A paper presented at the 17th International Conference on Sustainable Development at the Autonomous University, Barcelona, Spain, 2023.

Enhancing Sustainable Educational Development with the Development of a Prototype "Musication" System Using Music to Assist Students in Learning Computing and Programming Concepts

Mpho Lengoasa [1] and Johnson Dehinbo [2]
[1,2] Department of Computer Science, Faculty of Information & Communications Technology, Tshwane University of Technology, Soshanguve, Tshwane, 0152, South Africa
Corresponding author: Dehinbooj@tut.ac.za

OIDA International Journal of Sustainable Development, Ontario International Development Agency, Canada.
ISSN 1923-6654 (print) ISSN 1923-6662 (online) www.oidaijsd.com
Also available at https://www.ssrn.com/index.cfm/en/oida-intl-journal-sustainable-dev/

Abstract: It is important for any society to continually strive towards sustainable development by making regular progress in their endeavours. Development in any society can always be traced back to improved education. When people are well educated, they can contribute positively to the society. Therefore, many countries take educational development very seriously. Sustainable educational development thus implies that the educational development we seek should be sustainable. Sustainable educational development requires that we achieve such educational development in a conducive way such that we use all possible tools at our disposal today to achieve such educational development so as to make it easy for future generations to maintain and improve upon. One of the possible tools at our disposal today involves using Information Technology and Information Systems and Music to enhance development. Music is universal and a very effective tool that should play a larger role in the classroom due to its great appeal to students. Music should thus increase students' interest in learning programming in a very entertaining way. Educators need to be willing to incorporate music in their lessons in order to better enhance their students' learning. Music in every classroom could inspire more students to become creative and independent, allowing educators and their students to understand each other and connect in a new way to make learning more enjoyable and less difficult even for complex subjects. Learning programming is a complex task and is one of the subjects that students find challenging. This article highlights the use of music and development of a system to help students to grasp and understand computing and programming concepts effectively. A prototype system is developed with music-based theory where important concepts are explained in form of music lyrics with suitable beats that is repeatable and can easily be remembered, fulfilling the saying that "repetition is the power of learning". The usability testing of the developed system "Learning through music" is done to indeed see the usability and effectiveness of the system.

Keywords: Music, online systems, understanding, teaching and learning, programming, computing concepts, Sustainable Educational Development.

Introduction

Development in any society can always be traced back to improved education. When people are well educated, they can contribute positively to the society. Therefore, many countries take educational development very seriously. Sustainable educational development thus implies that the educational development we seek should be sustainable. Considering the statement by Brown (2017) which explains that sustainable development is defined as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs", then sustainable educational development requires that we achieve such educational development in a conducive way such that we use all possible tools at our disposal today to achieve such educational development so as to make it easy for future generations to maintain and

improve upon. One of the possible tools at our disposal today involves using Information Technology and Information Systems to enhance development. Malapela, Mabunda and Dehinbo (2022) observes that Information Systems development as the engine of information and communication technologies (ICTs) has been known to be capable of leading to development which can be in simple terms be understood to refer to a state of improvement. Mansell and Wehn (1998, p.11) explain that the former United Nations Secretary General Kofi Annan emphasises the enormous potential of information and communication technologies (ICTs) for development in his remarks to the first meeting of the United Nations Working Group on Informatics. Every nation that would love to fully actualize this enormous potential, therefore, should invest in tools to assist in learning Computing and Information Systems development. In this regard of Information Systems development, we have to plan ahead for ways that would ensure that future Information Systems developers are able learn to do their work effectively without any compromising situation.

And given that programming is the core art and science of developing Information Systems, we should invest more in programming. This involves investing more in tools to assist in learning programming by today's students who will then become drivers of technological development in future.

However, learning programming is very tedious. The low pass rate for programming in many institutions of higher learning is a testament to this (Kori, *et al*, 2016). On the other hand, we observe that even children as young as 2 to 3 years of age can easily learn, enjoy and recite music in any society. And we also observe that teenagers so much love music to the extent that most of them can be usually seen using earphones and carrying different music storage devices to listen to music even while walking. So, the question is why don't we find a way of utilizing the love of music to enhance the learning of programming concepts so that it can easily be learnt as we easily learn and recite music?

An example of important art that the whole world has always enjoy and is currently enjoying and might want to continue to enjoy, is music. Music is a universal language. Students and sometimes other people everywhere can be found listening to their MP3 players, smartphones and so forth. Even though music is a part of everyday life for most young people, it is rarely used to engage and help students learn. Songs can transfer knowledge and enhance emotion and truly have the potential to reach students in ways other teaching methods cannot or have failed to, over the years. The lyrics of songs can be used to carry information, it can spark memories and melodies can make one recall ideas and thoughts. Therefore, why not use this powerful instrument?

Music can be used to help us remember learning experiences and information. Music can also create a highly focused learning state in which vocabulary and reading material is absorbed at a great rate. When information is put to rhythm and rhyme, these musical elements will provide a hook for recall. Therefore, why don't we find a way of utilizing the love of music to enhance the learning of programming concepts which has been reported by many as being difficult to learn as evident in its low pass rate?

Thus, the research problem is that for most people, students mostly, especially in South Africa as a country, our standard of learning is relatively low. The government have even lowered it further to try and accommodate even struggling students. The pass mark for moving to the next grade in secondary schools has been lowered to 40%. Ironically this decrease may make one pass grade 12 but when it comes to passing when they get to university, it is a totally different story. Therefore, most students do not cope when they get to university and end up dropping out or repeating several times. While this low pass rate situation is applicable to most subjects especially in the science, technology and engineering fields, the situation for programming and computing is more severe. Even lecturers struggle to cope with rapid developments in programming and software development. While in Chemistry and Biology for example, the organisms and the chemical reactions a lecturer learnt while in university have rarely changed, but in programming and software development, most lecturers that learnt programming using Formular Translator (FORTRAN), Basic, Pascal etc. using structured programming concepts while in school, now have to relearn programming languages like Java, C++, Phyton etc which now uses new concepts such as object-oriented programming.

Even within each particular programming language, there have been significant shifts over the years. If someone thinks he or she has mastered programming and software development tool such as Hypertext Markup Language (HTML) version 2 or 3 for developing web application for example and hears of HTML version 5 and assumes that just minor differences will exist, the person is in for big surprises. This is because HTML 5 is a completely re-engineered version with different approaches. This could explain why from experience, it seems like very few professors in computing or Information Technology lecturers at senior levels still lecture programming. Some hide under the banner of "specializing only in Informatics" saying their specialization is more about investigating the impact of Information Technology on people, organization and society, possibly using questionnaire

and interviews. Some others hide under the cover of the statement that traditional universities should just lecture programming concepts without illustrating with specific current programming languages so as not to be seen as promoting one language over another.

However, universities of technologies (formerly called Technikons or Polytechnics) do so with specific current programming languages. Imagine just lecturing loops in programming as compared to further illustrating loops with "if, while, for and next" statements clearly demonstrated in C++ or Java. Reports from industrial advisory committees over the years at the Tshwane University of Technology shows that our graduating students do much better during their 6-month industrial experience scheme due to their previous practical knowledge of programming languages like Visual Basic, PHP, MySQL and Oracle Database Management Systems, C++ or Java specially used in the industry. So, they easily get jobs at the entry programmers' level. While the advocates of lecturing programming without illustrating with specific languages argues that such practice prepare students with thinking faculties needed for supervisory programming jobs, we believe that rather than having supervisory programming jobs and be subject to slow employment rates, it is better to be equipped to easily get jobs at the entry programmers' level as supervisory opportunities may then come in future. This is also important given that most students at the Tshwane University of Technology (and other universities of Technologies in the country such Durban University of Technology, Mangosuthu University of Technology) come from poor economic backgrounds with no "connections" for job placements.

Moreover, while we have established the need to still lecture programming concepts illustrated with specific programming languages, and while the situation described above is rosy for graduating students, majority of students are still stuck within the system due to low pass rate especially for programming. And this situation cannot be helped if majority of lecturers at senior levels dodge lecturing programming due to challenges in keeping up with rapid advances as explained earlier. So, in summary, if even lecturers at senior levels struggle with learning latest trends in programming, then more serious attempts are needed to support learning programming by undergraduate students.

