with no other qualification except Advanced level only.

4.3 ANALYSIS OF THE PERFORMANCE OF STUDENTS

Finally the groups were tested on the achievement test (marks) where a set of assumptions and hypothesis were set and tested using the one way Analysis of Variance (ANOVA) test. Both the independent and the dependent variables were tested against the achievement test performance. Results shown using one way ANOVA test of equality of variance and showed that the groups are different on performance on the achievement test.

The assumption was that the two group marks are normally distributed and have approximately equal variances on marks for the achievement test.

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A step by step approach was taken to show the results on the achievement test done by one way ANOVA tests following and answering each research question to test rate at which students performed.

Does the cognitive principle instructional strategy (CPIS) enhance students' conceptualization of computer concepts?

HYPOTHESIS

The null hypothesis states that the cognitive principle instructional strategy (CPIS) does not enhance students' conceptualization of computer concepts.

Using a one way analysis of variance (ANOVA) test with a 95% confidence interval (mean difference is significant at the 0.05 level) on the achievement test against the multimedia combinations of AN and AT (Modality principle), it indicates that the cognitive principle instructional strategy (CPIS) does not enhance students' conceptualization of computer concepts (accept null hypothesis) as depicted by the significant difference of **0.061** displayed in Table 6 below.

Table 6. Relationship between the AN versus AT groups.

ANOVA

achievement test mark

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	8.124	4	2.031	2.371	.061
Within Groups	59.956	70	.857		
Total	68.080	74			

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Using a one way ANOVA test with 95% confidence interval (mean difference is significant at the 0.05 level) on the achievement test against the multimedia combinations of AN and ANT (Redundancy principle), it indicates that the cognitive principle instructional strategy (CPIS) has no effect on student's performance (accept null hypothesis) as shown by the significant difference of 0.505 displayed in Table 7 below.

Table 7. Relationship between the AN versus ANT groups.

ANOVA

achievement test mark

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3.117	4	.779	.840	.505
Within Groups	64.963	70	.928		
Total	68.080	74			

Using a one way ANOVA test with 95% confidence interval (mean difference is significant at the 0.05 level) on the achievement test against the multimedia combinations of AN and N (Multimedia principle), it indicates that the cognitive principle instructional strategy (CPIS) has no effect on student's performance (accept null hypothesis) as shown by the significant difference of **0.139** displayed in Table 8 below.

Table 8. Relationship between the AN versus N groups.

ANOVA

achievement test mark

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	6.344	4	1.586	1.798	.139
Within Groups	61.736	70	.882		
Total	68.080	74			

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Does CPIS stimulate and or motivate student's interest in the subject?

HYPOTHESIS

The null hypothesis states that CPIS does not stimulate and or motivate student's interest in the subject.

Analyses using a one way ANOVA test on the on the combination of the cognitive principles- Modality principle, Redundancy principle and Multimedia principle respectively against stimulation and motivation of students indicates that CPIS stimulates and or motivate student's interest in the subject (reject null hypothesis) as shown by the significant differences for all groups which are below 0.05 as displayed in table 9 below. This means that it student's performance was affected by whether or not the student was exposed to CPIS in order to be stimulated or motivated.

Table 9. Relationship among groups and student's motivation, stimulation

		ANOVA				
		Sum of Squares	df	Mean Square	F	Sig.
animation/narration vs animation/text	Between Groups	23.580	4	5.895	3.822	.007
	Within Groups	107.966	70	1.542		
	Total	131.547	74			
an against ant	Between Groups	22.101	4	5.525	3.402	.013
	Within Groups	113.685	70	1.624		
	Total	135.787	74			
an against narration	Between Groups	59.510	4	14.877	13.210	.000
	Within Groups	78.837	70	1.126		
	Total	138.347	74			

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Is there a difference in understanding of computer concepts among students exposed to either traditional strategy or CPIS or both (blended strategy)?

HYPOTHESIS

The null hypothesis states that there is no difference in student`s understanding of computer concepts between traditional strategy and CPIS or both (blended strategy).

A one way ANOVA test on the achievement test conducted by students in the traditional group against other groups and with other groups indicates that animation and narration (AN), animation and text (AT) and narration, animation and text (ANT) multimedia materials, has a significant difference in student`s understanding of computer concepts between traditional strategy and CPIS or both (blended strategy) (reject null hypothesis) unlike the narration condition which was not significantly different (0.481) in terms of student`s understanding of computer concepts (accept null hypothesis).

