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# A Review of the Effectiveness of Educational Digital Game-Based Learning on Students in Tertiary Institutions

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**ABSTRACT**

The higher institution's evolution to a more digital era is increasingly making the long-standing learning approaches redundant and ineffective in maintaining student engagement. The digitalization of the educational system sometimes results in a misalignment of the learning approaches with contemporary students' skill sets and experiences. Many studies have attributed the increase in students' dropout and poor academic performance to this misalignment in the teaching approaches. Hence, introducing improved teaching methods is essential in uplifting students' learning experiences and academic engagement, contributing to successful student pass rates. Adopting the desktop literary review, the study utilizes relevant literature and theoretical frameworks including The Connectivism Learning Theory by George Siemens and Stephan Downes, The Cognitive Load Theory by John Sweller as well as, a range of theories surrounding the cognitive function in its interrogation of digital game-based learning, and to better understand their effectiveness among our students. This research study aims at advancing traditional conversations in the field of teaching and learning to the role of technology in modern day education, and will benefit educators as, valuable insights on digital game-based learning can be used to promote positive changes in the learning environment, transitioning from conventional approaches such as lengthy lectures in which, according to research studies, was said to be less effective in holding student engagement. The study concludes with a deep engagement and discussion on the positive influence of digital game-based learning on students' ability to focus and pay attention in learning environments in addition to, processing, comprehending and retaining valuable information, maintaining engagement and increasing memory capacity as well as, improving strategic and critical thinking and problem solving abilities within and beyond the academic institution.

## 1. Introduction

Due to the evolution of education and pedagogical practices within the context of contemporary technological developments, traditional approaches to teaching and learning are becoming outdated and obsolete (Raja, 2018). As such, educators in the tertiary environment are being

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constantly challenged to meet the ever-changing learning expectations of students, whilst maintaining focus and structure in classrooms and simultaneously imparting relevant knowledge and skill sets that are fundamentally important for their educational development and progression, within and outside of tertiary intuitions (Raja, 2018). New and improved approaches to learning, that not only cater to the specific learning needs of individuals but, that are also in alignment with the digital intelligence of this modern era, will not only transform and enhance the engagement of students, but will also result in more effective and interactive teaching and learning (Ariffin et al., 2014). This will significantly improve academic performance in tertiary institutions and will prepare students with the relevant knowledge to succeed in their career paths.

Through a systematic desktop study and with the support of appropriate theoretical frameworks, the positive impacts of integrating digital game-based learning into teaching practices will be shown, along with its effects on the cognitive and behavioral development of individuals and how that can in turn improve academic performance. Additionally, the contents of this study will provide a deeper understanding of the human cognitive process and how it can be influenced through digital gaming, which can be beneficial for students when it is practiced and monitored in an educational setting.

### 2.1. Background and Relevance of This Study

The information in this research study is relevant as it demonstrates how game-based learning can positively influence the receptors in the brain, giving students the ability to better focus and pay attention in classrooms as well as; in social interactions (Ariffin et al., 2014). This form of learning will further allow students to effectively engage, process and comprehend information at an adaptable rate, thereby increasing their intellectual stamina and mental capabilities (Wardoyo, 2020). This allows them to attain better academic outcomes, and additionally, gives them the ability to achieve an above average performance in their studies and aids them in excelling in their overall academic journey (Ariffin et al., 2014).

Additionally, understanding the effects of educational game-based learning on the human cognitive mind gives further insight into its capacity to positively develop perceptual capabilities when effectively incorporated into teaching and learning methods, allowing students to maintain concentration on a specific activity for a sustained period, as well as giving them the capability of recalling relevant information when necessary. These skills are not only essential in tertiary education but are also vital skill sets that will be required when students are employed (Wardoyo, 2020). This study will also be significant to educators as valuable information on the effects of digital game-based learning is provided, which can be used to structure lesson plans and activities for students in efforts to promote positive changes in the learning environment and to thereby facilitate the transition from old traditional teaching practices, into new and more relevant approaches that effectively suit the learning requirements of each student in a more proficient manner.

