Measuring cognitive load level in a multimedia learning environment towards the development of I-SIM

Medición del nivel de carga cognitiva en un entorno de aprendizaje multimedia hacia el desarrollo de I-SIM

Medindo o nível de carga cognitiva em um ambiente de aprendizagem multimídia para o desenvolvimento de I-SIM

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ABSTRACT

This study was administered to measure the Cognitive Load Level in a Multimedia Learning Environment towards the Development of I-SIM (Interactive Strategic Instructional Material) for Grade 7 Science students of Cayetano Arellano High School. Random sampling technique was used to determine the respondents. Pre-test and post-test instruments were prepared and the I-SIM was made from Science 7 least mastered skills, checked, and validated by Science experts in the field of Physics with the use of rubrics. Afterwards, the technicalities of the I-SIM was validated and assessed by the Tech-Vocational assesors. An adapted questionnaire by Leppink was used, modified and tested through Chronbach's alpha. Questionnaire and other materials was digitized using google forms, then various communication letters was made. Researcher administered the pre-test, then the I-SIM followed by the Leppink questionnaire, lastly the post-test and interview. Cognitive load level were above average after, These are evident in their post-test performance together with interview results and answered descriptively through mean and standard deviation. There is no significant difference between the Cognitive Load level and Academic performance that was revealed using Pearson-r correlation. In paired T-test, it revealed that there is a significant difference between the pre-test and post-test scores of students who were exposed in a multimedia learning environment where I-SIM was utilized. This simply implicated that learning was still present though Cognitive level was above average. Furthermore, based on the results, the reduction Cognitive Load is recommended to sustain academic performance of the students to be able to develop I-SIM.

Keywords: Cognitive Load, Multimedia Environment, I-SIM, ICT, Academic performance, Technology

RESUMEN

Este estudio se administró para medir el Nivel de Carga Cognitiva en un Ambiente de Aprendizaje Multimedia hacia el Desarrollo de I-SIM (Material Instructivo Estratégico Interactivo) para estudiantes de Ciencias del grado 7 de la Escuela Secundaria Cayetano Arellano. Se utilizó la técnica de muestreo aleatorio para determinar los encuestados. Se prepararon instrumentos de pre-test y post-test y se elaboró el I-SIM a partir de las 7 destrezas menos dominadas de Ciencias, verificado y validado por expertos en Ciencias en el campo de la Física con el uso de rúbricas. Posteriormente, los tecnicismos de la I-SIM fueron validados y evaluados por los asesores Tecno-Vocacionales. Se utilizó un cuestionario adaptado por Leppink, modificado y probado a través del alfa de Chronbach. Se digitalizó el cuestionario y otros materiales utilizando formularios de google, luego se realizaron varias cartas de comunicación. El investigador administró el pre-test, luego el I-SIM seguido del cuestionario de Leppink, por último el post-test y la entrevista. El nivel de carga cognitiva estuvo por encima del promedio después. Estos son evidentes en su desempeño posterior a la prueba junto con los resultados de la entrevista y respondieron descriptivamente a través de la media y la desviación estándar. No hay una diferencia significativa entre el nivel de carga cognitiva y el rendimiento académico que se reveló mediante la correlación Pearson-r. En la prueba T pareada, reveló que existe una diferencia significativa entre las puntuaciones previas y posteriores a la prueba de los estudiantes que estuvieron expuestos en un entorno de aprendizaje multimedia donde se utilizó I-SIM. Esto simplemente implicaba que el aprendizaje todavía estaba presente aunque el nivel cognitivo estaba por encima del promedio. Además, con base en los resultados, se recomienda la reducción de la Carga Cognitiva para sostener el rendimiento académico de los estudiantes para poder desarrollar I-SIM.

Palabras clave: Carga cognitiva, Entorno multimedia, I-SIM, ICT, Rendimiento académico, Tecnología