This means that AN, AT and ANT groups yielded higher scores with high mean differences (*) compared to N. Although N was not significantly different, the majority of the multimedia groups shows that student`s performance was affected by the type of strategy used. Table 10 below displays the mean and sig. differences for the four multimedia conditions against traditional or blended learning.

Table 10. Relationships among experimental and the control groups

Multiple Comparisons				
achievement test mark LSD				
(I) groupname	(J) groupname	Mean Difference (I- J)	Std. Error	Sig.
Traditional	Animation and Narration	-1.600 [*]	.282	.000
	Animation, Narration and Text	-.600 [*]	.282	.037
	Animation and Text	-1.133 [*]	.282	.000
	Narration	-.200	.282	.481

Is there a difference in performance between students who had prior computer knowledge and those who did not have?

HYPOTHESIS

The null hypothesis states that there is no difference in performance between students who had prior computer knowledge and those who did not have.

A one way ANOVA on the achievement test conducted by all the students with and without prior computer knowledge indicates that there is a significant difference in performance between students who had prior knowledge and those who did not have before coming to university (reject null hypothesis). This is supported by results shown in Table 8 low which has a significant difference of **0.030 < 0.05** meaning that the level of performance was affected by whether or not the student had prior computer knowledge.

Table 11. Relationship between test mark and prior knowledge

achievement test mark

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	6.294	2	3.147	3.667	.030
Within Groups	61.786	72	.858		
Total	68.080	74			

Is there a difference in performance between students who had a previous level of education and those who did not have?

HYPOTHESIS

The null hypothesis states that there is no difference in performance between students who had a certain previous level of education and those who did not have.

A one way ANOVA on the achievement test conducted by all the students who either had a certain previous level of education or not indicates that there is no significant difference in performance between students who had a certain previous level of education and those who did not have (accept null hypothesis). This is supported by the results shown in Table 12 below which has a significant difference of $0.203 > 0.05$ meaning that the level of performance was not affected by whether or not the student had a certain previous level of education.

Table 12. Relationship between test mark and a previous level of education

achievement test mark

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1.502	1	1.502	1.647	.203
Within Groups	66.578	73	.912		
Total	68.080	74			

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Is there a significant difference in student's performance among different age groups?

HYPOTHESIS

The null hypothesis states that there is no significant difference in student's performance among different age groups.

A one way ANOVA test on the achievement test against the age of the student shows that there is no significant difference in student's performance among different age groups (accept null hypothesis) meaning that student's age did not affect their performance in any way. This is shown in Table 13 below.

Table 13. Relationship between test mark and participant's age

achievement test mark

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2.977	3	.992	1.082	.362
Within Groups	65.103	71	.917		
Total	68.080	74			

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Does gender have an effect on student's performance?

HYPOTHESIS

The null hypothesis states that gender does not have an effect on student's performance.

A one way ANOVA on the achievement test against the gender of the student indicates that gender did not affect student's performance. This means that the null hypothesis is rejected at **0.081** significant levels. Even though females were fewer than males as with most cases at tertiary level, there was no difference in student's performance whether they were male or female. This is shown in Table 14 below.

Table 14. Relationship between test mark and gender of student

ANOVA

achievement test mark

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2.800	1	2.800	3.131	.081
Within Groups	65.280	73	.894		
Total	68.080	74			

Did the student's area of study have an effect on performance and academic achievement?

HYPOTHESIS

The null hypothesis states that the area of study did not have an effect on student's performance.

A one way ANOVA on the achievement test against the student's area of study showed that student's performance was affected by area of study (reject null hypothesis). This is shown in Table 15 below.

Table 15. Relationship between test mark and programme

ANOVA

achievement test mark

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	33.413	4	8.353	16.867	.000
Within Groups	34.667	70	.495		
Total	68.080	74			

Table 16 shows that Pure Sciences yielded a higher performance than all the other groups. There was no difference between Pure and Social sciences and between Social sciences and business studies mainly because they borrow most concepts from each other which involve the scientific nature unlike greater significant disparities among the other programmes which are far related in any way e.g. pure sciences and arts/humanities.

