American Journal of Engineering Research (AJER)
e-ISSN: 2320-0847 p-ISSN : 2320-0936
Volume-7, Issue-8, pp-200-209
www.ajer.org
Research Paper Open Access

Application Of Artificial Neural Networks Modeling For Self-Assessment Performance Evaluation Regarding Blended Learning Paradigm (Brain Based Approach)

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ABSTRACT
Recently, the integration of Information and Communication Technology ICT in the field of education has led to emerging of the term e-learning at educational field practice. Subsequently, the applications of this technology into interactive teaching/learning process have resulted in identification of some pitfalls. Through the study to overcome such pitfalls Blended Learning has been revealed to be as an optimal trend for future educational field practice.
This paper introduces an interdisciplinary study adopting Artificial Neural network (ANN) modeling as a relevant fairly realistic tool which originated from brain based learning approach while evaluating Blended Learning Performance. More specifically, comparative findings of learner's self-assessment scores have been investigated regarding the postulates that associated learners' different brain dominance with individual differences and learning styles. The introduced comparison characterized by measurement of different behavioral self-assessment performance during interactive subjection of learners to blended learning educational environment. In more details, this work considered (during measurement of learners' Self-assessment scores) Self Organized Learning Environment (SOLE) which results in statistical analysis of two diverse educational groups at vocational high school students. Namely, experimental and control groups representing blended e-learning and traditional learning respectively. Interestingly, presented comparison considered the analogy of Self-assessment learners' scores blended learning performance versus some design parameters of ANN. Finally, this study illustrates that blended learning most properly be an efficient approach of distance learning in terms of students' learning experience student / student interaction as well as student / instructor interaction and is likely to emerge as the predominant education model in the future. Conclusively, obtained simulation results shown to be in agreement with some recently obtained findings at educational field practice specifically at vocational high school.
KEYWORDS: *Blended e-learning; Self-assessment scores; Brain based learning; Artificial Neural Networks; learning performance.*

Date of Submission: 31-07-2018 Date of acceptance: 15-08-2018

I. INTRODUCTION

The field of the learning sciences is represented by a growing community internationally. In other words, rapid growth in the use of learning technologies, particularly the use of the ICT have offered educators with many more opportunities to investigate the most suitable learning environments for their students' learning styles. Currently, many educational experts have recognized now that conventional ways of conceiving learning including (e-learning technology) are facing increasing challenges in this time of rapid Technological, and social changes. Recently, that increasing challenges have adopted a novel trend which supported by what had been announced last decade (1990- 2000) (in U.S.A.) that called as Decade of the brain as announcement in 1989 WHITE HOUSE REPORT [OSTP, 1989]. Over the past quarter century, there has been much concern about the state of science, technology, engineering, and mathematics (STEM) education in U.S. schools and its effect on the future of U.S. competitiveness in a global educational field marketplace [STEM Education, 2010]. In the

context of recently adopted modified educational trend , classrooms have filled with a generation of learners seeking to interact with their course materials in an increasingly experiential way, the demand for instructional technology as a supplement to, or replacement for, traditional in-class instruction has soared as announced by [Keengwe, 2014]. This piece of research is motivated by the announcement of Decade of the brain [OSTP, 1989]. It aims to present an interdisciplinary solid comparative analytical study via computer simulation of Self Organized Learning Environment (SOLE) [wikihow.com] using realistic self-organized ANN modelling. More precisely, it essentially relies upon Brain-based learning referring to the latest scientific research about how the brain learns [edglossary.org, 2013], [Hassan, 2012]. Specifically, this work aims to illustrate the two different measured Self-assessment learners' scores of experimental group (after application of blended Learning strategy) versus that measured scores for learners in a control group class (traditional learning) [Chang, 2014].

In the context of ANN modelling, overwhelming majority of neuroscientists as well as educationalists have adopted the concept which suggests that huge number of neurons in addition to their synaptic interconnections constituting the central nervous system with its synaptic connectivity performing dominant roles for learning processes in mammals besides using neural networks for modelling human learning [Douglas, 1991] [Borzenko, 2009][Hardman, 2010]. Development of neural network technology is originally motivated by the strong desire to implement systems contributing tasks similar to human brain performance [Tsien, 2000][Tsien, 2001][Hassan, 2012]. Basically such systems are characterized by their smartness and capability to perform intelligent tasks resembling that of human [Kandel, 1979]. Objectively, after a completing of training of well-designed neural system models it is expected to respond correctly (in smart manner) and spontaneously towards input external stimuli [Ghonaimy, 1994]. Additionally, recent biological experimental findings have come to interesting results for evaluation of intelligent brain functions (Learning and memory) [Douglas, 1991] [Hassan, 2012] [Kandel, 1979].However, about quarter of a century ago, in practical neuroscience experimental work carried out by many biologists declared results that even small systems of neurons are capable of forms of learning and memory [Kandel, 1979][Douglas, 1991]. Recently, the relation between number of neurons and information-processing capacity; and efficiency at hippocampus brain area of mice is published at [Hassan, 2008]. You learn, you're causing certain neurons to fire over and over again. This repeated firing causes your synapses to change. They become more sensitive to neurotransmitters and become stronger. These changes last from days to years. This process underlies learning and memory from a cellular neuroscience perspective, learning and memory is considered as the same thing. Moreover, about both learning and memory features are tightly coupled to each other and they have well resemblance to human brain functionally in two ways:

1- Acquiring knowledge and experience through training/learning through adaptive weights neurodynamic.
2- Strong memorizing of acquired knowledge /stored experience within interconnectivities of neuronal synaptic weights.