RESUMO

Este estudo foi administrado para medir o Nível de Carga Cognitiva em um Ambiente de Aprendizagem Multimídia para o Desenvolvimento de I-SIM (Material Instrucional Estratégico Interativo) para alunos do 7º ano de Ciências da Escola Secundária Cayetano Arellano. A técnica de amostragem aleatória foi utilizada para determinar os respondentes. Foram elaborados instrumentos de pré-teste e pós-teste e o I-SIM foi elaborado a partir das habilidades menos dominadas da Ciência 7, verificadas e validadas por especialistas em Ciências da área de Física com o uso de rubricas. Em seguida, as tecnicalidades do I-SIM foram validadas e avaliadas pelos avaliadores Técnico-Vocacionais. Foi utilizado um questionário adaptado de Leppink, modificado e testado por meio do alfa de Chronbach. Questionário e outros materiais foram digitalizados usando formulários do google, então várias cartas de comunicação foram feitas. A pesquisadora aplicou o pré-teste, depois o I-SIM seguido do questionário Leppink, por último o pós-teste e entrevista. O nível de carga cognitiva ficou acima da média após, estes são evidentes em seu desempenho pós-teste juntamente com os resultados das entrevistas e respondidos descritivamente por meio de média e desvio padrão. Não há diferença significativa entre o nível de Carga Cognitiva e o desempenho acadêmico revelado pela correlação de Pearson-r. No teste T pareado, revelou que há uma diferença significativa entre as pontuações do pré-teste e pós-teste dos alunos que foram expostos em um ambiente de aprendizagem multimídia onde foi utilizado o I-SIM. Isso simplesmente implicava que a aprendizagem ainda estava presente, embora o nível cognitivo estivesse acima da média. Além disso, com base nos resultados, a redução da Carga Cognitiva é recomendada para sustentar o desempenho acadêmico dos alunos para que possam desenvolver o I-SIM.

Palavras-chave: Carga Cognitiva, Ambiente Multimídia, I-SIM, ICT, Desempenho acadêmico, Tecnologia

1 INTRODUCTION

Nowadays gadgets become essential as regards to developing human competence at work, educational aspects, all forms of information dissemination and a lot more. Thus, it serves as the main attraction of many and almost everything depends on it. Gadgets and high technology equipment turn to be the main fad of the crowd for personal and professional needs. At present, it controls the biggest part of our existence all over the world. Just like the undying innovation in technology, gadgets play an important role in our life to increase our productivity in various aspects.

Truly the world has changed a lot from the conventional one to a high technology-based lives. Even in teaching, technology plays a vital role in the entire learning and teaching process inside the classroom. Schools are where the teachers nurture and nourish the young minds of the children to be able to escape the bondage of ignorance. And as the world continuously changing, the strategies and approaches in teaching are also developing and changing from time to time. One of these changes that we must focus on is the integration of ICT as a teaching strategy. Absolutely this is not to replace the teacher, but this is a tool to help students to be more engaged and motivated in learning to better understand a specific topic. In the inclusion of ICT in education, the utilization of multimedia is given the most emphasis and importance where most of the materials used by the teachers are highly technologized.

As the technology or sometimes called "teach-nology" becomes the worldwide teaching tool to transfer and administer the learning process, the demand for the literacy of computer assisted educational tools for teachers also becomes prominent to the point that trainings, seminars and even workshops must be conducted to cater the needs of the 21st Century learning skills of the learners. The 21st Century learning skills must be well cultivated and properly executed or else these will bring up a dilemma or confusions to the teachers and to the students who supposed to be learning.

One of the DepEd orders that has been implemented in this generation is the inclusion of ICT in the world of teaching and learning where the teacher will not be dependent on technology, thus a strict facilitation is needed. At this moment, the Department of Education adapts the utilization of Multimedia by means of (ICT) Information and Communication Technology as stipulated in Science and Technology is very essential in all aspects that give rise to the development of an individual. That is why there are different guidelines that is related to managing the existing Multimedia materials which was found in DO 62, s. 2019 that promotes Science and Technology. Other guidelines that were set on giving importance and priority that will highlight patriotism as well as other programs for human development, which was stated in DO, 57 s. 2011. All of these are connected to different Sections and articles that promotes innovations, inventions that will help

to build higher order thinking and technological skills of the learners. Wherein the main goal of the Department of Education (DepEd) is to nurture and support the student's holistic growth and development.

So, in the view of today's technological language we can now assume that ICT integration in teaching highly affect the cognitive ability of the students, thus making the performance of the students improved and developed in the field of the academe. Exploring the vast world of multimedia is really considering a huge breakthrough in the transference of learning. Furthermore, as the 21st century is advancing; the teaching strategies must also be developed, innovated, more engaging and technology activity- based learning approach. According to Discroll in 2010, that through encountered various experiences in real life situation, learners develop its skills and learn in such a way to develop and improve which is continuous process.

Does this really mean that learning takes place to all the students in the presence of Multimedia? Are the students the same in their cognitive ability? How about their understanding and comprehension? These are the questions that need to be answered and clarified to improve the existing I-SIM that the school is using. This study will measure the cognitive load of the learners learning capacity and at the same time the integration of ICT Multimedia platform as a medium of instruction in teaching specifically in learning Science concepts.

2 THEORETICAL FOUNDATION

Cognitive load is the capacity of the learners to learn in a such a way that information is not bombarded but organized thus, the working capacity of the brain to process information takes one step at a time Sweller said in 2005. Apparently, in making or developing learning materials, make sure that the information is not overloaded, and these should contribute to the learning and not to confuse the learners. Remember that learning materials should aid students challenges to improve their academic performances. (Joseph, 2013).