Table 16. Multiple programme comparisons - (*-mean difference sig at 0.05 level)

Achievement test LSD

(I) current programme	(J) current programme	Mean Difference (I-J)	Std. Error	Sig.
Pure Sciences	Social Sciences	.333	.257	.199
	Business Studies	.667 [*]	.257	.012
	Accounting	1.267 [*]	.257	.000
	Arts/Humanities	1.867 [*]	.257	.000
Social Sciences	Pure Sciences	-.333	.257	.199
	Business Studies	.333	.257	.199
	Accounting	.933 [*]	.257	.001
	Arts/Humanities	1.533 [*]	.257	.000
Business Studies	Pure Sciences	-.667 [*]	.257	.012
	Social Sciences	-.333	.257	.199
	Accounting	.600 [*]	.257	.022
	Arts/Humanities	1.200 [*]	.257	.000
Accounting	Pure Sciences	-1.267 [*]	.257	.000
	Social Sciences	-.933 [*]	.257	.001
	Business Studies	-.600 [*]	.257	.022
	Arts/Humanities	.600 [*]	.257	.022
Arts/Humanities	Pure Sciences	-1.867 [*]	.257	.000
	Social Sciences	-1.533 [*]	.257	.000
	Business Studies	-1.200 [*]	.257	.000
	Accounting	-.600 [*]	.257	.022

From the open ended questions student's perceptions were needed to find out how engagement in experiment helped their learning to improve. The descriptive statistics showed that most students said the experiment helped them to become more engaged in their work and also improved their attitude and self discipline. This is a positive gesture to learning improvement as shown in Table 17 below.

Report

current programme		Mean	N	Std. Deviation
How experiment helped your improvement				
	Improved attitude and self discipline	3.10	10	1.595
	Have become more engaged in my work	3.00	18	1.645
	Helped learning process by Improving my understanding	3.55	11	1.368
	Instilled excitement and increased motivation	2.40	10	1.174
	Increased ability to use and appreciate multimedia	2.53	17	1.007
	No Response	3.78	9	1.481
	Total	3.00	75	1.424

Table 17. Mean relationships between student's perceptions on experiment.

Report

current programme		Mean	N	Std. Deviation
improve which areas to improve learning				
	All aspects	2.33	3	2.309
	Social aspects	3.17	12	1.467
	More labs, infrastructure, computers and technology materials	3.00	20	1.522
	improve lecture attendance by students and lecturers	1.67	6	.516
	No Response	3.00	11	1.342
	More tutorials, discussions, presentations and internet access	3.23	13	1.481
	Need for prior knowledge of computers	3.50	4	1.291
	More multimedia lectures with effective design and display principles	3.50	6	1.049
	Total	3.00	75	1.424

Table 18. Mean relationship between student's recommendations to improve learning.

Table 18 above shows that most students thought that in order to improve learning, there should be more labs, infrastructure, computers and technology materials and a significant number vouching for cognitive multimedia lectures whilst lecture attendance for both students and lecturers was not much of an issue.

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Participant's also had a number of recommendations to the university where the experiment was carried upon and most students strongly recommended the use of multimedia lectures with cognitive principles and some did not recommend anything saying everything was in order and others did not respond to the question at all. The recommendation relationships are shown in Table 19 below.

Report

current programme			
Recommendations to the university	Mean	N	Std. Deviation
Improve on Infrasructure	2.13	8	1.642
More powerpoint presentations, seminars, discussions and workshops	2.78	9	1.302
Use of multimedia lectures with cognitive principles	3.26	27	1.375
Everything is in order	3.50	6	1.378
Use blended learning that is traditional and multimedia	3.14	7	1.345
Improve lecture attendance and conduction	2.80	10	1.398
No recommendations	3.00	8	1.690
Total	3.00	75	1.424

Table 19. Means of participant's recommendations to the university.

4.4 GENERAL DISCUSSION

The results of this study have shown that almost all the research questions and objectives were met. The researcher was able to design and develop a working model of CPIS around the theory of multimedia learning. According to (Katherine ann Austin Stalcup, 2005) cognitive psychologist must rigorously test the CTML and examine the limitations of the principles and the conditions under which the theory and principles do and do not apply.

(Katherine ann Austin Stalcup, 2005) suggested that the theory is vulnerable in terms of its overly simplistic view of information processing, inadequate attention to working memory, incomplete consideration of attentional mechanisms, and incomplete attention to experimental design and method. This study simulated some of the previous research and proceeded to extrapolate components of the CTML theory and operational aspects of the experimental design.

From the experiments carried out results showed that the combination of different cognitive principles with certain multimedia components produced very significant variance in multimedia transfer scores, but that multimedia condition assignment also contributed to the unique variance in transfer test scores, beyond individual cognitive differences.