Accordingly, adopting of neural network modeling seems to be very relevant tool to perform simulation of educational activity phenomena. To implement realistically some simulated educational activities we should follow the advice that such models needed to be with close resemblance to biological neural systems. That resemblance ought to be not only from structural analysis but also from functional characterization. In other words, understanding learning / training process carried out by ANN is highly recommended for increasing efficiency and effectiveness of any simulated educational activity. The statistical nature of training / learning time of convergence for a collection group (of ANN models) observed to be nearly Gaussian. This simulates a group of students under supervised learning. Additionally, the parameters of such Gaussian distribution (mean and variance) shown to be influenced by brain states of student groups as well as educational instrumental means. The well application of educational instrumentation during proceeding of learning / training processes improves the quality of learning performance (learning rate factor). Such improvements are obtained in two folds. By better neurodynamic response of synaptic weights and by maximizing signal to noise ratio of input external learning data (input stimuli). So, any assigned learning output level is accomplished if and only if connectivity pattern dynamics (inside learner's brain) reaches a stable convergence state. i.e. following Hebbian learning rule [Haykin S., 1999], connectivity vector pattern associated to biological neuronal network performs coincidence detection to input stimulating vector. The rest of this paper is organized as follows. At the next section, the motivations of this research are presented. Generalized model of interactive blended learning is introduced at the third section. At the fourth section simulation results are presented. Finally, some conclusive comments are given at the end of this paper.

II. RESEARCH MOTIVATIONS

This research work has systematically two motivations which are briefly given by discussing two interrelated critical questions at the two next subsections A, and B, as follows.

A. How Learning Performed Inside Human Brain?

Most pictures of the brain show only the tissue visible on the surface—the deeply fissured and folded gray matter called the cortex. The complex organization and unique structure of this tissue gives it a central role in learning. Cortical tissue features astonishing connectivity: The approximately 1 trillion neurons in the cortex are linked by approximately 10 trillion connections, creating an incredibly dense network. [Carl Zimmer, 2011]. Similar to a telephone or computer network, these multifaceted connections help individual parts of the brain communicate flexibly and along multiple pathways, regardless of whether they are close to each other or on opposite sides of the brain. [David H. Rose, 2002].Within this large network, many smaller networks are specialized for performing particular kinds of processing and managing particular learning tasks. Three primary networks, structurally and functionally distinguishable but closely connected and functioning together, are equally essential to learning. We identify these networks by terms that reflect their functions: the recognition, strategic, and affective networks. The activities of these networks parallel the three prerequisites for learning described by the Russian psychologist [Lev Vygotsky, 1962]: recognition of the information to be learned; application of strategies to process that information; and engagement with the learning task.

B. What Does The Brain Have To Do With **Learning Process?**

Referring to (Ned Herrmann, 2014) what does the Brain Have to Do with It? “The brain is involved in all aspects of the learning process. It is the single bodily organ that is the central processor of all learning activities.” Blended learning is a blending of different learning methods, techniques and resources and applying them in an interactively meaningful learning environment. Interestingly, it is announced therein: ultimate aim of blended learning being to provide realistic practical opportunities for learners and teachers to make learning independent, useful, sustainable and ever growing. Current research shows that in order to achieve good blended learning results, there are three essential questions to answer when building a blended learning educational process as follows:

1. Learners: What is the best method for the target audience?
2. Learning Design: What is the best instructional model and delivery method for the content?
3. Learning Environment: What is the best method to meet your organizational constraints and requirements?

Referring to the paper [Ned Herrmann, 2014] therein, it focused to explore three specific ways you can more effectively:

.

- Find ways to engage the learner’s brain as much as possible when using a blended approach
- Look for ways to make blended learning designs as Whole Brained as possible by better understanding the implications of choices that are made when the specific ingredients of the blended “recipe” are decided on.
- Understand the impact of the learning environment challenges we all face.

III. MODELING OF INTERACTIVE BLENDED LEARNING (GENERALIZED APPROACH)

This section presents a novel approach proposed for learner's brain modeling in order to deduce the postulates individual learner's differences associated with their brain dominance. The presented deduction process based upon investigation of different implicit behavioral interaction of learners' brain dominance [1]. Learners' simulation of scores' assessment in blended learning system is given at the two subsequent subsections (A&B). Noting that presented simulation of individual learners' brain dominance concerned with behavioral interaction in accordance with predefined (desired) patterns. The aim of this section is to investigate realistically the advantages of blended learning over face to face instruction through ANN modeling and recently published results concerned with Self-assessment learners' scores [Chang, 2014].