According to Cognitive Load Theory (CLT) (Sweller, 2010; Sweller, Van Merriënboer, & Paas, 1998; Van Merriënboer & Sweller, 2005), cognitive load (CL) has its three types when it comes to instructions on the learners learning capacity, these includes intrinsic, extraneous and germane cognitive load. Intrinsic Load is defined as the natural difficulty of the task for a specific learner, while the Extraneous Load is caused by Not properly and overload designed instructional materials and unwanted images, moving objects or information that is irrelevant. On the other hand, Germane Load or Generative Load is the "Eureka moment" in which the learner will be able to interconnect the prior knowledge to the new ones (J. Leppink, Paas, der Vleuten, Gog & Van Merriënboer, 2013)

2.1 ICT integration in Education

Academically speaking students who are technologically inclined focus on broader and complex tasks than the lesser ones which was based on the constructive learning approach of Levin and Wadmany in 2006.

Significantly correlated, a study in 2009 by McMahon presented that critical thinking skills obtainment and ICT integration highly affects students' academic performances.

It is recommended to the students to be exposed in a multimedia learning environment where they can develop higher order thinking skills that can serve as a key to improve their given tasks. Schools are highly encouraged to utilize ICT in all areas across subject matters to be able to distinguish student's holistic development in a different learning environment. This will also become a proof that ICT helped them to become more independent learners with higher level of cognitive ability.

As Lowther et al. (2008) stated that in the picture of the implementation of ICT in teaching and learning process, it is said to be more efficient and effective. The learners can innovate, manipulate, and create their own ideas that builds their understanding as well as their comprehension during and after the utilization of ICT to aid in teaching process. Students who can

manipulate and integrate knowledge individually got the higher chance to learn specific concepts more. Thus, extending these learning will surely be an avenue for a broader and much complex concept for better understanding that helps their performance improve scholastically (As Lowther et. al, 2008). Furthermore, a proper and well-developed learning materials by the teachers helps to make students perform well especially when it captures the attention of the learners and rekindle its intention to a certain subject concept (Serhan ,2009). As a result, students will become much confident learners in which knowledge is now understood and applied. With the help of technology learners developed their capabilities for a meaningful learning experience.

Absolutely, disadvantages are inevitable, and it cause an enormous negative effect in a specific matter. But a Filipino researcher stands in a positive way where in In the Philippines developing status along with the implementation of ICT in the field of education is really a huge step to consider to students and teachers in our generation today. The development of technology is rapidly changing from time to time and must be aligned to the salient features of K to 12 that enable teachers to empower students in ICT skills. Standards that were set believed that these will help Filipino students perform well in their classes (Bonifacio, 2013). And these are all can be achieved in a such a way; students will experience it at first hand.

2.2 Experiential Learning

Learning is beyond the teacher's visual aids and discussions inside the classroom. It gives students a glimpse of life-long learning through experience like what Kolb (1984) said that it is a continuous learning based on how learners or people will learn, grow, and improved in given situation. McLeod (2017), added that this is also highly affected by the previous works of famous theorist and their studies who deals with experiential learning such as philosophical pragmatism by Dewey, Lewin who focused on social Psychology and Piaget on the developmental genetic epistemology. These are all for the development and learning that will take place in an individual, hence in the view of today's generation it is said to be different but in fact it can also be applied.

This is to where the 21st century learners are directed- to develop them as life-long learners so they can practically apply what they learn in their daily lives. And this is made possible by the different Learning Styles on how students will learn on their own way. These LS help students to know their strength on how they understand and develop their learning capacity in a way convenient to them. It is where their knowledge is being transformed in meaningful way through various learning experiences. Through these styles, the learners will become more diverse and accept the fact that they can learn not just in a single way but in many ways as possible. Thus, they can align their learning styles on how to equip themselves with necessary skills for learning is like a spectrum that leads the students to see the light of knowledge from the darkness of ignorance. Since there are several ways to learn nowadays in this generation, it is high time to make use and focus on educating students via multimedia platforms. These are the evidence of the effectiveness and how Experienetial learning is very influential when it comes to the learning management of todays' educational system for almost 40 years of its publication according to Oxford Research Encyclopedia (Kayes A and Kayes C, 2021).

2.3 Multimedia Learning

Digital natives are the new generation of today exploring the world of internet and gadgets in a new perspective. Even the acquisition of knowledge and skills of the learners evolves from the conventional to the high technology way of transferring it. And now there is so much of the multimedia learning materials that can be utilized for the development of student's daily performances.