Apart from the psychological advantages of effectively integrating digital games in teaching and learning, a pupil's overall behavior in classrooms can improve (Wardoyo, 2020). They may show more of a willingness to participate in activities and attend class sessions with the intention of remaining vigilant and to learn (Wardoyo, 2020). Students may be more encouraged and inspired to learn as adopting digital games into teaching practices, that are creative and educational, transcends old teaching methods and the knowledge that is imparted within students will coincide with the technological advancements in the external world, making it easier for them to adapt to technology outside the tertiary institution and most especially, in the workplace (Ankiewicz, 2020). Hence, the main objective of this study is to

deliver sufficient information on the advantages and effects of game-based learning, giving educators the ability to determine if they want to incorporate such practices in the learning environment. The more knowledge and information educational institutes have on new and improved teaching methods, the more they can make informed decisions that will help evolve and uplift education throughout the world.

This research study not only aims to widen the knowledge and understanding of the positive effects of educational game-based learning on students in tertiary institutions, but it also aims to explore the psychological advantages it poses in stimulating cognitive development and facilitating and enhancing academic performance in tertiary education.

### 2.2. The Importance of Technology in Teaching and Learning

The expansion in the field of technology has shifted the world into a more digitally focused era, requiring teachers in the academic environment to change their teaching methods, and to equip students with the necessary skills they will require to effectively navigate themselves in education and within the digital economy (Ankiewicz, 2020). The aim of technology within academic environments is to fundamentally uplift and enhance the process of learning. Technology has transformed teaching, taking it from a passive approach to a more interactive one through engaging with students on a deeper and more layered level capacitating blended learning, while gearing them with the skills to effectively solve problems, retain content and engage with the subject (Statti, 2020). According to the U.S Department of Education Office (2017), technology in the education sector offers potential to strengthen the learning process through redefining interactions between teacher and student, reshaping learning methodologies, and meeting the academic learning requirements of all learners.

Moreover, the infusion of technology in teaching and learning practices can further empower the understanding of subject content, while promoting learner engagement and encouraging collaborative learning (Raja, 2018). It supports a diverse academic culture, catering to all preferences of learning and allows for the development of new skill sets for students to thrive in the environment of ever-changing technologies (Trust, 2018 ).

#### 2.2.1. Technology, Gamification and the Learning Environment

In 2018, a survey concluded that 90% of individuals who gave a response preferred incorporating technology into tasks, as they believed it was a more effective way of sustaining engagement and boosting a sense of belonging (Paul et al., 2023).

From fields as diverse as video gaming, to leaps in computer technology and digital programming, to rapid technological developments in communication and artificial intelligence (AI), it is becoming evident that technological advancements worldwide are accelerating at an exponential rate and as such, digital inventions have become more prominent, generating a technological revolution (Raja, 2018). This revolution allows individuals to observe, gather, store and analyze data at a level that is surpassing traditional information systems and devices, changing the way in which individuals interact in society, conduct work activities, acquire information as well as, influencing how they make informed decisions in their daily lives (Ankiewicz, 2020). Digital innovations have, moreover, increased the gamification industry (Thorpe & Roper, 2019). With an estimated worth of $5.5 billion in 2018, the value of the gamification industry continues to increase globally (Paul et al., 2023). In 2021, gamification in the market industry was worth $11.94 billion, and by 2022, the market was valued at $14.87 billion. Currently, in 2023, the gamification market is worth $18.63 billion and is estimated to increase by 30.4% by 2024 (Paul et al., 2023).

By the year 2025, the sales revenue in the gamification market is predicted to reach $32 billion worldwide (Thorpe & Roper, 2019). 40% of organizations utilize gamification to successfully transform and develop business processes and operations (Thorpe & Roper, 2019). Additionally, a survey conducted in 2015, showed that 72% of respondents were more motivated and inspired to complete work-related tasks due to gamification. With regards to the education department, the following statistics will give an indication as to how the value of gamification has increased over the years; in 2012 the gaming market was valued at $3.91 million; in 2015 the educational gaming market was valued at $93.04 million. By 2017, the market reached $8.95 million and in 2020 the gamification industry was valued at $1.5 billion (Thorpe & Roper, 2019). With the figures stipulated, it is evident that use of technology has increased over the past decade thereby increasing its worth and creating a demand in society. Digital innovations are leading to the creation of breakthroughs in various fields, particularly in the field of education and learning, and are contributing to the ineffectiveness of old learning approaches (Statti & Torres, 2020). Hence, it is important to understand that the age of digitalization is ongoing and brings inevitable change, and it is imperative for educational institutions to align themselves to it, for more effective and efficient teaching practices. Moreover, society is becoming more influenced by the digital era, raising the standards of teaching and learning and thereby, driving educational institutions to integrate new ways of storing and using knowledge, information and data (Statti & Torres, 2020). As a result, the incorporation of technology in schools are continuing to grow at a rapid rate across the globe (Ankiewicz, 2020). Studies show that, 48 percent of students are using computer technology in classrooms, 42 percent are using digital smartphones, 33 percent use smartboards and 20 percent are using smart tablets (Ankiewicz, 2020). This gives an indication as to how technology has evolved not only in the external world, but also within academic environments (Statti & Torres, 2020). Hence, the knowledge of digital literacy integrated within educational teachings in higher institutions is a fundamental skill, allowing students to adapt to the increasing changes in technological advancements, improve efficiency, and empowers users one to communicate, socialize and comprehend information and data more effectively within and outside of learning environments (Paul et al., 2023).

