

# Investigation on the Effect of Instructional Designs for Human Cognition: A Case Study of Sri Lankan University Education

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**Abstract**— *Instructional designs are now popular in the education sector. In Sri Lanka, from Grade 5 to University education there are number of computerized instructional designs implemented for the student community. It is vital to think about whether our student community acquires the exact benefit from using these instructional designs offered within their education programs. Our research has been sparked by the low usage of Digital Instructional Designs in university education. This research intended to investigate effect on human cognition when using digital Instructional Designs. For this investigation we have conducted a survey over 100 undergraduates and 50 academics. These samples were chosen from six state universities and six private educational institutes in Sri Lanka. The survey results show that there is no significant difference among state university population and Private educational institute population in replying for the surveyed questions. As per the results it is evident that the users are reluctant to use the digitally created instructional designs due to the mental effort that they have to put on the use of the design. Also the results draw out an unrecognized relationship among the low usage and the mental models of the users which directly deals with the interfaces of the instructional designs.*

**Keywords**— *Cognitive Load Theory, Instructional Designing, Human Computer Interaction, Educational Instructional Designing*

## I. INTRODUCTION

Instructional design is a practice which creates instructional experiences which makes acquisition of knowledge and skills more efficient and effective way. Education is a one main domain which makes use of instructional designs at large scale. In Sri Lanka from year 5 up to the university education, numerous instructional designs which are available for the student community. Human computer interaction is directly binding with instructional design. Interface is the object which creates the communication among the user and the computer. The challenge of HCI designers to reduce the gap between the user and the system application. For that

they should have sound knowledge about human cognition. Human cognition can be defined as how human acquire and use knowledge with their working memory of limited capacity and the long term memory which holding many schemas of the human brain. As an illustration when we run too many programs, it may slow down the machine. Same as for computers, human brain also have limited amount of processing power. As per solution we can upgrade machine processing power but not actual human brain processing power. So this is the main limitation with the human brain when compare with machines.

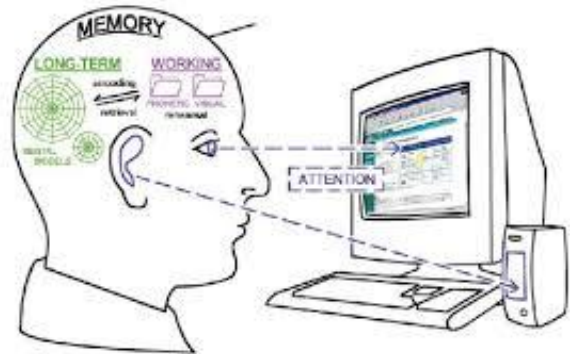


Figure 1: Human Cognition

Source: Web site of Learning Snippets  
(<https://learningsnippets.wordpress.com/tag/cognitive-load-theory/>)

The human brain which directly communicates with the computers through designs. Cognitive Load Theory helps to reduce the gap between the user and the computer application. It is uses the combination of information and cognitive structures to guide instructional design. This theory suggests that learning happens best under conditions that are aligned with human cognitive architecture. Cognitive architecture refers to the means in which cognitive structures are organized. Structures, in other words schemas allow elements of information to be categorized according to the way in which they will be used. When designing digital instructional design, designers can reduce the working memory load by providing only relevant content with simple and understandable manner. Then automatically can enhance

the usage of digital instructional designs for education sector in Sri Lanka.

## II. RESEARCH DESIGN

In order to finding the facts to the research questions, questionnaires and interviews were used for data gathering. Questionnaires was the main facts elicitation technique used and also the online sources which publishes the previous research work and studies related human cognition, instructional design and cognition load theory were used to enrich the investigation. Here the researched selected 6 state universities and 6 private universities for data gathering and distributed a questionnaire among them. Selected universities were University of Peradeniya, University of Moratuwa, University of Colombo, University of Sri Jayawardanapura, University of Kelaniya and University of Jaffna are the six state universities and Sri Lanka Institute Of Information Technology (SLIIT) , National Institute Of Business Management (NIBM), Asia Pacific Institute Of Information Technology (APIIT), ESOF Metro Campus, IDM Affiliated University College (City Campus), *Colombo International Nautical and Engineering College(CINEC)* are other 6 private Higher Educational Institutes which are used as the data gathering domains.