At the end of the day, if learning is essentially remembering and applying what new things you have learnt, then there is no harm if enjoyable arts such as music can be applied in assisting recalling and remembering programming constructs. Therefore, very important is developing a system or way to assist students with the use of music filled with concepts that will help them to remember their work, the way that they remember lyrics of a song that they heard 5 or more years ago. Music is mostly repetition, and that helps one to remember and know.

With these criteria in mind, the following research questions were used to guide this study:

The main question is to find out how music can be used to aid students to learn computing and programming concepts with the use of a system?

- In what way can music be used to enhance instruction and learning in a classroom or lecture room?
- How can the use of music as a learning method impact a student's interest, enhancement and understanding of concepts?
- How can a system or application be developed with music used to help students to understand concepts and be able to effectively apply them in computing and programming?
- How can a music application be evaluated to ensure that the application or system is working as intended?

Insights about teaching and learning with music were sought to explain, describe and understand the experiences of teachers and students. Lecturers who participated in this research implemented lessons that incorporated music using implementation strategies suggested by research. Lecturers and students shared their experiences and insights about the use of music for teaching and learning to provide information about the potential for using music in lectures.

Section 1 focuses on the background of this study of how music can be used to help students learn concepts easier and faster. It outlines the initial problem, the purpose of this paper, research questions to help determine the outcome of the topic as well as the importance, contributions and use of the study.

Section 2 presents the literature review with details of the previous work beginning with the history of music, how music is beneficial when it comes to brain activity and how the use of repetition in music or song is helpful with memory retention. Music and Mnemonics are also explained as well as multiple intelligences of how the brain works with music. And finally, it outlines the nature of music and how it can be used to make learning

better and easier. Section 3 contains the research overview strategy and approach, which is basically the plan and how this study is conducted. The research methodology is explained, which is quantitative and positivist. Functional requirements are also explained as well as how the system development is done with the help of a flow diagram and system architecture. Survey details are also outlined here for evaluation of the system.

Section 4 shows the outputs of the prototype application or system that is developed and also explains its contents and the functionality of all of the images that outline the developed system. It explains which page is which and demonstrates what the student sees and is supposed to see when operating the prototype.

While the results of the evaluation survey are deferred to further studies and future presentations, the next section concludes the paper, showing how each research question was answered. Recommendations and implications are also stated.

Literature Review

Caine and Caine (2001) suggest that new discoveries about intelligence based on brain-based learning theory are important in understanding how children learn and should be the basis of teaching strategies. The use of content-rich music should be included as one of many "complex activities and ongoing experiences in which the curriculum is embedded" (Caine and Caine, 2001, p. 19).

History of Music in the Curriculum

From ancient times music has been used as a device for learning and remembering information. "For thousands of years, knowledge was imparted from generation to generation through the medium of singing and chanting" (Armstrong, 2000, p.59). Songs have always been part of an oral tradition for passing down stories, history, information and lessons throughout most preliterate cultures. Stories and poems were sung by Griots in West Africa, Ashiks in the Middle East, Bakhshi in Central Asia, Troubadours in France, Naghal in Iran, Biwa-hoshi in Japan, Kikuyu in Kenya, Jali in parts of Indonesia and Bards in the British Isles for the purpose of transmitting information. Many of these song-tellers had special instruments and their format ranged from the singing of epic tales and news to choral and response storytelling (Sheppard, 2009). When the earliest institutions for learning were established, music was a part of their curriculum. Music was included in the curriculum at Takshashila University in northwest India, which was established in 700 BCE, along with subjects such as science, astronomy, math, archery and agriculture (Brahmaviharidas, 2010). The first western schools established by Pythagoras in 529 BCE (O'Connor & Robertson, 1999), Plato in 387 BCE (Norfleet, 2010) and Aristotle's Lyceum in 335 BC also provided for the study of music in the curriculum (Dirks, 1996). The importance of music in these first recorded educational programs demonstrates that it has always been considered an important part of learning across all cultures. When Charlemagne established schools for the purpose of teaching the clergy in the ninth century the seven liberal arts became the core curriculum, which had two divisions. The trivium included grammar, rhetoric and logic, while music was considered part of the quadrivium, which encompassed mathematics, geometry and astronomy (Kries, 2000).

These subjects became the foundation for all the educational programs in the European universities that arose beginning in the eleventh century, including ones at Bologna, Oxford and Cambridge (Kries, 2000). Song schools, first begun in Europe during the Middle Ages for common children, taught them to sing, play instruments, read, write and dance. Songs were used to teach reading and grammar since textbooks were rare, and music and math were often taught together (Watson, 1908). In 1875 Colonel Francis W. Parker was hired as superintendent of the Quincy Massachusetts school system to help improve the schools. There he introduced a new curriculum model that encouraged the use of songs for learning based on their connection to subjects being studied (Parker, Cooke & Stilwell, 1901). The results of his changes included not only greater levels of enthusiasm for learning, but also an improvement in student achievement (Edwards, 1935). In 1882 Colonel Parker moved to Chicago where he brought the concept of child-centered learning as he implemented his ideas into the schools there (Wilson, Gary & Greene, 1988). Francis Parker's ideas for teaching laid the foundation for the Progressive era in education, led by John Dewey after the turn of the century. In the lab schools that followed, songs were introduced about life experiences and children were encouraged to craft their own compositions based on their daily activities (Shiraishi, 1995).

The advent of radio in the 1920's brought a new use for music in the curriculum. According to an article in the Pittsburg Press, elementary students in Oakland, California were part of an experiment where penmanship was taught via the airwaves using rhythmic music. Geography lessons were also delivered from the radio with music signaling the beginning and end of each lesson ("Penmanship," 1925). The use of music in education further broadened its scope to be taught in conjunction with film, dance, theater, swing, jazz and drama in the 1930's and 1940's. By the 1950's folk songs also made their way into the content area curriculum. In an article that appeared in the September

20, 1958 issue of the *Christian Science Monitor,* a teacher in Massachusetts sang folk songs to teach history. Bonyum found music engaged his students in learning and used these songs to learn history. He eventually made a record and created a curriculum that correlated to the songs for use in other classrooms (Gustafson, 1958).

Television further facilitated the use of songs for learning. One of the most successful efforts to harness television for learning occurred in the late 1960's with the premiere of *Sesame Street.* This show debuted in the fall of 1969 and was aimed at development of cognitive and literacy skills for pre-schoolers. In the research and development stage for the show it was found that that segments using lively music were considered most appealing to children (Anderson & Levin, 1976, p. 811). In 1973 the use of music in educational television expanded in a new direction with the premiere of *Schoolhouse Rock.* These short cartoon videos were televised on Saturday mornings and used catchy melodies to teach concepts related to math, science, social studies and grammar (Calvert and Tart, 1993). In 1974 an article reporting new ways to integrate music into the curriculum appeared in *Daytona Beach News Journal*. A program piloted in Columbus, Ohio integrated music into every subject of the curriculum across all grade levels. Mathematics, language arts, science and history all used songs and elements of music to enhance the curriculum. A similar program in California was also piloted where students analyzed lyrics and learned about sound waves with music. In New York and Evanston, Illinois students composed songs and musical productions. Whether students were singing about history, analyzing songs or writing their own compositions; new ways to use music as part of the curriculum were being implemented all over the country ("Music education," 1974). The history of music in the curriculum provides evidence that music has been historically a useful tool to enrich the curriculum in all subject areas.

Music and the Brain

Recent advances in cognitive neuroscience have provided a wealth of information about the brain and how it encodes, stores and retrieves information. The human brain is divided into four different structures, each with a unique role in brain function. There are a trillion nerve cells in the brain that allow for more than a quadrillion connections. It is these connections among neurons that form the matrix of human memory within the brain's complicated structures. The most basic of brain structures, the brain stem, lies at the base of the spinal cord and regulates automatic body functions. The limbic system is found buried deep within the brain and is thought to be a structure that developed early in human evolution. Called the 'old mammalian brain,' this part of the brain is composed of four structures including the thalamus, hypothalamus, hippocampus and amygdala. The thalamus, where initial sensory input is first processed, forwards signals to other parts of the brain and is involved in connecting emotion and cognition. The hypothalamus regulates hormones. A critical component to processing memory, the hippocampus, converts information from working memory to long-term memory. When memories are intertwined with emotions, the amygdala is activated and encodes for long-term memory storage (Sousa, 2006).