Respectively, at subsection A, a realistic presentation of interactive simulation for learning scores' assessment which based on adaptable ANN model is introduced. Additionally, the mathematical formulation of natural brain learning dominance phenomenon is presented at subsection B which motivated by one recently published paper [Hassan, 2012]. Furthermore, it is worthy to notice that learning scores' assessment could be performed via either strategies active learning, or individual learning. In the ANN context, learning strategies are relatively corresponding to either teacher supervision, or unsupervised self-assessment (autonomous) learner's scores. Both are following mathematical formulations given at subsection B in below, that to converge towards predefined (desired) patterns.

A. An Overview of Interactive Blended Learning Environmental Model

Let’s start with a definition (Wikipedia) [Ann Herrmann-Nehdi, CEO Herrmann International, 2014]:"Blended learning is a blending of different learning methods, techniques and resources and applying them in an interactively meaningful learning environment". Blended learning environment integrates the advantages of e-learning method with some advantageous aspects of traditional method, such as face-to-face interaction. Blended learning brings traditional physical classes with elements of virtual education together

(Finn & Bucceri, 2004). As Brown (2003) stated that blended learning supports all the benefits of e-learning including cost reductions, time efficiency and location convenience for the learner as well as the essential one-on-one personal understanding and motivation that face to face instructions presents. There have been many other definitions of blended learning put forward in the literature. Simply put, Singh & Reed (2001) defined blended learning as a learning program where more than one delivery mode is being used with the objective of optimizing the learning outcome and cost of program delivery. Therefore, Singh (2003) proposed to refine this definition as "blended learning focuses on optimizing achievement of learning objectives by applying the "right" personal learning technologies to watch the "right" personal learning style to transfer the "right" skills to the "right" person at the "right" time. Definition of blended learning i.e. "a hybrid of traditional face-to- face and online learning so that instruction occurs both in the classroom and online, and where the online component becomes a natural extension of traditional classroom learning" (Rovai & Jordan, 2004, p.3). The philosophy of blended learning is based on utilizing information technology applications in the design of new learning situations that combine both classroom and online teaching (Graff, 2003; Smith and Rademacker, 1999). In addition, blended learning philosophy is to simulate active learning, individual learning and learner centered learning strategy. Blended learning has a positive influence on the learning process as it is characterized with some advantages such as flexibility in both time and place of the study. More precisely, blended learning environment integrates the advantages of e-learning method with some advantageous aspects of traditional method, such as face-to-face interaction. Blended learning brings traditional physical classes with elements of virtual education together [Finn & Bucceri, 2004]**.**

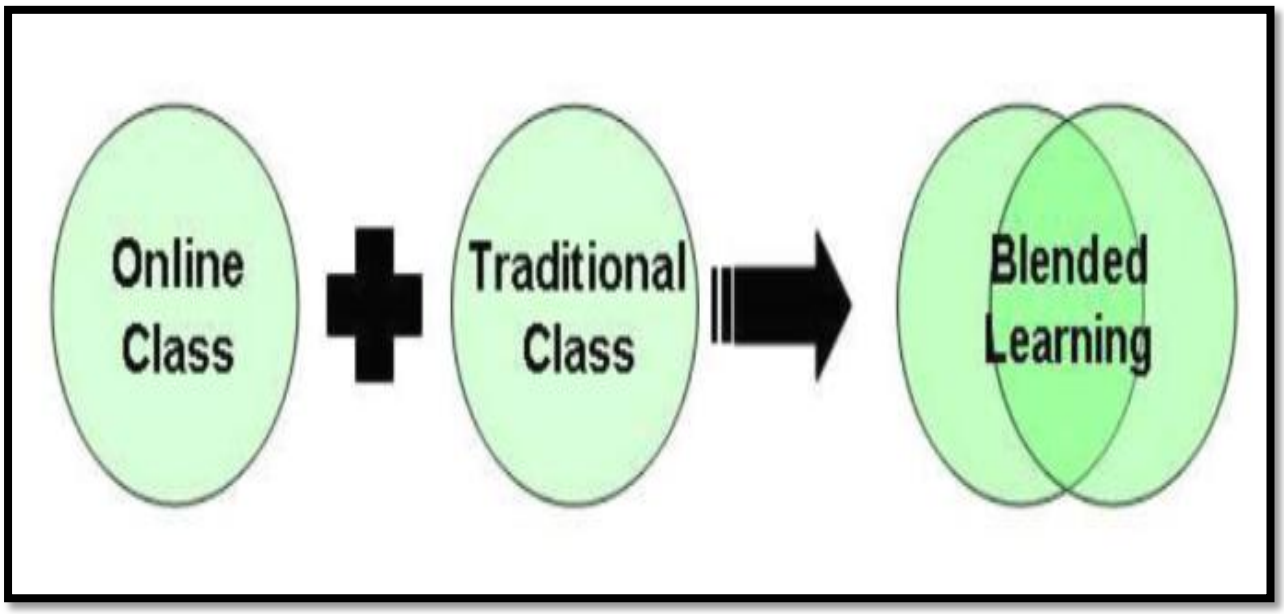

Figure 1 A Schematic Drawing for Blended Learning Environment (Adapted From [Tayebinik, M., 2012])