## III. LITERATURE BEHIND THE ANALYSIS

Information technology applications are greatly used in the education sector at present since the people around the world are interested in using state-of-the-art technologies to increase their knowhow. This research is intended to evaluate the effect of Instructional Designs for Human Cognition.

This literature is focused on explaining the key elements of the research.

### What is human cognition?

When a person has data of something, he tries to order them to gain valuable information. The information they gain becomes the knowledge when experiences added. The total mental abilities and processes, one uses to acquire knowledge come in the form of the cognition. Attention, memory, reasoning, computation, and etc. The human cognition is conscious and unconscious. That means for instance, when a person sees a rainbow, he might think about it at the very moment he sees it and appreciates the beauty of it which can be categorized as conscious cognition. Then again he might think about it an hour later without even knowing he is thinking about it which is the unconscious cognition. Human cognition is also concrete or abstract as well as intuitive. A baby can learn several languages and translate one language context to another. This is a great illustration of cognitive

process which uses existing knowledge to generate new knowledge.

Everyone's knowledge is based on the level of individual human cognition. Hence it is evident that human cognition is an aspect of psychology. In the researches of the field of psychology, the interest parties of the field had already come up with various theories.

### Cognitive Load Theory;

Such a theory that directly has a relationship with the human cognition is John Sweller's Cognitive Load Theory (CLT). The simple idea behind this CLT is the total amount of mental effort being used in the working memory by a human. This was broadly applied for Instructional and learning processes.

In the article Cognitive Architecture and Instructional Design of Educational Psychology Review by John Sweller, Jeroen J.G. van Merriënboer, and Fred G.W.C. Pass, it is clearly stated that "cognitive Load Theory has been designed to provide guidelines intended to assist in the presentation of information in a manner that encourages learner activities that optimize intellectual performance". The cognitive load theory is a combination of Intrinsic Cognitive Load, Extraneous cognitive Load, and Germane cognitive Load.

- Intrinsic Cognitive Load

As per Sweller's discussions Intrinsic Cognitive Load describes how a person's cognitive load behaves when he is given a task and performs it. It is found that when a person is assigned a brand new task his Intrinsic Load increases since he has to find out even the basics which are needed to fulfil that task. Intrinsic load is the fundamental complexity of the information that is to be learnt by the user. It highly depends on the understandability and interactivity of the elements of learning. The level of know-how of the user is related with the amount of the intrinsic load.

- Extraneous Cognitive

Extraneous Cognitive Load addresses the ascending cognitive load of a person when his actual tasks are being distracted by unnecessary/irrelevant tasks to him. In a nutshell Extraneous Load occurs due to inappropriate or unnecessary information which is placed on the learning material.

- Germane cognitive Load.

Unlike Intrinsic load and extraneous load, germane load is the load which processes, constructs and automates the schemas. It is about using the knowledge of the user for schematic construction which makes the users' task

easy. This load contributes the learning process the highest.

#### **What is an instructional design?**

An instructional design is an assistance used to make anyone aware or educate about things they need to know ranging from a printed paper which gives a message to a computerized interface. All materials that are used to instruct a person are known as instructional designs. Instructional design can simply be described as the systematic development of instructions so that the people will understand those instructions easily even when they go through it for the first time. According to researches, present instructional designing highly serve the education sector of countries. Especially the digital instructional designing plays a vital role here because Instructional designers often use technology and multimedia as tools to enhance instruction.

#### **What is human computer interaction?**

Human Computer Interaction is the study about people being interact with computers and to what extent computers are/ are not developed for successful interaction with human being. This interaction is mainly ensues because of the interfaces. The more the interfaces are user friendlier, the more the interaction is a success. The concepts of HCI are used in instructional designing and both these fields have their main concern on the human cognition.

Humans interact with computers in many ways and in many occasions. The way we communicate with computers mainly depends on the interface which we use to interact. It may range from a desktop to a pocket computer. Current technology has endeavoured the voice user interfaces which can recognize human voice commands and act accordingly. Not only voice but also the gesture recognition systems can change the way we interact with computers in a great manner.

#### **Human cognition and instructional design**

Instructional designs deals with the user through Interfaces and the design of interfaces has to incur CLT for their designs.

In the blog post, Instructional Designing for Digital Classrooms by Harish Bhagavathula it is stated "E-learning or the educational technology uses the instructional design principles to enable superior understanding and enhanced learning experiences. Now that most of the training institutions have moved on to digital classrooms globally..." This statement clearly shows that for learning purposes digital instructional designs are used.