The most evolved structures in the human brain are the cerebrum and cerebellum. The cerebellum is a deeply folded and highly organized structure located below the cerebrum and behind the brainstem. Thoughts, emotions and senses are coordinated here to support cognitive processing. The cerebrum, which makes up eighty percent of the human brain, is divided into four lobes, each with a different role in-cognition (Sousa, 2006). The cerebrum and cerebellum are divided into two hemispheres, left and right. Each side is specialized for specific functions, although there is some overlap between the two halves. The left side is generally involved in speech, sequential and analytical processes. The right hemisphere processes patterns, music and spatial relationships. Jensen (2008) warns that the left-right distinctions are an oversimplification of our current model in understanding how the brain works and can differ according to gender, occupation and handedness. For example, while most people process musical melodies and rhythms in the right hemispheres, this function migrates to the left-brain in accomplished musicians. Therefore, any teaching theory based solely on left-right distinctions should be considered outdated (Sousa, 2006). There are three types of memory involved in processing information. Sensory input is processed first in the thalamus, which must filter and screen for relevance. As a sensory stimulus enters the brain, neurons are fired to direct the incoming information to the correct processing area where it is stored in short-term memory for up to thirty seconds. Information is prioritized with emotional data receiving the highest priority. Sousa (2006) summarizes, "emotions consistently affect attention and learning" (p.44) and strengthens the neural network that encodes emotionally laden memories.

Because of the physiological response that the brain has when emotions are involved, learning and emotions are intertwined. Emotions are biological responses to stimuli and when activated, insure that students will be more likely to attend to and remember associated content. When emotions are connected to sensory data, neural connections become stronger. Humor, stories and songs are all excellent devices for activating an emotional response, getting attention and encoding multiple neural connections (Sousa,2006). The more pathways created, the more solid the

memory. Any activity that encodes multiple memory routes will result in enhanced learning. Content embedded in music and songs is effective in activating multiple neural networks (Jensen, 2008).

Working memory is processed in the frontal lobes and temporarily holds a limited number of "chunks" of information for conscious processing. In music, lyrics and melodies are chunked together into patterns of rhythm and verse to enable longer passages to be retained in memory. While processing sensory information, the longer a stimulus is held in working memory, the more likely it will be found meaningful and be encoded in long-term memory. As information is moved into long-term memory, intricate neural connections are made, based on relevance and past experience. From a physiological perspective, memories are formed when a series of neurons repeatedly fire together in a sequence or pattern. The more frequently these neural connections are activated together, the stronger the memory. The greater the number of connections made and attached to a memory, the more likely it is to be stored in multiple neural networks, allowing for different methods of retrieval (Sousa, 2006).

Retrieval of information stored in memory occurs when dormant neurons are triggered. The more pathways that have been established, the more ways there are to access memory. In music, melody and lyrics work together to cue each other for memory retrieval (Sousa, 2006). Neuroscience also suggests ways in which educators can improve recall. By providing memory cues, neural networks are triggered. When multiple neural paths have been established, memories can be accessed using more than one stimulus. For example, in songs, melodies and lyrics can provide recall cues for each other. "Music aids memory because the beat, melody and harmony serve as 'carriers' for the semantic content. This is why it is easier to recall the words to a song than a conversation" (Jenson, 2000, p.73).

The most important implication for learning from the field of neuroscience involves the activation of emotions when learning. "It is the reason that advertisers package so much of their message in stories and scenes that are intended to tug at the heart and kindle basic emotion" (Caine & Caine, 2001, p.47). Any instruction situated in emotion binds and improves learning (Jenson, 2008). Neuroscientists have begun to unlock the mystery of why music activates emotion. As a listener processes sensory input from music, the brain uses patterns of familiar schema based on experience to predict what will come next. There is a never-ending cycle of listen and predict, listen and predict, as a musical piece is played or sung. "Music sets up anticipations and then satisfies them" as the listener searches for expected patterns (Jourdain, 1997, p.312). When variations in expectations provide surprise, an emotional response occurs and the amygdala is activated. Composers use bridges and other musical devices to control expectations by deliberately and methodically breaking established patterns (Levitin, 2006). Emotional responses to music enhance memory by focusing attention to establish stronger and multiple neural connections (Jensen, 2000). Melodies used in science-content songs can be used to carry science content information, and because of the emotional response elicited by music, "there's a greater likelihood that the brain will encode it in long-term memory" (Jensen, 2008, p.75).

Music is emotionally powerful, and memories encoded in an emotional state are stronger and offer multiple paths for encoding and retrieval. Jenson (2005) summarizes why educators should include music in the curriculum based on our current understanding of how the brain works. Its social nature, emotional impact, ability to carry a message; accessibility and relevance are all cited. In listing ways to implement a music-rich curriculum, Jensen (2005) suggests using songs and melodies to introduce content, build community, enhance learning, assist in memory and convey information.

Musical Imagery Repetition

Music's special capacity for involuntary recall means that is that it is possible for science-content songs to become 'stuck' in the head. Tunes that are overly repetitive, simple in nature but have unexpected elements can become "earworms" (Cunningham, Downie & Bainbridge, 2005). Bennett has coined the phrase 'Musical Imagery Repetition' (MIR) to describe this phenomenon and defines it as "previously heard music that, while consciously unintended, repeats uncontrollably and pervasively in thought" (2002, p.2). Music is encoded into memory using an organized and structured format based on relevance. Important notes get priority for encoding, while the brain establishes certain entry and exit points in the stored memory of a musical selection. This phenomenon explains why when remembering part of a song, the brain "backtracks" to a natural starting point rather than recalling the lyrics or melody midphrase. These melody echoes are generally small pieces of a song equivalent to the capacity of working memory, approximately fifteen to thirty seconds in length (Levetin, 2006). These "earworms' can be powerful for voluntary or involuntary memory activation and are a commonly reported occurrence (Liikkanen, 2008).

Musical Imagery Repetition episodes can occur up to sixty years after the song was last heard and the chorus is the most likely part to become an earworm. Research by Bennett (2002) has provided some insight into melodies that become earworms. In order for a song to become an earworm, Bennett has suggested the 'Rule of Nine'

hypothesis; a song must be of average complexity, with the chorus repeated three times and the song heard three or more times. When science-content music has the ability to become 'stuck in the head,' it becomes a mnemonic device to enhance learning in the classroom. Farnsworth (as cited by Bennett, 2002) states that when music is used as a mnemonic device, it can facilitate learning.

Music and Mnemonics

Storr (1992) cites evidence from several researchers that songs, as a form of communication, most likely preceded verbal language in prehistoric man and music has been a powerful form of communication throughout history. "Preliterate societies relied on songs and poems to convey information, perhaps because the rhythmic structure that characterizes these forms of communication are easier to remember than is the verbal form that characterizes written speech" (Sloboda, cited in Clavert and Tart, 1993, p. 245). According to Storr (1992), "the mnemonic power of music is still evident in modern culture. Many of us remember the words of songs and poems more accurately than we can remember prose" (p.21). Belleza (1981) defines mnemonic devices as "learning strategies, which can often enhance the learning and later recall of information" (p.247). These memory aids cue recall of information using visual images, or words in the form of sentences and rhymes, and work by building associations within cognitive structures. Mnemonic strategies have been utilized for thousands of years to help learn speeches and other forms of prose. Bruning, Schraw, Norby and Ronning (2004) identify stories, rhymes and songs as specific mnemonic devices associated with visualization and language devices. According to Hodges (1982), songs and rhymes are "ready-made mnemonics" (p.27), suggesting both can be used in content areas to make recall of information easier.

Peterson, David and Thaut (2007) suggest, "music provides a helpful mnemonic for verbal learning throughout life and most notably during early development and in educational settings" (p. 217). In a study conducted by these researchers, subjects were asked to recall information presented either verbally or musically while brain activity was monitored using electroencephalogram (EEG) technology. Conclusions from the study indicate that the brain responds different to music, and that music and songs can be effective mnemonic devices for facilitating student engagement (Peterson, David & Thaut, 2007). Songs can be played at any point in the learning process and can be the focus of a lesson or used to supplement it to enhance and enrich learning (Wallace, 1994; Bennett, 2002; Jenson, 2005; Crowther, 2006).