As learning environments are being challenged by technological developments, it is becoming more apparent to educators that the quality and manner at which knowledge is delivered, has a direct impact on the level of student engagement attained (Ankiewicz, 2020). By creating a learning environment that is not only applicable to the learning standards required by students in tertiary institutions, but that is also in conjunction with the digital developments of the modern era, enhances the level of engagement with educational content as well as, increases the level of memory and retention in classrooms, which is essential in academic performance (Statti & Torres, 2020). Therefore, adopting new and innovative teaching methods that meet the needs and expectations of students in the era of advanced technology can be a vital aspect in the process of improving and uplifting learning experiences across the globe. Additionally, considering that individuals in the 21$^{st}$ century are currently growing and developing certain cognitive and mental capabilities alongside the evolution of technological developments, it is better to work proactively with this familiarity (Statti & Torres, 2020). Considering this, integrating digital learning in classrooms can be a more sustainable way of increasing the level of student engagement in the learning process in addition to enhancing academic performance, broadening student skills and retaining memory and focus.

### 2.2.2. The Theory and Foundation of Digital Game-Based Learning

The world has transitioned and is continuing to transition into a more digitally established economy. Concurrently, technological information systems within tertiary institutions are becoming more prominent and can be relied upon to obtain, analyze and to store relevant data

(Ankiewicz, 2020). Digitally developed systems and processors are becoming more interconnected and profoundly dependent on the innovations of computer software and updated programming (Ankiewicz, 2020). Thus, overall, continuing to alter how we communicate and conduct activities and furthermore, how we perceive information and acquire knowledge, and even inadvertently, transforming the way in which individuals teach and learn (Haleem et al., 2022).

Gaming has been used in an educational context for centuries. It has fundamentally progressed with the evolution of digital intelligence and technology, leading to the creation and development of digital game-based learning (Thorpe & Roper, 2019). Digital game-based learning is an amalgamation of education and digital games and can be further defined as an instructional learning approach that involves educational games, which can be accessed through digital and computer-based systems (Ariffin et al., 2014). Digital gaming in the learning environment aims to improve the educational experience within institutions through means of enhancing the quality of educational content by forming a balance between subject matter and games (Wardoyo et al., 2020). This successfully connects teaching practices and education with modern day technology.

This study explores the core foundation of game-based learning with references to appropriate theoretical frameworks that aim to show a clear link between cognitive abilities, digital gaming and teaching and learning. An understanding of the human mind, using the chosen theoretical approaches, highlights how stimulation through digital games in a learning environment can amplify the efficiency of human memory receptors and can improve focus, concentration, and memory (Chai et al., 2018). Applicable theories will also be explored to show how perceptual capabilities can be developed through the integration of digital games in teaching practices, allowing students to maintain concentration on a specific activity for a sustained period as well as, facilitating the capability to recall relevant information when necessary (Ariffin et al., 2014).

### 2.3. The Connectivism Learning Theory

The 20$^{th}$ century digital revolution allowed individuals to formulate new and improved methodologies and furthermore created the idea of decentralized learning, thereby facilitating convenient access to informational databases and, allowing for the dissemination of knowledge and academic resources across various networks (Haleem et al., 2022). These facts support the theory of Connectivism; a learning model that recognizes the significance of technology and digital media within educational settings and its substantial role in the learning process (Downes, 2019). Introduced in 2004 The Connectivism Learning Theory was developed due to innovations in digitalization (Alam, 2023). The theory acknowledges the influence of digitalization in the context of learning and proposes that the learning process is not exclusively an individual one, but a process that encompasses technology and diverse digital platforms, as opposed to theories of behaviorism, cognitivism and constructivism which predate the technological revolution in the 1900's and focuses on conventional teaching and learning approaches (Alam, 2023). Siemens and Downes (2004) further suggest that technology within the teaching and learning domain can provide a solution by efficaciously bridging the divide between traditional learning approaches and modern-day learning approaches. As technology evolves, the distribution of knowledge across digital platforms will evolve. Therefore, shifting the landscape of learning and acquiring information in addition to, creating a range of opportunities to incorporate effective collaborative class discussions and allowing students to connect with knowledge and information at a more comprehensive and efficient rate on digital networks (Lai et al., 2012). Thereby improving a student's ability to problem solve and adapt

to the changing technological environment and further, assisting them in the skill to discern relevant sources for information (Lai et al., 2012).