Thus, design, prior knowledge, previous level of education were relevant individual differences that affected transfer learning, but the impact of multimedia forms remained greater a predictor of transfer learning.

Motivated by display design research and previous on text placement, the placement, the experiments showed that the animation and narration (AN) condition yielded higher test scores showing that learners were able to produce better transfer results compared to other conditions like animation, narration, and text (ANT), animation and text (AT) and narration (N) alone this was due to the fact that the dual coding working memory works at its best when the memory is not congested either visually or verbally.

(Katherine ann Austin Stalcup, 2005) challenged the modality and redundancy and principles associated with the Cognitive Theory of Multimedia (Mayer R.E, 2001) by setting her research on display motion and associated impact on perception and attention, hence removing the motion associated with the scrolling text in the text, narration and animation condition. This manipulation (Katherine ann Austin Stalcup, 2005) said removed the remaining transfer test performance advantage of the animation and narration condition.

Although differences in prior knowledge and previous level of education contributed to the variance in transfer test scores, the present research suggests that display design attributes were responsible for the effects, effects, not multimedia combination.

Also the interviews placed on the open ended questionnaire indicates that most students were mainly concerned with the conditions of the available infrastructure in that there should be some improvement which would see them engaging in more comfortable environments and perhaps improve their grades as well.

Since the setup was done in a developing country, factors like backward technology affected most students since most of the learners were exposed to a computer at tertiary level which has a negative impact on their transfer results the computer literacy is low compared to their counter parts at the same levels in developed countries.

4.5 SUMMARY

These results and findings combined with constraints and given assumptions have marked the end of this study now until further research is taken up. The researcher concludes basing on the outcomes of the experimental designs and results analysis that the CPIS is an effective tool in enhancing and retaining knowledge in the learner.

CHAPTER FIVE: RESEARCH SUMMARY, CONCLUSION, RECOMMENDATIONS AND FUTURE WORK

5.1 INTRODUCTION

This chapter includes the summary of the study, conclusion, recommendations and the possible future work. These give the overall overview of the final outcome of this study after realising all the constraints and assumptions. The researcher concludes basing on the outcomes of the experimental designs and results analysis.

5.2 RESEARCH SUMMARY

The increasing development of computer technologies in developing countries has made multimedia learning an important learning and instruction strategy to improve the literacy rate. The multimedia components as seen in research, however, does not necessarily result in significant positive learning performance but the development of display design principles and effective multimedia instructional content that leads to desirable learning performance, motivation and satisfaction. Instructional designs like electronic learning and computer training provide different ways of delivering content, promote technology-centered environments that stimulate students and add variety to learning.

However, stimulation only without education does not always make for sound instructional design in multimedia delivery. Most importantly the empirically-tested strategies for multimedia instruction should be employed to facilitate knowledge construction by the learner. This has resulted in the design of the Cognitive Principle Instructional Strategies (CPIS) designed by this researcher. These are different types of multimedia lectures combined with selected cognitive principles has given out maximum conceptualization and understanding in learners. Learners were highly motivated and lecture engagement also increased.

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The lectures included different combinations of audio and video and text using principles such as modality and redundancy. Data was collected using random sampling and analyzed using an applied statistical package called Predictive Analytics Software. After analysis, the results indicated that the use of Cognitive Principle Instructional Strategies benefited learners more compared to traditional instruction strategies. The research revealed that CPIS is a motivational, interesting and even easier way of delivering lectures. Most learners have recommended instruction using CPIS as they highlighted the issues of high motivation, concentration, stimulation and understanding.

Some researchers have highlighted the advantages of using multimedia components alone not stressing their combinations whilst others outlined the positive effects of each of all the cognitive principles, but the main essence of this research does not only lie with the type of multimedia components but their combinations with certain cognitive principles in order to achieve optimal conceptualization of computer concepts.

If the CPIS is applied where student`s background is the same and students are well acquainted with the technology, students benefit and improve learning. However, there is need to integrate and blend CPIS together with the traditional lecture strategy. Proper monitoring and assistance during multimedia lectures is needed although most time is spent in designing and illustration which will benefit students.

This means that if the system is replicated among the student`s themselves, it will be easier to follow the actual computations whenever the computations are not easy to understand. However, the student can learn through repeated execution of the same problem thus making it better for slow learners and those without prior knowledge to understand.