Multiple Intelligences

There are differences in how each child's brain works, and in how people acquire and represent knowledge. To reach out to students with varying intelligences, teachers should "expand their repertoire of techniques, tools and strategies beyond the typical linguistic and logical ones predominantly used in U.S. classrooms" (Armstrong, 2000, p.38). Music, art, story and humor are but a few methods by which teachers can engage their students emotionally in the content being presented and provide multiple stimuli for encoding and recall of memories. In his ground-breaking book, *Frames of Mind* (1983), Gardner applied new understandings about brain function to develop a theory of human intelligence. Based on potentials and capacities inherent in biology and psychology (Gardner, 1999), eight different intelligences, or ways of solving problems and producing products, eventually emerged. The criteria for defining what is and is not considered an area of intelligence is related to evolutionary history, neuroscience, psychology, and "end-state" performances. The intelligences defined by Gardner currently include linguistic, logical-mathematical, spatial, interpersonal, intrapersonal, naturalist, bodily-kinesthetic and musical. Musical intelligence is but one of the eight identified human potentials but develops first in children. While not every child will be reached through music, there are connections that can be made through the use of music to other intelligences. Song lyrics involve linguistics in rhyme and analogies, rhythm and beat invite kinesthetic movement, and melodies provide a unique link between math and music in pattern and form (Armstrong, 2000; Gardner 1999).

Using science-content music in the classroom allows teachers to embed information in melodies for instruction. Additionally, to develop Musical Intelligence, students can be allowed opportunities to demonstrate learning by composing their own content-rich songs. In applying multiple intelligences theory to education, Gardner advises that there is no single instructional model advocated. Rather, multiple approaches to instruction should be developed for content area learning. Instruction based on this theory does not define a single teaching method, but establishes support for diverse learning styles, includes choice in assessment options and provides a significant role for the arts in meeting the needs of both students and teachers (Gardner, 1999).

Nature of Learning

Brain-based learning theory provided the theoretical framework for understanding how science-content music can be used for learning, but constructivism provides some insights into how songs are used to build knowledge. According to Kahveci & Ay (2008), there are several common elements shared by constructivism and brain-based learning theories. These approaches "have emerged out of two different fields but had commonalities in their implications for education" (p. 127). The principles that are shared by constructivism and brain-based learning include the importance of meaningful learning, recognition that there are individual differences in how people learn, there can be multiple representations in learning, personal and environmental factors affect learning and finally, affective components influence learning (Kahveci & Ay, 2008).

Brain-based learning "crosses and draws from multiple disciplines" (Jenson, 2008, p.4) encouraging multiple representations on which students can construct knowledge. Songs will resonate with some learners more than others, as there are differences in how children learn, a cornerstone of constructivist learning theory. Constructivism as a theory for building knowledge is based on the understanding that learning occurs through experience to make sense of the world. When students are exposed to new experiences, they integrate it with prior experience to build onto existing knowledge structures or to reconstruct them. According to Fox (2001) the tenets of constructivism are that learning is an active process of constructing knowledge; and while it is personal in nature, it is built through a social process in order to make sense of the world. Pellegrino, Chudowsky and Glaser (2001) discuss learning in terms of cognitive theory, which is based on constructivism in that it describes learning as an active process by which knowledge structures are built as students are exposed to new experiences and information. The role of prior knowledge is critically important in developing conceptual understandings. Cognitive learning theory is also connected to brain-based learning theory in that it describes how mental structures, or schema, are built through interactions of experience with memory and cognition. Pellegrino, Chudowsky and Glaser (2001) further indicate that student learning is considered to be constructed through the interpretation of and interaction with songs presented during teaching. Science-content music provided a novel learning experience, which students used to help construct new knowledge. Learning methods are always evolving and people are trying to find easier and better ways of teaching concepts to students and helping them to understand. Thus, learning music as in learning an instrument has a lot of benefits in developing the mind.

Costa and Kallick, 2000, states that "Engagement, persistence and creativity are components of higher-level thinking and complex problem solving". Therefore, imagine if it was used with theoretical concepts embedded as lyrics? Music alone promotes or exercises recall and retention of verbal information, which is excellent for memory? Ronald A Berk, with lots of research, has concluded that there are 20 potential outcomes if music is to be used to teach or learn, which are: Grab students attention; Focus students concentration; Generate interest; Create a sense of anticipation; Establish a positive atmosphere; Energize or relax students; Draw on students imagination; Build rapport among students; Improve students attitudes towards content and learning; Build a connection with other students and teacher; Increase memory of content/concepts; Facilitate the completion of repetitive tasks; Increase understanding; Foster creativity; Improve performance on tests and other measures; Motivate students; Make learning fun; Augment celebration of successes; Set an appropriate mood/tone; Decrease anxiety and tension on scary topics.

Summary of the literature review and uniqueness of this study

Music has been used as a device for learning and remembering information, it was even used in some countries as part of the curriculum, well music was a must to learn. This is because music, according to (Cunningham, Downie & Bainbridge, 2005) advances in neuroscience, encodes, stores and retrieves information, hence it became part a couple of curriculum around the world. Therefore, with this, the review shows that earlier research was only about research and there was no real-life system or application that made concepts lyrics, unlike in this study. All of these researchers have realized that music is a highly helpful tool when it comes to brain development. However, even though many of them have discovered the power of music with learning, there has not really been anyone to actually take the time to incorporate concepts and theory into music as lyrics. There are mostly cases of people trying to teach while a certain song is playing in the background, or they advise their students to study while listening to a specific song. As for musical imagery repetition which is previously heard music, with consciously unintended repeats uncontrollably and pervasively in thought, this is also why this study is being conducted because of the realization that music truly has a recall effect. Therefore, the uniqueness of this research is aimed at implementing a method of actually having the concepts explained in the form of lyrics with beats, hence the title "musication" with the outcome aimed at bringing more clarity.

Research Design and Methodology

Research Strategy and Approach

For this research paper, the quantitative research method is used because a prototype is made to investigate enhancing learning programming concepts. In quantifying such effect as well, a quantitative survey afterwards determine whether or not the students who participated were assisted with learning concepts and could also remember.

Functional Requirements

This system is will not replace any other learning method, but it will be an option for people who prefer or learn better when hearing a concept instead of reading.

-It should have an introduction of how the system works

-Have different types of categories of learning areas that one is interested in studying or learning/listen to.

System Development

The system is like a textbook, but summarized with the most important concepts one has to learn in that field, musically orchestrated, will be offline because it is optional. Simply, HTML and CSS will be used, as well as the use of Adobe Audition and Fruity Loops to form some new beats or to compose the concepts into proper and enjoyable music. As for the lyrics and music, Adobe After Effects will be used. Adobe Dreamweaver will be used for final touches.

Proposed System Architecture, development and implementation

The proposed system architecture is adapted from Satzinger (2016, p.200). There are 3 major layers given as follows: the view layer, the domain layer and the data layer. The view layer would contain the format screens and reports. These are real-time interactive flow of information between the user and the system. The domain layer contains the web application layer. This layer will implement the requests from the view layer and the corresponding results obtained from the data layer. The data layer is obviously the backbone of the system.