Referring to Figure 2, it presents an interactive Blended learning model. Through stimulating signals that well qualified in performing realistic simulation for evaluating learner's performance considering blended learning strategy. That Figure, illustrates inputs to the neural network learning model which provided by stimuli unsupervised learning environment [Haykin S., 1999].The correction signal for the case of learning with a teacher is given by responses outputs of the model will be evaluated by either the environmental conditions (unsupervised learning) [Hebb, 1949] or by the instructor. The instructor plays a role in improving the input data (stimulating learning pattern), by reducing noise and redundancy of learning model pattern input [Ghonaimy, 1994]. In accordance with instructor's experience, he provides illustrated model with clear data by maximizing learning environment signal to noise ratio [Hebb, 1949].

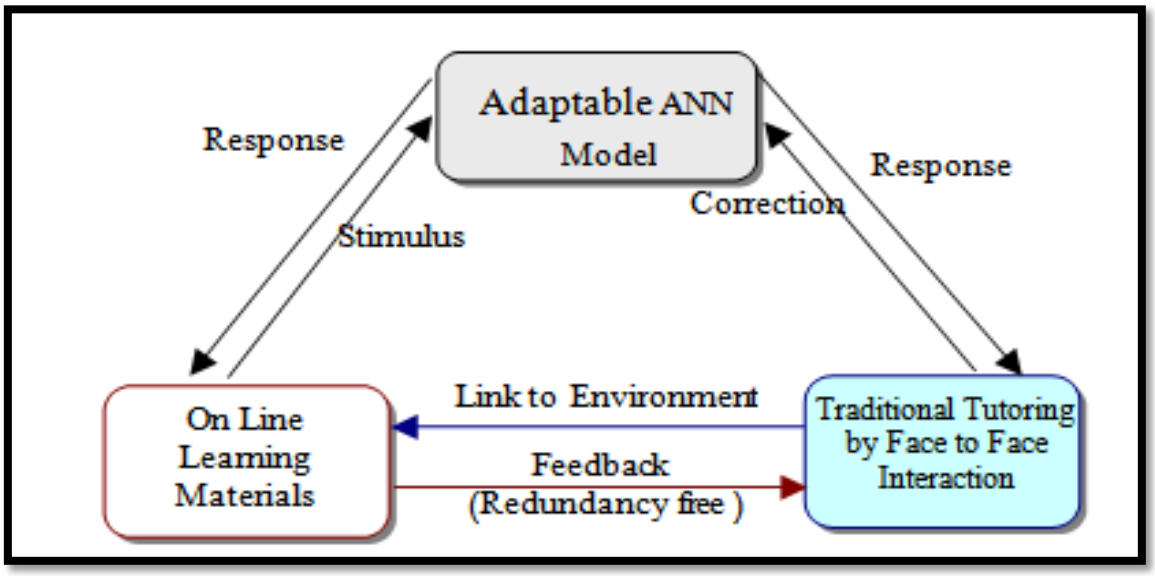

Figure 2 A general model presenting adaptability of blended learning system with diverse learners' interaction with e-learning environment

B. Mathematical Formulation of Brain Based Learning Phenomenon

Figure 2 illustrates generalized simulation of two diverse learning paradigms. It presents realistically both paradigms: by interactive learning / teaching process, as well as other self-organized (autonomous) learning. By some details, firstly is concerned with classical (supervised by tutor) learning observed at our classrooms (face to face tutoring). Accordingly, this paradigm proceeds interactively via bidirectional communication process between teacher and his learner (s).However, secondly other learning paradigm performs self-organized (autonomously unsupervised) tutoring process.