5.3 CONCLUSION

The proliferation of technology-enhance learning materials has engendered an excess of research on the efficacy of such materials, in an effort to create guidelines for instructions. Katherine ann Austin Stalcup, 2005) suggested that factors other than ability are critical to student performance.

Undoubtedly, both individual cognitive abilities and display design elements has and continue to contribute to electronic learning, but the relationship and more components need further testing in order to work out a simple set of practical guidelines for instructors.

This research has managed to meet the outlined objectives which included the effective development and implementation of the CPIS. The exploitation and usage of CPIS has stimulated and motivated students and they showed great interest in the course. The researcher discovered that students exposed to both CPIS and traditional strategy had greater conceptualization of computer concepts as compared to those exposed to traditional strategy alone. The use of CPIS has helped in investigating students` perceptions and other aspects on CPIS then use them to find and understand their preferences.

Designing and combining multimedia conditions brings a lot of benefits to the students, tutors, lecturers and the colleges at large. However use. of multimedia conditions can promote less reading and research as most of the work is pre-done and available which may lead to laziness among students and no initiative or room to solve problems. There is need for other pair wise comparisons and combinations of other cognitive principles. Expand research to other Zimbabwean universities in order to draw an overall and unbiased conclusion.

The proliferation of technology-enhanced learning materials has prompted a lot of research on the efficiency of such materials, in an effort to create guidelines for instructors. The use of cognitive principle instructional design strategies seem to be more effective in learners by improving knowledge retention and cognition in learners in relation to understanding of computer concepts. The present research suggests that any prescriptive strategy warrant serious scientific evaluation before claiming to optimize learning.

5.4 RECOMMENDATIONS

Current research has managed to address display design issues within specific learning contexts- introductory computer concepts. Evidence does not specifically provide hope that the scientific community is close to such a set of recommendation and guidelines.

(Katherine ann Austin Stalcup, 2005) noted that taking these into consideration physiological, attention, and perception research indicates that we are far from a `magic bullet` theory of multimedia learning.

The researcher strongly recommends that all of the cognitive principles be combined to provide an effective multimedia lecture which strongly motivates and stimulates the learner.

The researcher additionally recommends that in order for the computer conceptualization to take place effectively computer education should be introduced in the grassroots level so as to do away with the issue of prior computer knowledge a disparity and disadvantage to most students. Also the infrastructure of tertiary institutions should be upgraded in order to meet the increasing numbers of students. The student to computer ratio should be reduced to at least 2:1 compared drastic ones at present. Finally traditional learning should be mixed or blended with multimedia aspects like the CPIS in order to yield a higher transfer result.

5.5 FUTURE WORK

(Katherine ann Austin Stalcup, 2005), mentioned that in terms of the cognitive aspects of multimedia learning, further research is needed to examine the differences between learning expository text and narrative text. While both expository and narrative texts use the same general cognitive structures (Van den Broek, et al 2002) contended that `narrative texts possess a causal-temporal structure that is often more familiar than the logical structure of expository texts`.

(Van den Broek, et al. 2002) also noted that expository texts, while widespread in our society, are still a subset of the reading material encountered by most people. (Anderson & Krathwohl, 2001) illustrated a similar comparison, differentiating declarative (knowledge of facts) and procedural (knowledge of processes) knowledge.

Narrative texts may pose a different paradigm and challenge for instructional technology application compared to expository texts.

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With the current demand for distance learning and the integration of technology and learning, the efficacy of multimedia-delivered narrative learning modules is a question to be empirically addressed. The current study reveals that the current academic environment calls for further research on the effectiveness of multimedia-delivered narrative and expository texts.

(Sternberg, 1998) suggested that factors other than ability are critical to student performance. Clearly, both individual cognitive abilities and display elements contribute to effective learning, but the relationship and components have not been tested enough to devise a simple set of practical guidelines for instructors. Further research must address display design issues within the specific learning context. However present research has shown that students have been greatly motivated and stimulated which has increased learner engagement hence a positive attitude towards the learning of introductory computer concepts.

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APPENDICES

Appendix A. The Questionnaire

A COGNITIVE PRINCIPLE BASED INSTRUCTIONAL DESIGN FOR CONCEPTUALIZATION OF COMPUTER CONCEPTS:

ASSESSMENT OF A UNIVERSITY FIRST YEAR COURSE.

This is a closed and open questionnaire and you are required to give your immediate response to the set comments. It is very important that you answer all questions. The Likert scale below will guide you through.