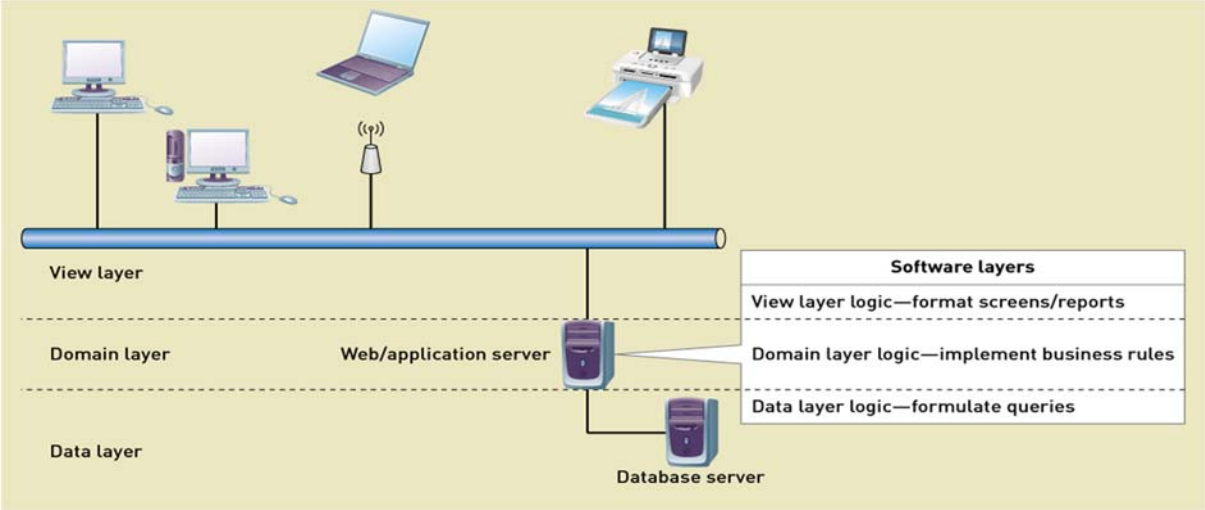

Fig. 1. Proposed 3-layer System Architecture adapted from Satzinger (2016, p.200).

In giving more details, the refined System Architecture is given in figure 2 below. Development of the actual prototype system to implement the system architecture proposed above is accomplished using various programming and database management platforms including Hypertext Markup Language (HTML), Java Servlets and Java Server Pages, PHP Hypertext processor, Microsoft's Active Server Pages (ASP), Database Management Systems (DBMS) such as Oracle, Microsoft Access, and MySQL.

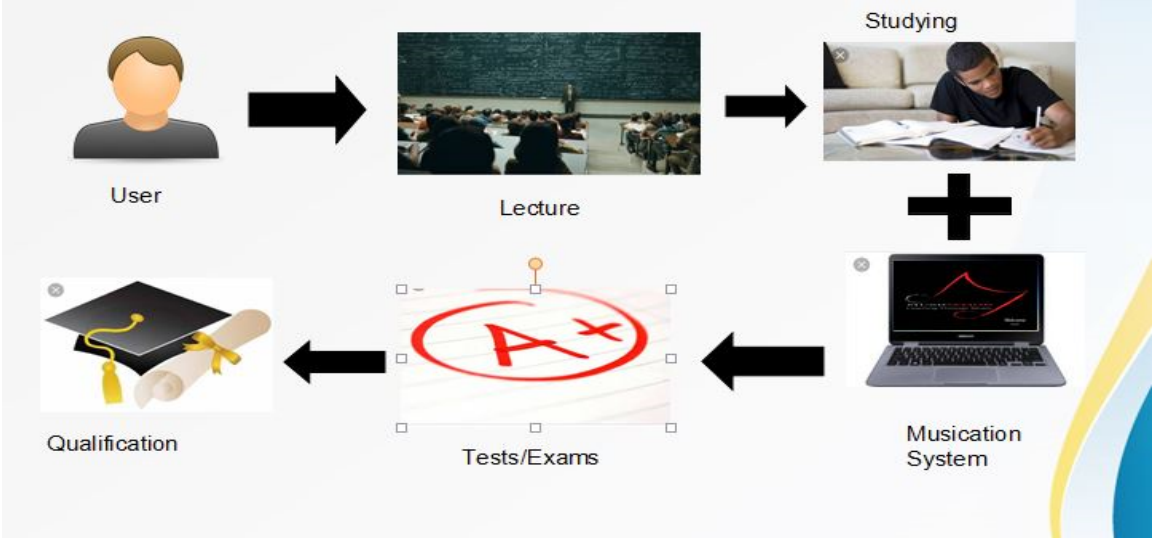

Figure 2. Refined System architecture of the Musication System

The system development of the actual artifact to implement the system is a magnificent effort on its own. This is based on the conceptual model that defines the structure, behavior and more views of how the application functions. Thus, the system development output are given below.

System Development Results

Introduction

This section shows the output of the developed system showing how the whole application works and what exactly it is that the user experiences when they use Musication. The output in figure 3 below is the version of Adobe After effects where the concept videos were developed. In this project window there was a lot of text, audio, recordings as well as images. The audio that was added were popular songs and they were cut, depending on how long the lyrics were. Figure 4 shows the final touches on Adobe Dreamweaver.

Adobe Dreamweaver Project output

This output displays how the final touches for the application were made. Adobe dreamweaver is a software in the creative cloud, after coding in HTML5 and CSS3. Here is where we made sure that the application will be able to run on all browsers and that they won't have to have internet access to do so.

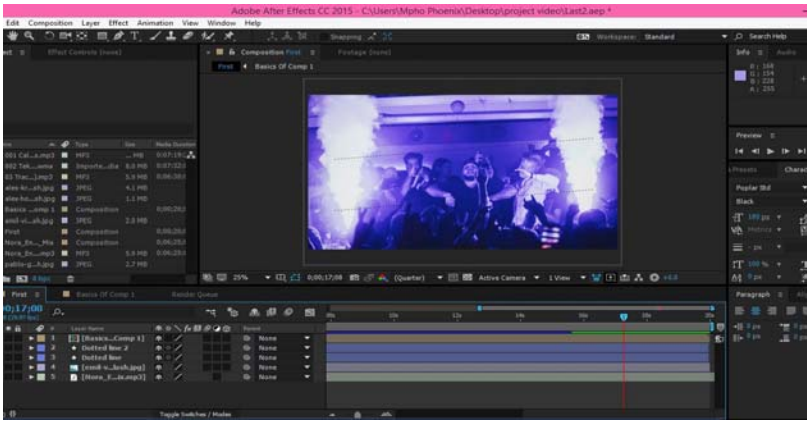

Figure 3. Video editing in after effects

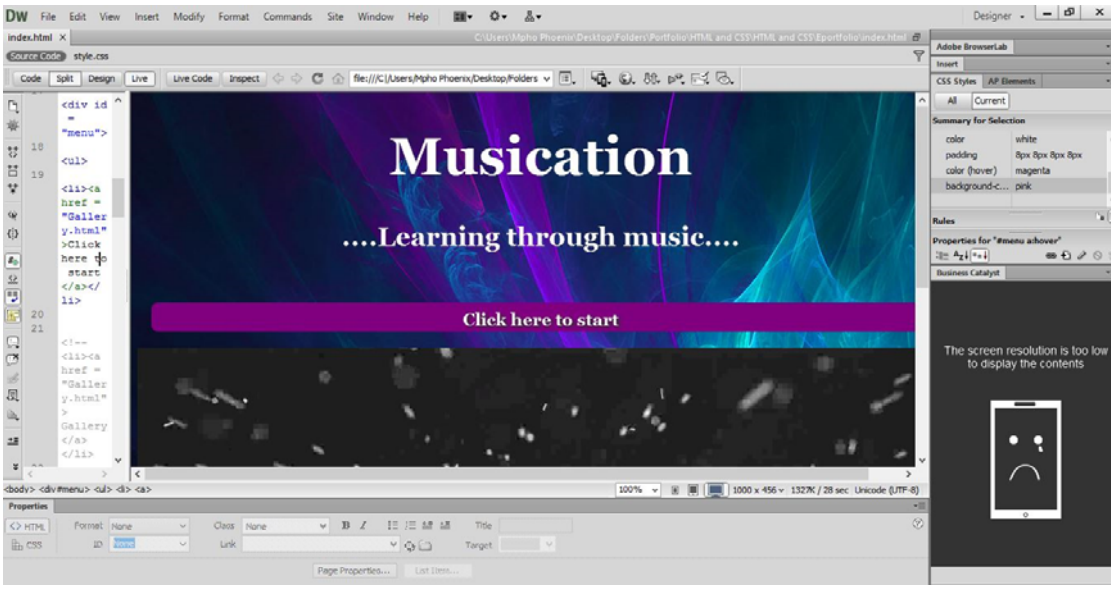

Figure 4. Final touches on Adobe Dreamweaver

Figure 5 below is an image of the home or landing page of the system. This page is basically the start of the whole system output. This page contains only the welcome video and the start button. This system was designed as simple as possible because it contains videos which take up a lot of space and because this is used on browsers, it needed to use the smallest files possible in order for it to function effectively and to not use too much Random Access Memory (RAM) as well as function on any and every computer.