Richard E. Mayer who is well-known in the study of the cognitive theory of multimedia learning and other cognitive researchers argues that multimedia gives way on how the human brains learn

from its surroundings. They attest that individual learn more profoundly from words and still images than purely words which is alluded to as the interactive media guideline. Interactive media analysts largely characterize interactive media as the combination of content and pictures and recommend that interactive media learning happens when we construct mental structures from these words and images (Mayer, 2005b). The words can be spoken or composed, and the pictures can be any shape of graphical symbolism counting outlines, photographs, movement, or video. Mixed media directions plan endeavors to utilize cognitive inquire about to combine words and pictures in ways that maximize learning adequacy. (Sorden, 2016). And according to the recent study, good and properly designed learning materials used to facilitate teaching and learning process is way better than complicated and complex materials that made students confused (Noetel, M, et. al, 2021)

CTML radiates in three different types known as the working, tangible and long-term memory and are related to student's holistic development by Sweller in 2005. Tactile memory is characterized by the information or paradigm stored in our mind, working memory is the one that controls and organizes data for better application and lastly, the memory that is relatable and can be used for future situation is known as the long-term memory. Cognizant of data in long-term memory when it has been exchanged to working memory. According to study of Mayer in 2005, tactile memory is directly connected in learning that focus on visual intelligence, which means it is related to pictures, videos and others multimedia platforms that can be perceived by the eyes and ears as well. Double channel sensors such as eye to visual and ear to auditory is related to working memory and tactile memory in which learning is evident or manifested like the usage of Braile; reading through fingers for the blinds and by lip reading for the hearing impaired individuals Schnotz (2005).

2.4 Cognitive Load in Multimedia Learning

In the emerging era technologies in the modern world, learning becomes so massive in the field of teaching. Learning is when a child acquires from its environment whether outside the school or inside the school. Cognitive Load Learning is a theory where we will be able to assess if a child or student acquires knowledge from its environment or not.

Cognitive Load Theory (CLT) may be a hypothetical system based on cognitive human engineering comprising of long-term memory and working memory by Sweller in 1988. CLT highlights the working memory limitations as determinants of the adequacy of the directions plan. Since working memory can be exceptionally restrained in both capacity (4±1 components) by Cowan in 2001 and length spotulated by Peterson & Peterson way back in 1959, it needs to be utilized as effectively as reasonable in arrange that pattern improvement is optimized and related learning obligations happen within the long-term memory, whose potential is interminable. Once records are spared in long-time period memory, it can be recovered when vital. In this manner, the event that working memory confinements will be decreased at that point learning has happened over a long period of time (Wernaart,2012). Furthermore, learning took place in an environment that is favorable with the cognitive ability of the learners in which construction of instructional design is highly recommended to replace unproductive cognitive load to the productive side of it (Paas, 2020).

In measuring the Cognitive Load of the learners, it cannot be observed directly so the internal processes of the information must be described since it can only be treated via theoretical construction. Currently, the assessment of Cognitive Load has various methods, and this is divided into two categories which are objectivity and causal relation (Brunken, et.al, 2003). In relation to this study, it was classified as subjective and indirect because it was all about self-reported invested mental effort of the learners. As it goes with the development of learning materials used for blended learning, the administration of Cognitive loading must be considered.

2. 5 Blended Learning

Looking at the generations nowadays who are now emerged in the multimedia environment learning seems for them in a quite another level. Seeing the teachers with the manila papers and other traditional visual aids makes the students attention span diverge in such a way that they have no focus on a given situation. On the other hand, in blended learning this will be able to catch the attention of the students since they are included in the generation Z- a generation that learns a lot visually in the utilization of assisted technology. Learning infused in a modern way (Blended) is not just the ICT or the technology itself it is needed to also have a face-to-face interaction with the teachers. In the most recent studies, using blended learning way of teaching has a vast form from face-to-face interactions to paper and pen type of test up to the usage of computer simulated materials that will guide the students to learn with technology infused strategy (O'Keefe, Rienks, & Smith, 2014), and since ICT integration is included in K to 12 Curriculum. The approach of modern advances in teaching with technology has helped course plans that mix different components of online and conventional courses. It includes a key and precise approach to combining modes and times of learning wherein coordination is the most excellent viewpoints of face-to-face and online intuitive utilizing suitable innovation (Brown, 2016).

In addition, BL is said to be effective in terms of transference of learning since the students who will acquire the knowledge is very familiar with this kind of strategy, but the only problem in BL is the generation gap for those teachers who started teaching before the rise of computers. These are some of the teachers who have difficulties to manipulate the technology as an assisted tool for learning, so in this view a teacher should also be well trained so that the computer simulated learning material will also be properly implemented, used and manipulated.

Though the world of Information Communication Technology truly changed the perspective of strategies in teaching and learning, there is still no exact assurance that the benefits of the outcomes in education is achieved in terms of the transference of learning (Sithole et al., 2019; Romiszowski, 2016), so there are open and continuous exploration on utilization of different Interactive Learning Materials for an improved and modified one.