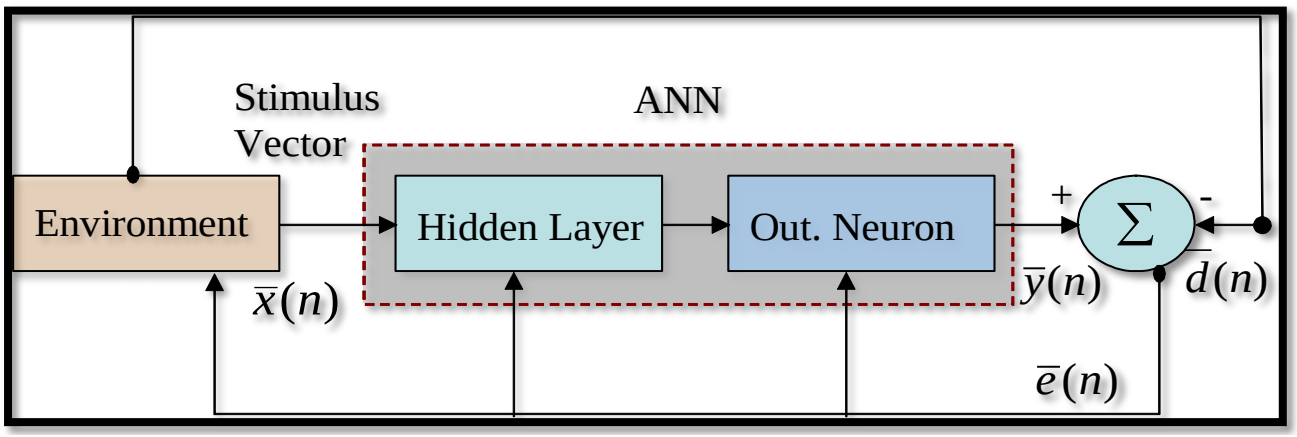

Figure 3 A Generalized ANN block diagram simulating two diverse self-learning assessments' paradigms (Formative and Summative).

Referring to above Figure 2; at any observed time instant (n) the error vector $\bar{e}(n)$ during assessment learning processes is given by:

$\bar{e}(n)$ $\bar{y}(n)$ - $\bar{d}(n)$ (1)

Where

$\bar{e}(n)$: Error correcting signal controlling adaptively

$\bar{y}(n)$: The output signal of the model

$\bar{d}(n)$: Numeric value(s) of the desired /objective parameter of learning process (generally as a vector).

Noting that this vector will not be taken into consideration for the case of unsupervised learning paradigm. Referring to above Figure 2 , the following four equations describes dynamical learning performance.

$V_k(n)=X_j(n)\ W^T_{kj}(n)$

(2)

$y_k(n)=\varphi(V_k(n))=(1-e^{-\lambda v_k(n)})/(1+e^{-\lambda v_k(n)})$

(3)

$e_k(n)=|d_k(n)-y_k(n)|$

(4)

$W_{kj}(n+1)=W_{kj}(n)+\Delta W_{kj}(n)$

(5)

Where: X…… …….the input vector, W……..……the weight vector,

φ…… the activation function, y ……..… the output,

e_k ……..……..……the error value, λ …… the gain factor suggested for ANN modeling,

and d_k …… ……... the desired predefined pattern (output vector values).

Noting that $\Delta W_{kj}(n)$ the dynamical change of weight vector value. The above four equations (2-5), are commonly applied for both (supervised, and unsupervised) learning paradigms. For consideration to autonomously unsupervised learning paradigm ; synaptic connectivity changes at any time instant (n) , are given by synaptic weight vector value W , which dynamically presented by equation (6) as follows:

$\Delta W_{kj}(n)=\eta\ y_k(n)\ x_j(n)$

(6)

However, for supervised learning equation (7) is considered

$$\Delta W_{kj}(n)=\eta e_k(n)X_j(n)$$

(7)

Where η is the learning rate value during self-assessment (unsupervised) learning This equation (6), simulates Hebbian unsupervised learning rule that relevant to simulate realistically behavioral animal learning. Noting that $e_k(n)$ in (6) is substituted by $y_k(n)$ at any arbitrary time instant (n) during learning process. In the assessment context, seeking and interpreting evidence for use by learners and their teachers after some consecutive time instants consecutive (n), reaches predefined correct (desired) patteern. This type of assessment called (Assessment for Learning) or equivalently Formative assessment. Unlike this type of assessment, summative assessment is known as Assessment of Learning results in an evaluation of student achievement by completely ending of learning process.

IV. SIMULATION RESULTS AND INTERPRETATIONS

Herein, a suggested design parameter of ANN modeling namely gain factor values (λi) has been adopted to simulate (implicitly) the measurement of learners' individual differences, as an Index of learners' Learning Styles. That adopted parameter is motivated by Felder-Soloman Index of Learning Style (ILS) measures learners' styles [Felder, R. M., and Brent, R., 2005]. Variances on students' blended learning perception according to learning style preferences. Herein gain factor values (λi) representing individual learner's characteristics and personality. That is simulated by various gain factor (slope) values and different neurons' number as well, contributing to the learning process. In Fig.5, a general normalized ANN learning model is shown as a set of performance curves. It represents various gain factor values (denoted by λ design parameter). This set of λ_i values are originated from the odd sigmoid activation function given by:

$$y(t)=\frac{1-e^{-\lambda t}}{1+e^{-\lambda t}} \qquad (8)$$

For $0 \le t \le \infty$

By changing values of this parameter, results in various response time (speeds)in reaching optimum (desired) achievements in accordance with the following equation:.

$Y(n) = (1-\exp(-\lambda_i (n-1)))/ (1+\exp(-\lambda i\ (n-1)))$ (9)

Where λ_i represents one of gain factors (slopes) for odd sigmoid function given by equation (8) and n represents the response time expressed in number of training cycles (epochs).