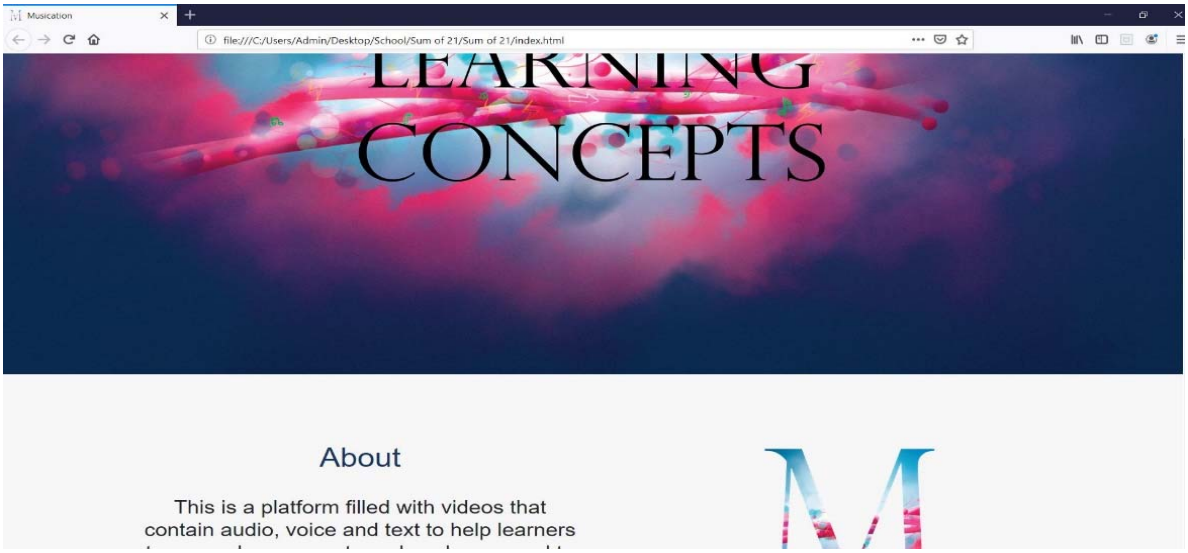

Figure 5. Welcome page of Musication

Figure 6 shows the concepts video page which contains different videos that you can choose from that contain the different topics or concepts that one is meant to learn and understand. The videos in this image that displays the videos can be accessed first on the home page by clicking “Click here to start”. The page contains mini videos of introductory chapters in the Information Technology course. It is the basics of the course and is very vital because the videos explain core concepts of I.T. such as the difference between hardware and software.

Figure 5. Concept videos

Subsequent output pages contain mini videos of introductory chapters highlighting some programming concepts presented as musical tips. These core concepts are presented below.

Some Programming concepts highlighted as musical tips

In addition to the videos explaining the core concepts of Information Technology, we include some programming concepts highlighted as musical tips. As one of the hallmarks of quantitative and positivist research is repeatability, it is important to note that anyone interested can use the concepts below and translate them into music lyrics in his or her own language, for the benefits of students learning programming, and with the ultimate goal of future sustainable development obtainable from system development in the society.

The programming concepts presented include a reinforcement of the basic language and structured programming concepts suitable for learning in the first year, which according to Dehinbo (2006) covers elementary topics such as data types, variables, operators, flow control, as well as modularization using functions. This is coupled with data manipulations such as data conversion, string and array manipulations. Inherent in this is the study of the lexical structure which is the set of basic rules that governs how one writes programs in any particular language (Dehinbo, 2006).

From the experiences portrayed by Dehinbo (2006) on various programming languages, and using the structures defined in various texts such as Lerdorf and Tatroe (2002, pp.1-20), the followings are considered very important and are incorporated into the lyrics of the musication system addressed in specific programming languages:

- How to form variable names: What are the reserved keywords that cannot be used as variable names? How long can a variable name be? What characters must begin a variable name and what other characters can be included?
- Case sensitivity: Are the reserved keywords or commands case sensitive? Are the variable names and user defined functions and classes case sensitive?
- Statement punctuations: What is used to end statements in various languages? For example, all C++ statements must end with " ; ".

- Are multiple statements allowed on a line? What is used to separate statements within such multiple statements? What symbol is used to mark compound statements? Do white-spaces matter or can you spread a statement across any number of lines?
- Comments: What are the comment-styles used?

Furthermore, understanding the various *data types* is very important in developing applications. Therefore, listening to the musication system, concepts incorporated into the lyrics of the system addressed in specific programming languages would expose students to various *data types* issues:

- Primitive data types: Are primitive *data types* such as Integers, Floating point numbers, Strings, Booleans and Arrays supported? Are there various functions for manipulating Strings and Arrays?
- Complex data types: Are other complex *data types* such as classes and references supported?
- What other peculiar *data types* are supported?
- Is variant data type supported so that a variable can be assigned values of different types?
- Can you mix *data types* in an expression?

Knowledge of **Expressions and operators** is also incorporated as the followings are considered to be relevant:

- How are simple and complex expressions formed?
- Operators allowed: What are the symbols used for arithmetic, logical and relational operators?
- Operator precedence: What is the order in which operators in an expression are evaluated?
- Casting: How is the conversion of a value from one type to another done?

Dehinbo (2006) also observes that the fact that Java is *strongly typed* implies that variable declaration associates an identifier name with a type. Such an identifier cannot accept new type (Van Hoff, 1997; Wigglesworth, 2000, p.64). Therefore, there can be no integer overflow. If one specifies a number beyond the bounds of the integer type, it will not be interpreted as a float. Conversely, the weak typing in ASP and PHP allows for overflow. Lerdorf and Tatroe (2002, p.24) state that attempts to store a "too-large" integer variable will lead to storage of a floating point number. This feature in ASP and PHP is useful for beginner students and thus incorporated into the lyrics.

Again, the fact that Java is *strongly typed* implies that one cannot mix *data types* in an expression (Wigglesworth, 2000, p.64). A float cannot be added to an integer without loss of precision. This is possible in ASP and PHP due to their *variant data type*.

To address the overflow problem above, the data range in most of the platforms is very high, with acceptable integers being as high as 2,147,483,647 (Lerdorf & Tatroe, 2002, p.24; Wigglesworth, 2000, p.110), except for ASP whose integer type is limited to 32767. It however uses *long integer type* to store up to 2,147,483,647 (Deitel *et al*., 2001, p.731). This high limit for integers will reduce the situations of overflows in students' programs and thus considered to be relevant and incorporated into the lyrics.

Similarly, the limit for the size of *Strings* is very high in all the platforms. No limit is specified for *Strings* in major textbooks for the Java-based platforms. In ASP, *Strings* can take up to 2,000,000,000 characters (Deitel *et al*., 2001, p.731). In the use of PHP, Bakken *et al.* (2002, p.12) state that there is no practical bound to the size of *Strings*, so a very long *String* does not present a problem.

The use of arrays is very important in programming. Yet a common source of error is to use the wrong parenthesis for specifying the subscript. This is common particularly among those who have used another platform that uses a different parenthesis. To overcome this problem, PHP, unlike other platforms evaluated, allows the use of both the "( )" as well as the "[]" (Lerdorf & Tatroe, 2002, p.118).

Despite the importance of array processing, the author observes that a limitation in most programming languages is that one has to traverse the array elements sequentially. PHP, unlike other platforms evaluated, provides various functions for traversing or iterating the array elements. These functions, according to Lerdorf and Tatroe (2002, p.126) include *current(), reset(), next(), prev(), end(), each()* and *key().*

The above are incorporated into the musication system both as explanation of concepts and as tips to watch out for. It is expected that such will lead to effective learning for the benefits of students learning programming, and with the ultimate goal of future sustainable development obtainable from computerization and system development in the society.

Survey results for usability and evaluation

This section is about the results of the survey given to the students to determine whether or not the application given to them really helped improve their learning and what do they think of the overall application. However, due to space limitations, the usability and evaluation survey will not be presented in this study but would possibly be presented as another future article.