The Connectivism Learning Theory is based on the notion of connectedness, which implies that the process of learning will effectively occur when connections are developed between numerous sources of information such as, a connection between a student and an information resource, which are known as "*nodes*" (Herlo, 2017). Connections as such, also referred to as "*links*", should be sustained to thereby facilitate the formation of knowledge (Siemens, 2004 ).

The synchronicity between the theory of Connectivism and digital game-based learning can be understood through means of examining Siemens (2004) key concepts of Connectivism.

### 2.3.1. The Principles of the Connectivism Learning Theory and Digital Game-Based Learning

George Siemens and Stephan Downes (2004) have articulated key principles that reinforce their research on the theory of Connectivism. The first principle of the Connectivism Learning Theory states that knowledge can be found in the diversity of different perspectives (Siemens, 2004 ). These perspectives, derived from various information sources, cultivate insightful opinions, deepen insights and overall, enhance the comprehension of knowledge (Siemens, 2004 ). If knowledge is said to reside in the diversity of perspectives and opinions, and if perspectives and opinions of individuals are influenced through information on various digital platforms in the age of technology, then it follows that introducing educational games on digital platforms will provide outcomes that are more impactful than long held traditional teaching and learning approaches as students will have a wider range of information available to them and thereby gain the ability to explore the different networks of data (Downes, 2019). This provides a diverse range of information, creating a widened spectrum of viewpoints and broadening their critical thinking ability, and furthermore, enhancing their level of engagement and mental stamina, and facilitating the process of obtaining information and learning.

The second principle in the Connectivism Learning Theory, looks at learning as a process of connecting (Downes, 2019). According to Siemens and Downes (2004), establishing connections with information sources, also referred to as "*nodes*", is a vital component in the scope of learning as it enables one to develop and broaden skills on digital platforms, thereby generating new thought processes, fostering innovative concepts, and contributing creative input in the field of teaching and learning. Although the process of conducting game-based activities involves an in-depth explanation to students thereby establishing a "*link*" between teacher and student, the contact during digital game-based learning may be limited (Siemens, 2004 ). However, there is an extensive connection being made between student and various information networks and according to Siemens and Downes (2004), the process of establishing a "link" which is the connection, with "nodes" being the information source, learners expose themselves to an extensive range of data and information, that will enhance their knowledge on a specific subject matter and improve engagement. Digital game-based learning can encourage interactive participation and engagement between students and will even enhance teambuilding skills depending on the nature of the digital game (Ariffin et al., 2014). Students will establish connections or "*links*", during the process of engaging with digital games in classrooms, thus supporting the process of learning (Wardoyo et al., 2020).

In the perspective of Siemens and Downes (2004), the third principle of the Connectivism Learning Theory asserts that learning may be embedded within non-human devices. During their research, George Siemens and Stephan Downes found that individuals tend to store information on digital applications or databases. Further, this led them to forming the conclusion that students prefer to store and secure valuable information on forums or digital

files and folders, allowing them to access data in a more effective and efficient manner. As such, there is a significant dependency on digital forums within educational institutions (Ankiewicz, 2020). In this context, the researcher can infer that the process of learning is enhanced through the ability to access information on digital systems and platforms, and integrating digital gaming within educational settings can prove to be of value, given that students are well equipped and have a proficiency in the era of digital intelligence.

The fourth principle of the Connectivism Learning Theory asserts that, there is value in the aptitude to acquire more knowledge than simply the knowledge that is currently known (Downes, 2019). Therefore, it is beneficial to explore diverse sources of information, all for the purpose of expanding beyond the current understanding of information within various areas of study. Digital game-based learning enables the ability to interact with various digital elements which promotes critical thinking as one is exposed to a range of current information and concepts otherwise unknown (Welbers et al., 2016). Therefore, as students encounter challenges in digital gaming, they can develop new skills and knowledge thus, expanding on concepts within theoretical knowledge and broadening their level of understanding on certain subject matters. Depending on the design of the digital game, students will progress through trial and error, and their interactive abilities with other students will improve (Lai et al., 2012). All of this leads to them expanding their current perception of ideas and promoting the development of new philosophies and thought forms (Ariffin et al., 2014).