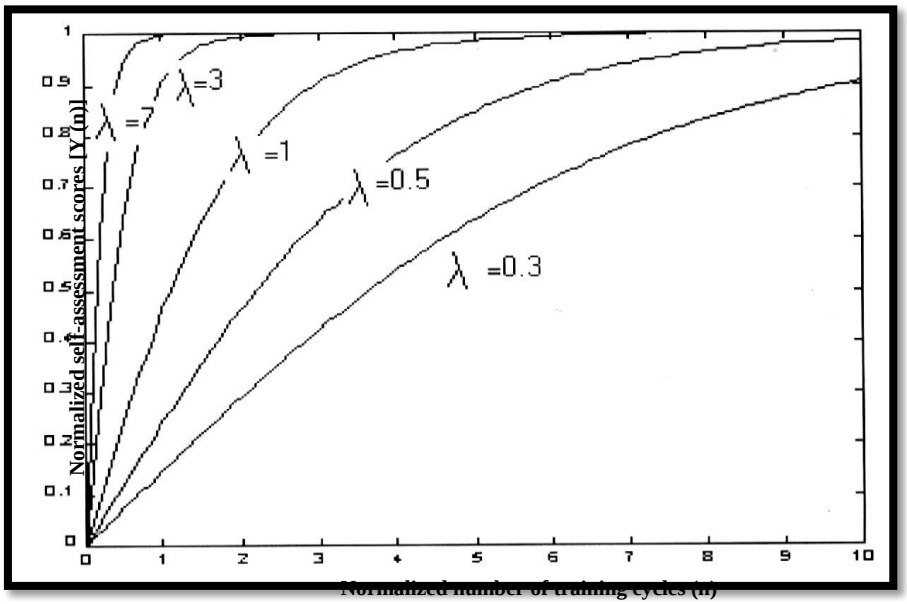

Figure 3 A set of self-assessment learning performance curves of model with various learning styles' values corresponding to gain factor (λ) values versus learning response time

Referring to recently findings announced at [Chang, 2014]. These findings showed that (a) There were no significant differences in achievement test scores between blended e-learning and traditional learning; (b) students in the experimental group obtained significantly higher scores on self-assessment than students in the control group; (c) students' scores on self-assessment were significantly higher after studying through blended e-learning than before. Overall, blended e-learning did not significantly affect students' achievement test scores, but significantly affected their self-assessment scores. This result confirmed that blended e-learning can enhance students' self-assessed learning performance (Chen & Lin, 2002; Garrison & Vaughan, 2008; Kim, Bonk, & Teng, 2009; Usta & Ozdemir, 2007; Vaughan & Garrison, 2005).

Effect of Neuron's Number on Learners' Self-Assessment Scores

The obtained depicted three curves at Figures 4 and the others shown at Figure 5 have been derived after running of simulation program for different neurons' number. By more details, Figure 4 considers the individual differences of learners as each of them characterized by his own Gain Factor Value (λ). Furthermore, at Figure 5 learner's ability to achieve Self-assessment Score is directly affected by the adopted learning methodologies based on learning rate values (η). At Figure 6, the three changes of Noise power σ (0.2, 0.1, and 0.05) in noisy environment considered to be in correspondence with three learning rate values η (0.01, 0.1, and 0.3), respectively. This Figure illustrates the relation among degrees of coincidence with predefined (desired) learned pattern, and learning rates which proved to have a realistic development of blended learning model that is similar to Gaussian (normal). A simplified macro-level flowchart for that simulation program is shown in below at Figure 7.

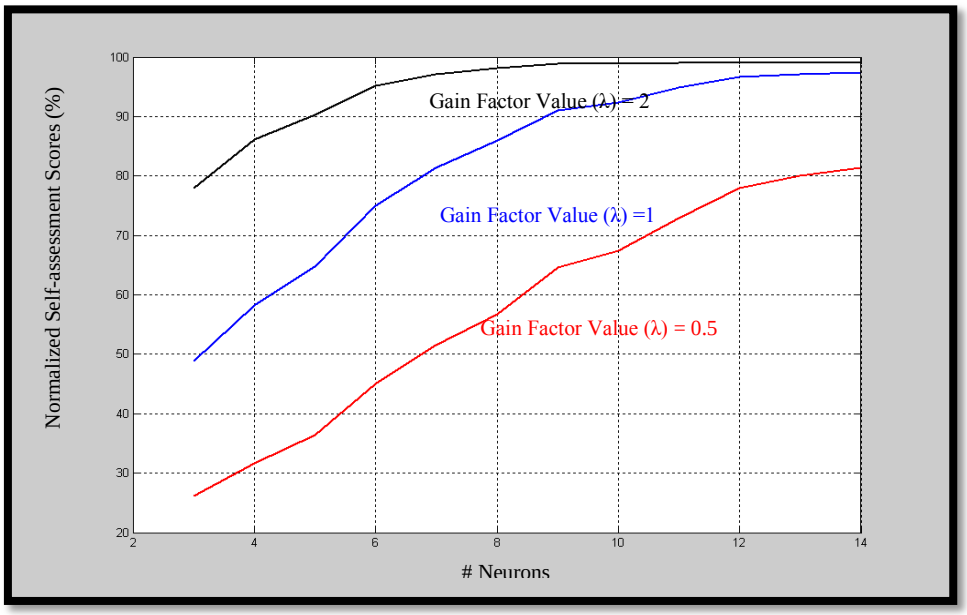

Figure 4 Illustrates learning performance accuracy versus different gain factor values when # training cycles = 300 and constant learning rate value = 0.3.