Conclusions

A conclusion can be regarded as a reasoned judgment after research and making a final say of what is one's point of view after all has been acquired. This section contains subheadings of a conclusion such as the followings: answers to pertinent questions, suggestions for further research, recommendations and implications as well as the final conclusion of everything.

Answers to pertinent questions

The research questions were answered with the use of a prototype system development as well as a survey. Though the results or findings from the survey on the impact of the prototype is not presented here, interested readers can implement the study using the concepts presented and translated into lyrics in their own language, and then conduct a survey with questions to be able to establish the impact of the prototype system on learning. Other pertinent questions and answers are presented next.

- **In what way was music used to enhance instruction and learning in a classroom or lecture room?**

The development of the "musication" prototype application system incorporates music beats and lyrics containing explanation of programming concepts as tips to watch out for while learning programming in specific language. It is expected that such will lead to effective learning for the benefits of students learning programming. The idea is that music can be used to enhance instruction and learning because it is fun and intriguing, rather than using the old traditional way of learning or the basic way of learning.

- **How can the use of music as a learning method impact a student's interest, enhancement and understanding of concepts?**

It was found that music can be used as a tool to enhance student's interests by using music that they like, which was what was done in this application. Music such as "kwaito varieties" common in South Africa were used with lyrics of concepts that the students had to know which made it easier for them to grasp concepts while listening to their some of their favourite songs.

- **How can a system or application be developed with music be used to help programmers to understand latest programming concepts and be able to effectively apply them in the work place?**

The organizational culture in every organization or society could determine the type of music enjoyed by such group of people. A prototype system can then be developed using the type of music but incorporating lyrics highlighting relevant latest programming concepts in the programming environment in the workplace.

Suggestions for further research

As for further research, suggestions are from the results of this study is that it should be implemented and conducted for a larger number of participants, as well as a number of different races and ethnic groups. Statistics are usually successful if conducted over a wider audience, to be able to establish whether or not the findings can be generalized across different learning styles. This research is mainly targeted at actualizing the old statement that "repetition is the power of learning" and if this is combined with preferred beats and lyrics, learning can be enhanced because so far, music's repetitive nature has been proven to be magnificent for memory recall as essential for learning codified knowledge.

Recommendations and Implications

As much as lecturers and students are concerned, learning strategies are often employed based on experience and instinct. Exploring the experiences of students and lecturers when concept music is used for learning could help

identify the pedagogical implications for this learning strategy. The assertions developed could have some implications for classroom instruction and the education community at large. The results also suggest recommendations for further research.

In terms of implications for classroom instruction, it is noted from literature that songs have been used for learning across all cultures in the past, yet today they are easily dismissed as an instructional tool. The results of this study suggest that the use of music has potential for learning outcomes that are more complex and versatile than one might initially suspect. During the course of the study, it was established that, for the lecturers and students who participated in this research, songs worked by engaging students, building vocabulary, supplying students with alternative examples and explanations of concepts, helping them to remember concepts in their field, and providing a conceptual scaffold for developing emerging concepts.

Educators have always sought new ways to engage students. Further studies should continually find new ways to involve and interest students in learning with a high level of engagement as when music was used as a learning tool. Music, like learning, is socio-cultural in nature and speaks to students in ways other strategies cannot. The social aspects of learning with music present only one caveat: greater engagement requires that either lecturers or strong student leaders must appear to be involved and having fun in order for some students to "buy-in" to the activity. Otherwise, while students may still have higher levels of engagement with music, they may find it embarrassing to be seen participating in such an exercise. However, music does have a broad social and cultural appeal that in the words of one student, it is "worth exploring".

Final note

The purpose of this study was to explore the experiences of students when music was used as a strategy in the varsity lecture room. Insights about teaching and learning with music were sought to explain concepts. As a lecturing resource, songs are more than a mnemonic device; they engage students in novel ways and help build conceptual understanding as a sense-making activity. A great deal of the research presented to frame this study was based on brain-based or cognitive learning theory, as most of the literature related to using music for learning were developed from that perspective. However, in the course of summarizing the results of this study, most of the findings suggested that content-based music helped students build a conceptual understanding of concepts based on socio-cultural and constructivist learning models as well. The assertions presented here suggest that there is more to learning science with songs than simply understanding how music is processed in the brain. Music has implications for instruction from different learning theories, suggesting that it can effectively be used for conceptual development when implemented in a sense-making context. The premise for this study came from experiences as a student, struggling to remember concepts while knowing that concepts embedded in music should be useful for instruction at different levels of learning, and have the potential to enhance students' understanding of concepts in different ways. Ultimately, a learning community and society at large has been shown as critical for developments in the society. And give the importance of system development in this generation, it is expected that future generations can continuously be partakes of sustainable development.

References

[1] Anderson, D.R., & Levin, S.R. (1976). Young children's attention to Sesame Street. *Child Development, 47*, 806-811.

[2] Armstrong, Thomas (2000). *Multiple intelligences in the classroom (2nd ed.).*Alexandria, VA: Assoc. for Supervision & Curriculum Development.

[3] Bakken, S.S. *et al.* (2002). *PHP Manual*: *Language reference* [Online]. Available from: http://www.php.net/docs.php [Accessed: 02/02/2003

[4] Bellezza, F. S. (1981). Mnemonic devices: Classification, characteristics, and criteria. *Review of Educational Research, 51*(2), 247–275. https://doi.org/10.3102/00346543051002247

[5] Bennett, Sean. (2002). *Musical Imagery Repetition* (Masters Thesis, Cambridge University, 2002). Retrieved from http://www.seanbennett.net/music/essays.html 2/21/2009

[6] Brahmaviharidas, S. (2010). *Amazing science part 3.* Understanding Hinduism.on-line by author. Retrieved from: http://www.hinduism.co.za/amazing.htm. Accessed [June 28, 2019].

[7] Brown, M. Leann. "Sustainable Development." *Oxford Research Encyclopedia of International Studies.* 22 Dec. 2017; Accessed 16 Sep. 2022. [Online]. Available at: https://oxfordre.com/internationalstudies/view/10.1093/acrefore/9780190846626.001.0001/acrefore-9780190846626-e-305.