Just tick your choice.

- (5)- **Strongly Agree**
- (4)- **Agree somewhat**
- (3)- **Unsure – (Try not to use) unless you really have to or if it cannot apply to your course.**
- (2)- **Disagree somewhat**
- (1)- **Strongly Disagree**

What is your age, please only use numbers (e.g. **21**)?

What is your gender? (*Tick*)

Male

Female

What previous level of education did you have before you started this current programme?

Advanced Level

Diploma

Certificate

Under which category does the programme which you are currently studying fall?

Pure Sciences

Social Sciences

Business Studies

Accounting

Arts/Humanities

I have prior knowledge to use of technology and computers. (*Tick*) **YES**

NO

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PART ONE

REMEMBERING CONCEPTS

-

(TICK IN APPROPRIATE BOX)

1. I had a better understanding from the narration and animation (AN) lecture than from that of on-screen text and animation (AT).

5
4
3
2
1
2. I learn and process information more effectively when using different multimedia components.

5
4
3
2
1
3. Experience from answering instant questions has helped me to process other course material more deeply.

5
4
3
2
1
4. I prefer blended learning because it is more effective when it comes to remembering concepts.

5
4
3
2
1
5. I learn faster when using pure traditional learning than when it is mixed with multimedia.

5
4
3
2
1

PART TWO

UNDERSTANDING CONCEPTS

-

(TICK IN APPROPRIATE BOX)

	<u>COMMENTS</u>	<u>SCALE</u>				
1	I had a better understanding from the narration and animation (AN) lecture than from that of narration, animation and on-screen text (ANT).	1	2	3	4	5
2	I often worry about whether I have really understood what I have studied on my own during multimedia lectures.					
3	I often need another source of lecture material to aid my understanding.					
4	Multimedia lectures allow me to learn at my own pace and repeat concepts I would not have understood.					
5	When I'm reading a textbook, I sometimes find it hard to understand exactly what the author means.					

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PART THREE

EFFORT TO STUDY - (TICK IN APPROPRIATE BOX)

	<u>COMMENTS</u>	Strongly agree	Agree somewhat	Unsure	Disagree somewhat	Strongly disagree
1	I had a better understanding from the animation and on-screen text (AT) lecture which did not include the narration part (ANT).					
2	Much of what I learn using multimedia makes little sense: It is like unrelated bits and pieces.					
3	Often I find myself questioning things I hear in the face to face lectures.					
4	I often look for extra material on some related subject areas to help me understanding more.					

PART FOUR

LEARNING METHODS - (TICK IN APPROPRIATE BOX)

	<u>COMMENTS</u>	<u>SCALE</u>				
		1	2	3	4	5
1	I had a better understanding from the animation and narration (AN) lecture rather than from the narration (N) lecture only.	<input type="checkbox"/>				
2	I find design using different multimedia components stimulating and motivating	<input type="checkbox"/>				
3	Use of cognitive principles mixed with multimedia components aid my understanding of difficult taught concepts.	<input type="checkbox"/>				
4	How information is displayed and designed during a presentation makes learning a lot easier	<input type="checkbox"/>				
5	I have managed to find conditions for studying which allow me to get on with my work easily.	<input type="checkbox"/>				

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PART FIVE

WORK DONE - (TICK IN APPROPRIATE BOX)

	<u>COMMENTS</u>	<u>SCALE</u>				
		1	2	3	4	5
1	Lecturers should be totally substituted by the use of multimedia technology.					
2	I often find it difficult to listen attentively during lectures.					
3	I often find it difficult to fully concentrate when reading a textbook.					
4	I end up using and relying on textbook and lecture material because I have no access to multimedia materials.					
5	I can easily remember concepts that are taught using pure traditional learning only.					
6	I learn better when extraneous material in textbooks is excluded rather than included.					

PART SIX

PRIOR KNOWLEDGE - (TICK THE APPROPRIATE BOX)

1. I have prior knowledge to use of technology and computers 1 2 3 4 5
2. Given the basic prior knowledge to computers, it is faster and easier to grasp concepts when learning..... 1 2 3 4 5
3. With my previous background to computers, I easily understand explanations of how scientific components work..... 1 2 3 4 5
4. My previous level of education has helped me to understand taught concepts.. 1 2 3 4 5
5. Prior knowledge reduces seriousness and concentration during lectures..... 1 2 3 4 5

OPEN ENDED QUESTIONS - fill in your response in space provided

1. Which other areas do you feel should be improved in order to improve student's learning.....
.....
2. What do you recommend to the University in relation to ways in which lectures are currently conducted.....
.....
3. In what ways has exposure to this experiment helped you organize yourself to improve your results.....
.....