Cognitive load theory has been designed to provide guidelines intended to assist in the presentation of information in a manner that encourages learner activities that optimize intellectual performance. The theory assumes a limited capacity working memory that includes partially independent subcomponents to deal with auditory/verbal material and visual/2- or 3-dimensional information as well as an effectively unlimited long-term memory, holding schemas that varies in their degree of automation. These structures and functions of human cognitive architecture have been used to design a variety of novel instructional procedures based on the assumption that working memory load should be reduced and schema construction encouraged. This paper reviews how the theory and the instructional designs generated by it and to what extent they are successful.

Since the Cognitive science intends to find the nature of human mind it procures researches in a number of areas including psychology, neuroscience, artificial intelligence, computer science, linguistics, philosophy, and biology. The output of these researches is a great support for instructional designers in order to correctly identify the human mind and to come up with efficacious instructional designs with accordance to the addressing set of users.

#### **How digital instructional designs are used in tertiary education?**

Almost all the universities around world use digital instructional designs as a material of knowledge distribution to their students, because without that they hardly can survive in the rapid acceleration of technological usage in education.

This research highlights the area that has to be concerned when the instructional designing is done.

#### **IV. HYPOTHESIS**

The main intention of this research is to discern the possibilities of integrating human cognition in Instructional Designs.

H: - Cognitive load theory **has** a strong correlation with Instructional Designing

NH: - Cognitive load theory **has NOT** a strong correlation with Instructional Designing

#### **V. PRESENT USAGE OF INSTRUCTIONAL DESIGNING IN EDUCATION SECTOR, SRI LANKA**

This research paper mainly outlines findings regarding the usage of instructional design for tertiary education in both government universities and private educational

institutes in Sri Lanka. For this investigation researchers have conducted a survey with 100 undergraduates and 50 academics that were randomly selected by researchers from six state universities and six private educational institutes in Sri Lanka. This was an explanatory case research study which made use of questionnaire as the method of data gathering tool which generated both qualitative data by open-ended questions and quantitative data by rating scale or closed questions. As per the comments noted down by academics in state and private universities, it is evidence that the traditional higher education system has been frequently attempted to increase capacity using the instructional designing in their learning methods. Instructional designing is used in both on-campus and distance tertiary education in Sri Lanka. As initial stage, some universities used online learning technologies, but it was limited to individual efforts. Then the Distance Education Modernization Project (DEMP), funded by the Asian Development Bank, which initiated in 2003, used instructional designing especially in online education to improve the quality and the relevance of learning in university education in Sri Lanka.

The rapid development of ICT infrastructures in Sri Lanka motivates every educational institution to make use of the internet as a medium of communication among the students. Today most of the state and private Universities use Moodle as its Learning Management System (LMS) and standard templates for courses are in place. Modular Object Oriented term Developmental Learning Environment (Moodle) is a web-based course management system, which is known as a Learning Management System (LMS) or a Virtual Learning Environment (VLE), is a free web learning environment that academics can use to model effective online learning platforms. According to the data analysis, it is evidence that Moodle has been widely used in higher education due to various advantages including flexible learning times and boundless distance education. The success of the Moodle is defined depend on the LMS components which are considered within the total learning infrastructure of universities such that maximum student success from both an institutional and System perspective.

According to the answers provided to the questionnaires in the terms of student's perspective, the usability of Moodle was assessed by the attributes of Moodle components, such as Interoperability, Flexibility, Cost effectiveness, Support and Training, Ease of Use, Scalability and Sustainability. This indicated that, human computer interaction holds a major role in attaining the goal of improving user performance to enhance the

usability of Moodle. The International Organization for Standardization defines the term usability as the ability of user who can effectively use a tool or system to accomplish a task with satisfaction and ease. These facts also clearly clarify the relationship among instructional designing of Moodle and human cognition which directly effect to the success of the tertiary education in both state universities and private educational institutes in Sri Lanka.