2.6 Strategic Intervention Material or SIM

To keep the students inside the school is not an easy thing to do for a teacher's job. Series of interventions are needed to be done for the students to stay and keep learning in the four corners of the classroom. The development of SIM is one of the best interventions for students who are academically challenged. The development of the so-called SIM paves way to save students from failing and repeating from school year level all over again. This also becomes the teachers' way to make their own modules that bridges the learners to pass and this is simply because the subject teachers know how to deal with their own struggles in certain subject matter.

In addition to this, intervention materials like the SIM (Strategic Instructional Material) will be able to help the students to improve and track their progress which is provided by their teachers (Barredo, 2010). And it also shows that exposing students to these kinds of materials make their understanding and paradigm in a specific topic broader and deeper. Since the students nowadays are visual learners, they tend to learn with the pictures and objects that are aesthetically done and prepared by the teachers. Nowadays, it is highly encouraged to utilize intervention materials like SIM for remediation and bridge the gap of ignorance and the lack of knowledge which is based in the Philippine educational system on K to 12 Curriculum. According to Bunagan (2012), the SIM or Strategic Intervention Material is a tool to refresh the topics that has been taught already which includes the least mastered skills and other concepts.

As a matter of fact, the making of SIM or any intervention materials has been encouraged already by the Department of Education in Memorandum No. 117, series of 2005. This is to highlight that in making intervention materials, teachers should undergo a proper training, write shop or workshop that will help their skills is making a good and well-done intervention materials suitable for the need of their learner. In line with this, SIM making is made as a contest for teachers to be able to make their own learning materials that can be part of the school's Learning resource which can be utilized by all Science teachers.

2.7 Development of I-SIM (Interactive Strategic Instructional Material)

Change is coming like what our President is always saying, and now change has come. As the world changes from time to time it affects the world holistically. Generation from generation, era after era, a rampant innovation happened not just in political aspect, but also in education. We even felt the change when K-12 was introduced to our country where arguments heightened to oppose or agree with it. This is considering as a huge breakthrough in the educational system, and in line with this is the inclusion of technologies in teaching strategies. Furthermore, as the 21st century is advancing the teachers and strategies must also develop and innovate, more engaging and technology activity- based learning approach. Learning is completely shown in a real-life situation, where application is a very powerful tool to execute what is learnt (Discroll, 2000, p.11).

Apparently, these are all related with feelings, thinking and with everyday activity that brought about learnings as a content from the things that was experienced and interacted. Conventional teaching method is very wide and broad in the school environment and most of these are now overlapping from one another. There is no one good teaching strategy, it means that whether conventional or in modern way, there is an assurance that it can also be applied in the digital era in the new set up of education. In addition to this, the learners must connect by the teacher to the lesson in a deeper understanding and to create a meaningful learning experience with the use of technologies. Learners also can learn a lot through and by experiencing it or sometimes known as hands-on activity where it is like the Experiential Learning of Kolb "it is concerned with the learner's internal cognitive processes" (Saul McLeod, 2010). Together with this, Prince postulated in 2004 that in Activity Based Learning (ABL) approach; involving students with hands on activity will give learning a chance to exist. These two types of method must connect to the interest of the learners to arouse their thirst for knowledge.

At this moment, the Department of Education adapts the utilization of Multimedia by means of (ICT) Information and Communication Technology that is why DepEd has implemented various guideline related to ICT in teaching and learning processes. Since the introduction of the K to 12 curriculums in the Philippines, the Department of Education implements various projects and programs that highly promotes teaching with the use of the ICT, since it is included in one of the salient features of the said curriculum. Total development of the students is encouraged when it comes to patriotism, different innovations and inventions which can be applied in teaching Science and technology. Including these in the teaching process gives an opportunity for the learners to hone and nurture their skills that can be used in the latter part of their lives. This was made because Science is perceiving as one of the hardest subjects and cannot be learnt in an instant without the real experiment or the hands-on activity. In this regard, the researcher made innovative way through the inclusion of I-SIM simply because, the use of ICT allocates addition of learning to the students and highly affects their responsibility in the academic aspect of their lives. Autonomy in learning is one of the benefits in depending on ICT that makes each learner, a decision maker of their organized information. – is a student-centered type of strategy, which molds students to become independent learners. This will lead these students to build and organized their own idea and make it meaningful. An alternative like a digital portfolio of Balanskat in 2006 is one of its examples through peer-based learning. In relation to this, exposing students to the multimedia learning environment becomes an avenue of leaning to entire development of the problem-solving skills of students, structure of knowledge, moral integration, and multidisciplinary approaches (Mizuko, 2008).

Indeed, the use of ICT integration in teaching encourages learners to be more engaged in the topic and able to learn independently. Certainly, these Computer assisted learning material like I-SIM and others alike surely affects their academic performances positively.