In a key perspective of Siemens and Downes research, the fifth principle of the Connectivism learning theory leans on the concept of maintaining connections (Siemens, 2004 ). Siemens and Downes (2004) proclaim that to foster continuous learning, connections must be nurtured and sustained. Therefore, students must have a continuous "link" to information sources to enable the acquisition of valuable knowledge and to cultivate and promote a culture of learning. Digital game-based learning offers a wide variety of information sources, that allow students to engage with each other as well as with other online networks (Wardoyo et al., 2020). It further provides instant feedback, giving learners the ability to recognize errors and allowing for the cycle of continual subject improvement (Vandercruysse et al., 2012). Through digital game-based learning, learners share a platform in which they can segment and exchange information, knowledge, and expertise, which can assist in the progression of cognitive and perceptual abilities (Qian & Clark, 2016). For this platform to facilitate learning it must be sustained through the maintenance of the connection between "*nodes*" (Alam, 2023). Hence, digital game-based learning must be applied on a continuous basis to see its positive effects on academic performance and to assist in the formation of long-term quality learning abilities (Siemens, 2004 ). These include the ability to find relevant information, analyze and segment the data according to its significance, and the ability to understand and process the information found; as per the sixth principle in the Connectivism learning theory (Downes, 2019).

The sixth principle emphasizes the importance of being able to identify connections or "links" across diverse concepts, fields and ideas (Downes, 2019). The ability to form a connection between information sources is a fundamental skill within tertiary institutions as, it is directly associated with the way in which students depict knowledge, perceive ideas, and understand concepts and philosophies in different subject fields (Ariffin et al., 2014). The ability to form connections between information resources in the academic environment is beneficial as students gain the capacity to connect components of data and information thereby, allowing for a deeper understanding on the subject matter (Welbers et al., 2016). Furthermore, linking data from various digital platforms gives one the ability to retain knowledge and information, and improves focus and concentration which allow students to recall information that was searched, stored, and analyzed on digital platforms (Kiryakova et al., 2014). The opportunity to link concepts and ideas on digital platforms further develops the skill to approach information in a

strategic manner, allowing for improved problem-solving capabilities and as such, the level of engagement with the subject matter is enhanced (Qian & Clark, 2016). Through well-designed digital games, students can explore different networks of data as they search for information to assist in the completion of the digital game (Vandercruysse et al., 2012). This process of self-directed learning through digitalization aims to facilitate and develop a student's ability to connect and comprehend different theories, and to effectively apply it to practical cases, promoting effective teaching and learning (Raja & Nagasubramani, 2018).

According to Siemens and Downes (2004), the seventh principle in the theory of Connectivism proposes that using updated information is the core of Connectivist learning (Downes, 2019). Information that is updated is more accurate as it depicts the latest developments, thus enhancing the reliability and trustworthiness of data (Alam, 2023). Furthermore, when using updated information, the risk of incorrect data is minimized and will be relevant for use in the academic environment, particularly in research practices and within the market industry (Alam, 2023). As per the digital era, artificial intelligence ensures that information is continually updated and that systems are in line with the newest trends and methodologies (Haleem et al., 2022). This ensures that quality data is being accessed in market industries, educational institutions and even within the personal lives of individuals. Digital games on student forums or other digital platforms allow students to access different networks and gain relevant data for academic purposes (Ariffin et al., 2014). Due to technological advancements in this era, institutions can align current information on digital platforms, allowing students to remain informed on current trends and to access updated information that is valid and applicable to the subject (Wardoyo et al., 2020). This can enhance the value of education and academic outcomes and effectively align it with current needs. Furthermore, digital games that are designed using updated information can be a substantial tool in the academic environment when built on pertinent data, facilitating effective decision making and problem-solving skills, along with improving student engagement and critical thinking (Lai et al., 2012).

The final principle is founded on the understanding that decision making can serve as a learning process (Herlo, 2017). As the world evolves, so will knowledge and technology (Haleem et al., 2022). New understandings of information will emerge and considering that the main aim of Connectivism is current information, it is important to acknowledge that as information and data progresses, individuals must adapt and align themselves accordingly, and evolve alongside information and technology (Alam, 2023). The decision to introduce digital game-based learning in tertiary institutions, can give students the ability to remain in alignment with the digital era, enhancing mental capabilities and knowledge, and improving skill sets that are necessary to progress in the academic environment.