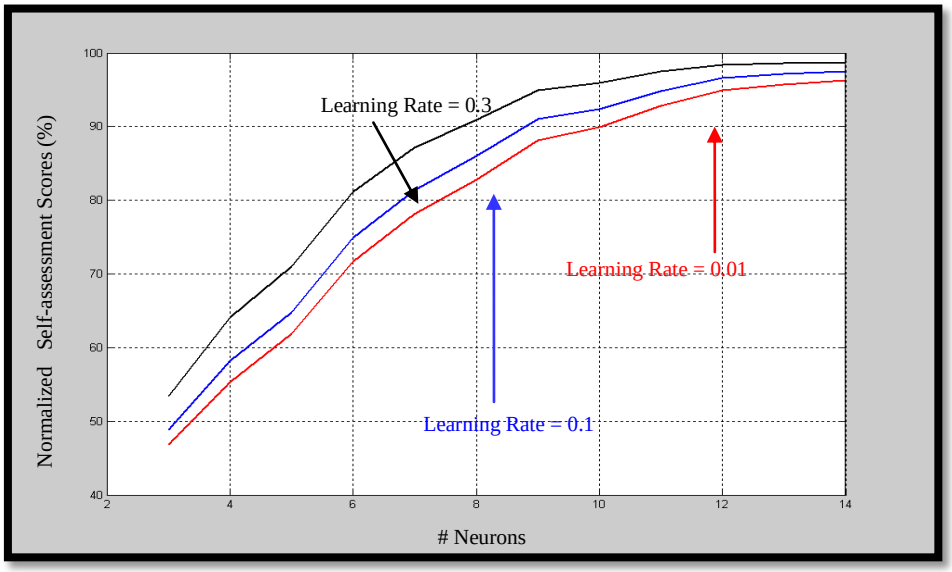

Figure 5 Illustrate simulated outcome presented as percentage degree of lesson focusing versus # Neurons for different learning rate values η (0.3, 0, 1, and 0.01) and constant gain factor = 1. These values of learning rate parameter η correspond respectively to three noise power levels (0.05, 0.1 and 0.2)

Referring to Figure 6 in below, the values learning rate parameters □ are analogously proportional to the signal to noise ratio (as communication parameter).Furthermore, those parameters' values are associated to diverse educational technology methodologies adopted for brain based learning systems [Hassan, 2004]. Additionally, the statistical distribution for relation between normalized number of training cycles resulting in degree of coincidence with predefined (desired) learned pattern, and learning rates seems to be similar to Gaussian (normal) as it has a bell shape, which proved to have a realistically developed blended learning model. Interestingly, that considered observed blended learning phenomenon proved to be in agreement with results of quantitative analysis and evaluation of learning creativity as introduced at [Hassan, 2007], [Hassan, 2009].

η=0.05 Corresponding to σ=0.2 & η=0.3 Corresponding to σ = 0.1

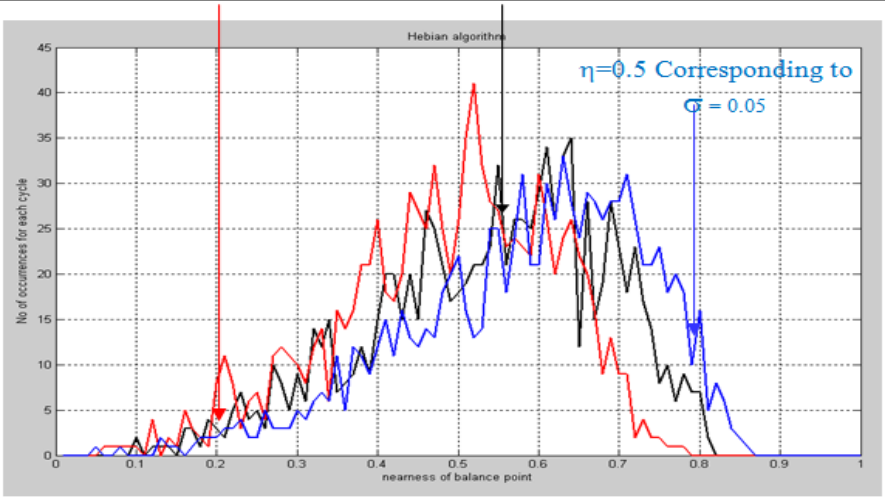

Figure 6 Illustrates the effect of three various noisy power levels with values: σ (0.2, 0.1, and 0.05) due to noisy learning environment. They resulted in three corresponding learning rate values η (0.3, 0, 1, and 0.01) respectively

Figure 7 introduces the flowchart for simulation program which applied for performance evaluation of behavioral learning processes. That Figure presents a simplified macro-level flowchart which briefly describes the algorithmic steps for realistic simulation program of adopted Artificial Neural Networks' model for different number of neurons.