[8] Bruning, R.H., Schraaw, G.J., Norby, M.M., & Ronning, R.R. (2004). *Cognitive psychology and instruction* (4th ed.). Englewood Cliffs, NJ: Prentice-Hall.
[9] Caine, G., & Caine, R. N. (2001). *The brain, education and the competitive edge.*Lanham, MD: Scarecrow Press.
[10] Calvert, S.L., & Tart, M. (1993). Song versus prose forms for students' very long-term,long-term and short-term verbatim recall. *Journal of Applied Developmental Psychology, 14*, 245-260.
[11] Costa, A. L., & Kallick, B. (2000). Getting in the habit of reflection. Educational Leadership, 57, 60-62.
[12] Crowther, Greg (2006). Learning to the beat of a different drum; Music as a component of classroom diversity. *Connect, 19*(4), *11-13*.
[13] Cunningham, S.J., Downie, J.S., and Bainbridge, D. (2005). Working paper. *"The Pain,The Pain:"* Modeling music information behavior and the songs we hate. Univ. of Waikato (New Zealand). Retrieved 2/22/209 from http://ismir2005.ismir.net/proceedings/2124.pdf
[14] Dehinbo, J. (2006). Towards a framework for determining suitable platform for teaching Web application Development in tertiary institutions in South Africa. MSc Dissertation submitted to the School of Computing, University of South Africa (UNISA), July 2006.
[15] Deitel, H.M. et al. (2001). e-Business & e-Commerce: How to program. USA. Prentice Hall
[16] Dirks, Arthur L. (1996). Organization of knowledge: The emergence of academic specialty in America. Published on-line by author. Retrieved from: http://webhost.bridgew.edu/adirks/ald/papers/orgknow.htm. Accessed [June 28,2010].
[17] Edwards, N. (Ed). (1935). Colonel Parker's Experiment in the Common Schools of Quincy, Massachusetts. *The Elementary School Journal, 35*(7), 495-504.
[18] Gardner, Howard (1993). *Frames of mind, the Theory of multiple intelligences.* New York, NY: Basic Books (Perseus Books Group).
[19] Gardner, Howard (1999). *Intelligence reframed; Multiple intelligences for the 21st Century.* New York, NY: Basic Books (Perseus Books Group).
[20] Gustafson, R. (1958). He uses folk songs to teach history - Two "musts" in reading aloud. *The Christian Science Monitor*. pp. 13.
[21] Helmrich, B. H. (2010). Window of Opportunity? Adolescence, Music, and Algebra. *Journal of Adolescent Research*, *25*(4), 557–577. https://doi.org/10.1177/0743558410366594
[22] Jensen, Eric (2005). *Top tunes for teaching, 977 song titles and practical tools for choosing the right music every time.* Thousand Oaks, CA: Corwin Press.
[23] Jensen, Eric (Ed.). (2008). Brain-based learning, *The new paradigm of teaching (2nd ed.).* Thousand Oaks, CA: Corwin Press.
[24] Jourdain, Robert (1997). *Music, the brain and ecstasy; How music captures our imagination.* New York, NY: Harper Press.
[25] Kahveci, A. & Ay, S. (2008). Different approaches, common implications: Brain-based and constructivist learning from a paradigms and integral model perspective. *Turkish Science Education, 5*(3), 124-129.
[26] Kori, K., Pedaste, M., Leijen, A. & Tõnisson , E. (2016). The Role of Programming Experience in ICT Students' Learning Motivation and Academic Achievement, *International Journal of Information and Education Technology*, Vol. 6, No. 5, May 2016.
[27] Lerdorf, R. & Tatroe, K. 2002. *Programming PHP.* Sebastopol, Calif.: O'Reilly & Associates Inc.
[28] Levitin, Daniel J. (2006). *This is your brain on music; the science of human obsession.* New York, NY: Penguin Books.
[29] Liikkanen, Lassi A. (2008). *Commonality of Involuntary Musical Imagery.* Paper presented at the 10th International Conference on Music Perception and Cognition, Sapporo, Japan
[30] Malapela, M., Mabunda, B. & Dehinbo. J. (2022). Enhancing Sustainable Development in Developing Countries with In-house Development of an Interactive Video Platform for Learning Programming Concepts. OIDA International Journal of Sustainable Development. Volume 15, Issue 08, pp. 11-28, 2022. ISSN: 1923:6654 (print) and ISSN: 1923:6662 (online). Journal issue & abstract available on: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4381700 and https://oidaijsd.com/?page_id=2730 Full-text retrieved 8 March 2023 from: https://oidaijsd.com/wp-content/uploads/2023/03/1-029-Mashadi-Malapela.pdf
[31] Mansell, R. and Wehn, U., eds. (1998) Knowledge societies: information technology for sustainable development. Oxford University Press, Oxford, UK. ISBN 9780198294108. [Online]. Available in LSE Research Online: August 2018. http://eprints.lse.ac.uk/24875/
[32] O'Connor J.J., & Robertson, E.F. (1999). *Pythagoras of Samos*. Published by JOC/EFR. Retrieved from: http://www-history.mcs.stand.ac.uk/Biographies/Pythagoras.html. Accessed [June 28, 2010].

[33] Parker, F.W., Cooks, F.J., Stilwell, K.M. (1901). Lectures and lessons upon the philosophy of education. *The Elementary School Teacher and the Course of Study, 2*(1), 1-27.
[34] Pellegrino, J. W., Chudowsky, N., & Glaser, R. (2001). Knowing what students know: The science and design of educational assessment. Washington, DC: National Academy Press.

[35] Peterson, David, & Thault, Michael (2007). Music increases frontal EEG coherence during verbal learning. *Neuroscience Letters,* 412, pp. 217-221, Retrieved February 15, 2009, from http://www.sciencedirect.com.
[36] Satzinger, J W., Jackson, R. B. & Burd, S.D. (2016). Systems Analysis and Design in a Changing World, 7th Edition. eText ISBN: 978130545268. Boston: Cengage Learning.
[37] Sheppard, T. (Ed). (2009). *Traditional storytelling.* Published online by the author. Retrieved from: http://www.timsheppard.co.uk/story/dir/traditions/index.html. Accessed [June 29, 2010]
[38] Shiraishi, F. (1995). Music education at the Dewey school 1896-1904. *The Bulletin of Historical Research in Music Education,17*(1), 1-18.
[39] Sousa, David A. (2006). *How the brain learns* (3rd ed.). Thousand Oaks, CA: CorwinPress
[40] Stake, R.E. (2006). *Multiple Case Studies Analysis.* New York, NY: Guilford Press
[41] Storr, Anthony (1992). *Music and the mind.* New York, NY: Ballantine Books. They Might Be Giants (2009). *Here Comes Science* [CD]. Los Angeles, CA. Disney Sound
[42] Van Hoff, A. 1997. The case for Java as programming language. *IEEE Internet Computing*. **17** (1) 51-56.
[43] Wallace, Wanda T. (1994).Memory for music: Effect of melody on recall of text. *Journal of Experimental Psychology: Learning, Memory and Cognition*, *20*, 1471-1485.
[44] Watson, F. (1908). *The English grammar schools to 1660: Their curriculum and practice.* Cambridge Univ. Press, England
[45] Wigglesworth, J. & Lumby, P. 2000. *Java programming: advanced topics*. Cambridge: Thomson Learning.
[46] Wilson, B., Gary, C. & Greene, G. (1988). Music in our schools: The first 150 years.. *Music Educators Journal. 74*(6), 25-101.
[47] Yin, R.K. (2009). *Case study research; Design and methods (4th Ed).* Thousand Oaks, CA.: Sage Publications

About the authors:

Name: Mpho Lengoasa

Brief description about affiliation and work.

Mpho Lengoasa obtained the National Diploma in Web application Development from Tshwane University of Technology, Soshanguve, (previously named Technikon Northern Gauteng), and B.Tech.. degree in Web application Development also from Tshwane University of Technology, Soshanguve. Her area of research interests includes web-based application development, software engineering, e-learning, e-commerce and software utilization for positive societal impact etc. with their impact on educational systems and on the society.

Mailing address: Department of Computer Science, Faculty of Information and Communications Technology, Tshwane University of Technology, Soshanguve, 0152, Tshwane, South Africa.

Tel: +27-12-382-9000

Fax

e-mail : Lengoasa.mpho2@gmail.com

Name: Johnson Dehinbo

Brief description about affiliation and work.

Johnson Dehinbo is currently a senior lecturer in the Department of Computer Science, Faculty of Information and Communications Technology, Tshwane University of Technology, Soshanguve, Pretoria, South Africa. Mr Dehinbo joined the university (previously named Technikon Northern Gauteng) as a lecturer in 1997. Mr Dehinbo has previously worked as a Computer Programmer/Analyst at the International Institute of Tropical Agriculture, Ibadan, Nigeria from 1991 to 1996, and as a Graduate Assistant at the Ogun State University, Ago-Iwoye, Nigeria from 1990 to 1991 and Federal University of Technology, Yola, Nigeria from 1989 to 1990.

He obtained B.Sc. degree in Computer Science & Statistics from Ogun State University, Ago-Iwoye, Nigeria in 1989, and B.Sc. Honours degree in Information Systems from University of South Africa (UNISA) in 2000. He then obtained two Masters' degree namely, an M.Sc. degree in Information Systems from UNISA in 2006 and also an M.Phil. Informatics degree from the University of Pretoria (UP) in 2011. He is currently busy with his doctoral studies.

His area of research interests includes Information systems and web-based application development, software engineering, e-learning, e-commerce and their impact on educational systems and on the society. He is currently lecturing the following courses or subjects such as: Web Applications development with ASP.NET using C# and VB; Web Applications development using PHP, Java servlet and Java Server Pages (JSP); Developing Client-Server Applications using Borland C++ Builder; Graphical User Interface Design, Development and Implementation; Research Methodology & Research Project 4; Client applications using HTML5, Cascading Style Sheets (CSS) and Javascript as well mathematical subjects like Discrete structures.

Mailing address: Department of Computer Science, Faculty of Information and Communications Technology, Tshwane University of Technology, Soshanguve, 0152, Tshwane, South Africa.

Tel: +27-12-382-9219

e-mail : Dehinbooj@tut.ac.za