2.8 Cognitive Load and Academic Performance

In the twist of fate, seeing well performed students academically is just the other half of the coin because it was found out that the effectivity of multimedia learning environment increased students grades in learning conceptual tests compared to the traditional way of teaching wherein project based, and notes did not turn out good. Therefore, the learning capacity is not always significantly improved in an online environment (Chang and Yang, 2009) but still additional facilitation. During this time of difficulties where the medium of learning is mainly focused in using technology. Academic performance of students should be monitored. According to the study that focuses on the effects of modern technology in the scholastic activities of the learners; results that are objectively assessed represents how Cognitive load level of students is related to change in the utilization of mobile learning in teaching (Zhampeissova, 2020).

It is evident that the increasing Cognitive Load was based on the digital environment along with science development and how the flow of unlimited information impacts the learning process of the students. This clearly implies that the effectivity of strategies and educational activities should be appropriate and developed to be able to guide the students in using digital resources. Furthermore, Reduction of cognitive load in a properly designed activities and educational system in technologically advanced or multimedia environment (Zhampeissova, 2020).

Identifying different processes and acquisition of knowledge is connected to one another in the reality of cognitivism. Thus, learning took place though cognitive load is present. It is in the educator to assist on the learning styles and behavior of their learners that can be achieved with the use of cognitive approaches (Zhampeissova, 2020). Learning in a new way gives rise to the students to improve their performances whether what to learn and what needs to be forgotten. Based on various articles, research, and related studies mentioned, the researcher found out an innovative way for a better learning experience in the academe as far of the of development of I-SIM in measuring the Cognitive Load Level of Grade 7 Science students is concern. This study paves the way of understanding Sciences from simpler to broader concepts.

With the researcher undertakings from prior studies, this serves as avenue for future teaching and learning process in the new normal set up in Cayetano Arellano High School.

3 METHODOLOGICAL PROCEDURES
Research Design

The design used to measure Cognitive Load level in Multimedia Learning Environment towards Improvement of I-SIM for Grade 7 Science students will be used in the study, a one group pre-test and post-test design was used as illustrated below:

$$E \quad O_1 \quad _X \quad O_2$$

Where:
E students who are exposed to Multimedia Learning Environment
O_1 is the administration of the pre-test
X is the implementation of I-SIM & Leppink Cognitive Load survey form.
O_2 is the administration of the post-test
An appropriate abovementioned design in getting the desired result of the study must be used, because it will isolate the chosen group exposing in a multimedia learning environment, making the I-SIM group, under all the same conditions to identify whether they can be affected or not by the treatment.

3. 1 PARTICIPANTS/DATA SOURCE

The Grade 7 learners' participants who are currently enrolled in science subject during the third up to the fourth grading period of S.Y 2019-2020 at Cayetano Arellano High School, Manila. A total of 30 random students, were the subject of the study.

Through fish-bowl method, a random sampling technique administered by the researcher to identify the assigned or designated group for students who belong to the Multimedia Environment group which is the Experimental one. The student's information was secured and safe which was only use for the study and in accordance with Republic Act No. 10173, Data Privacy Act in the Philippines.

3.2 DATA GATHERING PROCEDURES AND INSTRUMENTS

To be able to measure the Cognitive Load Level of Science 7 Students to development of I-SIM is pre-test and post-test instruments were prepared and the I-SIM was made from science 7 least mastered skills, checked, and validated by science experts in the field of Physics with the use of rubrics. Afterwards, the technicalities of the I-SIM were validated and assessed by the Tech-Vocational assessors. An adapted Likert scale questionnaire by Leppink was used to be able to determine and measure the cognitive load of the students when they exposed in a multimedia learning environment, it was modified and tested through Cronbach's alpha to test its reliability before the administration of the survey online form. Questionnaire and other materials were digitized using google forms, since the students still in online classes, then various communication

letters were made for approval for the study to conduct. Researcher administered the pre-test, then the I-SIM followed by the Leppink questionnaire, lastly, followed by the administration of post-test and online interview for the descriptive results of the study.

3.3 DATA ANALYSIS

The gathered data were treated statistically by getting the Chronbach's alpha for the reliability of the modified survey, Mean score, Standard Deviation, Pearson-r correlation and Paired t-test to be able to measure the Cognitive Load level of Science 7 Students towards the development of I-SIM.

4 RESULTS and DISCUSSIONS

The succeeding tables shows the difference and their relationship in this study.

Table 1
Cognitive Load Level

Range	Minimum	Maximum	Mean	SD	Variance
3.50	3.80	7.30	5.4333	.91249	.833

Table 1 shows the 3.50 range and the minimum level that is 3.80 which is the lowest possible level of Cognitive load while 7.30 is the maximum and considered to be the highest level of CL. On the other hand, the average cognitive load level from the start is quite high and it is shown by the mean score of 5.433. The .91249 SD is lower than 1 which means that the similarity of Cognitive Load levels of the Grade 7 learners is high since it is closer to 0.