THANK YOU FOR YOUR PARTICIPATION!!!

Appendix B. The Achievement Test

INTRODUCTION TO COMPUTERS - CS001

COMPUTER HARDWARE KNOWLEDGE TRANSFER AND PROBLEM SOLVING TEST.

ANSWER ALL QUESTIONS IN SECTION A (MULTIPLE CHOICE) AND SECTION B.

SECTION A---/12 marks

1. Which of the following connector types has four connection points, or four wires?
 - A. PS/2
 - B. USB
 - C. DB-9
 - D. BNC

2. You have installed a second network adapter in your Windows 2000 professional computer. The next day, your system will not start up. You try the Safe Mode advanced boot option. The computer starts but cannot see the C drive. Which hardware computer cannot start up except in Safe Mode?
 - A. Hard disk
 - B. Second network adapter
 - C. Workstation service
 - D. Registry

3. Overdriving or doubling the clock speed of a processor only increases the speed of the CPU.
 - A. TRUE
 - B. FALSE

4. NICs are used to connect workstations to servers or workstations to workstations.
 - A. True
 - B. False

5. USB stands for
 - A. Universal Serial Bus
 - B. Universal System Bios Reference
 - C. Universal Standard Bus
 - D. Universal System Bus

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6. When a piece of paper comes out of a laser printer almost completely black, the primary corona has failed to properly charge the -----?
 - A. Heated Roller
 - B. Toner
 - C. Fuser
 - D. EP Drum

7. You print a document to the printer, but when the document actually prints, it appears as garbage characters. What do you suspect is the cause of the problem?
 - A. A wrong print driver.
 - B. A corrupted print queue.
 - C. Insufficient disk queue space.
 - D. PCOSOLE is not installed.

8. In the Binary numbering system, what represents a shorted jumper?
 - A. 1
 - B. 0
 - C. a
 - D. b

9. You attempt to connect to a computer on the network but cannot. Other computers cannot connect either. Your network consists entirely of 10Base T. What are the most likely causes? [Choose the two best answers].
 - A. The computer is off.
 - B. ESD
 - C. The network is not connected to the computer.
 - D. Too many users are logged into the network.

10. What is a key troubleshooting process you must use as a service technician?
 - A. Interviewing the user
 - B. Ensuring power is applied to the computer
 - C. Execute a plan
 - D. Ensure you have known good operating system.

11. Which of the following describe the refresh rate for a monitor? (Choose all that apply).

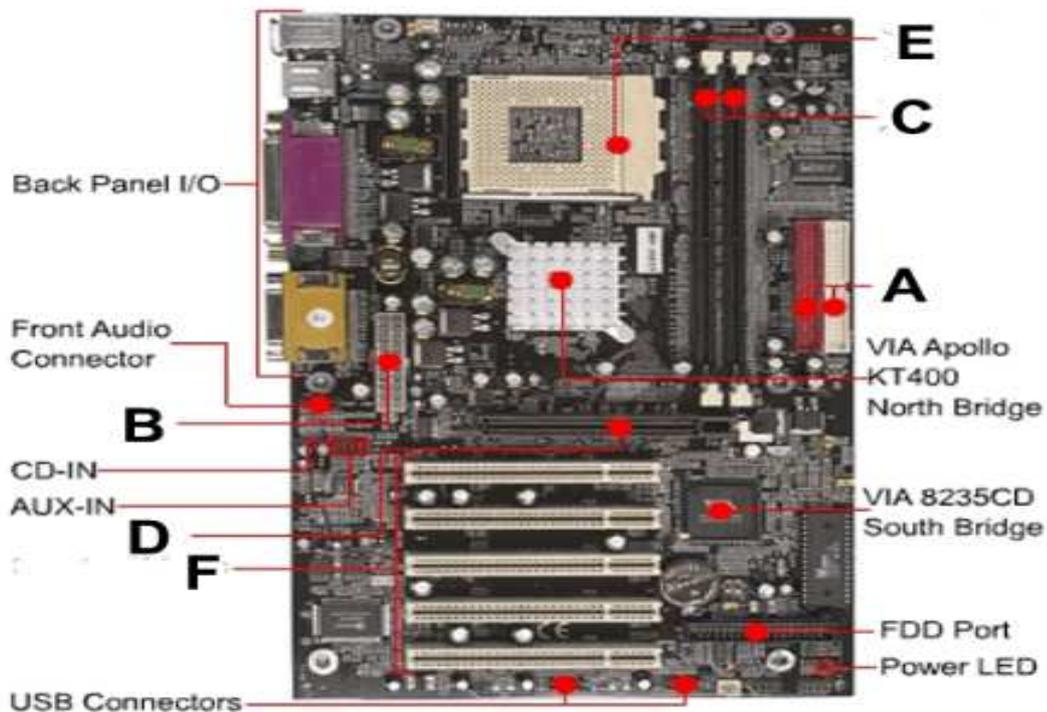
- A. The refresh rate is the amount of times a display`s image is repainted or refreshed per second.
- B. The refresh rate is the amount of times a display`s image is repainted or refreshed per minute.
- C. The refresh rate is expressed in hertz
- D. The refresh rate is expressed in Megahertz