In summary, the Connectivism Learning Theory supports the implementation of digital literacy in the form of digital game-based learning in tertiary institutions as it provides a safe space to learn, fail and succeed. Crucially, it encourages learning through accessibility to various networks, and it is challenging and can promote academic progression; furthermore, it facilitates the process of establishing connections and understanding valuable knowledge and information extracted through the exploration of digital networks (Alam, 2023). Digital educational games, being the combination of education and technology, allow students to remain in alignment with digital innovations and updated information, and this can lead to increases in mental capabilities, thereby improving learning outcomes, as well as fostering social abilities, student engagement and participation in classrooms (Wardoyo et al., 2020).

The Connectivism Theory provides a seamless understanding of the connection between knowledge and digital intelligence; however, it is of relevance to the study that mental capabilities are also examined and understood in the context of digital game-based learning.

The human psyche is multifaceted and encompasses an array of capabilities, one of which is the ability to perceive and store memory, allowing human beings to recall diverse forms of knowledge, depending on its value and significance (Paas & Merriënboer, 2020). Working memory is a combination of new and existing information which exists in the human mind for a short length of time (Paas & Merriënboer, 2020). This form of memory predominately allows individuals to focus on a particular task for a sustained period while eliminating insignificant information (Batista-García-Ramó & Fernández-Verdecia, 2018).

### 2.3.2. The Cognitive Load Theory

The Cognitive Load Theory, developed by educational psychologist John Sweller in the 1980's, professes that the human cognitive mind acts as an information processor and allows human beings to use and rely on working memory to problem-solve and to hold information for later use (Sweller, 2011). There is, however, a risk of mental overload when exposed to an assortment of stimuli which can cause limitations in memory capacity (Chai et al., 2018). John Sweller (1988) in his theory, provides context on the capabilities of working memory and its limitations. This psychological theory examines how the human cognitive system processes information and data, and how mental efforts are regulated during the process of learning. This theory is also based on the understanding that the cognitive mind can only hold information for a certain period depending on its value and significance and as such, it is necessary for individuals to discern pieces of valuable information in which to process, to sustain and retain memory (Reese & Taylor, 2016).

The Cognitive Load Theory derives from two concepts (Sweller, 2011). The first concept stipulates that there is a limit to the brain's capacity to process and hold new information. This cognitive system can also be referred to as working memory, and has the ability to temporarily store information in the cognitive mind (Sweller, 2011). Working memory guides decision-making and allows for comprehension of information, learning and reasoning (Cowan, 2014). The second concept asserts that there are no limitations to the amount of stored information processed in the cognitive system (Sweller, 2011). Information that is stored can be retrieved from long-term memory and held in the mind for a longer length of time (Sweller, 2011). Understanding the inner workings of memory requires an assessment of how information is processed through the cognitive mind and how this, in turn, is stored as memory. Furthermore, to gain insight as to how memory in the cognitive mind serves as a fundamental aspect of education and learning, the foundation of cognitive development should be considered (Chai et al., 2018).

## 2.4. Memory and the Human Cognitive Mind

Memory is the ability to effectively absorb and retain information, and this is directly linked to learning and engaging which are skills that are crucial within any environment (Thomas, 2023). When the cognitive mind is triggered by stimuli it can analyze and evaluate and capture information, that is then stored in different parts of the human brain as memory (Spencer, 2020). Furthermore, the proficiency to extract and utilize valuable information from stored stimuli is a vital skill and is imperative within learning environments (Chai et al., 2018). However, human beings need to firstly gain the ability to recall information, to effectively utilize it thereafter (Chai et al., 2018). Thus, studying the process in which information is passed in the brain, gives the researchers a deeper understanding as to how information can be triggered, enabling human beings to effectively recall essential information, thus aiding in the process of extracting valuable information when needed.