Furthermore survey findings proved that, uses of LMS/Moodle or the Instructional Designing at universities are constrained by the human's perceptual and Human Cognition. Overall response of questionnaires from both state university population and Private educational institute population pointed out that even though they like to use Moodle, still there are some kinds of inconsistency, irregular actions in its functionalities and complexity on it. In general almost each and every undergraduates and academics who participated in survey, were familiar with computers, Internet and other information systems, majority of them require assistance from specialized person when use the Moodle as beginners. Without significant difference among state university population's feedback and Private educational institute population's feedback, it is evidence that most of the users found problems in interfaces, malfunctions in search feature, weak organization in the forum and discussion board, no recovery mechanisms and inconsistency in downloading course materials. Therefore the survey results clearly demonstrated that current usage of instructional designing in the field of university education does not properly tally with the cognitive abilities of the undergraduates and academics that directly interact with the digital learning facilities.

### VII. CONCEPTUAL DESIGN

This framework describes if the Intrinsic Cognitive load and Extraneous Cognitive load are low and Germane Cognitive load is high, then its results a successive instructional design.

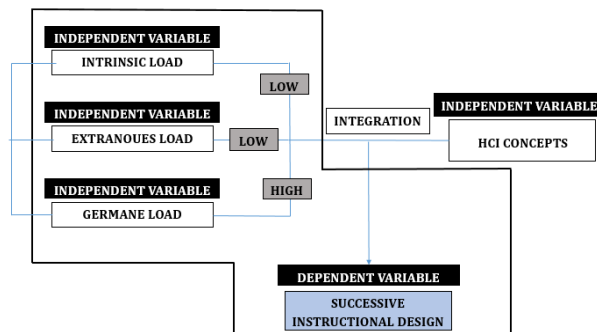


Figure 2: Conceptual Design  
Source: Author

#### VIII. PROBLEMS AND SOLUTIONS

As it was discussed in the previous chapters, the instructional design highly affected for the human cognition. A successful instructional design can enhance the capacity of the human cognition in the perspective such as attention, memory, judgement. So when it is developing the instructional design it has to be concern about so many aspects that combining the cognitive load, Human computer interaction and the instructional design. Always when it is generating instructional design it should be focus on keeping the human computer interaction in a precise level to archive success of the cognitive load. Some of the constraints frequently occur in using instructional design in the education sector will be discussed from next few paragraphs.

Identifying Key issues with the learners and the participants in the education sector is a one critical problem. In order to create a precise instructional design model it is vital to investigate and understand the real issues. In the designing process it has to be deal with the massive amount of information and should find the best way to present it to the users in order to keep their attraction and the attention on the content. As a solution for this in instructional design it should be investigate and analyse the domain in both aspects of human computer interaction and the cognitive load. That means when it is identifying the factors in the domain it can be determined how the human computer interaction and the cognitive load has incurred.

As Martin Ryder says *“An instructional design model gives structure and meaning to an instructional design problem ...”* a critical point of creating instructional design is the selecting the right design model at the right time. A design model should be able to tail both designer intension and the vison of the users, and also the model should be capable of controlling the work load depend on the various situations, In order to overcome these kind of problems as failure of selecting the right model the designer should be tactful to judge the kind of situation and the related scenarios to be handled.

Crafting the communication is another major challenge that meets in the instructional designing. That means the way or methods that the designers used to convey the information to the users. In education related instructional designs this can be seen frequently. When present the content to the user the designer should intelligent enough to provide that information in an attractive and understandable manner and also should concern about the cognitive load and how the cognitive load should be optimally used. In order to overcome this type of constraints the designer can think in the terms of

how to enhance the performance of the Human computer interaction while identifying the method for keeping close proximity between the user and the content.

Varian of the user perceptions is another issue that meet when instructional designing. The perception of the users is varying about a one factor, so designing the things that will easily covering all the users is a difficult task. For an example, if consider an education web site, that some users may like to learn the subject matters in the form of digital, or video format, but some may not like to go with that way. So this is the conflicts that occur in instructional design. In order to eliminate these, the designer should come to a median decision by considering the main aspects human computer interaction, cognition load.

#### IX. CONCLUSION

Uses of instructional designs for education purposes are popular in the present. Focusing secondary and the treasury level, the instructional designs implemented, but the problem is whether the community is using these contents in a manner that helps to enhance their education. The research was conducted intended to investigate effect on human cognition when using digital Instructional Designs. The results of the research indicated that the reluctance of the users to use the digitalized instructional designs due to the mental effort. The research focus on investigation the details about how the mental models, human computer interaction can be used in precisely to enhance the use of instructional designing.

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