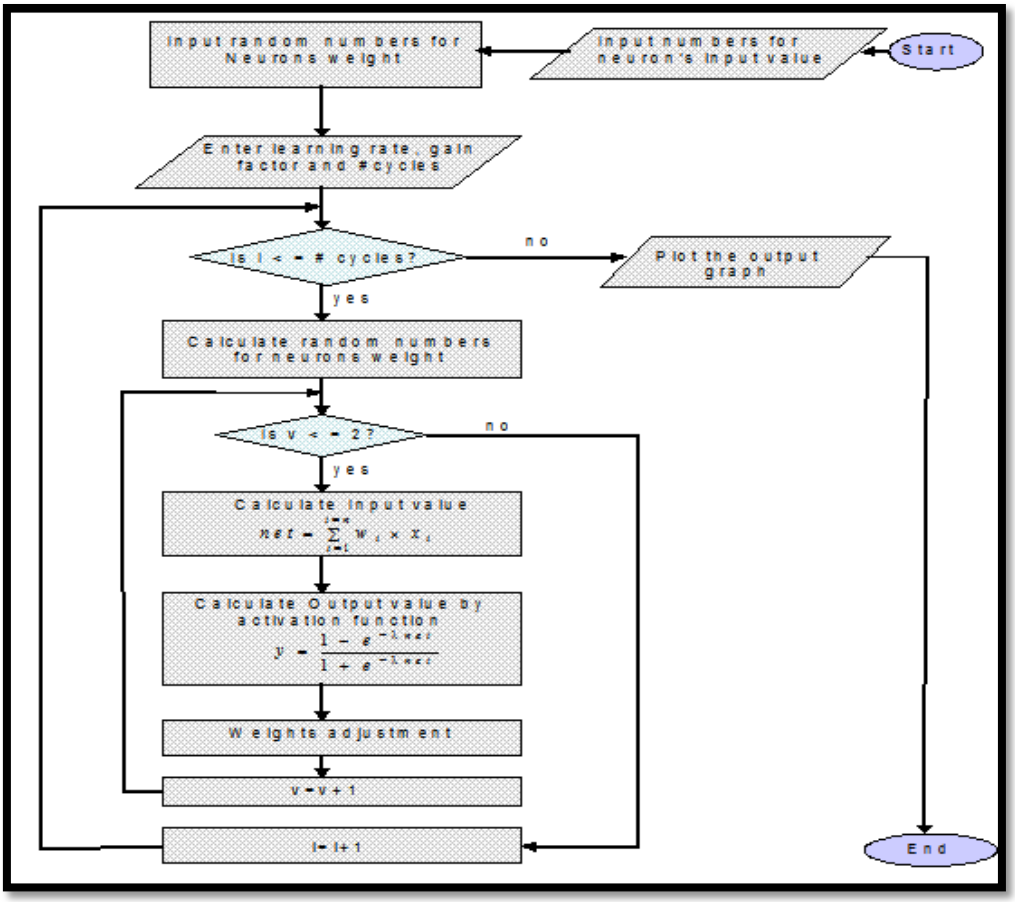

Figure 7 A simplified macro level flowchart that describing algorithmic steps for Artificial Neural Networks modeling considering various neurons' number.

V. CONCLUSIONS

Referring to the Figure 1 given in the above, it is clear that "blended learning provides more productive engagement among students in the online environment and in course content as well" (as cited in Bdawi, 2009, p.6). More specifically, this research investigated the postulates that every learner has been characterized by his own individual different brain dominance during interaction with blended learning paradigm. In more details, presented study investigated the variations of the learners' perception on blended learning in terms of their individual learning styles. The learner modeling using ANN is the main issue for deriving the adaptation methods aiming to build up updated the learner model in accordance with variation of number of neurons contributing blended learning process as well as traditional learning. In the context of ANN, obtained results revealed those students' views on blended learning which are varied between moderate to very high perception. That considers on items related to the ease-of-use and accessibility, quality of contents, usage and purpose, and general outcome. This research investigated the postulates that every learner with different brain dominance has different behavioral interaction in the blended learning. Significant relationships were found between the learner's brain dominance and his/her behavioral learning patterns based on the analysis of learner's interaction behaviors with the according to blended predefined patterns. Investigating these relationships is the first step towards proposing a novel approach of learner.

For future study extension of presented research work, both learning sequences (traditional learning comes before e-learning vs. e-learning comes before traditional learning) are highly recommended. That is to consider more elaborate investigational analysis and evaluations for other behavioral learning phenomena observed at educational field (such as learning creativity, improvement of learning performance, learning styles,……etc.) using ANNs modeling. As consequence of all given in the above, it is worthy to recommend realistic implementation of ANNs models , to be applicable for solving educational phenomena issues related to cognitive styles observed at educational phenomena and/or activities.

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