The human brain allows one to effectively process and interpret information from the external environment (Cowan, 2014). Data is collected through sensory receptors and produces thought forms which, thereafter, allows human beings to adapt and learn accordingly within certain environments (Batista-García-Ramó & Fernández-Verdecia, 2018). Thought forms are created through exposure to sensory information, and establishes a foundation in the development of memories in the cognitive process (Southworth, 2022). Visual imagery can be absorbed through the ability of sight, while auditory information can enter the cognitive mind through the ability to hear, and scents are taken in through the sense of smell, whereas and the sensory neurons on the skin are responsible for the ability to touch or to physically feel objects (Reese & Taylor, 2016). Information collected through human sensory receptors stimulates cognitive function, creating a thought which can last a few seconds, or a memory, which can last for a longer length of time; depending on the strength of stimulation (Southworth, 2022). The greater the stimulation of information, the more deeply thoughts are processed, formed and engraved in the brain, thereby creating patterns of information that are then stored in the cognitive mind for a sustained period (Thomas, 2023). This allows human beings to recall information that was processed, even years ago. Sensory information is processed through various parts of the cognitive mind and subsequently, stored as memory (Thomas, 2023). This process allows for the creation of new thought forms which aid in the facilitation of learning processes (Chai et al., 2018).

### 2.4.1. The Basic Anatomy of Memory

The human brain consists of different parts which work simultaneously to process information received (Batista-García-Ramó & Fernández-Verdecia, 2018). Sections of the cognitive system responsible for processing information and retaining memories are labeled as: the prefrontal cortex, the basal ganglia, the cerebellum, the hippocampus and lastly, the amygdala. Each of these serves a different function and plays a role in distinct types of memory formation (Batista-García-Ramó & Fernández-Verdecia, 2018).

Having two functional sides, the prefrontal cortex is responsible for the storage of lesser information in the human mind (Batista-García-Ramó & Fernández-Verdecia, 2018). This information, once received, lasts only a brief period and is an essential part of recalling relevant pieces of information throughout the day, to facilitate daily tasks (Chai et al., 2018). The neocortex, responsible for learning, serves as an information processer, by extracting valuable information from memories, thereby allowing one to draw conclusions and to create logical reasoning (Thomas, 2023). The basal ganglia function is predominately responsible for movements in the human body. However, it also stores relevant information and memories that later aid in decision making processes, learning and in controlling human emotions (Chai et al., 2018). The amygdala, a main and an integral part of memory processing, creates emotional responses to information that is processed and stored, allowing one to link feelings to memories. Lastly, the hippocampus, which is primarily linked to memory, serves in storing long-term and short-term memories (Thomas, 2023). Information within this cerebral function is imprinted in the mind making it difficult to forget (Batista-García-Ramó & Fernández-Verdecia, 2018). All aspects of the human cognitive function work in conjunction to transform thought forms and produce memories (Chai et al., 2018). Information received and stored in the human mind can be momentary, or it can become a lasting memory based on its duration in the cerebral cortex and the level of cognitive stimulation triggered by information received through sensory receptors (Chai et al., 2018). Individuals can also sustain mental focus and concentration when intentionally focusing on stimuli as it directly stimulates the cognitive function (Reese & Taylor, 2016). This can result in enhanced perceptual capabilities, intellectual stamina, and overall, increases mental skills and competencies (Southworth, 2022).

Digital games appeal to sensory receptors more specifically, through visual appeal (Wardoyo et al., 2020). They can gradually trigger the cognitive mind limiting cognitive overload and leaving a lasting imprint of the subject matter which can create a long-term memory of information (Haleem et al., 2022). When individuals are exposed to digital game-based learning, thought forms are created, and considering that visualization is a key aspect in memory formation, when students engage with digital games, they are directly stimulating the cognitive function; surpassing mental stain and creating visual memory of the subject (Chai et al., 2018). This memory, depending on the strength of stimulation, allows one to recall information when needed and maintains focus and concentration through balanced cognitive load as sensory receptors will be activated, and information will be processed (Chai et al., 2018). As a result, this process aids in effectively engaging students with learning content (Sweller, 2011). Considering this information, educators need to appeal to human sensory receptors if they want to increase concentration levels and help students retain vast amounts of information. In this age of technology, human beings are heavily stimulated through digitalization (Statti & Torres, 2020). Digital technology is primarily becoming a main source of seeking information, and according to the Connectivism Learning Theory, technology is in fact, changing what we learn and how we process information during the learning process (Alam, 2023). Therefore, integrating game-based learning in teaching practices can effectively and efficiently facilitate the learning process and can overall transform the learning environment (Haleem et al., 2022).