Based on the online interview with the chosen Grade 7 students, these are the results about their sensory memory, working memory and long-term memory:

For question no. 1 High Cognitive Load, **Average Cognitive Load**, Low Cognitive Load: In **Working memory**.
Average Cognitive Load was the result in the understanding of the students on how they learn the topic given in the I-SIM since the I-SIM has some hints and other clues to be able to get the desired answer. This showed that the working memory capacity reached to its limit that there was some point that the learners had some difficulties during the administration of I-SIM.
In Question no. 2 and 3 **Effective** or Not Effective (I-SIM as Multimedia Learning Material) in **Long-term memory** part.
In terms of the utilization of Multimedia via I-SIM most of their answers were affirmative that the material helped them to be able to learn the given topics with the use of appropriate still or moving pictures, videos, and simulations. This was possible because the learners were able to connect previous topics in current activities with the correct usage of pictures and videos related to the topic given, and this served as a clue for the learners.
Question no. 4 **Appropriate** or Not Appropriate; in view of **Sensory memory**.

The proper usage of words used in the directions, descriptions, and questions of I-SIM were appropriate. Hence, four out of five students agreed and one of them shows a little difficulty in some areas. This area fell into the visual sensory memory that terms, sentences, or paragraphs that the learners grasped during the utilization of I-SIM lasted only for a very short period based on the results of the interview.

Lastly, in question no. 5 **High Academic Performance**, Low Academic Performance

Since the utilization of I-SIM is effective, the students have high academic performance after its intervention as a learning material for Grade 7 Science.

In addition to all of these, I-SIM can reduce the Cognitive Load of the learners to be able to increase the learners conceptual learning or academic performance based on the result above mentioned. These can be used as a gauge or guide to the development of I-SIM making.

Table no. 2
Frequency and Percentage of Interview Questions
Table 2.1
QUESTION 1: In the lecture that just finished I invested...

Scale	Interpretation	Frequency, f	Percentage (%)
9	very, very high mental effort	1	3.3
8	very high mental effort	1	3.3
7	high mental effort	6	20.0
6	rather high mental effort	4	13.3
5	neither low nor high mental effort	5	16.7
4	rather low mental effort	3	10.0
3	Low mental effort	3	10.0
2	Very low mental effort	5	16.7
1	Very, very low mental effort	2	6.7
Total		30	100

The table presents the cognitive load of students in understanding Physics concepts. As shown from the table, high mental effort was observed in item no. 6 which reflects the concept of Heat Transfer and its types. With this, it can be a challenging part for the learners when it comes to the retention of concept, so reduction of Cognitive load is important in this matter for the improvement of I-SIM.

Table 2.2
QUESTION 2: The lecture that just finished was...

Scale	Interpretation	Frequency, f	Percentage (%)
9	very, very difficult	0	0.0
8	very difficult	2	6.7
7	Difficult	4	13.3
6	rather difficult	3	10.0
5	neither easy nor difficult	11	36.7
4	rather easy	3	10.0
3	Easy	4	13.3
2	very low easy	1	3.3
1	very, very easy	2	6.7
Total		30	100

The table above shows that the 36.7% of students consider the I-SIM neither easy nor difficult. This shows that utilization of I-SIM in a lecture can be done.

Table 2.3
QUESTION 3: To learn from the lecture was...

Scale	Interpretation	Frequency, f	Percentage (%)
9	very, very difficult	2	6.7
8	very difficult	2	6.7
7	Difficult	4	13.3
6	rather difficult	3	10.0
5	neither easy nor difficult	6	20.0
4	rather easy	5	16.7
3	Easy	5	16.7
2	very low easy	2	6.7
1	very, very easy	1	3.3
Total		30	100

The table above shows that the 20% of students learned from lecture is neither easy of difficult simply because of the category from easy to difficult.

Table 2.4
QUESTION 4: How much did you concentrate during the lecture?

Scale	Interpretation	Frequency, f	Percentage (%)
9	very, very much	1	3.3
8	very much	3	10.0
7	Much	3	10.0
6	rather much	7	23.3
5	Neither little nor much	7	23.3
4	rather little	3	10.0
3	Little	2	6.7
2	very little	1	3.3
1	very, very little	3	10.0
Total		30	100

The table above shows that the 23% of students concentrated during the lecture both rather much and neither little nor much since the I-SIM is a combination of topics from easy to average too difficult.

Table 2.5
QUESTION 5: How much did you understand each question?