12. You want to set up a sound card. Which of the following COM ports will you use?

- A. COM 1
- B. COM 2
- C. COM 3
- D. COM 4
- E. None of the choices

SECTION B--/ 18 marks

13. The Picture below shows a generic motherboard layout. Identify A, B, C, D, E, F.[6]



14. Identify any six of the computer hardware components that are illustrated below. [6]



15. State and give functions of any two examples of computer input hardware other than mouse and keyboard. [4]

16. The main memory consists of two major types namely: RAM and ROM. Describe each of them outlining their major differences? [2]

Appendix C. The project Independent and Dependent variables

Independent / Background Variables

- 1) **Age**
- 2) **Sex/gender**
- 3) **Previous level of Education**
- 4) **Prior knowledge**
- 5) **Programme /Area of study**

Dependent Variables

1) Students' ability to remember concepts

- I learn and process information more effectively when using different multimedia components.
- Experience from answering instant questions has helped me to process other course material more deeply.
- The assignment has improved my understanding and helped me select relevant information which I used in answering test questions.
- I prefer blended learning because it is more effective when it comes to remembering concepts.

2) Students' rate of understanding of taught concepts

- I learn faster when using pure traditional learning than when it is mixed with multimedia.
- I often worry about whether I have really understood what I have studied on my own during multimedia lectures.

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- After a multimedia lecture, I often need another source of lecture material to aid my understanding.
- Multimedia lectures allow me to learn at my own pace and repeat concepts I would not have understood.
- When I'm reading a textbook, I sometimes find it hard to understand exactly what the author means.

3) Combining different cognitive principles improves students learning

- I had a better understanding from the narration and animation (AN) lecture than from that of on-screen text and animation (AT).
- I had a better understanding from the narration and animation (AN) lecture than from that of on-screen text, animation and narration. (ANT)
- I had a better understanding from the animation and on-screen text (AT) lecture which did not include the narration part (ANT).
- I had a better understanding from the animation and narration (AN) lecture rather than from the narration (N) lecture only.

4) Amount of effort put in by students to study and understand

- Much of what I learn using multimedia makes little sense: It is like unrelated bits and pieces.
- Often I find myself questioning things I hear in the face to face lectures.
- I often look for extra material on some related subject areas to help me understanding more.

5) Learning methods motivate and stimulate interest in the subject

- I find design using different multimedia components stimulating and motivating.
- Use of cognitive principles mixed with multimedia components aid my understanding of difficult taught concepts.
- How information is displayed and designed during a presentation makes learning a lot easier.

- I have managed to find conditions for studying which allow me to get on with my work easily.

6) Amount of work done when reading lecture material and textbooks.

- Lecturers should be totally substituted by the use of multimedia technology
- I often find it difficult to listen attentively during lectures
- I often find it difficult to fully concentrate when reading a textbook.
- I end up using and relying on textbook and lecture material because I have no access to multimedia materials.
- I can easily remember concepts that are taught using pure traditional learning only.
- I learn better when extraneous material in textbooks is excluded rather than included.

7) Prior knowledge helps students to learn and organize material better.

- I have prior knowledge to use of technology and computers
- Given the basic prior knowledge to computers, it is faster and easier to grasp concepts when learning
- With my previous background to computers, I easily understand explanations of how scientific components work.
- My previous level of education has helped me to understand taught concepts.
- Prior knowledge reduces seriousness and concentration during lectures.