### 2.4.2. The Psychology of the Cognitive Load Theory and Its Implications in Digital Game-Based Learning

The Cognitive Load theory, draws on an understanding of the architecture of the human mind to conceptualize how individuals think, learn, and absorb information (Paas & Merriënboer, 2020). It provides insights on how learning experiences can stimulate the cognitive mind and is designed to enhance the retention of information in long-term working memory; through the reduction of cognitive load and mental strain from excess stimuli, which, in the context of teaching and learning, can be generated from receiving vast amounts of information in a short time frame (Sweller, 2011). According to John Sweller (1988), effective learning takes place when cognitive load is effectively managed and balanced. Educational games that are designed and structured according to relevant theory and balanced sensory appeal can hold the capacity to optimize cognitive load (Sweller, 2011). Digital games allow one to surpass over stimulation in the cognitive mind as they are more appealing to sensory receptors (Paul et al., 2023). Digital game-based learning activities that are designed with an equilibrium of simple and complex challenges, provide a well-balanced mental load that is conducive to effective learning (Lai et al., 2012). The Cognitive Load Theory supports digital game-based learning as it acts as a guide to design and develop activities that balance the cognitive function through digital forums. Well-designed digital games can effectively regulate sensory information and minimize mental overload, as opposed to traditional teaching methods which can lead to overstimulation of the cognitive mind and have the capacity to overwhelm sensory receptors (Sweller, 2011). Traditional teaching methods such as long formal lectures tend to over stimulate the cognitive function and as a result, students lose focus and decrease their engagement (Raja & Nagasubramani, 2018). In addition, traditional lecturers, due to the inherent limitations within their methods and approach, lack the ability to mentally challenge students (Zhang et al., 2020). This can lead to a lack of progression in the academic environment as students will fail to apply themselves and not be able to find a connection or ‘link” to the information being taught. The lack of technology usage in traditional teaching further results in an outdated learning environment, a situation in which students can quickly lose mental concentration as the teaching style embedded in traditional teaching techniques may not be appealing to all students

(Paul et al., 2023). Effective, well balanced digital game-based learning gives students the opportunity to explore diverse learning preferences by enduring more responsibility in the process of learning. This can enhance self-reflective skills which allow students to understand areas of improvement and they can communicate that within the classroom subsequently; increasing self-awareness, participation, mental focus and interactive social skills (Lai et al., 2012). Moreover, digital game-based learning allows students to track their personal progress in a subject while also allowing teachers to view this progress and to assist students where necessary (Welbers et al., 2016). This can cultivate a more personal method of teaching to ensure that students understand and are also able to apply information.

Additionally, when digital activities are designed with the consideration of mental overload, they can be conceptualized in a manner that will enhance the educational intent of the game through sensory appeal (Lai et al., 2012). This can optimize mental focus and concentration and will also allow for information to be stored as long-term memory (Thomas, 2023). Incorporating activities on digital platforms that appeal to visual sensory receptors regulates cognitive processing as sensory stimuli are balanced (Vandercruysse et al., 2012). This aids in accomplishing the goal of aligning education with technology, updated and relevant information, and maintaining and enhancing cognitive abilities within learners, which can promote effective learning and can lead to successful academic outcomes within tertiary institutions.

## 2. Concluding Remarks

Within the context of education, teaching and learning, it is crucial to consider the basic principles of working memory in cognitive development and applicable learning theories, most especially in the digital era to enhance academic progression as it is evident that teaching practices are shifting along with technological developments. Furthermore, it is becoming increasingly apparent that integrating digital media in teaching and learning methods will not only enhance the teaching process but will also contribute to effective student engagement (Ariffin et al., 2014). As suggested earlier, this can lead to increases in academic performance and pass rate successes within the tertiary institutions. Incorporating digital game based learning in tertiary institutions will have the following tangible outcomes; students will become more engaged due to cognitive stimulation; memory and concentration will increase, as memory is the result of direct cognitive stimulation; crucially, critical thinking and problem solving capabilities can be enhanced as students will become more positively enthused to interact with digital intelligence; and lastly, participation in classrooms will increase and this in turn, can increase social and team building skills. These outcomes strongly indicate that digitized games in learning environments can enhance the learning landscape of tertiary institutions and increase the rate at which students' progress in their respective fields of study. Furthermore, aligning education and technology through means of digital game-based learning in this technologically advanced era ensures that up-to-date information is utilized, providing more accuracy in theoretical and practical examples (Lai et al., 2012). Moreover, digital game-based learning promotes a balanced cognitive function and can accommodate various types of learning in the tertiary environment as lecturers can integrate diverse learning approaches that are in alignment with technology, catering to the individual needs of students, which is a key aspect to achieving successful outcomes in classrooms and further, contributes to increasing pass rates within tertiary institution.

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