Scale	Interpretation	Frequency, f	Percentage (%)
9	very, very much	0	0
8	very much	15	50
7	much	15	50
6	rather much	0	0
5	Neither little nor much	0	0
4	rather little	0	0
3	little	0	0
2	very little	0	0
1	very, very little	0	0
Total		30	100

The table above shows that the 50% of students understood each question very much and the other 50% is just much. This shows that the questions were properly made and simplified.

Table 3
Correlations

Variables	Pearson r	Sig. value	Interpretation	Decision to Ho
Cognitive Load*Posttest	-0.271	0.148	Not Significant	Accept

α = 0.05 Level of Significance

The table shows the correlation results of cognitive load and academic performance. It can be gleaned from the table that there is no significant relationship between these variables reflective of the Pearson r value of -0.271 with the corresponding probability value of 0.148 which is greater than alpha 0.05. Hence, the null hypothesis is accepted.

Single group, Pre-test Posttest Experimental Design – T-test for Paired samples (Correlated means)

Table 4
T-Test

Test Type	Mean	Standard deviation	t-value	Sig. value	Interpretation	Decision to Ho
Pretest	12.80	3.112	-10.268			
Posttest	16.90	3.294		0.000	Significant	Reject

α = 0.05 Level of Significance

Table no.4 illustrated that there is a significant difference between the pre-test and the post-test results and null hypothesis must be rejected since the P value or Sig. value of 0.00 is less than the Alpha 0.05.

5 CONCLUSION

In the light of the foregoing findings, the following conclusions were drawn:

1. The respondents in the experimental group have similarity in the levels of Cognitive Load in terms of their perception in learning Science concepts and though the students came from a wide range of sections of Grade 7.

2. The use of Multimedia in the form Computer Simulated Material such as I-SIM during the lesson proper as an activity and instructional tool, indicates that this is an effective intervention to break the ice in learning Science concepts. Though there is no relationship between Cognitive Load level and Academic performance, it does not mean that students with high cognitive load level got low scores and vice versa. This only shows the similarity in the average level of Cognitive Load of each student that is closer to the maximum level. In connection with this, in terms of their behavior

towards studying, the subject is rekindled during the utilization of the I-SIM. The students became motivated although still had the feeling of uncertainty that they could cope with the pressure and demands of learning Physics.

3. As a result of the interview and the survey form as well, the Cognitive load level affected its three aspects such as sensory memory, working memory and long-term memory as self-reported and invested mental effort after the I-SIM was conducted. This was a big help on the reduction of Cognitive Load level and development of I-SIM. Avoid the usage of highfalutin words; construct easy instructions or directions relevant to the topic used in terms of the sensory memory of the students to mitigate confusion. On the other, properly placed pictures, videos and even audios and sound effects for it can boost student's long-term memory where they can relate these from the prior and present topics. The results shown that in working memory, hints and clues and others mnemonic techniques must be applied to reduce Cognitive Loading in the development of I-SIM.

4. Based on the Reduction of Cognitive Load from the interview, it is advisable to develop I-SIM using simple terminologies, brief explanation, direct to the point sentences, proper selection of photos, gifs or videos, appropriateness of the usage of sound effects or background music and lastly avoid unnecessary elements in the learning material that is not related to the specific topic. These were the results to reduce Cognitive Load to develop I-SIM and to exercise the best practices to ensure that learning took place from the material to the learners.

5. Having a self-phased or student-phased mode experience in using I-SIM in computer or tablet during the lesson proper part helped the respondents to attain good scores; this positively impacted the performance in 30- item test. There was an effect between the pre-test and post-test scores. This clearly shows that the intervention using I-SIM to the students plays a very important role to alleviate their academic performance. And with this approach since the Cognitive Load of students are in Average Level, there are several ways to reduce it to make it in the Lowest possible level, so that in this manner, the learning material or the I-SIM is improved and so with the students' academic performance.

6. Since the study was only focused on Grade 7 science students of Cayetano Arellano High School, it is recommended to make use of other grade levels under the K to 12 Curriculum with other disciplines as well such as Mathematics, English etc. This is a must to be able to measure and assess the Cognitive Load level of higher grade levels to design appropriate learning materials. The intervention of I-SIM which was only limited used for the instructional material can also be used for intervention of those students who have problems with tardiness and absenteeism. In addition, a much-developed gamified learning during online classes must be intensified where games and scientific concepts converge for purposeful learning.

7. There should be a continuation of the study that focuses on different types of Cognitive Load namely, Intrinsic, Extraneous and Germane Cognitive Load for the development of learning materials like I-SIM. The specification of each type that determines what to improve and not to improve in constructing learning materials will be determined to be able to reduce Cognitive Load. Measuring cognitive load is not just limited in an online environment, thus a related study must be done in designing printed teacher-made learning resources is encouraged as well.

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